Best Available Techniques (BAT)
for the Dairy Industry in Egypt

Final report

Study carried out by
the Flemish Institute for Technological Research (VITO, Belgium),
the Egyptian Ministry of State for Environmental Affairs
(EEAA, Egypt) and a Technical Working Group:
Osman Abd El Aleem Abd El Lateif Aita,
Shadia Elshishini Saad Elshishini, Fatheya Abdel Hady Soliman,
Samah Reda Mohammed Shaalan

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BOOKMARK

Chapter 1 Introduction

This chapter clarifies the background of the BAT4MED project and explains the 'Best Available Techniques' concept and its use/interpretation within the EU legislative framework. It subsequently describes the general framework of this BAT study and addresses, among other things, the main objectives and the working procedure of the study.

Chapter 2 Socio-economic and environmental-legislative framework of the sector

This chapter provides a socio-economic review of the dairy sector. Its socio-economic importance is assessed by means of the number and sizes of the companies involved, the employment rate and some financial indicators (turnover, added value, profit, investments), when data are available. These data allow the economic strength and viability of the sector to be determined, which is important for assessing the feasibility of the proposed measures.
Furthermore, the main legal provisions which apply to the dairy industry are listed.

Chapter 3 Process description

This chapter gives a general overview and description of the processes and methods used in the dairy sector. For each of the process steps, the associated environmental issues are described.

Chapter 4 Available environmentally friendly techniques

In this chapter the various measures which are or can be implemented in the dairy industry to prevent or reduce environmental impacts are explained. The available environmentally friendly techniques are discussed per environmental medium. When needed, technique descriptions are further elaborated on in separate technical data sheets (database available on http://databases.bat4med.org).

Chapter 5 Selection of the best available techniques

This chapter evaluates the environmentally friendly measures described in Chapter 4, with regard to their environmental impact, their technical and economic viability. The techniques selected, are considered BAT for the sector as a whole.

Chapter 6 Recommendations

In this chapter the value of the BAT report is described and recommendations for the future are elaborated.

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ABSTRACT

This report determines the Best Available Techniques for the dairy industry in Egypt. Techniques considered are those that are or can be applied in industrial dairy companies, so not the artisan dairy producers. All dairy products are considered, such as the production of milk, butter, cheese, yoghurt, ice cream, milk powder and other milk derivatives.

The most important environmental aspects for the dairy industry in Egypt are water consumption and wastewater, energy consumption and waste. Also some general techniques, not targeting one specific environmental aspect, are considered.

This study mainly aims at identifying the BAT to reduce environmental impact of the dairy industry in Egypt. Since the concept of BAT is not integrated into regulations in Egypt, an additional goal is to identify both limitations and possibilities of the methodology for the case of Egypt.

In total, the report discusses and evaluates 56 techniques, of which 48 are considered BAT for the entire Egyptian dairy sector. 6 techniques were evaluated as BAT, but only under certain circumstances (e.g. due to technical or economic limitations). The selection of these BAT is based on a socio-economic sector study, company visits (technical audits), information exchange and a comparison with BAT studies from Europe and other countries. The formal discussions were held during the Technical Working Group meetings. Details on the members and timing of these meetings can be found in Annex 1.

CHAPTER 1 INTRODUCTION

1.1 Background of this study: the BAT4MED project

1.1.1 Context

The Mediterranean region represents one of the most vulnerable environments in the world, accounting for 60% of the world's 'water-poor' population and 8.3% of global carbon dioxide emissions.[1] The World Bank has estimated that the annual cost of environmental damage in some countries on the southern and eastern coasts of the Mediterranean is above 3% of gross domestic product each year. Despite the more than 30 years of international efforts to protect the sea, the Mediterranean region nowadays remains fragile and continues to deteriorate. Industrial production processes account for a considerable share of the overall pollution in the region.

To combat this ongoing decline and improve co-ordination among already existing initiatives, the Euro-Mediterranean leaders decided in 2005 to join forces and launch Horizon 2020, an initiative to tackle the top sources of Mediterranean pollution by the year 2020. Against the background of this initiative, the European Commission included in the 2010 'Work Programme of the Environment (including climate change)' theme of the Seventh Research Framework Programme a specific topic serving the aims of Horizon 2020: 'ENV.2010.3.1.4-1 Integrated Pollution Prevention and Control of industrial emissions in the Mediterranean region'. The topic addressed Mediterranean Partner Countries. It aimed at preparing the ground for the implementation of best available techniques (BAT) to respond to particular health and environmental impacts from industrial emissions, with the overall objective of reducing 'pollution leakage' due to the displacement of polluting industries. The BAT4MED project, Boosting Best Available Techniques in the Mediterranean Partner Countries, arises within this context.

Furthermore, the pattern of economic growth of the Mediterranean Partner Countries relies increasingly on the ability of their industrial activities to face up to the competitive challenges of the EU markets. In order to be fully integrated in and have access to the EU market in socially acceptable conditions, the industrial production of the MPCs and the products offered must increasingly comply not only with performance and quality standards, but also with environmental quality requirements. The effectiveness and efficiency of the economic relations and commercial flows in the Mediterranean countries in the near future is going to depend also on the environmental performance that the most significant and strategic industrial sectors in the MPCs will be able to guarantee. BAT4MED arises to respond to the need of the Mediterranean Partner Countries to design new prevention-based environmental control systems that will not affect their necessary economic development.

[1] UNEP/ Plan Bleu 'A Sustainable Future for the Mediterranean' (2006).

1.1.2 Industrial emissions and best available techniques

The EU countries of the Mediterranean region are combating industrial pollution mainly through implementation of the EU Industrial Emissions Directive (IED), published on December 17, 2010 (Directive 2010/75/EC) and in force since January 6, 2011. This Directive builds among others on the former Directive on Integrated Pollution Prevention and Control (IPPC). The latter Directive introduced a regulatory system with an integrated approach to preventing and controlling the environmental pollution caused by industrial activities covered by this Directive. In essence, the policy requires polluting industrial operators to obtain integrated environmental permits to run their industrial facilities. Such permits are based on the application of best available techniques (BAT), being the most effective techniques to achieve a high level of environmental protection, taking into account the costs and benefits.

The IED defines Best Available Techniques as follows:

'best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:

> *(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;*
> *(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;*
> *(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole.*

In summary, 'application of the BAT' means that each operator subject to the integrated environmental permitting obligation has to take all preventive measures that are economically and technically viable (at a sector level) to avoid environmental damage.

The concept of BAT also often represents a significant business advantage: the adoption of preventative environmental measures can reduce the consumption of natural resources (raw materials, energy, water, etc.), reduces waste streams and increases the efficiency of the production process. This in turn may contribute to the increase in competitiveness of industrial facilities.

In accordance with the IED, the European IPPC Bureau draws up and regularly reviews and updates the so-called BAT reference documents (BREFs) for all industrial sectors subject to the Directive and some relevant 'horizontal' issues such as 'Energy efficiency' or

'Monitoring'[2]. The aim of this series of documents is to accurately reflect the exchange of information which has taken place on best available techniques, the associated developments in industry and policy as well as the monitoring efforts. It provides reference information for the permitting authority to take into account when determining permit conditions. By providing relevant information concerning best available techniques, these documents act as valuable tools to drive environmental performance.

1.1.3 Main aims of the BAT4MED project

The BAT4MED project aims to assess the possibilities for and impact of dissemination of the EU Integrated Pollution Prevention and Control approach to the Mediterranean Partner Countries (MPCs). It intends to promote and support the implementation of best available techniques in the national environmental programmes. In this way, the project wants to contribute to an overall objective of ensuring a higher level of environmental protection in the Mediterranean region.

1.1.4 Sector-based BAT studies

The current BAT study is drawn up within the framework of work package 3 of the project, which focuses on identifying, assessing and selecting the BAT for pollution prevention and control in two key industrial sectors common in three MPCs (Egypt, Morocco and Tunisia). These key industrial sectors were selected according to their 'environmental benefit potential' (EBP) in the MPCs. A previous work package concentrated on determining the EBP per industrial sector and ranking the sectors of the three MPCs according to the EBP methodology developed. This resulted in the following two industrial sectors being selected for further study: the **dairy industry** and the **textiles industry**.

Sector-based BAT studies are developed for both sectors and in each country, particularly taking into account the regional and local conditions to determine the economic and technical viability of available environmentally friendly techniques.

The primary objective of drafting these BAT studies is of a more demonstrative nature: the studies are drawn up in close collaboration with European institutes with specific knowledge of the EU IPPC implementation processes and Egyptian/Tunisian/Moroccan partners from governments, industry and environmental administrations or institutes. This leads to an exchange of knowledge on the potential use of and the most appropriate procedures for drafting a BAT study, adapted to the specific local situation and needs.

As in the EU, such BAT studies may be used by competent authorities as a basis for adapting their environmental legislation and administrative procedures to the current state of techniques, e.g. for setting emission limit values at sector level or determining

[2] The BREFs are available online at http://eippcb.jrc.es/reference/ (in English). A French version of most BREFs can be consulted at http://www.ineris.fr/ippc/node/10.

permit conditions. They are also particularly relevant for operators, as they allow them to be kept informed of the available environmentally friendly and eco-efficient techniques in their sector and support the decision making process when changes to the production processes or plants are required or considered.

1.2 The BAT study for the Egyptian dairy industry

1.2.1 Main aims of the study

The principal objectives of the current study are:

- to map the state of play in the dairy industry in Egypt by, amongst other things, providing an overview of the number and kind of enterprises, their main inputs and outputs, their overall competitiveness and their main environmental impacts;
- to describe the processes applied in Egyptian dairy plants, the available environmentally friendly techniques and the associated environmental aspects;
- to select from this list of environmentally friendly techniques the best available techniques, based on an assessment of economic, technical and environmental aspects;
- to provide suggestions for further data gathering and research, in order to improve any future BAT evaluations.

1.2.2 Content of the study

The starting point of this study on the best available techniques for the dairy industry is a socio-economic review of the sector (Chapter 2). This forms the basis for determining the economic strength and viability of the sector, which in turn enables assessment of the feasibility of the measures proposed in Chapter 4.

Subsequently the processes are described in detail and for each process step the environmental impacts are determined (Chapter 3).

In Chapter 4 an inventory is made of environmentally friendly techniques applicable to the dairy sector, and based on an extensive literature survey and data from suppliers and plant visits.

Next, in Chapter 5, each of these techniques is evaluated with respect to its environmental benefit as well as to its technical and economic viability. A cost-benefit analysis allows us to select the Best Available Techniques.

General conclusions, recommendations and an evaluation of the report are discussed in Chapter 6.

1.2.3 Procedure and guidance

As a first step for gaining insight into the local circumstances of the dairy industry and the techniques and processes applied, five plants were visited. These plants were selected taking into account their current state of the art in using environmentally friendly techniques and their willingness to participate. Company-specific data was gathered on, among others, consumption and emission levels. By means of checklists based upon the candidate best available techniques identified in the BREF on Food, Drink and Milk Industries and the Flemish BAT study of the dairy sector, some initial basic differences between the EU and the Egyptian context, the plants and the processes applied were identified.

Furthermore, relevant available documents (BREFs and BAT national guidelines, expert information, pilot projects, sector publications, available company data etc.) and experts were consulted in order to gather more detailed information on the sector as a whole, the processes and techniques applied and the environmental impact, and to ensure that all relevant background information was taken into account.

To support the data collection and to provide scientific guidance during the study a technical working group (TWG) was set up, composed of government and sector representatives as well as independent technical experts. This working group assembled 3 times to discuss content related matters (17 November 2011, 3 April 2012 and 13 November 2012) A list of members of the sector working group and extern experts that participated in this study is supplied in Annex 1. The author has taken the utmost account of the remarks of the sector working group. However, this report is not a compromise text, but is consistent with what the author at this moment considers the state of techniques and the corresponding most appropriate recommendations.

CHAPTER 2 SOCIO-ECONOMIC AND ENVIRONMENTAL-LEGISLATIVE FRAMEWORK OF THE SECTOR

In this chapter the socio-economic and environmental-legislative context of the dairy sector is outlined and analysed.

Firstly, it is attempted to describe the industry branch and precisely delimit the subject of the study. Then, a kind of barometric indicator level is determined, based on a number of socio-economic characteristics on the one hand, and an estimation of the viability of the sector on the other hand. A third section depicts the most important environmental-legislative issues for the dairy sector.

This socio-economic and legislative framework can be important when evaluating candidate BAT. For example, the effects on different environmental media need to be translated to a single score for global environmental impact (on the environment as a whole). This can be based on different aspects, but given the qualitative approach in this report, one of the possible criteria is, for example, weighting of the different environmental media based on priorities set in legislation, based on environmental quality standards for water, air, etc.

2.1 Description and delimitation of the sector

The BAT study focuses on milk and all milk derivatives (yoghurt, butter, cheese, ice cream…) handling and processing in the Egyptian dairy sector, including SMEs and large enterprises. Looking at the distribution chain, it is the milk processing on which this report focuses.

2.1.1 Delimitation and sub-classification of the sector

The dairy sector is one of the sub-sectors of the food processing sector. According to the data from the Egyptian bureau of statistics (1997), dairy product facilities represent about 9% of facilities and 15.9% of the total manpower in the food industry in Egypt.

Production of raw milk in 2009 was recorded at 5.7 million tons, up from 4.0 million tons recorded in 2002. Around 20% of the produced raw milk is consumed on the farm itself. Of the remaining 80%, 70% is distributed and processed through MSME-scale producers to supply milk, cheese and home-made butter. Only 10% is processed by the modern commercial large-scale sector. Cheese production is the major activity, both in MSMEs and the large scale dairy operations in Egypt. However, the largest amount of cheese production is accomplished at the MSMEs.

In Egypt, the size of companies is defined as follows:

- Micro company 1 - <5 employees
- Small company 5 - <50 employees
- Medium company 50 - <150 employees
- Large company >150 employees

In this study, we will only look at the best available techniques for industrial companies. This means that micro and small dairy companies will mostly be excluded: these are mostly very traditional, manually operated dairy producers serving a very local market.

2.1.2 The distribution chain

For any statements on potentially useful environmental techniques to be made, it is essential to study the dairy production chain and identify the factors which affect it. In this context, it is also useful to remember that the set-ups for such dairy chains tend to be largely informal in nature. Such an undertaking will facilitate:

- An understanding of the different stakeholders within the entire dairy chain;
- Provide indications as to the nature of interactions amongst them;
- Feature the stronger and weaker links within the chain; and
- Generate a list of options and improvements which may then be used to identify dairy sector reforms, which could ultimately strengthen the economic, environmental and social benefits.

Figure 1 provides a snapshot of the various stages within the dairy chain and the key players for each stage. As mentioned before, it is milk processing that is studied in this report.

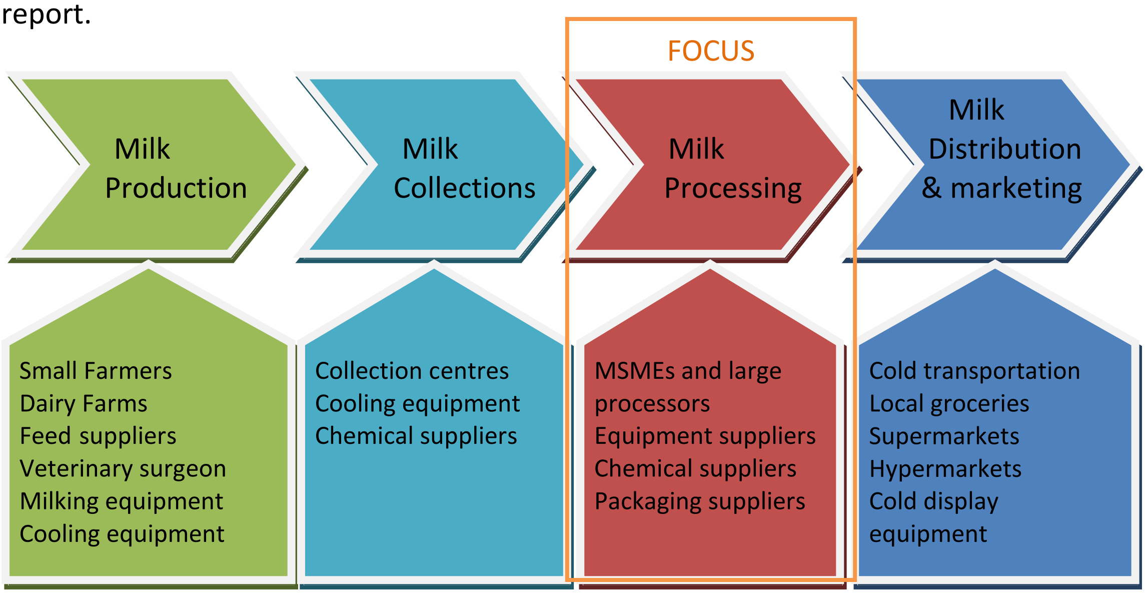

Figure 1: positioning of the dairy industry in the distribution chain

2.2 Socio-economic characteristics of the sector

This section describes the status of the sector based on a number of socio-economic indicators. These indicators provide a general overview of the sector structure and form a basis for the estimation of the sector viability in the next sections.

2.2.1 Number and sizes of the companies

According to the most recent data available (1997) from the Central Agency for Public Mobilization and Statistics (CAPMAS), the total number of milk processing facilities in Egypt is 3,334. The majority of these facilities process less than 1 ton of milk per day and there are very few facilities processing more than 10 tons of milk daily. Only 4 companies have the capacity to be classified as IPPC companies, based on the minimum requirement in the IED: IPPC dairy companies process more than 200 tons of milk daily (yearly average). This study includes mostly companies smaller than this limit and is therefore relevant for small and medium industrial dairy plants.

There are around 25 companies involved in the industrial processing and packaging of dairy products. Of these, only 14 companies are members of the Dairy Industry Development Association (DIDA) and about 7 or 8 can be considered as significant players. Most of these companies use fresh milk as the main input for their production processes. Recombination (use of skimmed milk powder) remains unimportant due to its higher cost.

Overall the private commercial sector (basically members of the DIDA) accounts for around 15% of the production of dairy products. They have, however, made significant progress since the early 1980s and taken market share away from the public sector companies, Misr Milk and Food Company.

The progressive expansion of the private sector is an important feature of the Egyptian dairy sector. Following the nationalisation of leading private dairies in the early 1960s, the only industrial production of dairy products was in the hands of the state-owned Misr Food & Dairy, with 8 factories. In 1974, the 'open door' policy opened the dairy industry to private sector investment. Over the following 10 years, about 150 licences for private dairy operations were issued and 20 new dairy factories opened. Misr Food & Dairy lost market share to more dynamic private companies and in 1997, it accounted for less than 5% of total commercial milk volume. In 1997, there were reportedly close to a dozen significant local industrial producers of dairy products besides Misr Dairy, which is now due for privatization. *It becomes very significant to note here that the role of the private sector in dairying has become increasingly important over the years, so much so that the proportion of the Government in terms of ownership in the dairy sector is minimal.*

The commercial sector, both private and public factories, has a significant overcapacity: the installed capacity is now larger than the production. Their total capacity is estimated at 1.9 million tons of dairy products per year, although actual yearly production is only around 500-800 thousand tons. Furthermore, it appears that progress towards changing Egyptian consumers' preferences from fresh to processed products is slow; this could seriously impede further development of the private industrial sector. At the same time, although strong urban demand provides a firm basis for modern large-scale producers to expand commercial production, factors such as high capital and material costs and limited purchasing power are expected to be major constraints on production[3]. (Source: expert data and knowledge).

2.2.2 Employment

Table 1 represents a classification of the dairy processing facilities by manpower, which is an important indicator for facility size. However, modern facilities employ fewer workers for the same production rate. It is clear from this table that 75% of the facilities operate with less than 4 workers and 7.8% have more than 80 workers. This emphasizes the importance of MSMEs in the Egyptian dairy sector.

[3] ECORYS-NEI, Macro & Sector Policies (2005). Egyptian Processed Food Sector Review, Final Report. Industrial Modernisation Centre – Egypt.

Table 1: Classification of facilities by manpower for the dairy sector in Egypt (1997)

Manpower	Number of facilities
1-5	3,190
6-10	57
11-15	21
16-20	20
21-25	10
26-30	6
31-40	4
41-50	11
51-100	12
101-500	3
501-1,000	/

2.2.3 Evolution of turnover, added value and profit

The data presented below are only relevant for large dairy companies: the data are not available for SMEs.

2.2.3.1 Turnover

Turnover data for the dairy sector as a whole are not available. However, a report published in 2011 for Juhayna Food Industries (around 200 tons of milk processed daily), *the main player in the sector*, mentions that the average daily turnover of this company amounts to 1.3 million US dollars.

2.2.3.2 Added value

With respect to indicators of the performance of the agro-food sector, Egypt is very poorly positioned when compared to other Mediterranean countries. In terms of labour productivity (measured as production per employee or value added per employee), Egypt is ranked in last position amongst the 11 southern Mediterranean countries. Furthermore, when looking at the rate of value added per unit of production (in terms of value), the Egyptian agri-food sector with 20% ranks 10 among the 11 southern-Mediterranean countries.

Table 2 provides details of the output and value added of the dairy products segment in aggregate and on a per employee basis. The general picture for the dairy products segment is quite similar to the one presented for the agri-food sector, compared to other southern-Mediterranean countries.

Egypt achieves a lower share of value added to output than the other benchmark countries[4] but has a low wage component in value added. On a per employee basis, Egypt achieves a lower level of output and value added. Similarly Egypt is shown as

[4] ECORYS-NEI, Macro & Sector Policies (2005). Egyptian Processed Food Sector Review, Final Report. Industrial Modernisation Centre – Egypt.

having a low level of wages (wages component) and non-wage component per employee (Table 2).

Table 2: Dairy products: output and value-added (Egypt, 1998)

Parameter	Value $US
Value of output of which:	332
- Production cost etc.[5]	269 (81%)
- Value added of which	63 (19%)
*Wages component	13 (21%)
*Non wages component[6]	50 (79%)
Parameter	**Value $US/employee**
Output per employee	41,050
Value added per employee of which	7,750
- Wages component	1,660
- Non-wages component	6,090

International companies encouraged a conversion to increasing added value by introducing several value-added products (such as light, digestive and flavoured products). As a result, the value-added products' share of the total packaged market climbed from 8% in 2008 to 13% in 2009, and reached 20% in 2010. In addition, international players have launched several advertising campaigns to change the Egyptian consumer mindset to perceive yogurt as part of their daily cuisine throughout the year, rather than mainly in Ramadan (this process was also helped by the new value-added products). Accordingly, the conversion rate from bulk yogurt to packaged yogurt was a considerably high, 9% in 2009. It is expected that the high conversion rate to packaged products will be sustained in the medium term.

Finally, the updating of dairy product standards (see 2.4.2.1) is expected to have a positive effect on increasing the exports of value-added foods, which will now be compatible with the Codex Alimentarius and EU import standards.

2.2.3.3 Profit

In 2009, it is reported that the most profitable category in the dairy segment was yogurt, which had a margin of 50% (combined margin for the manufacturer and the retailer as sales are based on retail prices), followed by milk (42%)[7]. Cheese had the lowest margin of just 24%. The increase in raw material costs in 2008 only had a modest negative impact on dairy margins, as producers passed on most of the increase to the end consumer. Prices in Egypt tend to be sticky, with decreases in costs

[5] Refers to the non-value added component of total output.
[6] I.e. profits, taxes etc.
[7] EFG HERMES (2010) Juhayna food industries report.

generally not matched by decreasing prices; despite a drop in input costs in 2009, prices continued to increase and profit margins significantly expanded. One of the reasons for the yogurt segment's higher profit margin is the growing popularity in Egypt of value-added products, which have higher profit margins.

2.2.4 Evolution of the investments

Recently, the Egyptian dairy sector is attracting investments and expanding internationally. In June 2010, a public share offer by Egyptian dairy goods and juice maker Juhayna Food Industries, worth EGP192 million (USD34 million), was oversubscribed by 6.8 times. Juhayna is a leader in Egypt's packaged dairy sector with a 65% market share. Its products are exported to over 48 countries, including the US, Europe and the Gulf states[8].

Dairy is among the better performing of Egypt's agribusiness subsectors with numerous investments and employment opportunities throughout the value chain and, increasingly, in the manufacturing of processed dairy foods.

Regional agri-food platform 'Gozour', established by Citadel Capital and a group of leading regional co-investors, has acquired three dairy companies including:

- Nile Company for Food Industries (Enjoy), one of Egypt's top manufacturers of dairy and juice products;
- Dina Farms, the largest private farm in Egypt with 4,200 hectares of agricultural land and 45,000 tons of raw milk in 2009;
- El-Misrieen—the first company to produce and bring UF cheese to the Egyptian market—already produces high quality cheeses and juices.

As a part of Gozour, Enjoy and El-Misrieen will benefit from synergies in distribution networks and the joint sourcing of both packaging and raw materials such as sugar, fruit and, most importantly, milk. The companies will have direct access to the milk supply of Dina Farms, a commodity that is currently in high demand on the local market.

Saudi's largest dairy company **Almarai** acquired the Egyptian dairy company Beyti for USD115 million on June 2009, as part of its plans to engage on a USD1.6 billion expansion plan outside of the Gulf States to 2013. Almarai is reportedly aiming to capture half of Egypt's dairy market by that year. Almarai will invest EGP100 million (USD18.3 million) in upgrading Beyti's operations. It is thought that Almarai will strive to introduce an array of fruit-milk drinks into the Egyptian market through its joint venture with **PepsiCo**[9]. In December 2009, ownership of Beyti was transferred to **International Dairy and Juice**, Almarai's JV with Pepsi.

In 2009, the world's largest dairy exporter, New Zealand's **Fonterra**, announced a partnership with **Arab Dairy Products** to market its products in Egypt. According to a

[8] Egypt weekly market review, Volume II – Issue 16, June 2000.

[9] EFG HERMES (2010), Almarai Company Report.

report in National Business Review, Arab Dairy Products will manufacture and market Fonterra's Anchor cheese brand. Arab Dairy Products will invest EGP100 million in upgrading their facilities to produce Fonterra products.

It is expected that more international investments in Egypt's dairy sector will occur in the coming years as companies seek to benefit from the high level of demand driven by a fast-growing population and rising per capita incomes.

2.2.5 Production and price setting

The packaged dairy industry effectively began in the 1980s with the entrance of the private sector, with several major producers (including Juhayna and Enjoy) coming onto the scene. Prior to this, the packaged dairy market was relatively small and dominated by the public sector. In Egypt, the main drivers for growth in the packaged dairy market include: i) a strong demographic profile—a large and young population with a high growth rate, ii) room for per capita consumption to grow from its relatively low levels; and, most importantly, iii) increased penetration as a result of a growing consumer trend away from bulk products and towards healthier and packaged products.

Over the past few years, the market has evolved from being dominated by local players to a mix of local, regional and international players. This was accompanied by some consolidation (including acquisitions by private equity funds) and vertical integration to secure raw materials (raw milk, fruits and animal feed) and control and expand distribution channels. The yogurt and, more recently, milk segments have seen the highest levels of activity. As a result, local leadership of the market has been threatened. Today, the yogurt segment is less concentrated, and it is believed that this will eventually be the case for packaged milk, as the conversion rate from bulk to packaged products accelerates. Packaged dairy producers will need to focus on: i) tapping into all highly consumed dairy categories, ii) investing in research and development to offer a full product spectrum in each category and respond quickly to changes in consumer preferences - and iii) controlling supply and distribution channels.

2.2.5.1 Production

Only the most important commercial products are mentioned here. This means packaged milk, cheese and yoghurt are described, but ice cream, butter and milk powder are not (not enough data).

Packaged Milk

The milk market is segmented into packaged milk, representing only 12% of total consumption, and bulk milk (fresh unpasteurised milk) sold by a milk pedlar or small stores. Long-life (UHT) milk comprises the bulk of the packaged milk market output, as the retail sector is not sufficiently equipped to accommodate fresh milk storage and distribution.

Egypt’s total milk consumption grew at a 4-5% in 2008-2009 and is forecast to continue to grow at this rate through to 2014. The total milk market size in Egypt reached 1.5 million tons in 2009, according to the Middle East Marketing Research Bureau (MEMRB). At 21 kg per capita per annum, Egypt’s milk consumption is significantly below the world average of 50 kg, and comes in at the lower end of the range of developing countries as well.

MEMRB estimates that the production of packaged milk market jumped by 21% in 2009 (cf. the previously reported 4-5% yearly growth), reaching 191,000 tonnes. This was due to a faster shift from bulk to packaged milk. Packaged milk is expected to continue its growth in the medium term, growing faster than total milk consumption, with a conversion rate of 1-2%. This is a result of: i) dairy producers marketing their products and launching new brands for the lower end of the market, at prices close to those of the bulk milk sold in stores, and ii) the Ministry of Health and dairy companies campaigning about the benefits of packaged milk and educating the public on the health risks associated with bulk milk.

Cheese

The cheese segment is the second largest segment, following milk, in the dairy market. Total cheese consumption in Egypt grows at 3-4% annually. In 2009, it reached 453,000 tonnes, according to the Food and Agricultural Policy Research Institute (FAPRI). Cheese is essential to the typical Egyptian diet, with per capita consumption standing at 5.6 kg per year, higher than the world’s average of 4.6 kg per annum.

The most popular type of cheese in Egypt is Domiati cheese (a soft white cheese), which is one of the least expensive cheeses. The total soft white cheese market (artisanal and packaged production) grew with 14% in 2008-2009. This growth is underpinned by an increase in supply and the number of manufacturers, as well as consumers economising by shifting away from more expensive food items. Consumption of soft white cheese is expected to grow by an average of 10% in 2010-2011.

The production of cheese requires additional processing to milk. This partly explains why the conversion rate to packaged cheese (4% per year), is higher than the milk conversion rate. In addition, major soft white cheese producers in Egypt pre-package their products and have capitalized on the importance of appealing to traditional consumers by selling their cheese in a semi-packaged format (wrapped in plastic and often presented on a tray, similar to lose white cheese, in refrigerators).

Yoghurt

In 2009, total yogurt consumption was 203,000 tonnes, nearly 2.6 kg per capita. This is relatively low as compared to the international average of yoghurt consumption (e.g. France’s is 49.1 kg per capita). The total yogurt market grew at an average 18% in 2008-2009. Industrial-packaged yogurt comprises nearly 50% of yogurt consumption and is segmented into ‘set’ yogurt (spoonable) and ‘stirred’ yogurt (for drinking).

There is only a 10% difference in the price of industrial-packaged yogurt and bulk (primitively packaged) yogurt. This is due to the fact that bulk yogurt is also sold at retail outlets, and retailers add their fixed costs to the price (whereas milk pedlars do not incur these fixed costs). This similarity in price may explain the greater proportion of industrial-packaged yogurt consumption compared to milk. Additionally, the entrance of international players (Danone and Lactel-Nestlé) resulted in the yogurt market expanding and seeing a quicker conversion to packaged products (9% in 2009).

2.2.5.2 Pricing

Dairy producers purchase their milk directly from dairy farms as well as from milk collection centres where small-scale farmers sell their milk. Raw milk prices are set through a committee comprised of dairy farmers, manufacturers, and Ministry of Agriculture officials. The committee convenes four times a year to set a price for raw milk. Factors that affect the price include feed prices, the milk-to-feed ratio, comparable market prices, and world powdered milk prices.

Despite the efforts of this committee, there is an ongoing tug of war between dairy farmers and producers over the price of raw milk, particularly at times of higher feed prices. Most dairy companies recently increased the price they pay to large and medium-sized dairy farms to EGP2.6/litre from EGP2.4/litre to factor in the impact of the higher cost of producing raw milk in the summer (as milk yields per cow decline due to the hot weather). However, this was lower than the EGP2.8/litre requested by the farms.

The government does not provide subsidies to dairy farms. In 2009, the Ministry of Agriculture agreed in principal to provide an EGP100 million subsidy to compensate farmers to keep prices down (Egyptian policy).

The acceleration of the conversion to packaged products in Egypt will chiefly depend on mid to low-income families, taking several factors into consideration: i) GDP per capita is relatively low in Egypt, ii) nearly 57% of the population lives in rural areas with even lower spending per household, and iii) the population is young and growing, indicating a high family formation rate. Accordingly, the availability of low-priced packaged milk is essential to accelerate the conversion from bulk to packaged products.

2.2.6 Conclusion

Egypt is still a net importer of dairy products (import more than export: mostly skimmed milk powder, butter and high quality cheeses like gruyere). To improve the dairy sector performance, the following elements should be considered:

- Improving the supply of milk in quality and in quantity through encouraging the establishment of milk producer groups;

- Clustering of small milk processors (cheesemakers) to collectively use raw material, packaging facilities, and to assist them in finding assured market outlets through contracting with retailers and exporters;
- Developing a marketing strategy focused on maintaining the Egyptian share of the Arabian market and aggressive marketing to European and North American markets.

2.3 Sector viability

2.3.1 Procedure

The viability of an industry branch is determined by its competitive position on the one hand, and by its financial situation on the other.

2.3.2 Competitive position

2.3.2.1 Aim and approach

A good instrument for determining the competitive position of a sector is Michael Porter's 'Five Forces' framework. Michael Porter (1980, 1985) identifies five sources of competition: (i) the entry of new competitors, (ii) the threat of substitutes, (iii) the bargaining power of buyers, (iv) the bargaining power of suppliers, and (v) the rivalry among the existing competitors. The essence of the theory, and the way in which these sources of competition can influence BAT determination, has been described in the BREF Economics and Cross-media Effects.

2.3.2.2 Potential entry of new competitors

During the past five years, one new company has been established which is DANONE Co. In addition Dina Farm Co. has upgraded its production line to increase its capacity, and Bell Egypt Co. has extended its plant BEE. These companies were created in response to a real market demand, and in that sense did not create any competition problems for already existing companies.

There are no legislative barriers for new market entrants. Local dairy production is not subject to subsidies or any other form of special government assistance. Investment projects in the dairy business are eligible to the preferential terms of Investment Law No. 8/97. Investment projects in the field of livestock (cattle) rising for dairy production purposes are also covered by Investment Law No. 8/97.

2.3.2.3 Threat of substitutes

Soft white cheese, cream and butter based on vegetable oil instead of milk, have a considerable market in Egypt. As a result of replacing milk fat with palm and coconut oil, as well as the reduced protein content of these products, they are half the price of natural dairy products. This leads to increased turnover, profit and market share. However, although growing, at the moment the vegetable oil-based product market is still relatively small. It is therefore not yet considered a serious threat for the dairy industry.

2.3.2.4 Bargaining power of suppliers

Most companies depend on a whole range of suppliers for their raw materials, so their opportunities to switch suppliers are rather limited. Raw milk prices are agreed upon in committee discussions. Both elements suggest that any potential environmental costs cannot easily be transferred to suppliers.

2.3.2.5 Bargaining power of buyers

Retailers are the main customers of the dairy processing industry, and they choose the brand they buy, how and when they buy it, as well as the associated promotion procedure. Some hypermarkets have even made arrangements with dairy processing companies, to produce specific products under their own brand names. Thus retailers generally have a high bargaining power. This of course is only relevant for the included companies, which are medium to large companies. For the very small companies (not included in this study), the situation will be different.

However, currently milk processing companies can add the costs of environmental measures to the price of products and the retailers pass these added costs on to the consumers, who are prepared to bear them. This situation is likely to change when environmental costs have a significant impact on the price of the end-product. Market expansion also chiefly depends on the availability of low-price products to mid- and low-income families.

2.3.2.6 Rivalry among existing competitors

Five large companies control the prices, as they collaborate to set different product price. Other companies adhere to these prices. Accordingly, there is no price competition in this sector. In addition, there is no big difference in the quality of the same products; the only difference is the taste of the product, so there is no quality competition either.

The milk market in Egypt is highly concentrated, with four players holding a combined 94% market share in 2009. The largest player, Juhayna, had a dominant 69% market share in the plain milk segment and 74% in the flavoured milk segment in 2010. Each of the other three players, Faragello, Beyti and Enjoy, had less than a 10% market share each in the plain milk segment, and 3-11% in the flavoured milk segment. Increased competition is likely to come from Beyti (now owned by the Almarai-PepsiCo JV) and Enjoy (owned by Gozour), as they are adding capacity and/or undergoing restructuring. In addition, competition will come from Labanita, a producer of fresh packaged milk that recently launched long-life milk products and Dina Farms, which recently launched fresh milk production.

The white cheese market is more fragmented than the milk market, with seven players comprising over 80% of the market in 2009. Additionally, the majority of cheese manufacturers have tended to specialise in cheese production, rather than covering the whole dairy product range. Both factors suggest that there is room for consolidation in this segment. In Egypt, Greenland (part of Americana Group) has the largest market share of 36%, followed by Panda at 18% and Domty at 15%, both local companies.

The yogurt market is significantly more penetrated than the milk market. There is intense competition in the set (spoonable) yogurt segment, with Juhayna and Danone competing head-to-head with a 31% market share each in 2009, and Lactel-Nestlé trailing at 14%. Juhayna has a dominant market position in the stirred (drinkable) yogurt segment, as it was the first to introduce stirred yogurt to Egypt under the 'Rayeb' brand in 1990. Lactel-Nestlé, however, gained market share in 2008 and 2009 through aggressive marketing campaigns.

2.3.3 SWOT Analysis

The strengths, weaknesses, opportunities and threats (SWOT) of the Egyptian dairy processing industry that are mainly based on local conditions are presented below.

a- Strengths

- Key geographical location; proximity to Gulf Arab countries and Europe; two to three days and less than a week to reach the Gulf and European sea ports respectively.
- Low labour cost compared to neighbouring and developed countries, and increased availability of skilled labour.
- Direct sea and air shipping services to Europe for enhanced export performance.
- Improved quality and HACCP system in the dairy industries in recent years;
- Increasingly improving business environment such as tax incentives to exporters and investors, improved customs regulations etc.
- Issue of the new unified dairy law will facilitate and clarify the misunderstanding between traders, processors and dairy law enforcement agencies; also the establishment of a new National Dairy Authority.

b- Weaknesses

- Due to the inability of the majority of companies to invest in research there is a low level of innovation within the sector and, therefore, a lack of product development.
- The agriculture system is underdeveloped and fragmented, and the use of local raw materials on a commercial scale is hampered by an inconsistent supply of raw material to the industries, due in part to the lack of contract farming and a very weak relationship between producers and processors.

- Poor logistics such as cold store chains and refrigerated transport systems, combined with a lack of knowledge of the hygienic handling of raw milk from farm to factory, and consequently milk quality spoilage.
- The majority of the companies operating in the sector are classified as micro, small and medium-sized. These enterprises are not organized and therefore cannot benefit from economies of scale and export marketing.
- Weak domestic market and underdeveloped distribution channels, such as supermarkets and hypermarkets.
- Administrative and bureaucratic burdens (especially lack of transparency of customs regulations on imported items) and a very long clearing time required due to all the bureaucratic requirements placed on companies, which has made enterprises/industry segments relying on the imported inputs uncompetitive.

c- Opportunities

- High potential to attract foreign direct investments in the dairy processing sector and to become a regional hub for multinationals for their regional offices in marketing, R&D and operation in the Middle East.
- Scope for the introduction of enabling structures, such as dairy cooperatives.
- Increased marketing opportunities through the new preferential access agreements with the Arab countries and other regional markets.
- There is a considerable potential for increased product development by complementing the range of products already established.

d- Threats

- More globally, the competitive threat from other developed countries, especially the US, the EU and New Zealand in cheese products.
- Political instability in the region constitutes a serious threat, particularly for attracting FDI and tapping into global value chains.

2.3.4 Financial information

2.3.4.1 Introduction

To assess the financial situation of the sector a number of financial ratios can be selected that represent each of the four areas of financial health: profitability, value added, solvability and liquidity. By comparing the ratios of the dairy sector with those of industry as a whole, we get an indication of the relative financial health of a sector. In case the sector faces acute or structural financial problems, this can be an argument to determine techniques with substantial costs to be unaffordable.

However, financial ratios are not readily available for Egyptian dairy companies. Therefore, this information is not provided here. There is however some information available on financing issues for the dairy industry in Egypt. This is described in the paragraphs below.

2.3.4.2 Financing

Long-term industrial financing for the private sector in Egypt needs to be improved. Credit to the industrial sector as a whole from the specialized banks is very low. Venture capital and similar facilities for technology promotion are at a rudimentary stage. These deficiencies constitute fundamental constraints to the growth and upgrading of the private dairy processing and marketing sector. A financial system that collects, allocates and supervises the use of investment resources is crucial. On the other hand, there is lack of information and knowledge from the dairy industries side about how to access finance for technology improvement, expansion and for working capital.

A proper training and technical assistance for the dairy processing industry, especially SMEs, in the preparation of business plans as required by the banks, provision of long term grant/long-term loan with moderate interest rate, and setting up a micro-finance scheme for the micro industries (which are mostly operating in the informal sector) are vital for the adoption and adaptation of appropriate technologies and, hence, raising competitiveness.

2.3.5 Conclusive estimation of the viability of the sector

The critical problems addressed that affect the viability of Egyptian dairy sector are:

- Lack of supply of good quality milk in sufficient quantity: except in the case of a handful of big enterprises, fresh milk is collected from small farms by wholesalers. Middlemen in some concentrated areas perform assembly functions through village collection points.
- Due to unavailability of milk quality testing methods and equipment, the quality of milk supplied is usually poor and this has impacted on the quality of dairy products and hence the competitiveness of enterprises and the industry as a whole.
- Highly fragmented sector without specialization: the dairy-processing sector has more than 3,000 processors (only registered processors; the number in the informal sector could not be quantified) including cheesemaking. Due to their small size, the implementation of any quality and food safety regulations is impossible. They also lack specialization, as cheesemaking is not their core business.
- High price of imported DSM: since imported DSM is becoming a reliable source of raw material for feta cheesemaking (the most important cheese production in Egypt), the competitiveness of the feta cheesemaking factories is jeopardized by the high cost of DSM and packaging material. The devaluation of the Egyptian pound has aggravated the problem further.
- Low level of marketing compared to European cheesemakers: due to its fragmented nature, the Egyptian cheese industry does not have the

capability to market its products in Europe and North America. Its European competitors are increasing their market share in the Arab world through aggressive marketing, better packaging and continuous improvement in the quality of their products. These developments pose a threat to the new enterprises engaged in the export market.

The Egyptian dairy sector still has some way to go before it can catch up with both leading regional players and world leaders in the sector. The trade data analysis of the unit values of exports for key processed dairy product-groups indicate that Egypt is positioned very much as a low cost/quality supplier of dairy products.

Overall, Egypt's strategy should be to seek to maintain its quality advantage in (relatively) high unit value exports, while seeking to raise the unit values (quality) of products for which Egypt is a low-cost quality supplier.

The identified Activities needed to improve the critical problems of Egyptian dairy sector are:

- Improve the supply of milk in quality in quantity: encourage the establishment of milk producers groups and assist them in establishing milk collecting and cooling centres, encourage contract supply of milk (milk producers groups and industries).
- Clustering of small and micro processors: clustering of small milk processors (cheesemakers) to collectively use raw material, packaging facilities, and to assist them in finding assured market outlets through contracting with retailers and exporters.
- New strategy: in the short-term revision of the tax laws for the export industries, while designing a strategy to improve the supply of local fresh milk.
- Low level of marketing compared to European cheesemakers: Egyptian cheese is popular, especially in the Arab world, and a continuous marketing strategy should be developed to maintain Egypt's share of the Arabian market; while an aggressive strategy must be developed to European and North American market.

2.4 Environmental-regulatory aspects

In the next paragraph the environmental-regulatory framework of this BAT study is outlined, primarily focussing on the Egyptian legislation. Foreign legislation is also addressed.

2.4.1 Environmental permit conditions

2.4.1.1 Air emissions

Article 40 of Law 9/2009, Article 42 of the executive regulations and Annex 6, deal with gaseous emissions from fuel combustion. The statutes relevant to fuel combustion are:

- The use of Solar oil and other heavy oil products, as well crude oil shall be prohibited in dwelling zones.

- The sulphur percentage in fuel used in urban zones and near the dwelling zones shall not exceed 1.5%.
- The design of the burner and fire-house shall allow for complete mixing of fuel with the required amount of air, and for the uniform temperature distribution that ensure complete combustion and minimize gas emissions caused by incomplete combustion.
- Gases containing sulphur dioxide shall be emitted through stacks rising sufficiently high, or using fuel that contains high proportions of sulphur in power generating stations, as well as in industry and other regions distant from inhabited urban areas, provided that atmospheric factors and adequate distances to prevent these gases from reaching the dwelling and agricultural zones and regions, as well as the water courses shall be observed.
- Smokestacks, from which a total emission of wastes reaches 7000 – 15000 kg/h, shall have heights ranging between 18 – 36 metres.
- Smokestacks, from which a total emission of gaseous wastes reaches more than 15000 kg/hour, shall have heights exceeding at least two and a half times the height of surrounding buildings, including the building served by the chimney.
- The permissible limits of emissions from sources of fuel combustion are given in Table 3(Ministerial Decree no. 1095/2011).

Table 3: Maximum limits for stack emissions from fuel combustion

Pollutant***	Maximum emission limits*, mg/Nm^{3} **					
Type of fuel	***TSP***	***CO***	***SO_2***	***NO_X***	***Pb in TSP***	***Hg fumes***
Natural gas	50	100	150	500		
Coke oven gas, Refinery gases…	100	300	350	500		
Gas oil (diesel)	100	250	1,300	500		
Heavy fuel oil	100	250	1,500	500	2	1
Coke	100	300	1,300	500	2	1
Agricultural waste	100	250	100	500		

**Reference conditions regarding % oxygen in exhaust are 4% in case of steam boilers, 15% in case of gas turbines and 6% for combustion of coke and agricultural waste.*

***Normal conditions refer to 273 K and 1 atm.*

****Total heavy metals should not exceed 5 mg/Nm^{3}, for combustion of solid fuel other than those in the Dioxins and Furans table should not exceed 0.1 ng/Nm^{3}.*

2.4.1.2 Effluents

Limits for pollutants in wastewater vary depending on the type of the receiving water body. The parameters that should be monitored and/or inspected are BOD, COD, pH, temperature, residual chlorine, TSS, TDS, oil and grease.

The following table presents the permissible limits for discharges to the different receiving media (sea, Nile, canals, agricultural drains, public sewer) according to the different relevant laws.

Spent lubricating oil has a negative impact on water and soil and therefore its disposal should be monitored/inspected. A record should be kept for this purpose.

Table 4: Environmental regulations and limits for wastewater

Parameter (mg/l unless otherwise noted)	Law 4/94 Discharge in coastal environment	Law 93/62 Discharge to sewer system (as modified by Decree 44/2000)	Law 48/82 Discharge into: Underground reservoir & Nile branches/canals	Law 48/82 Discharge into: Nile (main stream)	Law 48/82 Discharge into: Non-potable surface water – Municipal	Law 48/82 Discharge into: Non-potable surface water – Industrial
BOD_5 (5 day, 20°C)	60	600	20	30	60	60
COD (permanganate)	-	-	10	15	40	50
COD (dichromate)	100	1,100	30	40	80	100
pH (units)	6-9	6-9.5	6-9	6-9	6-9	6-9
Oil & grease	15	100	5	5	10	10
Temperature (°C)	10°C > avg. temperature of receiving medium, Max 38°C	43	35	35	35	35
Total suspended solids	60	800	30	30	50	60
Settleable solids (ml/l)	-	After 10 min: 8 cm After 30 min: 15 cm^3	-	-	-	-
Total dissolved solids	±5% of TDS of receiving medium	-	800	1,200	2,000	2,000
Total P	2					
PO_4		25	1	1	-	10
Total N	10					
NH_3-N (ammonia)	3	-	-	-	-	-
NO_3-N (nitrate)		100	30	30	50	40
Total recoverable phenol	0.015	0.05	0.001	0.002	-	0.005
Fluoride	1	-	0.5	0.5	-	0.5
Sulphide	1	10	1	1	1	1
Chlorine	-	-	1	1	-	-
Surfactants	-	-	0.05	0.05		-
Probable counting for the colon group in 100 cm^3	5,000	-	2,500	2,500	5,000	5,000
Aluminium	3	-	-	-	-	-
Arsenic	0.01	2	0.05	0.05	-	-
Barium	2	-	-	-	-	-

Parameter (mg/l unless otherwise noted)	Law 4/94 Discharge in coastal environment	Law 93/62 Discharge to sewer system (as modified by Decree 44/2000)	Law 48/82 Discharge into			
			Underground reservoir & Nile branches/canals	Nile (main stream)	Non-potable surface water	
					Municipal	Industrial
Beryllium	-	-	-	-	-	--
Boron	0.4	1	-	-	-	-
Cadmium	0.01	0.2	0.01	0.01	-	-
Chromium	0.01	-	-	-	Total concentration for these metals should be: 1 for all flow streams	
Chromium hexavalent	-	0.5	0.05	0.05		
Copper	1	1.5	1	1		
Iron	1.5	-	1	1		
Lead	0.01	1	0.05	0.05		
Manganese	0.1	-	0.5	0.5		
Mercury	0.001	0.2	0.001	0.001	-	-
Nickel	0.1	1	0.1	0.1		-
Selenium	0.001					
Silver	0.05	0.5	0.05	0.05	-	-
Tin	-	2	-	-	-	-
Zinc	1	-	1	1		-
Cyanide	0.01	0.2	-	-	-	0.1
Total Metals	-	5	1	1	1	1
Pesticides	0.2	Should be absent	Should be absent	Should be absent	Should be absent	Should be absent
Colour	Should be absent	-	Should be absent	Should be absent	Should be absent	Should be absent

2.4.1.3 Solid waste

A number of laws address solid waste management. The following laws apply to scrap and sludge from the WWTP:

- Law 38/1967 which addresses public cleanliness, regulates the collection and disposal of solid wastes from houses, public places, commercial and industrial establishments;
- Ministry of Housing, Utilities and Urban Communities (MHUUC) Decree No. 134 of 1968, providing guidelines from domestic and industrial sources, including specifications for collection, transportation, composting, incineration and land disposal;
- Law 31/1976, amending Law 38/1967;
- Law 43/1979, the Law of Local administration, which provided that city councils are responsible for 'physical and social infrastructure', effectively delegating responsibility for infrastructure functions;
- Law 9/2009 regulates incineration of solid waste.

2.4.1.4 Health and safety of workers

Legislation regarding health and safety issues is as follows:

- In the boiler house: gaseous emissions, regulated by Article 43 of Law 9/2009, Article 45 of the executive regulations and Annex 8. The limits for the relevant pollutants are presented in the following table;
- Wherever heating is performed: temperature and humidity are regulated by Article 44 of Law 9/2009, Article 46 of the executive regulations and Annex 9;
- In refrigeration rooms: ammonia leaks are regulated by Article 43 of Law 9/2009, Article 45 of the executive regulations and Annex 8;
- Near heavy machinery: noise is regulated by Article 42 of Law 9/2009, Article 44 of the executive regulations and Table 1, Annex 7;
- Ventilation is regulated by Article 45 of Law 9/2009 and Article 47 of the executive regulations;
- Smoking is regulated by Article 46 of Law 9/2009 and Article 48 of the executive regulations, and Law 52/1981;
- Work environment conditions are addressed in Labour Law 12/2003, Minister of Housing Decree 380/1983, Minister of Industry Decree 380/1982.

Table 5: Permissible limits as time average and for short periods

Material	Threshold			
	Time average		Exposure limits for short periods	
	ppm	*michael*^{3}	*ppm*	*michael*^{3}
Ammonia	25	18	35	27
Carbon dioxide	5,000	9,000	15,000	27,000
Carbon monoxide	50	55	400	440
Sulphur dioxide	2	5	5	10

2.4.1.5 Hazardous materials and waste

Law 9/2009 controls the management of hazardous materials and wastes. The dairy industry does not generate any hazardous wastes. Hazardous chemicals such as hydrochloric and nitric acids are used for washing vessels. The hazardous chemicals used in the lab and the fuel for the boilers, fall under the provisions of Law 4/1994. Articles 29 and 33 of the law make it mandatory for those who produce or handle dangerous materials in gaseous, liquid or solid form, to take precautions to ensure that no environmental damage shall occur. Articles 25, 31 and 32 of the executive regulations (Decree 1095/2011) specify the necessary precautions for handling hazardous materials. Storing of fuel for the boilers is covered by Law 9 as hazardous material. There are no explicit articles in Law 9/2009 or in Decree 1095/2011 (executive regulations), regarding holding a register for the hazardous materials; Article 33 is concerned with hazardous wastes. However, keeping the register for the hazardous materials is implicit in Article 25 of the executive regulations regarding application for a license.

2.4.1.6 Environmental register

Article 22 of Law 9/2009 states that the owner of the establishment shall keep a register showing the impact of the establishment activity on the environment. Article 17 and Annex 3 of the executive regulations specify the type of data recorded in the register. The emergency response plan and the hazardous materials register will also be part of the environmental register.

2.4.2 Other Egyptian legislation

2.4.2.1 Legal standards

Egyptian standards are designed and implemented by two organizations: the Egyptian Organization for Standardization and Quality Control (EOS) and the General Organization for Export and Import Control (GOEIC). The former has to enforce requirements and standards for imported and domestic products; the latter inspects imported and exported goods. Most Egyptian standards on dairy products are mandatory, especially technical standards that relate to food safety including food pathogens and pesticide residues. However, some mandatory standards relating to quality aspects move beyond restrictions imposed for health and safety reasons (e.g.

Total solids, Solids Not Fat, fat, protein milk powder contents). It is questionable whether such standards need to be mandatory, and could not be replaced by voluntary industry standards. Under the Quality Control Plan (Presidential Decree 42/2003) Egyptian dairy food standards (63 standards) are harmonized towards international standards (CODEX, EC) (under approval). Those 63 standards were given priority since they directly affect consumer health and food safety in addition to the fact that the updating of these standards has a positive effect on increasing exports of value added products, which will now be compatible with Codex Alimentarius and EU import standards.

A dairy products specialized committee is formed, comprising 15 experts of the Chamber of Food Industries, ministries and regulatory authorities, dairy processing companies, universities and research centres and also consumer protection agencies. The main aims of the updating are to:

- Enable exported Egyptian dairy products to be compatible with world market demands and at same time to be competitive with imported dairy products in the local market.
- Permit processors to be innovative and to develop new products to satisfy export demand without compromising product quality and safety aspects and without being restricted with other unrelated aspects such as salt and sugar content or flavours, provided it is permitted for food use and is declared on the label to protect the consumer’s rights.
- Defining the basic prerequisites for product quality, safety and environmental aspects and clarifying which conditions of violations are punishable by law and which are not.

Egyptian authorities recognize foreign standards only when there is no Egyptian standard for the goods or products concerned. Thus all manufacturers and importers are required to abide by Egyptian product standards. In cases where no mandatory standards exist, the following standards may be acceptable:

- Egyptian Product Standards (voluntary);
- International Standards (CODEX/ISO/IEC);
- European Standards (EN), or in the absence of EN standards, British (BN), German (DIN) and French (NF) standards may be applied;
- American Standards (ANS);
- Japanese Standards.

Dairy companies are required to label their products with the product-specific Egyptian standard. They are required to indicate whether the product is produced from fresh milk or powdered milk or both. The labelling law requires processors to indicate the percentage of powdered milk in the mixture, calculated on the basis of its weight after restoration. This law applies to pasteurized milk, UHT milk, ice cream, cheese and yoghurt.

In order to address hygiene related issues in the dairy sector, in the year 2001, the Government of Egypt also issued a decree to pasteurize all locally produced milk.

However, it has been reported that MSMEs are having problems in responding to this directive.

2.4.2.2 Regulatory conformity assessment

As noted above the GOIEC is responsible for supervising the inspection of imported and exported goods. EOS is responsible for auditing factories to make sure that systems are in place that enable (Egyptian) standards to be met. Egyptian dairy manufacturing companies, whether they produce for the domestic market or for export markets, are subject to regular controls by officials from the Ministries of Health, Ministry for Agriculture, Ministry of Supply and the Industry Control and Chemical Administration of the Ministry of Industry.

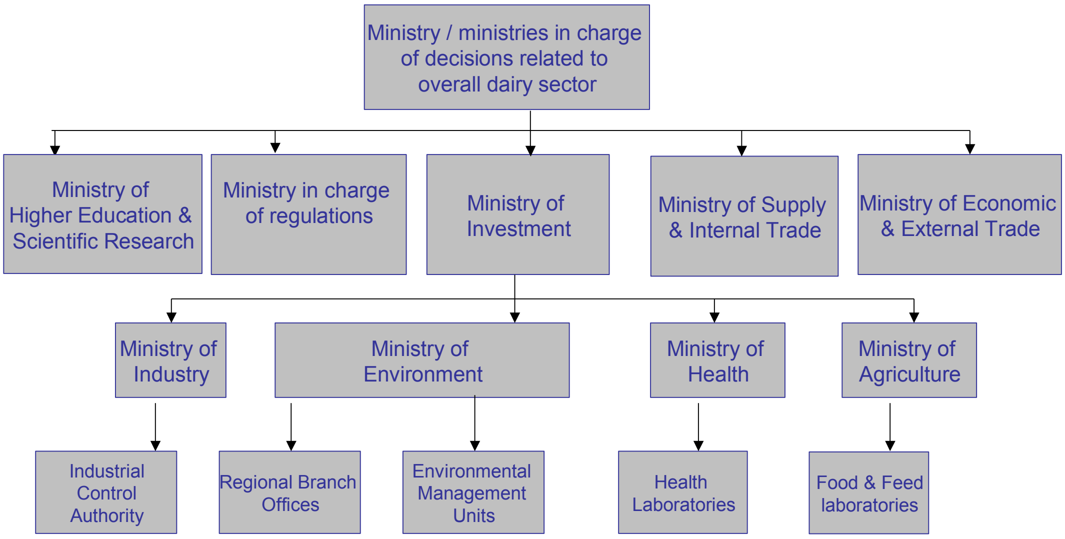

Figure 2: Organization Chart Depicting the Policy and Regulatory Framework Applicable to the Dairy Sector in Egypt

2.4.2.3 Voluntary standards

Although regulatory agencies in developed countries do not formally require foreign exporters to be HACCP or ISO-certified, governments and importers alike definitely recommend the application of a recognized, rigorous and systematic quality control system during production. Many established producers in Egypt have attempted to adopt HACCP and are aware of its ability to detect contamination at many production stages.

2.4.3 European legislation[10]

2.4.3.1 Industrial Emissions Directive

Industrial production processes account for a considerable share of the overall pollution in Europe (for emissions of greenhouse gases and acidifying substances, wastewater emissions and waste).

In order to take further steps to reduce emissions from such installations, the Commission adopted its proposal for a Directive on industrial emissions, 2010/75/EU, on 21 December 2007.

This proposal was a recast of 7 existing pieces of legislation and its aim is to achieve significant benefits for the environment and human health by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques. The IED entered into force on 6 January 2011 and has to be transposed into national legislation by Member States by 7 January 2013.

The IED is the successor of the IPPC Directive and in essence, it is about minimising pollution from various industrial sources throughout the European Union. Operators of industrial plants engaged in activities covered by Annex I of the IED are required to obtain an integrated permit from the authorities in EU countries. About 50,000 installations were covered by the IPPC Directive and the IED will cover some new activities which could mean a slight rise in the number of installations.

The IED is based on several principles, namely (1) an integrated approach, (2) best available techniques, (3) flexibility, (4) inspections and (5) public participation.

1. The **integrated** approach means that the permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, waste generation, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure. The purpose of the Directive is to ensure a high level of protection of the environment taken as a whole.
   Should the activity involve the use, production or release of relevant hazardous substances, the IED requires operators to prepare a baseline report before starting an operation of an installation or before a permit is updated having regard to the possibility of soil and groundwater contamination, ensuring the integrated approach.
2. The permit conditions including emission limit values (ELVs) must be based on the **best available techniques (BAT)**, as defined in the IPPC Directive. BAT conclusions (documents containing information on the emission levels associated with the best available techniques) shall be the reference for setting permit conditions. To assist the licensing authorities and companies in determining the BAT, the Commission organises an exchange of information between experts from the EU Member States, industry and environmental organisations. This work is co-ordinated by the

[10] Source: European Commission – DG Environment: http://ec.europa.eu/environment/air/pollutants/stationary/ied/legislation.htm.

European IPPC Bureau of the Institute for Prospective Technology Studies at the EU Joint Research Centre in Seville (Spain). This results in the adoption and publication by the Commission of the BAT conclusions and BAT Reference Documents (the so-called BREFs). In February 2012, a guidance document was published to lay down rules concerning the collection of data and on the drawing up of BAT reference documents and their quality assurance (2012/119/EU). This guidance was also used as a basis when drawing up these reports.

3. The IED contains certain **elements of flexibility** by allowing the licensing authorities to set less strict emission limit values in specific cases. Such measures are only applicable where an assessment shows that the achievement of emission levels associated with BAT as described in the BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to
   (a) geographical location or the local environmental conditions or
   (b) the technical characteristics of the installation.

   The competent authority shall always document the reasons for the application of the flexibility measures in the permit including the result of the cost-benefit assessment. Moreover, Chapter III on large combustion plants includes certain flexibility instruments (Transitional National Plan, limited lifetime derogation, etc.)
4. The IED contains mandatory requirements on **environmental inspections**. Member States shall set up a system of environmental inspections and draw up inspection plans accordingly. The IED requires a site visit to take place at least every 1 to 3 years, using risk-based criteria.
5. The Directive ensures that the **public has a right to participate** in the decision-making process, and to be informed of its consequences, by having access to
   (a) permit applications in order to give opinions,
   (b) permits,
   (c) results of the monitoring of releases and
   (d) the European Pollutant Release and Transfer Register (E-PRTR). In E-PRTR, emission data reported by Member States are made accessible in a public register, which is intended to provide environmental information on major industrial activities. E-PRTR has replaced the previous EU-wide pollutant inventory, the so-called European Pollutant Emission Register (EPER).

A short summary of the IED is also available at the EUROPA website[11].

2.4.3.2 Urban Wastewater Directive[12]

Directive 91/271/EEC concerns the collection, treatment and discharge of urban wastewater and the treatment and discharge of wastewater from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.

[11] http://europa.eu/legislation_summaries/environment/air_pollution/ev0027_en.htm.

[12] http://europa.eu/legislation_summaries/environment/water_protection_management/l28008_en.htm.

Industrial wastewater entering collecting systems and the disposal of wastewater and sludge from urban wastewater treatment plants are subject to regulations and/or specific authorisation by the competent authorities.

The Directive establishes a timetable, which Member States must adhere to, for the provision of collection and treatment systems for urban wastewater in agglomerations corresponding to the categories laid down in the Directive. The main deadlines are as follows:

- 31 December 1998: all agglomerations of more than 10,000 'population equivalent' (p.e.) which discharge their effluent into sensitive areas must have a proper collection and treatment system;
- 31 December 2000: all agglomerations of more than 15,000 p.e. which do not discharge their effluent into a sensitive area must have a collection and treatment system which enables them to satisfy the requirements in Table 1 of Annex I;
- 31 December 2005: all agglomerations of between 2,000 and 10,000 p.e. which discharge their effluent into sensitive areas, and all agglomerations of between 2,000 and 15,000 p.e. which do not discharge into such areas must have a collection and treatment system.

Annex II requires Member States to draw up lists of sensitive and less sensitive areas which receive the treated waters. These lists must be updated regularly. The treatment of urban water is to be varied according to the sensitivity of the receiving waters.

The Directive lays down specific requirements for discharges from certain industrial sectors of biodegradable industrial wastewater not entering urban wastewater treatment plants before discharge to receiving waters.

Member States are responsible for monitoring both discharges from treatment plants and the receiving waters. They must ensure that the competent national authorities publish a situation report every two years. This report must also be sent to the Commission.

Member States must set up national programmes for the implementation of this Directive and must present them to the Commission.

The Directive also provides for temporary derogations.

2.4.3.3 Emission Trading Scheme (ETS) Directive[13]

Launched in 2005 with the Directive 2003/87/EC, the EU ETS is now in its third phase, running from 2013 to 2020. The EU emissions trading scheme (EU ETS) is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively.

[13] http://ec.europa.eu/clima/policies/ets/index_en.htm.

The EU ETS works on the 'cap and trade' principle. A 'cap', or limit, is set on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. The cap is reduced over time so that total emissions fall. In 2020, emissions from sectors covered by the EU ETS will be 21% lower than in 2005.

Within the cap, companies receive or buy emission allowances which they can trade with one another as needed. They can also buy limited amounts of international credits from emission-saving projects around the world. The limit on the total number of allowances available ensures that they have a value.

After each year a company must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so.

2.4.3.4 The Waste Framework Directive[14]

The Directive 2008/98/EC establishes a legal framework for the treatment of waste within the Community. It aims to protect the environment and human health through the prevention of the harmful effects of waste generation and waste management.

It applies to waste other than:

- gaseous effluents;
- radioactive elements;
- decommissioned explosives;
- faecal matter;
- wastewater;
- animal by-products;
- carcasses of animals that have died other than by being slaughtered;
- elements resulting from mineral resources.

In order to better protect the environment, the Member States should take measures for the treatment of their waste in line with the following hierarchy which is listed in order of priority:

- prevention;
- preparing for reuse;
- recycling;
- other recovery, notably energy recovery;
- disposal.

Member States can implement legislative measures with a view to reinforcing this waste treatment hierarchy. However, they should ensure that waste management does not endanger human health and is not harmful to the environment.

[14] http://europa.eu/legislation_summaries/environment/waste_management/ev0010_en.htm.

2.4.3.5 Water protection and management: the Water Framework Directive[15]

With Directive 2000/60/EC the European Union has established a framework for the protection of:

- inland surface waters;
- groundwater;
- transitional waters;
- coastal waters.

This Framework-Directive has a number of objectives, such as preventing and reducing pollution, promoting sustainable water usage, environmental protection, improving aquatic ecosystems and mitigating the effects of floods and droughts.
Its ultimate objective is to achieve ‘good ecological and chemical status’ for all Community waters by 2015.

According to this Directive Member States have to identify all the river basins lying within their national territory and assign them to individual river basin districts. River basins covering the territory of more than one Member State will be assigned to an international river basin district.
Member States are to designate a competent authority for the application of the rules provided for in this Framework-Directive within each river basin district.

2.4.3.6 REACH Regulation: Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals[16]

REACH is the European Community Regulation n. 1907/2006 on chemicals and their safe use. It deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. The law entered into force on 1 June 2007.

The aim of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. At the same time, REACH aims to enhance innovation and competitiveness of the EU chemicals industry. The benefits of the REACH system will come gradually, as more and more substances are phased into REACH.

The REACH Regulation places greater responsibility on industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA) in Helsinki. The Agency acts as the central point in the REACH system: it manages the databases necessary to operate the system, co-ordinates the in-depth evaluation of suspicious

[15] http://europa.eu/legislation_summaries/environment/water_protection_management/l28002b_en.htm.
[16] http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm.

chemicals and is building up a public database in which consumers and professionals can find hazard information.

The Regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified.

2.4.4 Foreign legislation (GCC Market)

Gulf Cooperation Council (GCC) is a considerable market for Egypt dairy products. The GCC consists of six countries: the United Arab Emirates (UAE), Bahrain, Kuwait, Oman, Qatar and Saudi Arabia. The Office of Agricultural Affairs (OAA) in Dubai covers Bahrain, Kuwait, Oman, Qatar and UAE.

2.4.4.1 Food standards

Yemen joined the Gulf Standards Organization (GSO) in early 2010 to bring the number of GSO member countries to seven. Formerly, GSO consisted only of the 6 GCC member countries. GSO is responsible for developing food and other standards in the GCC. The GSO food standards committee has been actively updating GCC food standards. Over the past few years, the committee has been working to harmonize existing standards within the guidelines of the Codex Alimentarius, ISO and other international organizations. However, in some cases, differences still exist between some of the proposed new standards and existing international guidelines. Once a new standard is approved by the GSO food standards committee, each member country should officially adopt the standard, thus making it a national standard as well as a GSO standard.

The current standards bring the GCC into closer compliance with the guidelines of Codex Alimentarius and generally offer more flexible requirements for importing foods from foreign markets.

The GSO has created subcommittees to follow-up on other issues related to food.

- Bio-technology and organic food subcommittee, chaired and hosted by the UAE.
- Labelling subcommittee, chaired and hosted by Oman.
- Additives subcommittee, chaired and hosted by Saudi Arabia.

The GSO also, when the need arises, forms working groups to address specific issues. For instance, a working group has developed two Halal standards. The first standard outlines general Halal requirements while the second standard outlines requirements for approving foreign centres, certifications and Halal labelling.

2.4.4.2 Customs and tariffs

In January 2003, the ‘GCC Unified Customs Law and Single Customs Tariff’ (UCL) was issued. The UCL established a unified customs tariff of five per cent on nearly all processed food products. Under the UCL, live animals, fresh fruits and vegetables, some seafood, grains, flour, tea, sugar, spices and seeds for planting are exempted from tariffs. It also established a single entry point policy. In other words, a product entering any GCC member market would pay the appropriate duty only at point of entry and would then be permitted duty free transit among GCC member countries. In practice, this policy is employed only with unopened containers trans-shipped between GCC markets. Partial shipments tend to be subject to the five per cent import duty again in the country of destination. However, it is expected that all goods, even partial shipments from opened containers, will eventually receive single-entry treatment once customs procedures are fully unified within the next few years.

2.4.4.3 Food import procedures

In 2007, the GCC Food Safety Committee developed a 'Guide for Food Import Procedures for the GCC Countries.' This guide was meant to unify the applied procedures for clearing food consignments, as well as to unify the required import certificates for different types of foods. The intent was to help facilitate the movement of food products within the GCC once customs unification is fully implemented. In 2008, the GCC member countries decided to postpone the application of the guide to ensure that it complies with the guidelines of international organizations such as Codex Alimentarius, World Animal Health Organization and International Plant Protection Consortium. The guide is still being reviewed by members of the GCC.

In each of the country's eight countries the respective health department is responsible for enforcing the federal food safety standards on locally produced and imported foods through its food control section. The representatives of the eight food control sections of the emirates meet regularly to discuss and coordinate issues of mutual interests and share information. However, each operates independently of the other. Food is imported via land and sea ports, but in smaller volumes. Occasionally, municipalities act independently when issuing regulatory requirements, which can be disruptive to trade if proper prior notice is not provided.

Food products are regularly inspected at the time of entry, at production facilities and at the point-of-sale. Fines are levied and products destroyed for severe violations. Imported and locally produced food products are subject to the same food safety regulations and labelling requirements. At present there are no environmental laws regulating food product packaging.

CHAPTER 3 PROCESS DESCRIPTION[17]

In this chapter, the processes that are characteristic for the dairy industry are described and their environmental impact is assessed.

The description aims at providing a general overview of the applied process steps and their environmental impacts. This serves as a background for listing the environmentally friendly techniques which could be adopted to reduce the sector's environmental impact (chapter 4).

The process details and the sequence of the different process steps, in practice may vary from company to company. Not all possible process variants can be outlined in this chapter. Moreover, the true processes might be somewhat more complex than described herein.

This chapter in no way aims at judging whether certain process steps are BAT or not. Consequently, the fact that a process is or is not mentioned in this chapter, does not imply that the process is or is not considered a BAT.

[17] Largely adopted from ' Eva Korsström and Matti Lampi *Best Available Techniques (BAT) for the Nordic Dairy industry*. Available at: http://www.norden.org/pub/miljo/miljo/sk/2001-586.pdf. Retrieved from the World Wide Web on January 17, 2012'

3.1 General dairy processes

3.1.1 Milk reception

According to the size and technology level, the raw milk arrives to the receiving platform in different containers including insulated tankers, metal churns and plastic barrels. Milk temperature varies from 4°C to 30°C. Upon reception, the raw milk is filtered, deaerated and measured either by volume or by weight. As milk temperature normally rises slightly during transportation, the milk is usually flash cooled to a temperature below +4°C before being stored in a silo awaiting further processing. Also, the milk could be directly pasteurized and stored in a processing tank for the next process. In case of products such as Roumy cheese, raw milk is processed in the cheese vats without pasteurization.

The raw milk silos can be equipped with cooling water jackets for circulation of chilled water, but some silos are fitted with insulation only.

Environmental issues
Chilling water is consumed for cooling of incoming milk. Filters are used for milk filtration. Water, detergent and sanitizers are used for rinsing, cleaning and sanitizing the reception line and the inside of the tankers and other milk containers. When the hoses are disconnected some milk is spilt on the floor, unless they are thoroughly drained.

3.1.2 Basic treatments

For pasteurized dairy products, the milk must be treated in such a way that all pathogens and most spoilage microorganisms are destroyed. This is achieved by pasteurization, a form of heat treatment that is required by law for all dairy products. Some types of cheese of small dairies are, however, made from unpasteurized milk.

The general milk treatment comprises the following steps aimed at preparing the milk, rendering it more suitable for subsequent processing:

- filtration to remove foreign particles
- deaeration (degassing) to expel gases and malodorous volatile substances
- separation to skim the cream from the milk
- standardizing the fat and non fat solids (SNF) content by mixing cream and skimmed milk
- homogenization to reduce the size of the fat globules
- pasteurization to kill all pathogenic microorganisms

3.1.2.1 Deaeration

Deaeration of the milk is necessary to expel gases and malodorous volatile substances at the milk receiving step and to remove excess air/oxygen in order to improve the growth of probiotics and syneresis stability of cultured products. The deaeration is normally carried out in a vacuum vessel in connection with the pasteurization.

3.1.2.2 Cream separation

Centrifugal separation is a very common process in dairies. In addition to skimming of milk, it is also used for whey separation and butter-oil purification.

A centrifugal separator consists of a stack of discs in a rotating bowl. The entering milk is accelerated to the same speed of rotation as the bowl and is distributed in the separation channels between the discs. The cream, having a lower density than skimmed milk, moves inwards towards the axis of rotation, whereas the skimmed milk moves outwards to the space outside the disc stack. The two fractions are then discharged from the separator through separate outlets.

In most dairies the cream separation is carried out by means of self-cleaning separators. The milk is separated into a stream of cream containing 40% fat and a stream of skimmed milk containing 0.04 - 0.07% fat. The separator also discharges sediment consisting of dirt particles, udder cells, bacteria, leucocytes, etc., which is normally carried to the drain. The total amount of sediment in milk is normally about 1 kg/10,000 litres.

The separator is usually connected to the preheating section of the pasteurizer, as the optimum temperature for separation is about 65°C.

3.1.2.3 Standardization

Standardization of milk fat and protein content is necessary in the production of some cultured products and cheese. The most common ways are:

- milk fat reduction by separation or increasing by adding cream;
- milk protein fortification by adding skim milk powder;
- ultrafiltration (UF) treatment, where the milk flows under pressure over a membrane which retains the milk fat, protein and colloidal calcium phosphates.

3.1.2.4 Homogenization

The aim of homogenization is to prevent gravity separation of the fat in the product. Homogenization takes place after separation, usually at 70°C. The fat globules of the milk are subjected to mechanical treatment by forcing the milk at high pressure through a narrow gap of about 0.1 mm, which breaks them down into smaller globules.

The homogenizer consists of a high-pressure pump driven by a powerful electric motor, and a backpressure device. The homogenizing pressure is between 10 and 25 MPa, depending on the product.

3.1.2.5 Heat treatment

To ensure total destruction of all pathogenic microorganisms, it is necessary to heat the milk to a given temperature and to keep it there for a given length of time. The most widely used heat treatment is pasteurization, where the milk is heated to 72°C for at least 15 seconds (HTST/contiguous / plate heat exchanger) or 63°C for at least 30 minutes (LTLT/batch/vats). The milk is then cooled to about 4°C in case of storage or production of pasteurized milk, or cooled to the temperature of the next processing step (e.g. 45°C for yoghurt production).

Another type of heat treatment is called Ultra High Temperature treatment (abbreviated UHT), where the milk is heated to 135°-140°C for a few seconds. This kind of treatment is used for products with long life milk, which have a typical shelf life of about six months.

In some cases (raw cheese) the milk is heat treated at a temperature below the pasteurization limits in order to prevent serious quality deterioration. This process is called thermization and comprises heating to 63°-65°C for about 15 seconds.

The pasteurized milk is generally cooled by means of regenerative heat exchange (please refer to chapter 4) and the lowest temperature obtained in this way is about 8-9°C. Further cooling to 3-4°C requires chilling water and an even lower final temperature requires use of brine or alcohol solutions. In the small scale, tap water is used for cooling to yoghurt or cheese processing temperatures (inoculation or renneting).

Environmental issues

The main environmental issues of the milk treatment described above are related to the high levels of energy consumed in heating and cooling of the milk, and the electricity consumed by the homogenizer, separator and pumps.

Water is consumed for rinsing and cleaning of the equipment, processes which in turn result in wastewater containing milk solids and cleaning agents. Water/milk mixtures are also generated at the start-up of the production line, when the water in the pipes is replaced by milk. The inputs and outputs of the main steps of the pasteurization process are presented in Figure 3.

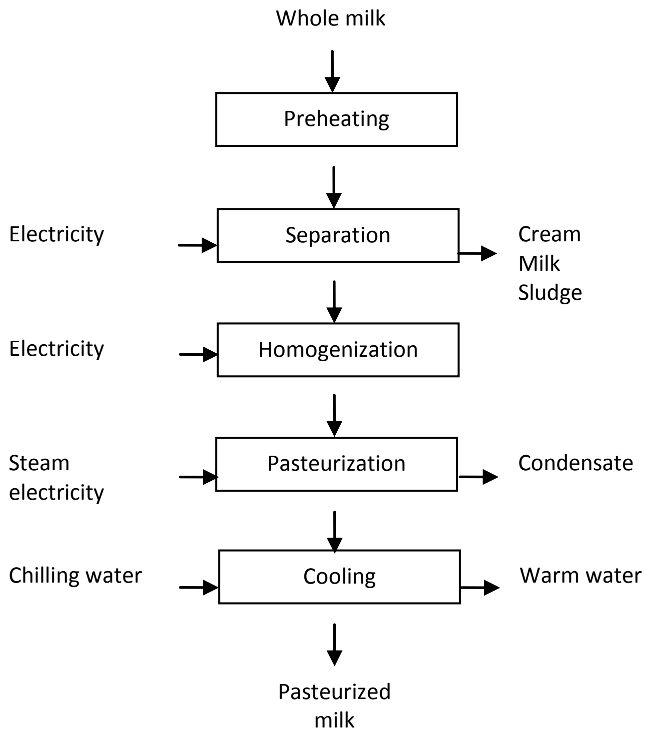

Figure 3: Inputs and outputs of the milk pasteurization process

3.2 Production of fluid milk and cultured milk products

3.2.1 Pasteurized milk and long life milk

3.2.1.1 Pasteurized market milk and cream

The market milk undergoes pasteurization as described in the previous section. The fat content of the milk is adjusted to the desired level by mixing cream and skimmed milk in the right proportions. This procedure is called standardization and is carried out either as pre-standardization (before pasteurization), post-standardization (after pasteurization) or as direct standardization (directly after separation).

Labour-intensive and requiring large tanks, automatic in-line fat standardization has become more attractive. In this method the fat content is adjusted to the required level by remixing a calculated proportion of the cream from the separator with the skimmed milk line.

Cream sold to consumers is also produced with different fat contents. The cream is pasteurized separately at a slightly higher temperature (80°- 90°C) than the milk. Cream with a high fat content intended for whipping must be stored at a low temperature (4 – 6°C) for a relatively long time in order to obtain proper crystallization of the fat. As heat is released during crystallization, the cream must be cooled to prevent an increase in temperature.

3.2.1.2 Pasteurized market milk and cream

Sterilized milk can be stored for long periods at ambient temperature without spoiling, thus offering many advantages both for the producer, the retailer and the consumer. The production of long life milk involves Ultra High Temperature treatment (135-150°C for 4-15 seconds) followed by aseptic packaging.

There are two main types of UHT systems:

- direct systems, where the product is heated in direct contact with steam, followed by flash cooling in a vacuum vessel, and
- indirect systems, where the heat is transferred to the product through a partition (plate or tubular) wall.

The direct system can be further subdivided into two categories:

- steam injection systems;
- steam infusion systems.

Regardless of the type of UHT system, the operating phases are the following:

- pre-sterilization of the equipment with hot water;
- cooling of the equipment;
- UHT process;
- aseptic filling and packaging;
- aseptic intermediate cleaning (AIC) between production runs to remove fouling in the production line;
- final cleaning in place (CIP) comprising pre-rinsing, caustic cleaning, hot water rinsing, acid cleaning and final rinsing.

The sterilized, cooled product is finally pumped to an aseptic tank, which provides a buffer between the continuous process line and the aseptic filling machine. The aseptic tank is sterilized with steam and filled with sterile air prior to production. Sterile compressed air is usually used for transferring the product from the tank to the filling machine.

Environmental issues

The environmental issues for the production of liquid milk products are the same as those for common milk treatment previously described in section 3.1.

For long life milk the environmental impact is greater than that of pasteurized milk, due to the UHT treatment. The UHT-treatment requires more steam and the pre-sterilization step increases the consumption of water. If the temperature drops during production, the product in the line must be rejected. The rejected product can be reused in other products, provided it is permitted by legislation and does not compromise the quality of the final product or it can be used as animal feed.

3.2.2 Cultured milk products

Cultured milk is the collective name for products prepared by lactic acid fermentation. Such products are for example yoghurt, and sour cream.

The production of cultured products involves inoculation of the heat-treated and standardized milk with a starter culture, followed by incubation for a certain time.

3.2.2.1 Yoghurt

Yoghurt is typically divided into the following types:

- set yoghurt, which is incubated and cooled in packages;
- stirred or drinking yoghurt 'rayeb', which is incubated in tanks, but the coagulum is broken down to a liquid, sweetened and flavoured if required, and cooled before packing.

Regardless of the yoghurt type, the milk used for yoghurt production is heat-treated (90-95°C, 5 minutes), homogenized and standardized to the desired fat and protein content. The content of dry matter is standardized either by addition of skimmed milk powder, or by addition of retentate (UF concentrate). Deaeration is usually also a part of the process.

After the heat-treatment, the milk is cooled to the desired inoculation temperature (42-45°C).

It is common to inoculate the pasteurized milk with DVI (Direct Vat Inoculation) yoghurt cultures according to the culture manufacturer instructions

After inoculation the stirred or drinking yoghurt is incubated in insulated tanks until the required pH is reached and is subsequently sweetened, flavoured, diluted with water if required, and cooled to 15-22°C prior to filling. The set yoghurts are incubated after filling in an incubation room and cooled afterwards in a cooling rooms or tunnels.

3.2.2.2 Other cultured products

The manufacturing process for other cultured products involves more or less the same steps, only the temperature programmes are different.

Environmental issues

The production of cultured products involves several heating and cooling steps, which result in high consumption of cooling and heating energy (chilling water, cooling water and steam). There is also a high degree of product spill in the form of product/water mixtures generated at production start-ups and end rinsing, and by product changeovers. This spill is usually collected, but as it contains soured product, it can only be used as animal feed. The inputs and outputs of the process are presented in Figure 4.

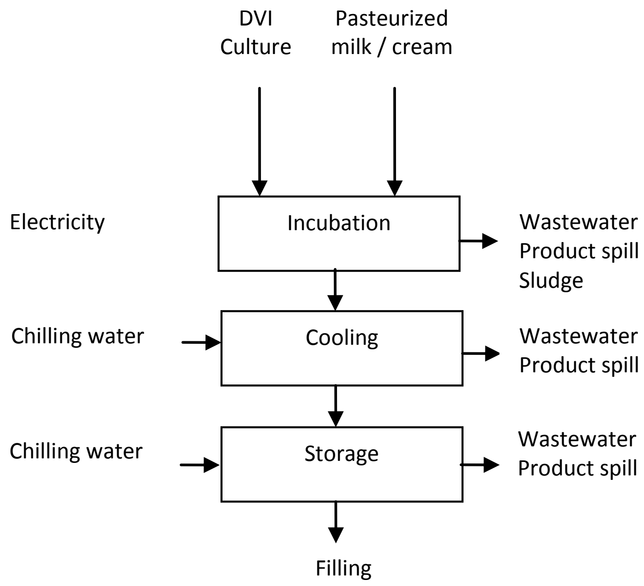

Figure 4: Inputs and outputs of production of cultured products

3.2.3 Filling and packing

The filling of the products into their final packages takes place in adapted filling machines. These machines are cleaned by CIP at given intervals. Usually the machines have their own CIP units with special detergents.

Aseptic filling involves pre-sterilization of the filling machine, sterilization of the packaging material and filling with a sterile product in a sterile environment.

The package should preserve the food value of the product by protecting it from bacteriological contamination, mechanical shock, light and oxygen. Liquid milk products are packed in beverage carton, which is mainly paperboard covered by a thin layer of food-grade polythene on either side. Milk cartons for long life milk have an additional layer of aluminium foil.

Cultured products are packed either in beverage carton, or in plastic cups with lids of aluminium foil or paper. In some cases the portion cups are wrapped together in card as multipacks.

Environmental issues

The main environmental issues are: product loss from spills and packaging mistakes, wastewater from cleaning operations, and solid waste generated by the package itself.

Most packages end up as household waste. Empty packages and rejected material from the filling machines, as well as packages from non-conforming products, represent a great proportion of the solid waste from the production plant.

There are several ways to reduce the environmental burden caused by the packaging material, ranging from choice of material to recycling and use for energy production. However, the possibilities for recycling are limited, for hygienic and safety reasons. The inputs and outputs of the filling and packaging step are shown in Figure 5.

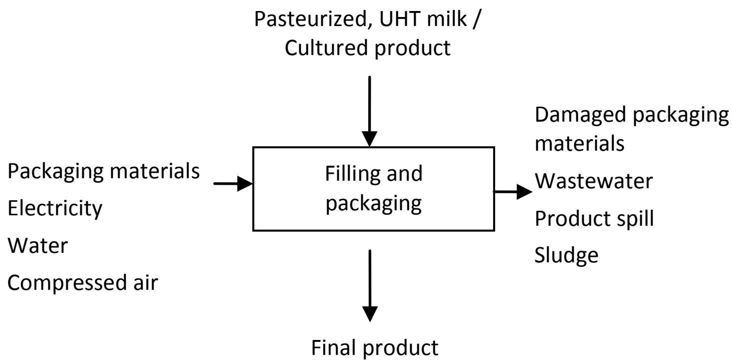

Figure 5: Inputs and outputs of the filling step

3.3 Production of butter and butter oil

3.3.1 Butter making

Butter is usually divided into two main categories:

- sweet cream butter
- cultured cream butter

Large-scale butter manufacturing processes involve quite a number of stages. Butter can be produced either batchwise in churns or continuously in a butter making machine. Although churns are still used, they are nowadays mostly replaced by continuous machines.

The cream used for butter is pasteurized and, if necessary, subjected to vacuum treatment before being transferred into ripening tanks. In these tanks the cream undergoes a temperature treatment programme in order to give the fat the required crystalline structure. The tanks are usually triple-shell tanks with heating and cooling media circulating between the shells.

If cultured cream butter is produced, the ripening of the cream takes places in the same tanks. The cream is mixed with a starter culture and is simultaneously acidified during ripening.

From the ripening tanks the cream is continuously fed to the double-cooled churning cylinder of the butter making machine, where the fat globules are disrupted. The formed butter grains and the surrounding liquid (buttermilk) are then separated in the separation section of the machine. Here the butter grains undergo a first washing with chilled buttermilk. The remaining buttermilk is removed from the grains in the squeeze-drying section and the grains are subsequently treated in several working sections. The finished butter is continuously extruded from the end nozzle and is transferred to the packaging machine.

In batch processes the ripened cream is agitated in specially designed churns until phase conversion takes place and butter grains are formed. The buttermilk is decanted off and the grains are washed in fresh chilled water. The grains are then worked to produce a homogenous mass with controlled moisture content.

The packaging material used for butter must be greaseproof and impervious to light, flavouring and aromatic substances. It should also be impermeable to moisture to prevent the butter from drying out. Butter is widely wrapped in aluminium foil, whereas dairy blends and spreads are packed in plastic tubs with an inner lid of aluminium foil.

Butter, dairy blends and spreads should be stored cold at +5°C. Butter can also be frozen for long term storage, which requires temperatures below –15°C. Sufficient air circulation must be provided in order to allow even chilling.

Environmental issues

The impact of the pasteurization step is associated with the consumption of heating energy as well as with the high organic load of the rinsing and cleaning water. As frequent cleaning is required, the loss of milk solids is also high.

The churning step produces buttermilk, which represents a potential environmental loading, unless collected. The buttermilk usually amounts to approximately 50% of the original cream volume, and it can be used as an ingredient in other products. Sour buttermilk is usually used for manufacturing Mish cheese.

In comparison with the batch process, the continuous process reduces the amount of waste by eliminating the butter grain washing step and by employing a system for continuous recovery of butter fines. When a continuous butter production line is closed down, the residual fat remaining in the equipment has to be rinsed out before the equipment is cleaned, which results in high organic loads in the generated wastewater. The inputs and outputs of the butter making process are described in Figure 6.

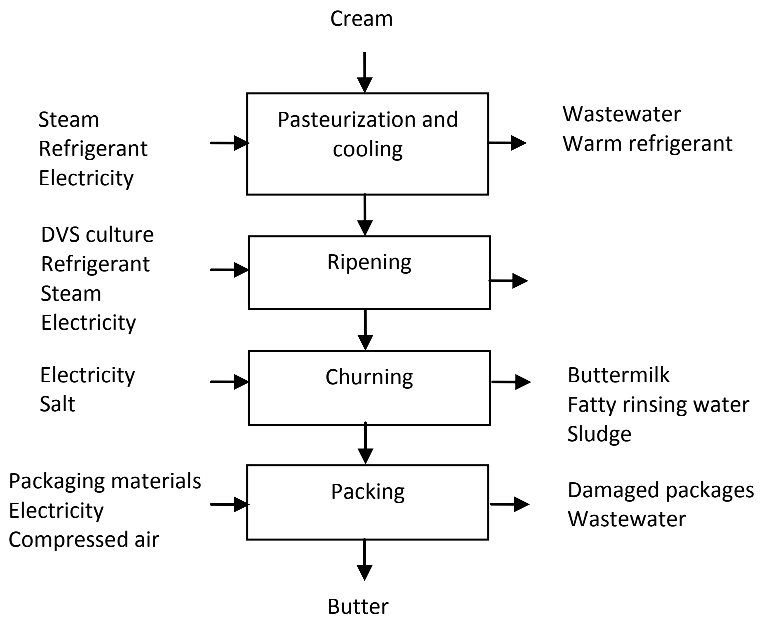

Figure 6: Inputs and outputs of the butter production process

3.3.2 Production of anhydrous milk fat (AMF)

Anhydrous milk fat products are divided into three categories:

- Anhydrous Milk Fat
- Anhydrous Butter oil
- Butter oil

This description will cover the manufacture of AMF in general.

AMF can be produced either directly from cream or via butter. When cream is used, the incoming cream is heated or pasteurized before it is submitted to centrifugal preconcentration in order to increase the fat content to 75%. The cream concentrate undergoes phase inversion in a homogenizer, after which it is further concentrated in a separator to butter oil of 99.5% fat. These steps are carried out at a temperature of 60°C. The butter oil is then preheated to 95-98°C and the moisture content is reduced to 0.1% in a vacuum chamber, followed by cooling to packaging temperature (35-40°C).

The centrifugal concentration steps produce a by-product also called buttermilk, which still contains some fat. This fat can be separated and reused in butter production.

AMF is often produced from butter. This method involves melting and heating of the butter to 60°C, followed by final concentration, preheating, vacuum treatment and cooling, as described above.

The AMF obtained can be further refined by the following methods:

- Polishing, that is washing of the oil with water after the final concentration in order to obtain a clear product. 20-30% water is added and after a short hold it is separated out again, thus removing mainly protein.

- Neutralization in order to reduce the level of free fatty acids. The procedure involves addition of 8-10% NaOH and water followed by separation of the saponified free fatty acids.
- Fractionation of the oil into high-melting and low-melting fats by melting and slow cooling, whereupon the different fats crystallize and are filtered out. The fractionation is usually preceded by polishing.
- Decholesterisation for removal of cholesterol from the oil. This is done by mixing the oil with modified starch.

The AMF is usually put in containers. Nitrogen is used to remove air from the container, thus preventing oxidation of the oil.

Environmental issues

Energy is consumed in the heating steps and for melting of butter, and cooling water is required for cooling. The phase inversion performed by the homogenizer requires electricity. The refining processes require water and the generated wastewater, which contains water-soluble substances, is carried to the drain. The process also produces a by-product in the form of buttermilk, which contains less than 1% fat. The inputs and outputs of the production of AMF from cream are described in Figure 7.

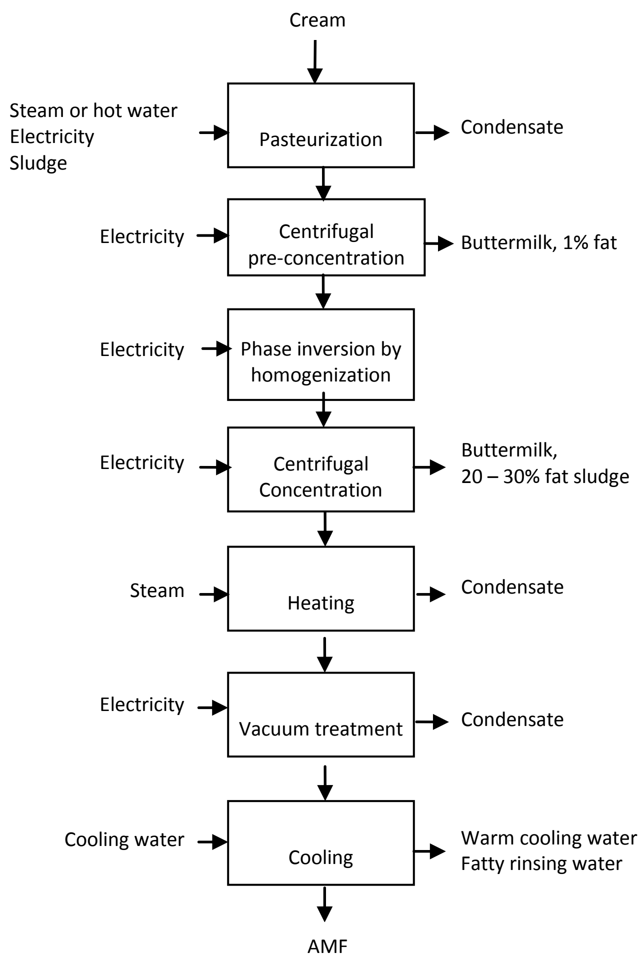

Figure 7: Inputs and outputs of production of anhydrous milk fat from cream

3.4 Production of cheese

Cheese is generally defined as a milk concentrate obtained by coagulation and consisting mainly of casein and fat. The residual liquid is called whey. The different cheese types can be categorized according to the following attributes:

- Consistency, depending on the moisture content (extra hard <41%, hard, semi-hard, semi-soft, soft >67%).
- Fat content (high fat >60%, full fat, medium fat, low fat, skim <10%).
- Curing characteristics (ripened, mould ripened, unripened).

Cheese production comprises numerous steps, of which several are common to most types of cheese. However, there are also many procedures that are type-specific. The following description is intended to give a general view of the most important procedures.

3.4.1 Curd production

The milk used for most types of cheese is preferably pasteurized before being pumped into the cheese vat. The fat content of the cheese milk is standardized either by direct in-line standardization after separation, or by pre-standardization prior to pasteurization.

When the milk enters the cheese vat (usually at a temperature of 30°C), Direct Vat Inoculation (DVI) starter culture is added. In the small scale dairies, the milk is usually used without pasteurization or culturing with starter for production of raw milk cheeses like Roumy.

Rennet is added when the acidity of the cheese milk has reached the desired level. The rennet acts to coagulate the milk solids into curd. The coagulation time is usually about 30 minutes and when the curd is firm enough the coagulum is cut. The cheese vat is equipped with cutting knives that gently break the coagulum into small cubes. In the small dairies, a large wooden stick is used for curd stirring and cutting

When the curd is cut, the suspension is gently stirred in order to expel whey from the grains. At this stage some of the whey can be drained off, depending on the type of cheese that is produced. This reduces the energy consumption of the subsequent heating step.

The suspension is heated in order to exhibit the acidification of the curd and to promote syneresis (whey expulsion from the curd). There are several ways to heat, depending on the type of cheese:

- Indirect heating by steam in the vat jacket.
- Indirect heating by hot water in the vat jacket.
- Direct heating by addition of hot water.

The temperature varies from 38°C up to 44°C depending on the cheese type. The heating phase is followed by final stirring until the desired acidity and firmness of the curd has been obtained. In the small dairies, salt brined whey is added to the curd in the vat at the end of cooking step

Environmental issues

The main environmental impact of curd production is related to the energy consumption required for the heating of the curd. Depending on the type of cheese produced, 85-90% of the original milk volume is drained off as whey, which requires further treatment. Rinsing of the cheese vats generates wastewater containing cheese fines and traces of fat. Electricity is required for the cutting and stirring tools. The inputs and outputs of traditional curd production are described in Figure 8.

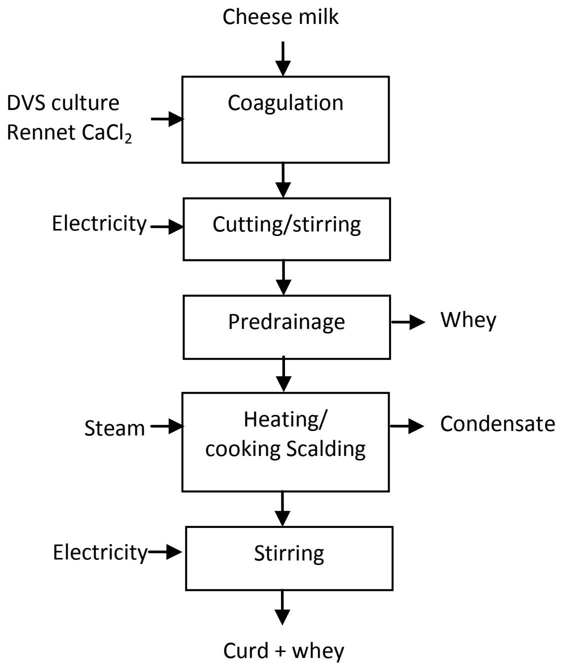

Figure 8: Inputs and outputs of traditional curd production

3.4.2 Curd handling, whey separation

The downstream handling of the curd varies depending on the type of cheese to be manufactured. The main differences are outlined in Figure 9. The cheese types A, B and C represent semi hard/ hard cheeses. The cheese types D and E represents soft cheeses.

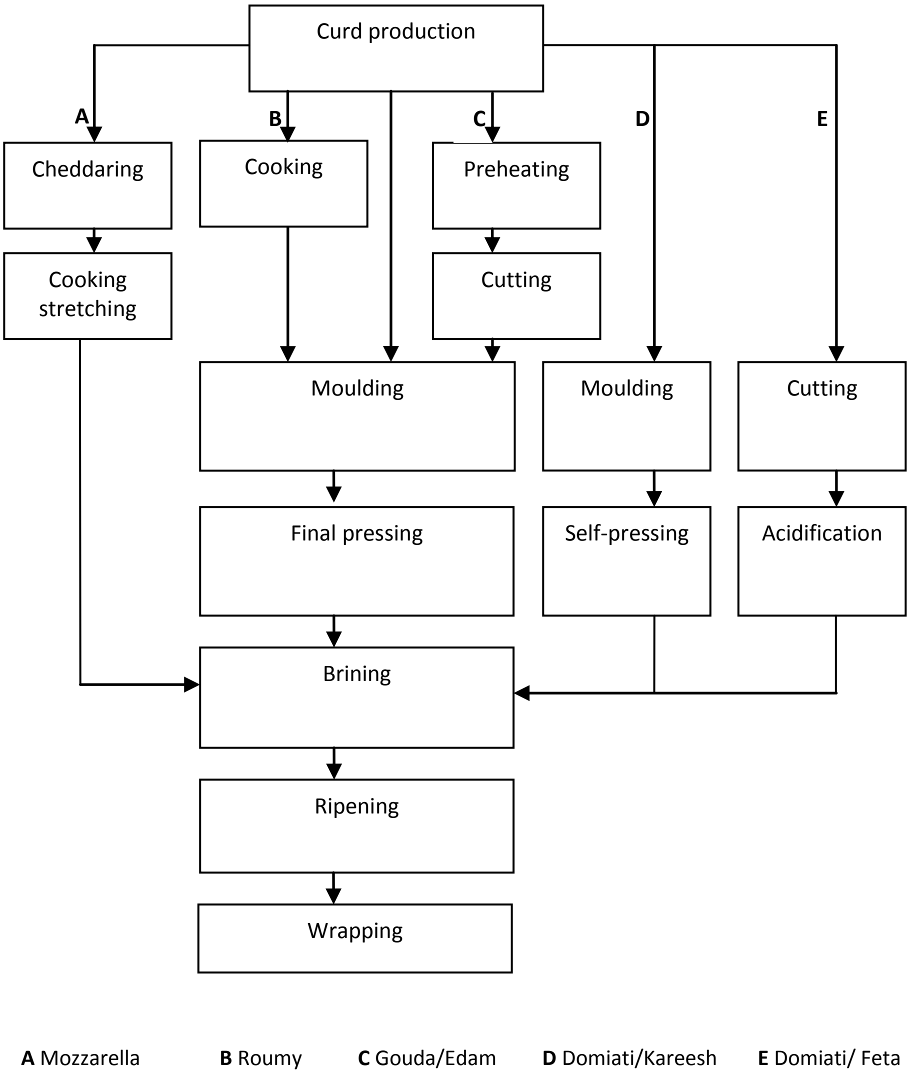

Figure 9: Curd handling for different cheese types

After cooking and final stirring (and salting in case of Roumy cheese in small dairies) the whey is separated from the curd. When producing cheeses with a granular texture, the whey is removed before the curd is distributed into moulds for final pressing. This is usually done by means of cheesecloth and strainer.

The pre-pressed cheese curd is conveyed out of the vat and simultaneously cut into smaller blocks for moulding. The cut blocks are placed in plastic or stainless moulds either manually or by means of a mechanical moulding device.

The curd in the moulds is subjected to final pressing in order to:

- remove the last whey;
- provide texture;
- shape the cheese;
- provide a rind on cheeses with long ripening time (Roumy cheese).

Semi-soft and soft cheeses, like the blue-veined cheeses and Domiati cheese, are allowed to settle by self-pressing, during which procedure the cheeses are turned several times.

After the final pressing the cheese is unmoulded (blue-veined cheese) or cut into blocks (Domiati cheese). The moulds are washed before refilling.

'Elastic' cheese, like Mozzarella, is obtained by cooking and stretching of cheddared curd. The milled chips are cooked with hot water at 82-85°C manually or in a continuous cooking and stretching machine with counter-rotating augers. The cheese is worked until it is smooth and elastic, and is subsequently moulded. The moulded cheese is cooled in a hardening tunnel prior to de-moulding and brining. This entire process is called the 'pasta filata' process.

The cooking water is usually saved and the fat is separated.

Environmental issues
The pressing of cheese produces more whey. Curd grains are often spilt on the floor during moulding and are usually flushed into the sewer by water at the end of the day. The operation of the presses requires electricity and compressed air. The pasta filata process requires both heating and cooling energy. Water and cleaning chemicals are used for cleaning of the cheese moulds and the pressing equipment. The inputs and outputs of cheese pressing are described in Figure 10.

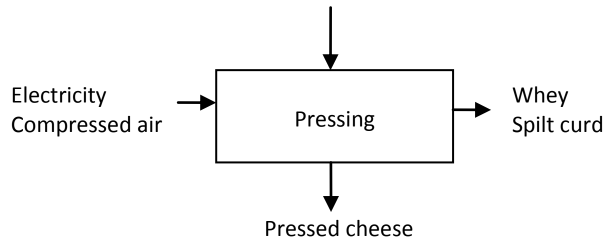

Figure 10: Inputs and outputs of cheese pressing

3.4.3 Salting

Salt is added to cheese as a condiment, but it also serves as a retarding agent for starter and other bacteriological activity. The salt content of cheese is usually 0.5-17%.

The method used for salting depends on the cheese type, the alternatives being:
- milk salting as in Domiati cheese;
- whey salting as in Roumy cheese;
- dry salting, where dry salt is applied manually or mechanically to the curd (e.g. Mozzarella), or to the cheese surfaces during the ripening period as in Roumy cheese;
- brine salting, where the cheese is placed in a container with brine (e.g. Gouda, Edam).

3.4.3.1 Brine salting

In large-scale production of brine-salted cheese the most common brining systems are shallow brining, deep brining or rack brining. Regardless of the system used, the idea is to keep each cheese immersed in brine for a given time, which depend on the type and the size of the cheese. The salt concentration of the brine is usually 18-23%, the temperature being 10-14°C.

The salt concentration of the brine needs to be readjusted as moisture is expelled from the cheese in exchange of sodium chloride. The microbiological activity in the brine must also be kept under control in order to prevent quality defects in the cheese. For this purpose the brine can be pasteurized, but this method upsets the salt balance and requires expensive equipment, as brine is highly corrosive. Other alternatives are filtration, UV-treatment and addition of chemicals. The chemicals used are mainly sodium hypochlorite, sodium or potassium sorbate, or delvocide (= pimaricine).

Environmental issues
Mostly the brine is never changed. However, small surplus volumes are discharged to the drain, thus causing a significant load on the wastewater due to the high concentration of salt. The inputs and outputs of cheese brining are described in fig. 3.9.

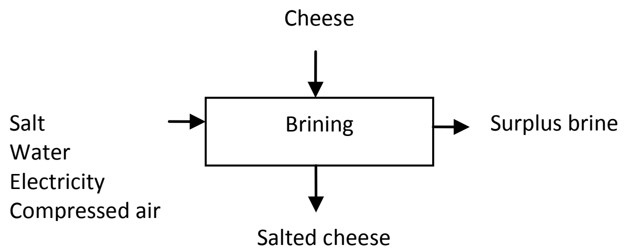

Figure 11: Inputs and outputs of cheese brining

3.4.4 Ripening

Ripening of cheese induces a series of microbiological, biochemical and physical changes in the cheese. The ripening takes place in storage under controlled conditions and involves several ripening stages with specific combinations of temperature and humidity. A complete air conditioning system is required to maintain the ripening conditions.

Environmental issues
The cheeses are covered to prevent drying and to protect the cheeses from dirt. Cheese with rinds can be covered with paraffin or wax, whereas rindless cheese is wrapped in plastic film. The ripening temperatures in the ripening rooms are strictly maintained, which requires large quantities of energy. Cooled storages consume refrigerants, some of which might accidentally leak into the air. The inputs and outputs of the ripening of cheese are described in fig. 3.10.

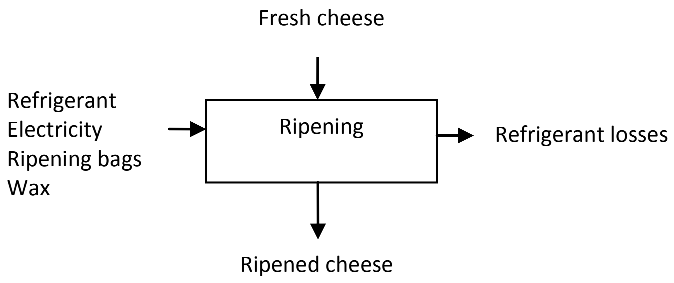

Figure 12: Inputs and outputs of cheese ripening

3.4.5 Ultrafiltration

Ultrafiltration (UF) is a membrane technology used for concentration of large and macromolecules. In cheese manufacturing it can be used for concentration of milk protein and fat in order to standardize the protein to fat relation.

In Egypt, UF is largely used to produce cast feta and Domiati cheese using whole pasteurized milk or high reconstituted skimmed milk with palm oil. UF is carried out at approximately 50°C. The retentate (concentrate) is cooled to renneting temperature. Salt, $CaCl_2$, sorbate and rennet are added. The retentate is poured into stainless pans, incubated on 45 for 4 hours, kept in cold rooms overnight before they are cut to blocks. The cheese blocks are packed in plastic packs. Also the rennetted concentrate is packed in Tetra Paks. The warm permeate, containing only lactose, some minerals and non-protein components, is used to heat the incoming milk in the regenerative section of the pasteurizer.

For the production of feta-cheese retentate from the UF process is mixed with culture or GDL, rennet and salt, and the mixture is allowed to coagulate in packs. The curd is allowed to acidify and is subsequently filled in tins together with brine.

Environmental issues
UF limits the losses of protein and fat. However, the cleaning of the membranes requires large quantities of water, heat and cleaning chemicals.

3.4.6 Processed cheese

Processed cheese is made from finished cheese, milk powder, milk protein, butter and palm oil by further processing into cheese spreads with soft consistency or firm cheese blocks. The process comprises mixing the different ingredients, followed by heating under vacuum in steam-jacketed cookers and blending with emulsifiers and stabilizers.

The cheese used as raw material for this process can be either high quality cheese or cheese with defects. Several types are usually blended together.

3.4.7 Karesh

Karesh is a product defined as an unripened curd cheese made of sour skimmed milk. The skimmed milk is pasteurized at high temperature (85-95°C, 5 – 15 min), followed by cooling to 25-28°C. A coagulum is formed by addition of starter and a small amount of rennet, followed by incubation. The obtained coagulum undergoes termination and is then self-drained, pressed or ultra-filtered. Salt is added and the cheese is packed. The whey from Karesh cheese is collected for further treatment.

3.4.8 Packing

Processed cheese spreads are usually packed in plastic tubs with an inner lid of aluminium foil. Soft cheeses like cottage cheese are packed in small plastic containers, whereas others, like Camembert are wrapped in aluminium foil or paper. Aluminium foil is also used for blue veined cheeses.

Hard cheeses can be packed as such in cardboard boxes, or cut into smaller blocks that are packed in plastic bags. Before the cheeses are cut, the rind is cut off and collected together with non-conforming pieces for further processing into grated or processed cheese.

Many cheese types are brushed or washed after ripening before being packed in retail packages.

Environmental issues

The major wastes from the packing of cheese are solid wastes in the form of discarded cuts and small pieces of cheese, as well as spent ripening bags and wax residues. In addition, there are liquid discharges from cleaning of surfaces and packaging machines. The inputs and outputs are described in Figure 13.

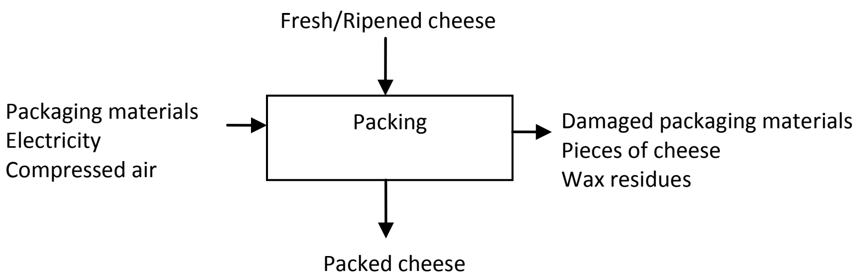

Figure 13: Inputs and outputs of packing of cheese

3.5 Whey processing

When cheese is produced, 10-25% of the milk is converted to cheese and the remaining 75-90% is whey. Whey from cheese manufacture is known as sweet whey as from Gouda, Edam, or acid whey as from Mozzarella, or salted whey as from Roumy and Domiati cheese, or milk permeate as from UF cheese. It still contains about 50% of the nutrients from the original milk. The valuable nutrients of whey can be recovered by means of several different processes. The predominating products today are whey powder, demineralised whey powder, lactose and de-lactosed whey powder.

Whey concentrate or powder is used both as animal feed and for human consumption. Lactose can be used for human consumption and in industrial products.

3.5.1 Separation

Regardless of the treatment of whey, the first step is always separation of cheese fines and cream, because these components interfere with the subsequent treatment.

The cheese fines (casein) are removed first, either by means of cyclones, centrifugal separators or rotating filters. The recovered fines can be pressed as cheese and used in processed cheese.

The fat is recovered in centrifugal separators and can be used for standardization of the cheese milk.

Whey is an excellent growth media for bacteria and must therefore be processed as soon as possible after collection. If this is not possible, the whey has to be chilled or pasteurized as soon as the fat has been removed.

3.5.2 Concentration

RO (reverse osmosis) is often used to pre-concentrate the whey. It is based on a membrane technology, which retains both high and low-molecular substances. The permeate consists of water, which can be used internally in the dairy for cleaning purposes.

The pre-concentrated whey is then evaporated to its final concentration (45-65% dry matter) under vacuum in evaporators. Most of these evaporators are equipped with mechanical and/or thermal vapour compression in order to save energy.

The concentrated whey can be further dried to powder in the same way as milk in drum or spray dryers

Whey proteins can also be separated from the whey by a combination of denaturation with heat (90-95°C) and precipitation with acid. The obtained denatured whey protein is precipitated, collected and pressed. The by product could be sold as Ricotta cheese from sweet or acid whey; or Mish cheese from Roumy cheese whey (5% salt); or used in the manufacture of soft and semi-hard cheeses to improve structure and yield.

Environmental issues

The application of membrane processes requires special cleaning chemicals (mainly acids and lye), thus generating wastewater containing chemicals and energy.

3.6 Production of milk powder

The evaporation is used as a first step to reduce the moisture content, followed by drying. The reason for this is that the drying process requires up to twenty times more energy per kilogram of evaporated water than the evaporation process.

Today the need for energy efficiency has resulted in the use of multiple-effect evaporators and double-stage dryers.

3.6.1 Evaporation

In the dairy industry evaporation is used for preconcentration of skimmed milk, milk and whey before drying and for production of condensed milk. In the case of preconcentration of milk, the solids content to be obtained lies in the range of 45-50%. For condensed milk, a solids content of 25-33% is required. The initial solids content of milk is 9-13%.

Falling film evaporators are the most commonly used evaporators. They usually have a tubular structure made of stainless steel, but plate-type evaporators are also applied. The pasteurized milk is introduced at the top of the evaporator and is distributed as a thin film that flows down over the heating surface, which is surrounded by steam. The milk is preheated to the evaporation temperature before entering the evaporator. The milk becomes slightly superheated in the evaporator and part of the water is vaporized immediately.

By connecting several evaporators in series multiple effect evaporation is achieved, which improves the energy efficiency, as the vapour from the first effect can be used as the heating medium in the following effect.

Environmental issues

The most significant impact of the evaporation process is the high level of energy consumed. The thermal vapour recompression (TVR) evaporators also generate noise.

The condensate from the evaporators is usually regarded as clean enough to allow direct disposal, but it is often collected and used for cleaning purposes instead of hot water. Improper adjustments of the equipment can, however, cause pollution of the condensate by milk solids and the reuse of condensate for cleaning is therefore a controversial subject. Another solution commonly applied is to use condensate as feed water to the steam boiler. The inputs and outputs of the evaporation process are shown in fig. 3.12.

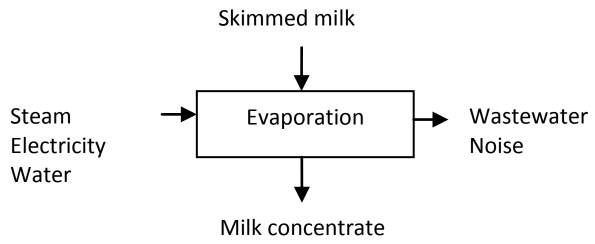

Figure 14: Inputs and outputs of the evaporation process

3.6.2 Spray drying

In spray drying an atomiser disperses the pre-concentrated milk as fine droplets into a conical base chamber, where it is mixed with hot air of 150-250°C. The water in the milk is evaporated and the milk settles as a powder at the bottom of the spray tower. The powder is pneumatically conveyed to the packing section by cooling air.

As the last traces of moisture are the most difficult to remove, spray drying is often carried out as two-stage drying, where the pneumatic conveying system is replaced by a fluid-bed dryer. In the fluid-bed dryer excess moisture is removed and the powder is cooled down. The fluid bed is connected to the bottom of the drying chamber and consists of a casing with a perforated bottom. The powder is conveyed through the dryer by vibration. The incoming powder passes through drying sections, where air at a gradually decreasing temperature passes through the bed. Finally the powder is separated from the air in a system of cyclones.

Environmental issues

The fine milk powder residues in the exhaust air from the drying system are a possible source of pollution, as they cause acidic deposits on the surrounding areas. This can be prevented by the use of filters or scrubbers.

The presence of hot air and fine dust creates a fire and explosion hazard. All modern dryers are equipped with explosion release mechanisms and fire prevention systems.

Cleaning of the spray tower is normally a dry operation, as moisture can induce bacterial growth.

A large amount of heat is lost in the drying process. Some of it can be recovered from the exhaust air in specially designed heat exchangers. It is also possible to use the heat of the condensate from the evaporation process in the drying process, which can save some 5-8% of the drying costs. The inputs and the outputs of the spray drying process are shown in Figure 15.

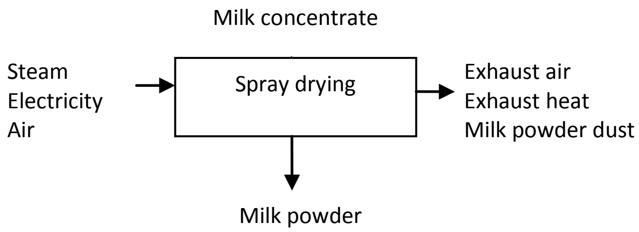

Figure 15: Inputs and outputs of the spray drying process

3.6.3 Packing

The powder is usually packed in multi-layer paper bags with an inner bag of polyethylene, which is welded. The bag sizes are usually 15 and 25 kg, but also big bags are common. Containers and barrels are also used. The bags are stored on pallets and shrink-wrapped for protection.

Environmental issues

Milk powder dust from leaking sacs and from the filling operation can cause corrosion of the equipment, if it comes in contact with water. It is therefore important to keep the packing and storing areas dry. The dust also forms corrosive acidic deposits on the surrounding roofs, if it is let out in the exhaust air. The inputs and outputs of milk powder packing are described in Figure 16.

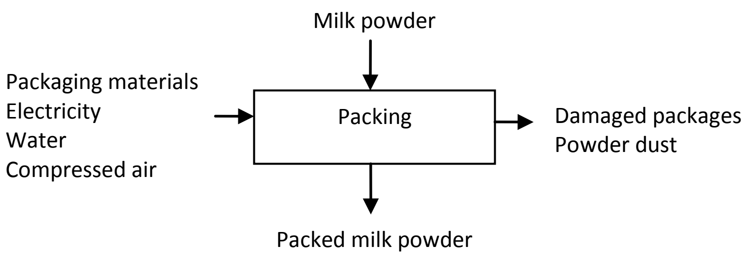

Figure 16: Inputs and outputs of powder packing

3.7 Ice cream production

3.7.1 Ice cream production

There are four main categories of ice cream:

- ice cream made exclusively of milk products
- vegetable fat ice cream
- sherbets made of fruit juice with addition of milk based ingredients
- water ice (granita) made of water, sugar and fruit concentrate.

The ice cream manufacturing process comprises the basic steps shown in Figure 17.

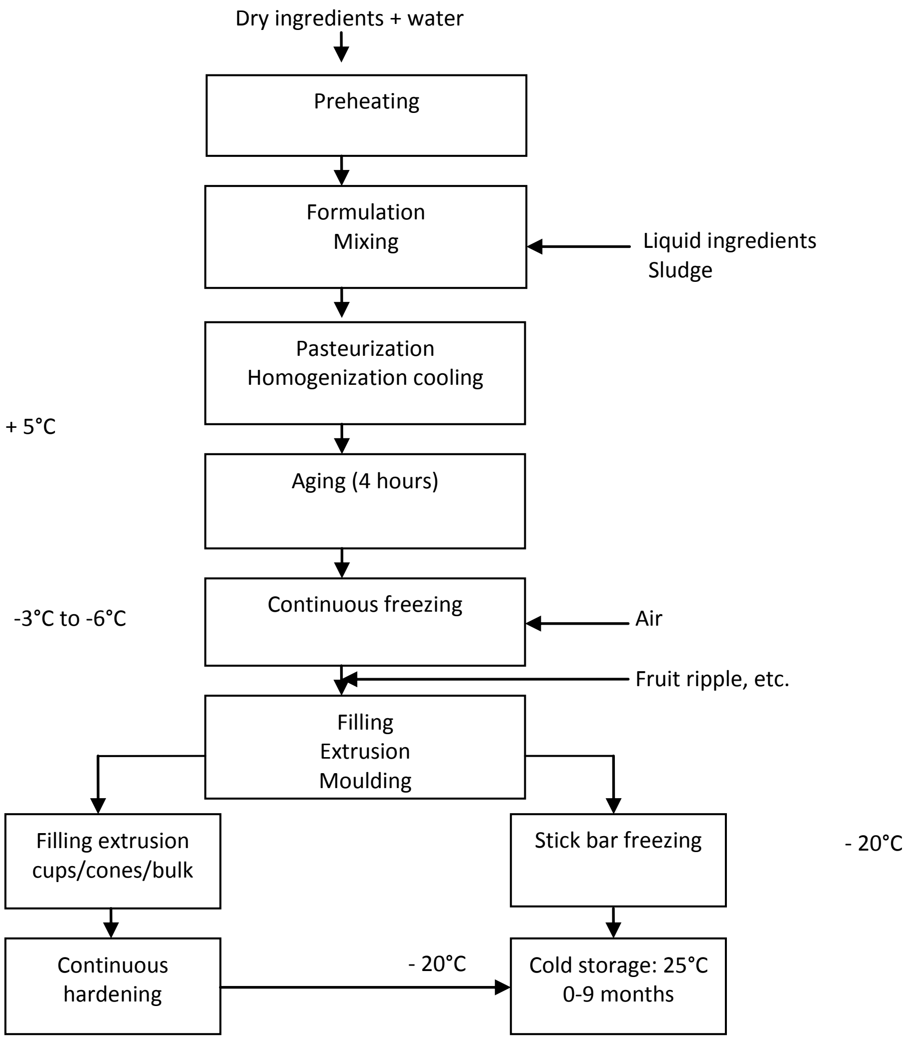

Figure 17: Inputs and outputs of the ice cream manufacturing process

3.7.2 Production of ice cream mix

The ice cream manufacturing involves handling of both dry and liquid raw materials. They are stored in silos, tanks, containers or bags. Milk products are chilled before storage, whereas high viscosity products like glucose, vegetable fat and anhydrous milk fat must be stored at higher temperatures (30-50°C). When butter is used as an ingredient, it is melted and stored in tanks, usually under protection of an inert gas (N_2). The dry ingredients must be stored and handled in a dry area. Dry bulk materials, such as crystalline sugar and milk powder, can be stored in silos.

The ingredients are weighed or metered by volume into a mixing tank equipped with an efficient agitator. The mixture is heated indirectly and blended to a homogenous mass.

The ice cream mix is preheated to 73-75°C in a plate heat exchanger before being homogenized. Then the mix is pasteurized at 83-85°C for about 15 seconds and cooled to 5°C.

The mix is then aged in an ageing tank for at least 4 hours at 2-5°C while being gently agitated. During the ageing the fat crystallizes and the stabilizer takes effect.

Environmental issues

The heating and pasteurization steps require energy in the form of hot water and steam. Chilling water is required for cooling. Rinsing of the equipment generates wastewater containing milk residues and fat. The inputs and outputs of the ice cream mix preparation are described in Figure 18.

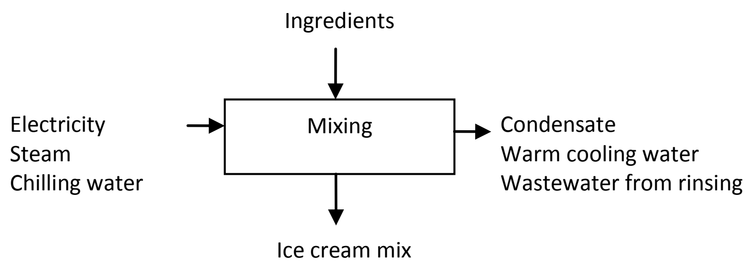

Figure 18: Inputs and outputs of ice cream mix production

3.7.3 Freezing, whipping and filling

After ageing, the ice cream mix is pumped into a continuous freezer, which consists of a cylinder with a cooling jacket containing ammonia, and a rotating scraper that continuously scrapes off the frozen mix from the inner wall of the cylinder. The freezer has a dual function:

- to freeze the water in the mix
- to whip air into the mix

The mix is frozen to a temperature between –3° and –6°C while 80–100% air is being incorporated. The texture of the frozen mix is soft, which makes it suitable for pumping and subsequent processing, that is either packing, extrusion or moulding.

The ice cream is filled in cups, cones or containers in a filling machine and the packages are passed through a hardening tunnel, where the ice cream is frozen to –20°C.

The ice cream can also be extruded on trays or into moulds in a tray tunnel extruder.

The trays pass through a hardening tunnel for final freezing to –20°C. After hardening the products are removed from the trays, wrapped and packed in cartons.

Moulding of ice cream bars with sticks takes place in specially designed freezers. The ice cream is filled directly from the continuous freezer into moulds, which are conveyed through a brine bath of –40°C. The frozen bars are removed from the moulds by passing them through a warm brine solution, which melts the surface of the bars.

The bars are automatically extracted and can be dipped in chocolate before wrapping.

Environmental issues
Freezing of ice cream mix requires electricity for whipping and refrigerant (ammonia) for freezing.

Filling mistakes cause mainly solid wastes consisting of product and discarded packaging material.

Handling of non-conforming products is usually regarded as problematic what ice cream lollies and cones are concerned. The ice cream is usually separated from the stick and the wrapping by hand. If the product is already hardened, it has to be melted first. Bulk packages melt slowly at ambient temperature, and the melting must therefore be quickened with the aid of hot water.

The ice cream mix from non-conforming products and from mixer start-ups can be reworked into new products, provided that it is of good quality. Ice cream mix, which is not suitable for reworking, can be sold as animal feed. The inputs and outputs of the process are described in fig. 3.17.

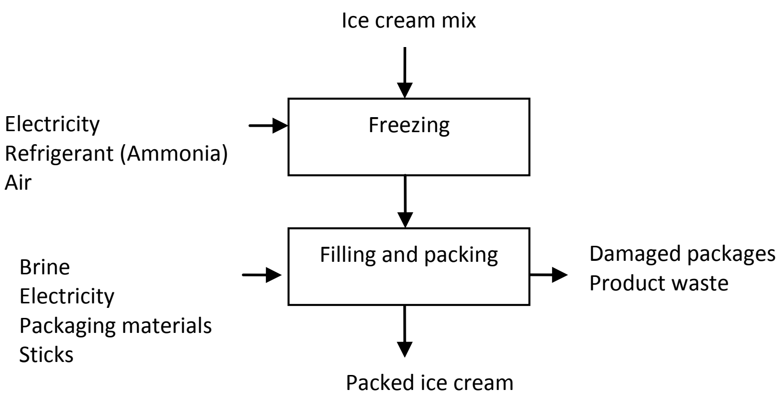

Figure 19: Inputs and outputs of ice cream freezing, filling and packing

3.7.4 Hardening and storing

Products packed in cups, cones and containers require final hardening in a hardening tunnel at -20°C. The individually packed products are packed in cartons and stored in a cold storage on shelves or pallet rackets at -25°C.

Environmental issues
Storing of frozen products requires considerable amounts of refrigerants and electricity for the cooling compressors. The maintenance of the cooling equipment is of great importance in order to avoid accidental leakage of refrigerants.

The inputs and outputs of the process are described in Figure 20.

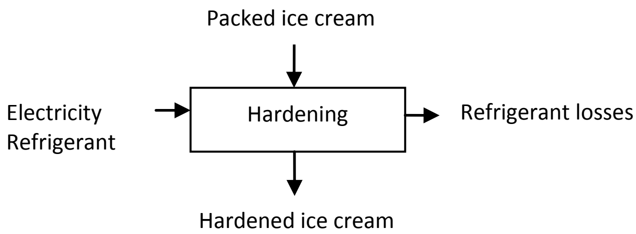

Figure 20: Inputs and outputs of ice cream hardening

3.8 Packaging and storing

Liquid dairy products are mainly packed in beverage carton packages of various sizes. *Yoghurts* and related products are packed in plastic cups with lids of aluminium foil or plastic-coated paper. Carton and cardboard boxes are used as secondary packaging material. These packages are, in turn, wrapped together in plastic film and stored on wooden pallets.

Other products, such as *butter and cheese*, are wrapped in aluminium foil, plastic film or filled in small plastic containers.

For *fresh dairy products* packed in beakers it is common to use cardboard or plastic trays as secondary packaging. The trays are used both for transportation and for displaying the products in stores. They prevent damages to the beakers and protect the content from external shock. The plastic trays are returned to the dairy and are reused after being washed.

Roller cages of metal are used for transportation and displaying of liquid products in beverage cartons. The cages are also returned to the dairy, where they are washed before being reused.

The equipment used for packaging consists of filling machines, conveyors, mechanical tray formers, wrapping machines and palletizers. The packages are transported to the storages by means of forklifts and electrical trucks.

Most dairy products require storing in cool storages with a temperature below +6°C. The production is usually planned in such a way that the storing time for fresh products is kept to a minimum. Season products like ice cream are usually produced in advance and stored for longer periods.

Environmental issues

The consumption of packaging materials and the solid wastes deriving from damaged or otherwise non-conforming packages are the main environmental issues related to the packaging operations. The use of recycled material in primary packages is not possible due to hygienic safety reasons.

Refrigerated or deep freeze storage requires large amounts of cooling energy and refrigerants, depending on the size and temperature of the storage spaces.

3.9 Cleaning and disinfection

The cleaning represents an essential part of the operations in a dairy plant. The specific hygiene standards and cleaning requirements are normally defined by the authorities.

The objective of cleaning dairy processing equipment is to achieve chemical and bacteriological cleanliness, which means that the equipment is first thoroughly cleaned with chemical detergents followed by disinfection with a disinfecting agent.

3.9.1 Cleaning in place (CIP)

The design of modern dairy equipment allows cleaning and disinfecting to take place without dismantling of the equipment, i.e. cleaning-in-place (CIP). Rinsing water and cleaning solutions are pumped through all the components that are in contact with product and some equipment has built-in cleaning nozzles to improve the distribution of the cleaning solution.

The cleaning solutions are generally distributed to the CIP circuits from a central CIP station consisting of several tanks for storing of the cleaning solutions. The solutions are heated by steam and their concentration is constantly monitored and adjusted.

The cleaning programme differs according to the equipment to be cleaned, but the main steps are:

- Pre-rinsing with water
- Cleaning by circulation of detergent
- Final rinsing with water
- Disinfection
- Cooling with water

3.9.1.1 Pre-rinsing

The equipment is rinsed with warm water to remove any product residues for 3–10 minutes. The rinsing water is usually collected separately for further treatment in order to minimize pollution.

3.9.1.2 Cleaning

The equipment is cleaned by circulation of an alkaline solution (usually sodium hydroxide of 0.5-1.5%) at 75°C for about 10 minutes. Equipment like pasteurizers, with hot surfaces requires longer circulation times and stronger solutions.

The returning cleaning solution is directed back to the detergent tank for reuse. For this purpose, the return pipes are equipped with conductivity transmitters, which detect the content of the pipe.

If required, alkaline cleaning is followed by cleaning with acid. In this case an intermediate rinsing with warm water must be carried out between the cleaning steps in order to rinse out the alkaline solution. The acid solution (nitric acid of 0.3–0.7%) is circulated for about 5 minutes at 65°C. 'Hot' equipment requires a circulation time of 30 minutes.

3.9.1.3 Final rinsing

Any remaining cleaning solution is rinsed out with warm or cold water. Chemical-free water from the final rinsing is usually collected and reused for pre-rinsing.

3.9.1.4 Disinfecting

The disinfection step is normally carried out immediately before the production line is to be used again. This can be done either chemically by use of a disinfecting agent (e.g. hydrogen peroxide, peracetic acid, sodium hypochlorite), or by circulating hot water of 90-95°C for about 10 minutes.

3.9.1.5 Cooling

If the equipment has to be cooled down or if the disinfecting agent must be flushed out, the equipment is rinsed with cold water.

3.9.1.6 Exceptions

Special equipment, like UF-plants or other membrane appliances, has its own special detergents and internal cleaning circuits in order to prevent damage to the membranes. The chemicals used are mainly phosphoric, sulphuric and hydrochloric acid as well as potassium hydroxide.

Butter making machines are cleaned separately from the ordinary CIP plant due to the large amount of residual fat in the machines.

Environmental issues
The use of central CIP units reduces the amount of cleaning solutions needed, thus saving both detergents and water. Cleaning is still one of the most water-consuming operations in the dairy, accounting for 24-40% of the total water consumption.

The pollution load on the wastewater is high due to residual milk fat and proteins as well as cleaning chemicals. The organic load caused by the cleaning chemicals is minor; the main problem is the fluctuation of the pH of the wastewater, which disturbs the balance of the wastewater treatment plant. The storage of concentrated chemicals also represents a risk, both for the environment and the occupational safety. .

The cleaning solutions can be replaced by commercially available CIP-detergent mixtures, in which the cleaning properties of alkaline and acid detergents are combined. However, some of these mixtures contain phosphates and tensides, which increase the load on the wastewater. The inputs and outputs of cleaning are described in Figure 21.

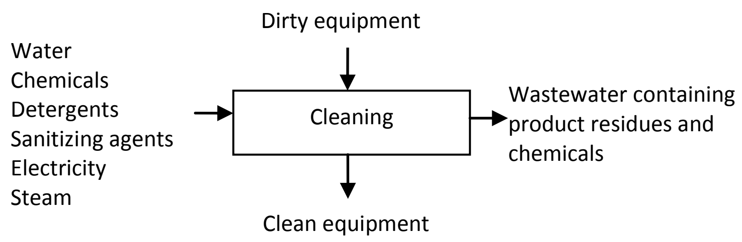

Figure 21: Inputs and outputs of CIP

3.9.2 Manual cleaning

Manual cleaning is required whenever cleaning-in-place is not possible. The floors of the production facilities are manually cleaned and any product spills on the floor or on the outside of the equipment have to be manually flushed. Special detergents and foams are used in combination with low-pressure cleaners and brushes.

Environmental issues
Manual cleaning consumes a great deal of water. Leaking hoses and taps increase the water consumption even further. The water containing detergents and product residues usually flows directly to the drain.

3.9.3 Cleaning of milk tankers

The road tankers are cleaned every day at the end of each collection round. The cleaning takes place in the reception area or in a special cleaning station by connecting the tanker to a cleaning system. The outside of the tanker is also cleaned daily.

Environmental issues
The cleaning of the milk tankers has the same environmental impact as the other cleaning operations mentioned above. In addition, the cleaning of the outside of the tanker produces wastewater containing sand particles, heavy metals, road salt and lubricants.

3.10 Utilities & general processes

3.10.1 Steam

Steam of 140-150°C is the most frequently used heating medium in dairy processing. It is produced in a steam boiler and distributed to the processing area by insulated pipes. The condensate is returned to a condensate tank and is recirculated as boiler feed water. The boiler is normally fuelled with oil, coal or gas, but also electricity can be used. Depending on the efficiency of the boiler and the heat losses in the distribution pipes, about 65-77% of the total thermal energy can be utilized in production.

Environmental issues

When fossil fuels are used for steam production, the boiler plant emits carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen oxides (NO_X) and polyaromatic hydrocarbons. Inadequate adjustment of the combustion process increases the emission of flue gases even further. The storage of fuel oil is an environmental risk, as leakage can cause serious pollution of soil and water. The inputs and outputs of steam production are described in Figure 22.

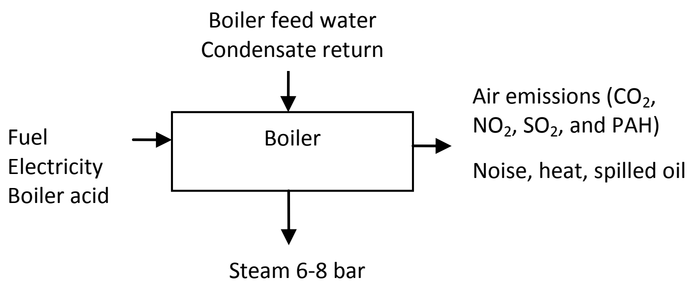

Figure 22: Inputs and outputs of a steam boiler

3.10.2 Electricity

Electricity is used for the operation of machinery, for refrigeration, ventilation, and lighting and for the production of compressed air. Dairies normally purchase their electric power from local distributors. The electrical system in a dairy comprises:

- high voltage switchgear
- power transformers
- low voltage switchgear
- generating set
- motor control centres

The environmental impact of the production of electricity depends on the primary source of electric power, and is therefore regarded as being out of scope of this report.

3.10.3 Compressed air

Pneumatically controlled automation systems are frequently used in dairies. Compressed air is also used for powering actuators in some equipment, such as filling machines and valves, for emptying product from pipes and for agitation. The compressed air is classified according to the quality demands of the application.

The compressed air is produced in an air compressor and is directed to a dehumidifier, where the water vapour is removed by cooling and precipitation. High quality air is further dried in adsorption filters and sterilized in sterile filters.

Drying of compressed air by cooling results in a dew point of +2°C, which normally is sufficient for the compressed air used in the production area. Drying by adsorption is required for air that will be used in areas where the temperature is below 0°C.

Environmental issues

Air compressors are driven by electricity and the consumption is quite high. Leaks in the pipelines increase the consumption. The compressors require cooling, which is usually done by water or air. The cooling water is often recirculated via a cooling tower in order to reduce the water consumption. It can also be used for cleaning purposes.

CFC-based refrigerants were formerly used in drying of compressed air, but they are replaced by less hazardous hydrogenated chlorofluorocarbons (HCFCs). In the near future also the HCFCs should be replaced by other refrigerants. The inputs and outputs of production of compressed air are described in Figure 23.

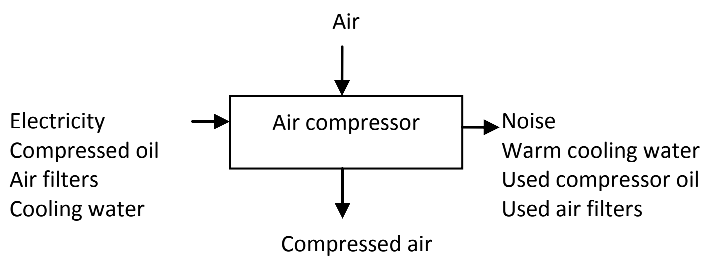

Figure 23: Inputs and outputs of compressed air production

3.10.4 Refrigeration

A refrigeration system is a closed system where the refrigerant cycles between gaseous and liquid form through alternate pressure reduction (expansion) and pressure increase (compression). When the refrigerant expands it vaporizes and absorbs heat from the surrounding liquid, the secondary coolant, which in turn is cooled. The absorbed heat is removed from the refrigerant in a condenser by air or water.

Ammonia is the most commonly used refrigerant, as the use of Freon is restricted due to its negative effects on the ozone layer. The secondary coolant is usually chilling water, brine or glycol.

Most dairies have chilling water basins or silos, where the chilling water is stored and cooled. These systems are usually accumulating, which means that ice is produced at night, when the electricity is cheaper. The benefits of an accumulating system are, however, reduced today, as the production often runs in three shifts requiring continuous chilling water production.

Environmental issues
The consumption of electricity is high. Also water is consumed in large quantities, especially for cooling of compressors and of the refrigerant. The water is recirculated to some extent, or used as secondary water for cleaning purposes.

In older plants the heat released from the refrigerant in the condenser is very often lost, whereas modern plants are equipped with heat recovery systems.

Refrigerant leaks are an important environmental issue, especially when Freons are used. Today most of the harmful CFCs are replaced by HCFCs, which in turn will be replaced in the near future. Ammonia and glycol leaks are also a problem, both for the health and safety of the personnel and for the environment.

Modern screw compressors are cooled by oil and the used compressor oil is classified as hazardous waste. The inputs and outputs of the process are described in Figure 24.

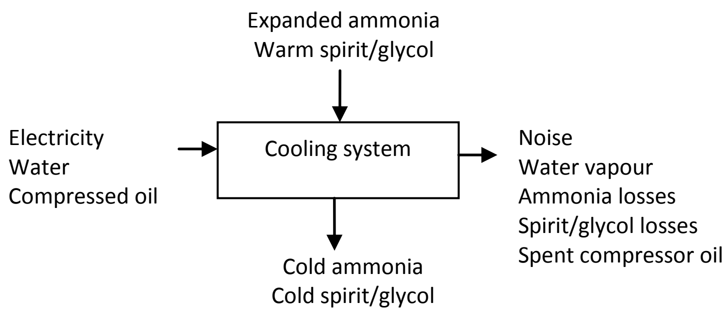

Figure 24: Inputs and outputs of cooling

3.10.5 Water supply

Dairy processing characteristically requires large quantities of fresh water. Water is used primarily for rinsing and cleaning of process equipment. The incoming water must be treated in such a way, that it meets with the quality requirements of the application.

The dairy water is often supplied from the municipal waterworks, which supply potable water. Many dairies have their own wells, which means that some pre-treatment of the water might be necessary.

Water used in dairy products must be of higher quality than drinking water. The pre-treatment often includes softening and dechlorination by filtration.

Environmental issues
Water is a valuable resource and excess use of it should be avoided whenever possible. Leaking water pipes increase the consumption considerably.

Pumping of water requires electricity, and the consumption is directly related to the water consumption.

3.11 Environmental issues in the Egyptian dairy industry

Environmental issues in the Egyptian Dairy Industry vary depending on the size of the plant. Large companies whether multinational or national use up-to-date technology with efficient control systems. On the other hand, small producers are using manual processes with less emphasis on health-related issues. The main issues of concern are:

3.11.1 Poor manufacturing practices in SMEs

Small and medium facilities do not implement GMP (Good Manufacturing Practices)
In regard to:

a. Workers wearing protective clothing and gloves
b. Flooring that does not allow bacterial growth
c. Screens are not installed on windows and doors, nor air curtains on doors
d. Raw material and product handling
e. Shoes are not always cleaned at the entrance of production facilities

3.11.2 Manufacturing practices in large facilities

Recently established medium to large companies as well as multinationals have high standards of operation as regard to water recycling, and reuse options. However, water and energy are neither monitored nor controlled.

3.11.3 Wastewater contamination

The wastewater generated from the dairy industry is characterized by its high BOD and COD levels. The limits required by law depend on the media that receives the discharged effluent. The following table presents a typical analysis for a dairy plant as compared to other sectors and the limits required by law.

Table 6: Analysis of wastewater for different sectors compared to limits required by law

	TSS, mg/l	BOD, mg/l	COD, mg/l	TDS, mg/l
Dairy Industry	12,150	14,000	21,100	19,000
Fruits and vegetable canning	2,200	800	1,400	1,270
Textile industry	1,800	840	1,500	17,000
Pulp and paper	1,640	360	2,300	1,980
Beverage Industry	760	620	1,150	1,290
Discharge to Public sewer	800	600	1,100	--
Discharge to coastal environment	60	60	100	±5% from sea TDS
Discharge to non-potable surface water	60	60	100	2,000

Wastewater contamination is mainly due to:

1. Leaks and spills from filling machines and out-dated equipment
2. Leaking milk valves
3. Lack of level control devices
4. Tank and line cleaning result in an effluent stream contaminated with milk
5. Water/milk mixtures are also generated at the start-up of the production line, when the water in the pipes is replaced by milk.
6. Discharge of out-of-specs dairy product into the wastewater
7. Discharge of whey into wastewater as only a small number of companies process or re-use cheese whey

3.11.4 Air pollution

The only source of air pollution in dairy plants is boiler stack emissions. Regular boiler tune up can keep the emissions within the limits of the law.

3.11.5 Water and energy conservation

Water and energy consumption are not regulated by law and there is no incentive for their conservation. Examples of lack of conservation practices:

- Bad or non-existing insulation of hot and cold lines
- Lack of pressure control on steam lines
- Lack of temperature control on pasteurizers

3.11.6 Lack of regulations and/or incentives for energy and water conservation

There are neither incentives nor regulations that would enforce energy and water conservation measures to be taken by plant owners, who usually show a lack of interest. This is reflected as:

a. No monitoring equipment for measuring water and electricity consumption at the different production lines

b. No development of benchmarks for water and energy use per ton of production due to lack of incentive
c. Poor housekeeping in SMEs

CHAPTER 4 AVAILABLE ENVIRONMENTALLY FRIENDLY TECHNIQUES

This chapter describes the various measures and techniques which can be implemented in the dairy industry to reduce or, better still, to prevent environmental impact. These environmentally friendly techniques are called 'candidate BAT'. The candidate BAT are discussed per thematic area. For each technique the following areas are addressed (based on the guidance 2012/119/EU, and adjusted according to needs in this report):
- description of the technique;
- applicability;
- environmental benefit and cross-media effects;
- economics, to determine economic viability;
- driving force(s) for implementation;
- example plants;
- reference literature.
The candidate BAT were identified by means of intensive literature survey, technical audits, discussions with operators, (con)federations, industry experts and representatives of authorities participating in the TWG.

This chapter concentrates on local issues. A more extensive description of each of the candidate BAT is available on http://www.bat4med.org, in the form of technical data sheets.

This chapter's information forms the basis for the BAT evaluation of chapter 5. Consequently, in this chapter it is not intended to decide whether or not a certain technique can be considered a BAT. In other words, the fact that a technique is discussed in this chapter does not necessarily mean that the technique is a BAT. In this chapter, each technique will be discussed without prejudging whether it meets all the BAT criteria.

4.1 Introduction

In the paragraphs below, available environmentally friendly measures are discussed. As mentioned in chapter 2, the focus here is on wastewater, water consumption, energy consumption and waste. Also, general measures, e.g. best management practices that have a positive impact on different aspects are mentioned.

For each of the environmental aspects, the main process steps generating impact are identified and candidate BAT are listed and described.

In this chapter, the descriptions of the techniques and measures are limited, while the focus is on local issues, specific for Egypt. For more elaborate descriptions and details, we refer to the technical datasheets in the candidate BAT database.

4.2 Water consumption

Water is an important input to numerous dairy processes:
- As process water for heat treatments;
- For cooling;
- For cleaning;
- For the production of steam;
- …

Where possible, a distinction should be made between classic water sources such as groundwater or tap water, and alternative sources like rainwater, captured or recuperated water.

4.2.1 W1: Transport solid materials dry

Database reference: technique number 1
Relevant process(es): general measure

a. Description

Raw materials, co-products, by-products and wastes can be transported without using water. For example, powders can be transported through air stream systems, cheese and yoghurt through Archimedes screws.

b. Applicability

In the dairy industry, this measure is not really considered relevant. Most (all) materials used are liquid. But if there should be a solid material used that would be transported using water, this technique becomes relevant. Also for solid wastes, this should definitely be applied.

c. Environmental benefit

- Reduced water consumption;
- Reduced wastewater production and pollution;
- Increased potential for recovery and recycling of substances e.g. to be sold as animal feed.

d. Financial aspects

Reduces cost for water consumption and wastewater treatment.
A higher price can be obtained for the by-product with less water content (e.g. animal feed).

e. Driving forces for implementation

Hygiene standards are improved.

f. Example plants in Egypt

No example plants known today in Egypt.

4.2.2 W2: Dry cleaning of equipment and installations

Database reference: technique number 2
Relevant process(es): general measure

a. Description

By removing as much residual material as possible from vessels, equipment and installations before they are wet-cleaned, the wet cleaning can be minimised and the necessary hygiene standards maintained. Dry cleaning can be facilitated by providing and using catchpots with a mesh cover, making sure that suitable, dry clean-up equipment is always readily available and providing convenient, secure receptacles for the collected waste, amongst other things.

b. Applicability

The technique can be used, for example, to collect the solid residues from cheese production, sweep curd losses instead of washing them to the drain, treat spills of curd, yoghurt or ice-cream mix as waste rather than just washing them to the drain, and so on.

c. Environmental benefit

- Reduced water consumption;
- Reduced volume of wastewater;
- Reduced entrainment of materials in wastewater (less BOD and COD);
- Reduced use of energy needed to heat water for cleaning;
- Reduced use of detergents.

d. Financial aspects

Very cheap to operate (in Europe) plus the measure reduces costs for water consumption, heating, detergents…

e. Driving forces for implementation

Reduced energy and water use, reduced need for wastewater treatment and lower detergent use and expenditure.

f. Example plants in Egypt

SMEs: Reyada, Dina, Farm cheese, Domty, El Masryeen,…

4.2.3 W3: Selecting water sources according to the required quality

Database reference: technique number 3
Relevant process(es): general measure

a. Description

There are different sources of water: classic water sources (like ground- and tap water) and alternative sources like rain, catchment and recovered water. Purified wastewater should be reused if possible. However, the reuse of water as well as the reuse of rainwater or collected water can be subject to a number of legal, technical and social restrictions.

b. Applicability

With effective production planning, it is technically viable in all dairy companies to select water sources according to the required quality. Alternative water sources might, for example, be used for steam generation, fire prevention, cooling, ice water or external cleaning of lorries.

In Egypt however, this technique is not applicable, since the only readily available water source is tap water. Also, any reuse of purified wastewater is prohibited by legislation, even for sanitary purposes inside the plant.

c. Environmental benefit

- The quantity of fresh water can be limited;
- Over-pumping of water supply layers and the resulting exhaustion and quality change is prevented by only pumping the amount of groundwater needed;
- Reduction of the amount of wastewater, by using purified effluent as an alternative source.

d. Financial aspects

In general, the measure is economically viable for all dairy companies, although a high level of investment may be needed to modify infrastructure in existing dairy companies.

e. Driving forces for implementation

Scarcity of water (regional) might be a driving force for implementation of this measure.

f. Example plants in Egypt

No example plants known today in Egypt.

4.2.4 W4: Minimise/optimise water consumption

Database reference: technique number 4

Relevant process(es): general measure

a. Description

Different measures might be implemented to optimise water supply, e.g. automatically start/stop water supply so that fresh process water is only added if necessary, water hoses fitted with a manual firing trigger or pressure-regulated water supplied via spraying valves.

b. Applicability

In some form (whether this is only one measure or several) technically viable for all dairy companies. An example is the use of automated cleaning of milk collection trucks where water use is optimally matched to the type of milk collection truck.

c. Environmental benefit

- Reduction of the amount of fresh water used;
- Reduction of the amount of wastewater.

d. Financial aspects

Optimisation of the water supply through implementation of one or several measures is economically viable for all dairy companies.

e. Driving forces for implementation

Reduced water consumption and possibly related costs.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.2.5 W5: Pre-soak floors and open equipment to loosen dirt before cleaning

Database reference: technique number 5
Relevant process(es): general measure

a. Description

Pre-soaking can loosen the dirt and make subsequent cleaning easier.

b. Applicability

Applicable where hardened or burnt-on dirt needs to be removed during cleaning.

c. Environmental benefit

Depending on the circumstances, the consumption of water and energy for heating water may be reduced. The consumption of chemicals may be reduced.

d. Financial aspects

There might be a reduction in total cost of water, energy and chemicals because of reduced consumption. However, this technique might become time consuming and as such increases the downtime.

e. Driving forces for implementation

Easier cleaning and possibly reduced cost of water, energy and chemicals.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.2.6 W6: Minimisation of centrifugal separator waste discharges

Reference database: technique number 6

a. Description

Both the frequency and the volume of waste discharges from centrifuges are usually specified by the manufacturers of the equipment. By checking the actual performance against the specification and running the equipment at its specified performance, the amount of waste might be reduced. This is a matter of quality assurance.

By improving the preliminary milk filtration and clarification processes, the deposits in the centrifugal separators are minimised, leading to a reduction of the frequency of cleaning.

b. Applicability

Applicable for all centrifugal separators.

c. Environmental benefit

- Reduced wastage of raw materials;
- Reduced water consumption and wastewater pollution.

d. Financial aspects

Reduced losses.

e. Driving forces for implementation

Reduced loss of raw materials and increased yield.

f. Example plants in Egypt

All large scale plants, like Juhina, Enjoy and Biety.

4.2.7 W7: CIP (cleaning-in-place) and its optimal use

Database reference: technique number 7
Relevant process: general measure

a. Description

CIP systems are cleaning systems that are incorporated into equipment and can be calibrated and set to use only the required quantities of detergents and water at the correct temperature conditions. CIP systems can be optimised, for example by incorporating the internal recycling of water and chemicals, carefully setting operating programmes, which coincide with the real cleaning requirements of the process, using water efficient spray devices and by removing product and gross soiling prior to cleaning.

b. Applicability

Applicable to closed/sealed equipment through which liquids can be circulated, including e.g. pipes and vessels. Smaller companies will have fewer opportunities to implement this, since the type of equipment needed is less present in those companies.

c. Environmental benefit

- Reduction of water consumption;
- Reduction of detergents used;
- Reduction of energy needed to heat water;
- When reuse of water and chemicals is possible: reduction in amount of wastewater.

d. Financial aspects

The capital cost is high. CIP is usually integrated in new equipment. Retrofitting a CIP system may be possible, but is potentially more difficult and expensive.
CIP optimisation reduces costs of water, energy and chemicals.

e. Driving forces for implementation

Automation and ease of operation. Reduced requirement to dismantle and reassemble equipment for cleaning.

f. Example plants in Egypt

All large scale plants, like Juhina, Enjoy, Biety, etc.

4.3 Wastewater

In the dairy industry, there are different sources of wastewater:

- Cooling water;
- Cleaning water;
- Condense water;
- Waste flows containing dairy products;
- …

4.3.1 WW1: Minimising the use of EDTA

Database reference: technique number 8
Relevant process(es): general measure, during cleaning

a. Description

In many cases in CIP, the acid step is not required and cleaning is undertaken using only the alkali step. In these cases, if limescale and deposits are present, it is reported that they can only be removed with the help of a chelating agent such as EDTA. EDTA forms very stable and water soluble complexes which are not normally degraded in biological WWTPs, so the heavy metals remain in the wastewater and not in the sludge, and they are discharged to surface waters. The EDTA can then also remobilise heavy metals from river sediment. Furthermore, nitrogen contained in EDTA may contribute to eutrophication of waters.

By optimising the milk processing time and using good quality raw milk, in which proteins have a higher heat stability, the formation of milkstone can be reduced. Multiple phase cleaning, i.e. using both acids and alkalis, can be used. A change-over from single-phase cleaning with EDTA to two-phase cleaning with NTA as a substitute is possible at least for the lower temperature range of pasteurisers.

b. Applicability

Applicable in all dairies. However, today in Egypt, EDTA is not used. Instead, other alternatives are used, like caustic soda.

c. Environmental benefit

Optimal use of milk and reduced EDTA consumption.

d. Financial aspects

Optimal use of raw materials and chemicals reduces costs.

e. Driving forces for implementation

Optimal use of milk and reduced EDTA consumption.

f. Example plants in Egypt

All large scale plants, like Juhina, Enjoy and Biety.

4.3.2 WW2: Prevent the use of halogenated oxidizing disinfectants and sterilizers

Database reference: technique number 9
Relevant process(es): general measure

a. Description

The chemicals used for disinfection and sterilisation of equipment and installations operate on the principle that they affect the cell structure within bacteria and prevent their replication. Assessment of the environmental and human health effects of active substances in disinfectants is ongoing. The halogenated oxidizing disinfectants and sterilizers react with organic components in the wastewater, forming toxic substances. They can also have a negative effect on wastewater treatment.

b. Applicability

Avoid using halogenated oxidizing disinfectants and sterilizers can be applied in all dairy companies, when there are enough alternatives available. In Egypt, these substances are hardly ever used: instead, hot water is used to carry out the disinfection

c. Environmental benefit

The negative effects (risk of ozone depletion and global warming) of halogenated oxidizing disinfectants and sterilizers can be reduced.

d. Financial aspects

No significant cost effects are generated by this technique.

e. Driving forces for implementation

Reduced risk and increased product quality.

f. Example plants in Egypt

This technique could be applied in all dairy plants in Egypt, but is not relevant for the situation as it is (not used today).

4.3.3 WW3: Provision and use of catchpots over floor drains

Database reference: technique number 10

Relevant process(es): general measure

a. Description

A catchpot can prevent solids from entering the drainage system and the wastewater treatment plant.

b. Applicability

Applicable to all installations, widely applied in the food sectors.

c. Environmental benefit

Solids which are not prevented from falling on the floor by other means do not enter the wastewater. This reduces the SS, BOD, COD, FOG, total nitrogen and total phosphorus in the wastewater.

However, it increases solid waste.

d. Financial aspects

Very cheap to operate and requires little investment.

e. Driving forces for implementation

Reduced contamination of wastewater.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.3.4 WW4: Segregation of effluents to optimise use, re-use, recovery, recycling and disposal

Database reference: technique number 11

Relevant process(es): general measure

a. Description

There are generally four types of water streams present in a dairy installation, i.e. water directly associated with use in process, domestic/sanitary wastewater, uncontaminated water and surface/rainwater. A water segregation system can be designed to collect these water streams and separate them according to their characteristics, e.g. contaminant load.

b. Applicability

Segregation of wastewater is applicable in new and substantially altered existing installations. Some water reuse opportunities exist in existing installations, but only very simple situations where e.g. the output of a process is partly used as input again. Retrofitting an entire segregation system on the other hand requires high costs and possibly entails physical or engineering constraints.

c. Environmental benefit

Reduced contamination of water and reduced volume of wastewater.
Reduced water consumption.
Possible heat recovery and thus reduced energy consumption.

d. Financial aspects

There is a high capital cost, however this may be offset by the reduced running costs due to the lower requirement for wastewater treatment. Reduced costs associated with water consumption and in some cases energy consumption. Retrofitting is often too expensive.

e. Driving forces for implementation

Reduced waste because materials recovered can be used. Reduced wastewater treatment and waste disposal and the associated reduced costs.

f. Example plants in Egypt

This technique is applied in many dairy plants in Egypt, however hardly in the really extended way where the entire segregation system is implemented.

4.3.5 WW5: Use of self-neutralisation

Database reference: technique number 12
Relevant process(es): general measure

a. Description

The objective of neutralisation is to avoid the discharge of strong acid or alkaline wastewater. It can also protect downstream wastewater treatment processes. The term self-neutralisation is used when, in some cases, the size of the equalising tank in combination with suitable variations in the pHs of the wastewater streams, means that no addition of chemicals is required.

b. Applicability

Applicable in installations with strongly acidic or alkaline wastewater. Self neutralisation can be applied e.g. in dairies where both acid and alkaline cleaning solutions are used and are both sent to the neutralisation tank.

c. Environmental benefit

Avoids effects of strongly acidic or strongly alkaline wastewater.
Due to the addition of chemicals to the wastewater, the dissolved solid/salt content may increase significantly in the treated water and the solid waste produced might be difficult to dispose of.

d. Financial aspects

Overall, the technique is considered to be economically viable for the whole sector.

e. Driving forces for implementation

Avoids effects of strongly acidic or strongly alkaline wastewater.

f. Example plants in Egypt
This technique is applied in all large scale plants, like Juhina, Enjoy and Biety.

4.3.6 WW6: Use of proper wastewater treatment technique

Database reference: technique number 13
Relevant process(es): utilities
a. Description
The aim of wastewater treatment is to make wastewater suitable for discharge. The aim of a buffer is to realise a consistent volume and possibly a consistent quality. It is implemented to allow further purification processes to run as effectively as possible. The aim of primary treatment is to physically remove solids and sedimentary matter from the wastewater. Secondary treatment primarily involves the removal of organic substances and nutrients (e.g. nitrogen and phosphorous). The aim of tertiary treatment is to thoroughly purify wastewater, by N and P removal. Depending on where the treated wastewater is discharged (surface water, sewer) and the type and amount of contamination, a specific combination of primary, secondary and/or tertiary treatment is optimal.
In Egypt, when discharging onto the public sewer, the need for treatment is rather limited, since the requirements are much less stringent. However, when discharging into the surface water, the BOD needs to be reduced significantly, which requires aerobic treatment.
b. Applicability
The use of appropriate treatment of wastewater is technically viable in the dairy sector: a lot of knowledge is already available.
c. Environmental benefit
By implementing appropriate wastewater treatment consisting of primary and/or secondary and/or tertiary treatment techniques, it is possible to limit the amount impurities that enter the environment. By reusing the purified water as process water, the amount of fresh water consumed can be limited.
d. Financial aspects
The cost of treatment of wastewater can vary greatly depending on the type, design and size of the purification system. The type of wastewater flow also has an impact.
For most Egyptian companies, that discharge into the surface water, the costs of the required treatment (secondary and/or tertiary) will be very high and therefore the technique will hardly ever be economically viable.
The paragraphs below provide a few examples of concrete cost price data concerning wastewater purification in Flemish dairy companies.

- The cost price for identifying the phosphorus content in wastewater amounts to approx €3 per analysis (2007).
- Comprehensive P-removal is accompanied by additional costs (also see appendix 5), incl. costs for:
- Silt disposal
  - The cost price for disposing of silt to the agricultural sector is e.g. determined by the season, and supply and demand. More silt automatically results in higher disposal costs. Silt can only be disposed of to the agricultural sector during

certain periods. Further, the silt must be pre-treated, e.g. via thickening. Storage capacity must be provided for periods when silt cannot be disposed of for agricultural purposes.

- The higher the P content in the silt, the lower the amount of silt that can be used per hectare.
- Silt from an actual dairy company (total silt quantity: approx. 820 tons/year; annual water volume: Approx. 400,000 m³/year; imposed Ptot norm: 2 mg/l), which is formed by adding $FeCl_3$ in the biological phase, for financial reasons, preferably disposed of as soil improver to agricultural sector (>95% of total silt quantity). This means the silt is treated with chemicals ($FeCl_3$ and lime) and diluted to 30-32% ds. The cost price for dilution amounts to 52–54 €/ton. The cost price for chemical treatment and disposal to the agricultural sector amounts to 26–28 €/ton. The total cost price for disposing of the silt to the agricultural sector in this specific situation is thus 78–82 €/ton.
- In periods when it is not permitted to spread the silt on agricultural ground, and if there is insufficient capacity to collect the silt, part of the silt (<5% of the total amount) is disposed of as compost. This requires the silt to be diluted to 23-24% ds at a cost price of 48.7 €/ton (2006). The total cost price for disposing of the silt as compost in this situation is 85–100 €/ton.
- The cost price for silt disposal, by a specific dairy company to an external company that uses the silt in its wastewater purification system, amounts to 21 €/ton.

• Chemicals
The cost price for $FeCl_3$ varies greatly depending on the quantity acquired. The average cost price is estimated at 150 €/ton. In practice, costs prices ranging from 200 €/ton to less than 100 €/ton are encountered.

e. Driving forces for implementation

Legislative requirements for the discharged wastewater quality.

f. Example plants in Egypt

This technique is applied in large scale plants, like Juhina, Enjoy and Biety.

→ Sub-technique of WW6: Aerobic processes

Database reference: technique number 27
Relevant process(es): utilities

a. Description

Aerobic processes are only generally applicable and cost effective when the wastewater is readily biodegradable. Micro-organisms in the mixed liquor can receive the oxygen input from either the surface or from diffusers submerged in the wastewater. Surface injection of oxygen is carried out by means of either surface aerators or oxygenation cages. Different techniques can be used, of which some examples are:

- Activated sludge technique: The activated sludge technique produces an activated mass of micro-organisms capable of stabilising a waste aerobically. The biomass is aerated and maintained in suspension within a reactor vessel.

Plants can use air, oxygen or a combination of the two. When they use oxygen they are called pure oxygen systems.

- Pure oxygen systems: Pure oxygen systems are essentially an intensification of the activated sludge process, i.e. the injection of pure oxygen into an existing conventional aeration plant. This is often undertaken after increased or variable plant production which has rendered the aeration plant ineffective, for at least some part of its operational cycle.
- Sequencing batch reactors: The SBR is a variant of the activated sludge process. It is operated on the fill and draw principle and normally consists of two identical reaction tanks. The various stages of the activated sludge processes are all carried out within the same reactor.
- Trickling filters: In fixed film aerobic processes such as trickling filters, the biomass grows as a film on the surface of packaging media and the wastewater is distributed so as to flow evenly across it. The trickling filter medium normally consists of rocks or various types of plastic. The treated liquid is collected under the media and passed to a settling tank from where part of the liquid can be recycled to dilute the strength of the incoming wastewater. Variations include alternating double filtration or permanent double filtration.
- Bio-towers: Wastewater from the processing of FDM often have an organic strength too high for conventional aerobic treatment. Consequently, treatment is necessary to reduce the BOD to an acceptable level prior to further treatment, e.g. at a MWWTP. Bio-towers or roughing filters are specially designed trickling filters (see Section 4.5.3.1.5) operated at high organic loading rates that can achieve high levels of BOD removal. The technique uses above-ground tanks containing plastic media with a high surface area. Microbial film adheres to the media and consumes the organic material. The wastewater is often recycled over the bio-tower to achieve a further treatment. The wastewater from these units is then discharged to a conventional biological process.
- Biological aerated flooded filters and submerged biological aerated filters: Biological aerated flooded filters (BAFF) and submerged biological aerated filters (SBAF) are hybrid suspended/attached growth systems, which are best described as activated sludge plants which contain high voidage media to encourage bacterial growth. Generally, they also allow a certain amount of physical filtration within the same structure.
- High rate and ultra high rate aerobic filters: High rate and ultra high rate aerobic filters give the potential for higher than usual loading rates to aerobic systems. The process employs a high wastewater recycle rate, directed through an integral nozzle assembly. Air is introduced through the nozzle, providing a high shear force on the bacteria and an intense degree of turbulence/oxygenation. It is this high shear force undergone by the bacteria which makes this process so different from other aerobic techniques, i.e. micro-organisms are passed through the nozzle resulting in the existence of only very small bacteria in the system, which differs from other systems where bacteria are not subjected to such shear and where higher life forms also exist.

If you have to treat and reduce BOD before discharging in surface water in Egypt, aerobic treatment is a good option.

b. Applicability

The applicability will mostly depend on the space requirements.

c. Environmental benefit

Reduced BOD/COD, phosphorus and nitrogen levels.
High energy consumption.

d. Financial aspects

The capital cost depends on the system chosen for the aerobic treatment. The investment costs are nevertheless quite high.

e. Driving force for implementation

Regulatory requirements.

f. Example plants in Egypt

This technique would/should be applied in all dairy plants in Egypt that are required to treat their wastewater before discharging (in surface water).

4.3.7 WW7: Minimise the production of acid whey and its discharge to the wastewater treatment plant (WWTP)

Database reference: technique number 14
Relevant process(es): acid type cheese production

a. Description

In cheese manufacturing, about 90% of the milk used ends up as whey. If acid whey, which is separated after curd formation, is discharged to a WWTP, it may cause low pH levels. To prevent this, spillages are avoided by draining the top or platform of the salting vats and whey should be processed quickly so less acid whey is produced due to lactic acid formation.

b. Applicability

Applicable in the manufacture of acid type cheeses.

c. Environmental benefit

Reduced wastewater pollution.

d. Financial aspects

Reduced wastewater treatment costs.

e. Driving forces for implementation

Reduced wastewater pollution and associated treatment costs.

f. Example plants in Egypt

SMEs: Reyada, Dina, Farm cheese, Domty, El Masryeen.

4.3.8 WW8: Minimise boiler blowdown

Database reference: technique number 15
Relevant process(es): utilities

a. Description

Boiler blowdown is used to limit the accumulation of salts, e.g. chlorides, and is therefore necessary to keep the parameters within prescribed limits. It is also used to remove the sludge deposits and corrosion products. Wastewater at high pressure and temperature is always discharged, either for a set time or continuously. It is therefore preferable to restrict the blowdown as far as possible.

The total dissolved solids content of the boiler water is best kept as close as possible to the maximum authorised value. This can be done via an automated system consisting of a conductance probe in the boiler water, a blowdown regulator or a blowdown regulating valve. The conductance is continually measured. If the measured conductance exceeds the maximum value, then the regulating valve is opened further.

b. Applicability

Applicable where a boiler is used.

c. Environmental benefit

Reduced wastewater generation.

Reduced energy consumption. To do this, heat can be recovered from the blowdown.

d. Financial aspects

Mostly there will be a saving in energy costs.

e. Driving forces for implementation

Reduction in energy costs.

f. Example plants in Egypt

This technique is applied in all large scale dairy plants in Egypt.

4.3.9 WW9: Maximise condensate return

Database reference: technique number 16

Relevant process(es): utilities

a. Description

If hot condensate is not returned to the boiler it has to be replaced by treated cold make-up water. The additional make-up water also adds to water treatment costs. Instead of routinely discharging condensate to the WWTP because of the risk of contamination, the condensate can be collected in an intermediate tank and analysed to detect the presence of any contaminant.

b. Applicability

Applicable where steam is produced in a boiler.

c. Environmental benefit

Reduced wastewater generation. Reduced energy and water consumption. Reduced consumption of boiler feed-water treatment chemicals.

d. Financial aspects

Savings in energy costs.

e. Driving forces for implementation

Reduced energy consumption and associated costs.

f. Example plants in Egypt

This technique is applied in all large scale dairy plants in Egypt.

4.4 Energy

For the production of dairy products, a number of energy inputs are needed: electricity, hot water and steam. The main energy consuming production steps are concentration, drying and cooling processes. A significant amount of energy is also consumed during standardization, homogenisation, pasteurisation/sterilization, packing, CIP and cooled storage.

4.4.1 E1: Switch off equipment when it is not needed

Database reference: technique number 17
Relevant process(es): utilities/general measure

a. Description

Switching off equipment, lights, ventilation, pumps and other utilities when they are not needed is the easiest way to save on energy consumption. This can be timed according to a fixed programme or schedule.

b. Applicability

Technically viable for the entire dairy sector.

c. Environmental benefit

Reduced energy consumption.

d. Financial aspects

Reduction in energy cost.

e. Driving force for implementation

Reduced energy costs.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.4.2 E2: Insulation of pipes, vessels and equipment

Database reference: technique number 18
Relevant process(es): utilities

a. Description

Insulation of pipes, vessels and equipment such as ovens and freezers can minimise energy consumption.

b. Applicability

Applicable to all installations, whether new or existing. New installations often have pre-insulated pipes.

c. Environmental benefit

Reduced energy consumption and associated fuel consumption and air emissions.

d. Financial aspects

A Danish dairy company invested 1,408,000 euros with a payback period of 7.6 years. Savings come from energy/fuel costs.

e. Driving force for implementation

Reduction in energy costs.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.4.3 E3: Avoid excessive energy consumption in heating and cooling processes

Database reference: technique number 19
Relevant process(es): utilities

a. Description

Excessive energy consumption in heating and cooling processes can be avoided by e.g. optimising the length of heating and cooling processes, using a high-yield compressor for cooling or regularly defrosting the entire cooling system. Of course, the product quality should not be put at risk when doing so.

b. Applicability

This measure is technically viable for all dairy companies. Measures to be implemented must be examined for each company specifically.

c. Environmental benefit

Reduced energy consumption.

d. Financial aspects

Energy costs can be cut. This technique is generally regarded as economically viable for all dairy companies.

e. Driving force for implementation

Reduced energy costs.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.4.4 E4: Implement and optimise heat recovery

Database reference: technique number 20
Relevant process(es): utilities

a. Description

Residual heat can be recovered and reused in the production process by using e.g. a heat exchanger or a heat pump.

b. Applicability

Heat can be recovered from various sources in a dairy company. Physical space is needed for installing a heat exchanger and a hot water storage tank. The measure is generally considered technically viable. The approach though, is to be determined at company level.

c. Environmental benefit

Reduced energy consumption.

d. Financial aspects

In general, because of the savings in energy costs, the measure is assumed to be economically viable. The BREF FDM gives an example: recovery of heat from hot whey, in order to heat up raw milk, has a payback time of 3.8 years.

e. Driving force for implementation

Reduced energy costs.

f. Example plants in Egypt

This technique is applied in all large scale dairy plants in Egypt.

4.4.5 E5: Use a plate heat-exchanger for pre-cooling icewater with ammonia

Database reference: technique number 21
Relevant process(es): utilities

a. Description

A plate heat exchanger can be used to pre-cool the returning ice water with ammonia, prior to a final cooling in an accumulating ice water tank.

b. Applicability

It is commonly installed in new plants, but can also be installed in existing plants.

c. Environmental benefit

Reduced energy consumption. Ammonia leakages should be prevented from a safety point of view.

d. Financial aspects

Price depends on the existing ice water system and capacity. Example: investment costs of approximately 50,000 euros, including a plate cooler, a pump, valves…

e. Driving force for implementation

The measure creates a reduction in electrical energy consumption and additional cooling capacity, without the need for investment in a new ice water tank.

f. Example plants in Egypt

This technique is applied in all large scale dairy plants in Egypt.

4.4.6 E6: Partial homogenisation of market milk

Database reference: technique number 22
Relevant process(es): homogenisation

a. Description

Instead of homogenising the entire quantity of milk, it is also possible to homogenise cream with a small amount of skimmed milk. The homogenisers size can be significantly reduced, leading to energy savings. The homogenised mixture is remixed with skimmed milk, before in enters the final heat treatment.

b. Applicability

This technique is widely used in modern dairies in Europe.

c. benefit

Reduced energy consumption.

d. Financial aspects

Smaller homogenisers are cheaper in terms of investment and operational costs: the investment cost is about 55% of that of the homogeniser used normally.

e. Driving force for implementation

Lower investment and energy costs.

f. Example plants in Egypt

This technique is applied in the plants that have microfiltration including El Masryeen and Juhina.

4.4.7 E7: Use of continuous pasteurizers

Database reference: technique number 23
Relevant process(es): pasteurisation

a. Description

Pasteurisation is a heat treatment aimed at killing disease-creating bacteria as well as most decay-causing micro-organisms. It takes place in a heat exchanger, without direct contact between heated milk and the heating medium. The pasteurisation step must be optimised in order to limit energy consumption, e.g. by using a continuous process, using a regenerative heat exchanger or replacing old systems with new pasteurisation systems.

b. Applicability

Technically viable for all dairy companies that implement the pasteurisation process step.

c. Environmental benefit

Reduced energy consumption and wastewater production, compared to batch pasteurizers.

d. Financial aspects

Optimisation requires investment, but is accompanied by cost savings. In general, this measure is considered economically viable for dairy companies.

e. Driving force for implementation

Reduced energy and wastewater treatment costs.

f. Example plants in Egypt

This technique is applied in all dairy plants in Egypt.

4.4.8 E8: Optimise evaporation process by, e.g. implementing a multi-phase evaporator and optimising vapour compression

Database reference: technique number 24
Relevant process(es): evaporation

a. Description

Evaporation is aimed at increasing the dry matter content in liquids. The process must be optimised in order to limit energy consumption, for example by implementing multi-effect evaporators or optimise vapour compression in function of heat and energy available in the installation.

b. Applicability

Technically viable for all dairy companies.

c. Environmental benefit

Reduced energy consumption.

d. Financial aspects

Reduced energy costs.

e. Driving force for implementation

Reduced energy costs.

f. Example plants in Egypt

This technique is applied in the companies Dina and Green Land.

4.4.9 E9: Two-stage drying in milk powder production

Database reference: technique number 25
Relevant process(es): drying for milk powder production

a. Description

After the milk has been thickened in an evaporator, the condensed milk may be further dried to 95-97% dry matter content. Using a spray dryer with a downstream or integrated fluidised bed dryer (FBD) leads to more efficient energy use. Also, lower residual product moisture can be achieved with less harm to product quality.

b. Applicability

Applicable in the dairy sector.

c. Environmental benefit

Reduced energy consumption: it is reported that if an integrated FBD is used, the energy consumption for drying can be reduced by approximately 20%. The two-stage solution provides better process economy, as the energy consumption is lower. The total energy consumption when drying skimmed milk with an initial dry matter content of 48% is 6,678 kJ/kg powder (1,595 kcal/kg) in one-stage drying and 5,652 kJ/kg powder (1,350 kcal/kg) in two-stage drying. Even greater savings can be achieved by three-stage drying, which is an extension of two-stage drying.

Reduced water consumption. Reduced dust emissions.

Spray dryers do create noise emissions and explosive dust/air mixtures can occur.

d. Financial aspects

High capital costs. Investment involves additional capital and operational costs. Fire and explosion protection is required.

e. Driving force for implementation

Reduced energy and water costs.

f. Example plants in Egypt

This technique is applied in the companies Dina and Green Land.

4.4.10 E10: Use combined heat and power generation (CHP)

Database reference: technique number 26
Relevant process(es): utilities (evaporation/drying steps)

a. Description

CHP is a technique through which heat and electricity are produced in one single process. It can be used in processes for which heat and power loads are balanced. For dairy, when plant size increases, the amounts of thermal and electrical energy needed for evaporation/drying steps increases, making CHP a viable alternative.

b. Applicability

The applicability of CHP depends very much on several technical aspects. The technique is well known and technically mature, but it is vital that the right design decisions are made, e.g. the main factors to consider are the consumption pattern of electricity and heat and the ratio between electricity and heat consumption.

In Egypt, the demand for heat and electricity is often not high enough to facilitate the use of CHP.

c. Environmental benefit
Reduced energy consumption and air emissions (NO_X, CO_2 and SO_2).
d. Financial aspects
The price of electricity and gas is important in the decision whether to implement CHP. A balance of relatively expensive gas or other fuels and cheap electricity militates against the selection of CHP. In Egypt, electricity is rather cheap today, which hinders the use of CHP in Egyptian dairy installations.
e. Driving force for implementation
Reduced energy costs.
f. Example plants in Egypt
This technique is applied in the companies Juhina, Beity, Enjoy, Domty and Green Land.

4.4.11 E11: Improve steam collection

Database reference: technique number 28
Relevant process(es): utilities
a. Description
Steam collection can be improved by an inspection and repair programme for condensation pots.
b. Applicability
Improving steam collection is technically viable for all dairy companies that use steam as an energy carrier.
c. Environmental benefit
Steam/energy losses can be reduced. Water consumption can also be limited.
d. Financial aspects
This measure is considered to be generally economically viable.
e. Driving force for implementation
Reduced energy costs.
f. Example plants in Egypt
This technique is applied in all large scale dairy plants in Egypt.

4.4.12 E12: Isolate unused/infrequently used pipework

Database reference: technique number 29
Relevant process(es): general measure / utilities
a. Description
There may be branches of the steam distribution system that are no longer used and can be removed from the system. Also, pipes that supply steam to infrequently used equipment can be isolated using valves or slip-plates.
b. Applicability
Fully applicable.
c. Environmental benefit
Reduced energy consumption. Reduced water consumption.
d. Financial aspects
No high investment cost, but savings in energy costs.

e. Driving force for implementation
Reduced energy costs.
f. Example plants in Egypt
This technique is applied in all dairy plants in Egypt.

4.4.13 E13: Repair steam leaks

Database reference: technique number 30
Relevant process(es): utilities
a. Description
Steam leaks are a possible cause for moist insulation. Regular maintenance and repairs are recommended to detect and repair such leaks.
b. Applicability
Technically viable for all dairy companies that use steam as an energy carrier.
c. Environmental benefit
Reduced energy consumption. Reduced water consumption.
d. Financial aspects
Economically viable: no or little investment costs and savings in energy costs.
e. Driving force for implementation
Reduced energy costs. Smooth, untroubled production which is not interrupted by breakdowns and accidents.
f. Example plants in Egypt
This technique is applied in all dairy plants in Egypt.

4.4.14 E14: Avoid losses of flash steam from condensate return

Database reference: technique number 31
Relevant process(es): utilities
a. Description
When condensate is discharged from steam traps and flows along the return pipework, some flash steam is formed. Often flash steam is vented to the air and the energy it contains is lost. It may be possible to capture and use the flash steam, e.g. in the boiler.
b. Applicability
Applicable where flash steam is produced and can be reused.
c. Environmental benefit
Reduced energy consumption. Reduced water consumption.
d. Financial aspects
Savings in energy costs.
e. Driving force for implementation
Reduced energy consumption and associated costs.
f. Example plants in Egypt
This technique is applied in all dairy plants in Egypt.

4.5 Waste and by-products

Depending on the type of dairy product and process, large quantities of waste and by-products are generated.

Packing materials like paper and cardboard, plastics, wood, plastic bottles or cups and glass bottles fall under this waste title. Hazardous waste is rather rare or non-existent in the dairy industry.

A distinction can be made between flows that can be reused internally (e.g. whey and cream) or flows that can be reused externally (e.g. rejected end-products to be used in animal feed or as soil improver).

Some examples of waste flows or by-products in the dairy industry are:
- Spillage during filling;
- Waste caused by hygiene requirements;
- Leakages;
- Process losses;
- …

4.5.1 BP1: Automated filling incorporating recycling of spillages

Database reference: technique number 32
Relevant process(es): filling

a. Description

Automated filling machines for filling bottles, cans, etc. can reduce spillage. In the production of fruit yoghurt, seasoning can be added by an automated dosing pump straight into the pipes for the filling machine.

b. Applicability

Widely applicable for companies where filling is relevant.

c. Environmental benefit

Reduction of waste. Reduced energy and water consumption since there is a reduced amount of water contamination.

d. Financial aspects

Economically viable for all companies that have the filling process.

e. Driving force for implementation

Reduced water consumption and savings in water treatment costs.

f. Example plants in Egypt

This technique is applied in the plans: Juhina, Beity, Enjoy, Dina, Green land, Danone, Labanita and Lactel.

4.5.2 BP2: Restrict loss of raw materials and products in pipes

Database reference: technique number 33
Relevant process(es): general

a. Description

Due to the use of online detection techniques, the classic removal technique (flushing pipes with water until valves to draining system are manually closed after visual inspection) is less used. Examples in the dairy industry where water is used to remove raw materials and products from pipes include i) start/end HTST treatment, ii) product change and iii) cleaning process systems and pipes.

Dry techniques for removing raw materials and products from pipes include e.g. compressed air, vacuum or pigging using a rubber stopper.

Relevant for the dairy sector are:

- maximising the recovery of diluted non-polluted product by detecting the transition between product and water 'online'
- removing deposited butter from pipes using a cooled butter block and compressed air.

b. Applicability

Technically viable for all dairy companies. The choice of technique (with or without water) as well as the online detection technique is to be determined for the company specific situation.

c. Environmental benefit

Reduced waste production. Reduced emissions to water. Reduced energy consumption.

d. Financial aspects

The measure requires investment, but is also accompanied by savings in operational costs.

e. Driving force for implementation

Reduced energy costs, water treatment costs.

f. Example plants in Egypt

This technique is applied in all plants, especially those where stirred yoghurt, UF cheese and UHT processed cheese are produced, including Juhina, Beity, Enjoy, Dina, Labanita, Lactel, Bel Egypt and President.

4.5.3 BP3: Minimisation of losses during butter making

Database reference: technique number 34

Relevant process(es): butter and cream production process

a. Description

Due to the high viscosity of cream, the cream heater may be rinsed with skimmed milk, which is then retained and used before the cleaning. This reduces fat losses. The buttermilk that results can be used as a product and not disposed of.

b. Applicability

Applicable in butter and cream making.

c. Environmental benefit

Reduced waste.

d. Financial aspects

Increased product yield.

e. Driving force for implementation

Reduced waste and increased product yield.

f. Example plants in Egypt

SMEs: Dina, Reyada, Green Land.

4.5.4 BP4: Separate outgoing flows to optimise use, re-use, recovery, recycling and removal

Database reference: technique number 35
Relevant process(es): general

a. Description

Outgoing flows could include raw materials, partially processed products, end products, by-products and wastewater flows. Separating these flows means certain flows can be reused, recovered or recycled. Some examples in the dairy industry:

- Use as animal feed: recovered end products that are incorrectly packaged, rinses from yoghurt drums, whey not intended for human consumption…
- Use in other production processes: cream from preparing milk, yoghurt, ice cream and cheese (e.g. for butter)…
- …

b. Applicability

Technically viable.

c. Environmental benefit

Reduced waste. Reduced amount of raw materials and water to be used. Reduced amount of wastewater.

d. Financial aspects

Economically viable.

e. Driving force for implementation

Reduced waste because materials recovered can be used. Reduced wastewater treatment and waste disposal and the associated reduced costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt: separated materials are reused in Egypt to produce Mish cheese.

4.5.5 BP5: Recovery and use of whey

Database reference: technique number 36
Relevant process(es): cheese manufacturing

a. Description

In cheese manufacturing about 90% of the milk used ends up as whey. Sweet whey (from rennet type hard cheese production) can be reused in the process or in other processes to make by-products. Even when salt whey (after salt is added to curd when removing liquid) cannot be reused in the process without the removal of salt it can be collected as it is or concentrated by evaporation and used as animal feed.

b. Applicability

Applicable in cheese manufacturing companies.

c. Environmental benefit

Reduced waste. Reduced wastewater pollution (e.g. BOD with whey recovery = 2397 mg/l versus BOD without whey recovery = 5312 mg/l, COD with recovery = 5312 mg/l versus COD without recovery = 20559 mg/l).

d. Financial aspects

Wastewater treatment costs will be reduced.

e. Driving force for implementation

Reduced wastewater treatment costs.

f. Example plants in Egypt

SMEs such as Dina, Reyada, Domty, El Masryeen.

4.5.6 BP6: Segregation of packaging materials to optimise use, re-use, recovery, recycling and disposal

Database reference: technique number 37

Relevant process(es): general measure

a. Description

Suppliers of raw materials, additives and cleaning chemicals may take back their empty containers for recycling. In addition, used packaging materials, if separated from other materials, may be sent for recycling if they cannot be reused.

b. Applicability

Applicable in all new and existing dairy companies.

c. Environmental benefit

Reduced waste, more recycling opportunities.

d. Financial aspects

Economic data may differ from company to company and also depends on conditions agreed with supplier and/or the recycling operator.

Waste disposal and waste treatment charges are reduced.

e. Driving force for implementation

Prevention and recycling schemes for waste. Reduced waste generation and associated disposal costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.5.7 BP7: Optimisation of packaging design – to reduce the quantity

Database reference: technique number 38

Relevant process(es): packaging

a. Description

Pollution prevention with respect to waste packaging is addressed using the waste minimisation hierarchy: avoid, reduce, reuse and recycle packaging.

The choice of packaging and packaging materials can be based on requirements, e.g. those used in Europe, in Article 9 and Annex II of Directive 94/62/EC on packaging and packaging waste.

b. Applicability

Widely applicable.

c. Environmental benefit

Reduced consumption of materials and reduced waste.

d. Financial aspects

The only example are known is from a confectionary company, reporting a payback period of 2 years.

e. Driving force for implementation
Reduced packaging use.
f. Example plants in Egypt
This measure is applied in all dairy plants in Egypt.

4.6 General

There are a number of environmental measures and techniques which are more general in the way they influence environmental impact. Most of these general techniques affect more than one environmental compartment. In the following paragraphs these more general techniques are listed and shortly described.

4.6.1 G1: Identification of potential accidents

Database reference: technique number 55 and 71
Relevant process(es): general measure
a. Description
Accidents may occur as the result of numerous occurrences, e.g. failure of utilities supply or loss of containment from bulk storages. Information on potential accidents identified can be used to assess the risk. When a risk assessment is completed, it is necessary to identify the accidents that may have a significant environmental impact and which are currently not adequately controlled. Through this, priority actions can be identified.
b. Applicability
Applicable in all installations, however, if potential accidents are identified at the design stage of an installations, their prevention can be more easily and economically incorporated than if they are added later.
c. Environmental benefit
Reduced risk of accidents which may pollute the environment.
d. Financial aspects
No high investment costs, especially when identified at the design stage.
e. Driving force for implementation
Reduced risk of accidents which may pollute the environment.
f. Example plants in Egypt
This measure is applied in all dairy plants in Egypt.

4.6.2 G2: Optimise the use of chemicals

Database reference: technique number 58
Relevant process(es): general measure
a. Description
Optimisation of chemical use could include:
- minimise the use of EDTA
- avoid the use of halogenated oxidising biocides
- avoid the use of P-based cleaning products

- use and optimise CIP cleaning system wherever possible
- …

b. Applicability

The choice of chemicals is very company specific. The design of the plants, the available cleaning technology, the type of pollution and type of production process are some of the factors determining the choice of cleaning and disinfection products. In general however, the optimisation of chemical use is technically viable for all dairy companies.

c. Environmental benefit

Limit the impact that chemicals have on the environment.

d. Financial aspects

Possible cost savings through the limitation of amount of chemicals used. Economically viable.

e. Driving force for implementation

Reduced costs for chemicals.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.3 G3: Environmental management system

Database reference: technique number 59
Relevant process(es): general measure

a. Description

The best environmental performance is usually achieved by installing the best technology and operating it in the most effective and efficient manner. An environmental management system (EMS) is a tool that operators can use to address design, construction, maintenance, operation and decommissioning issues in a systematic, demonstrable way. It includes the organisational structure, responsibilities, practices, procedures, processes and resources for developing, implementing, maintaining, reviewing and monitoring the environmental policy.

b. Applicability

An EMS can generally be applied to all installations. The scope and nature of the system will be related to the nature, scale and complexity of the installation and the range of environmental impacts it may have.

c. Environmental benefit

EMS are designed to address the overall environmental impact.

d. Financial aspects

Accurately determining costs and economic benefits of introducing and maintaining a good EMS.

e. Driving force for implementation

A number of advantages can be provided by these systems, e.g. improved insight into the environmental aspects of the company, improved basis for decision-making, improved motivation of personnel, etc.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.4 G4: Collaboration with downstream and upstream partners

Database reference: technique number 60
Relevant process(es): general measure

a. Description

Agreements with downstream or upstream partners that can help to limit the environmental impact of a dairy company are for example:
- Buy materials in bulk or in large packages and use return packaging wherever possible.
- Limit noise problems caused by vehicles.

b. Applicability

It can be part of an environmental care system. It is generally technically viable.

c. Environmental benefit

Environmental impact can generally be reduced by collaborating with downstream and upstream partners.

d. Financial aspects

The measure is not accompanied by noteworthy costs and/or savings.

e. Driving force for implementation

Creation of a chain of environmental responsibility, to minimise pollution and to protect the environment as a whole.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.5 G5: Optimise operation by providing training

Database reference: technique number 61
Relevant process(es): general measure

a. Description

Giving staff at all levels the necessary training and instruction in their duties can help to improve the control of processes and minimise consumption and emission levels and the risk of accidents.

b. Applicability

Applicable for all dairy companies.

c. Environmental benefit

Reduced consumption and emission levels and reduced risks of accidents throughout the installation.

d. Financial aspects

Training requires both an investment of money when it is given by external advisors, and an investment in time. It will, however, also create a saving in costs through optimal production, reduced consumption and limited accidents.

e. Driving force for implementation

Routinely, considering the environmental impacts can help to focus efforts for achieving lower consumption and emission levels, leading to cost savings.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.6 G6: Design equipment to minimise consumption and emission levels

Database reference: technique number 62
Relevant process(es): general measure

a. Description

Careful design of pumping and conveying equipment can prevent solid, liquid and gas emissions. Energy consumption can be minimised. Easy-to-clean equipment makes the recovery of product easier. Good and thought-through design of equipment is therefore important to minimise consumption and emission levels.

b. Applicability

Applicable to all dairy plants. Especially interesting for new plants or when a change is made in an existing plant.

c. Environmental benefit

Reduced consumption of energy, water and substances, and reduced emissions to air, water and land.

d. Financial aspects

Reduced consumption costs (energy, water, …).

e. Driving force for implementation

Reduced consumption and emission levels and their associated costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.7 G7: Maintenance

Database reference: technique number 63
Relevant process(es): general measure

a. Description

The effective planned preventive maintenance of vessels and equipment can minimise the frequency and size of solid, liquid and gas emissions as well as water and energy consumption.

b. Applicability

Applicable in all dairy installations.

c. Environmental benefit

Reduced consumption of energy, water and substances and reduced emissions to air, water and land. Reduced waste and noise emissions.

d. Financial aspects

Savings due to continuous operation, reduced losses etc.

e. Driving force for implementation

Smooth, untroubled production which is not interrupted by breakdowns and accidents.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.8 G8: Methodology for preventing and minimising the consumption of water and energy and the production of waste

Database reference: technique number 64
Relevant process(es): general measure

a. Description

Prevention and minimisation requires the adoption of a systematic approach. A successful methodology usually consists of multiple steps:

1. Obtaining management commitment, organisation and planning
2. Analysis of production processes
3. Assessment of objectives
4. Identifying prevention and minimisation options
5. Carrying out an evaluation and feasibility study
6. Implementing the prevention and minimisation programme
7. Ongoing monitoring by measurement and visual inspection

b. Applicability

Technically viable for dairy companies.

c. Environmental benefit

Reduced energy consumption and associated air emissions. Reduced waste heat released. Maximisation of the reuse of water. Waste minimisation.

d. Financial aspects

Reduction of costs due to reduction in consumption.

e. Driving force for implementation

Reduction of costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.9 G9: Analysis of production processes

Database reference: technique number 65
Relevant process(es): general measure

a. Description

An important condition for successful prevention and minimisation of energy and water consumption and waste production is to have a good overview of the areas and process steps that are relevant to the loss of materials, the generation of waste and the consumption levels.

b. Applicability

Technically viable.

c. Environmental benefit

General reduction of environmental impacts when used in combination with other measures.

d. Financial aspects

No specific information available.

e. Driving force for implementation

Better insights into the process, leading to prevention and minimisation of consumption levels.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.10 G10: Apply production planning to minimise associated waste production and cleaning frequencies

Database reference: technique number 66

Relevant process(es): general measure

a. Description

Well-planned production schedules which minimise the number of product change-overs and consequently the number of ‘interval cleans’ can minimise waste generation, water consumption and wastewater generation. They may also reduce energy consumption.

b. Applicability

Generally applicable.

c. Environmental benefit

Reduced consumption of water, energy and chemicals and generation of wastewater and waste.

d. Financial aspects

Cost savings due to reduction in consumption of water, energy and chemicals. Reduced water treatment costs.

e. Driving force for implementation

Reduced consumption of water, energy and chemicals and generation of wastewater and waste and the associated costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.11 G11: Good housekeeping

Database reference: technique number 67

Relevant process(es): general measure

a. Description

Enforcing a system to maintain the plant in a clean and tidy manner can improve the overall environmental performance. Spillages and leaks can be actively minimised and spilled materials can be collected dry immediately.

b. Applicability

Generally applicable.

c. Environmental benefit

Reduced waste generation, reduced contamination of wastewater by wet cleaning, reduced odour and emission and reduced risk of infestation by insects etc.

d. Financial aspects

Avoids expenditure on odour abatement, waste disposal and wastewater treatment.

e. Driving force for implementation

Reduced waste production and improvement of safety (prevention of slipping and tripping accidents).

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.12 G12: Limit emission from storage

Database reference: technique number 68
Relevant process(es): general measure

a. Description

General measures for limiting or preventing emissions include inspection and maintenance, location and design, and monitoring. Other measures include safety and risk management, operational procedures and training and fire prevention systems.

b. Applicability

Generally applicable.

c. Environmental benefit

Emissions into air, soil and water can be limited.

d. Financial aspects

Generally economically viable.

e. Driving force for implementation

Reduced wastewater treatment costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.
(See also horizontal techniques from the ESB BREF: Prevention and Control of emissions of storage of solids, liquids and liquefied gases).

4.6.13 G13: Process control techniques

Database reference: technique number 69
Relevant process(es): general measure

a. Description

Improving the process control of inputs, process operating conditions, handling, storage and wastewater generation can minimise waste by reducing off-specification product, spoilage, loss to drain, overfilling of vessels, water use and other losses. Process knowledge is necessary. It is vital that the process monitoring and control equipment is designed, installed and operated so that it does not interfere with hygiene conditions in the production process and does not lead to product loss and waste itself. Examples: temperature control, level measurement, flow measurement and control.

b. Applicability

Generally applicable. Which techniques will be implemented is company specific.

c. Environmental benefit

Reduced water and energy consumption, reduced waste generation.

d. Financial aspects

Investment cost for equipment. Cost savings through reduction of energy and water consumption, reduced waste generation etc.

e. Driving force for implementation

Depending on the control technique, different driving forces can be identified. For example minimisation of product deterioration (temperature control), reduced product losses and associated cost savings (level measurement), etc.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.14 G14: Risk assessment

Database reference: technique number 70
Relevant process(es): general measure

a. Description

A risk assessment is an important part of the management procedure, as it is the application of this technique which will determine whether managers consider whether there is a significant risk of an accident occurring.

b. Applicability

Generally applicable. The depth and type of risk assessment carried out will depend on the characteristics of the plant and its location.

c. Environmental benefit

Reduced risk of accidents which may lead to environmental pollution.

d. Financial aspects

No specific information available.

e. Driving force for implementation

Reduced risk of accidents which may pollute the environment.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.6.15 G15: Identify and implement control measures needed

Database reference: technique number 72
Relevant process(es): General measure

a. Description

An evaluation has to be undertaken on the identified sources of potential accidents to determine whether new control measures are required or existing control measures need to be improved. Typical control measures that can be considered are: management procedures, operational procedures, preventative techniques, containment and process design/process control.

b. Applicability

Generally applicable.

c. Environmental benefit

Reduced risk of accidents which may pollute the environment.

d. Financial aspects

Generally inexpensive.

e. Driving force for implementation

Reduced risk of accidents which may pollute the environment.

f. Example plants in Egypt
This measure is applied in all dairy plants in Egypt.

4.6.16 G16: Develop, implement and test an emergency plan

Database reference: technique number 73
Relevant process(es): general measure
a. Description
Emergency procedures/plans need to be developed and put in place to ensure that, if an event does occur, the normal situation can be restored with a minimum effect on the environment. It needs to be tested to make sure it will work properly if an accident occurs and it is needed.
b. Applicability
Applicable where there is a significant risk of pollution occurring from an accident.
c. Environmental benefit
Minimising the pollution resulting from accidents.
d. Financial aspects
No high investments needed, but may save or limit various costs after an accident, e.g. liability costs, fines, remediation…
e. Driving force for implementation
Minimising the pollution resulting from accidents, limiting the damage to a company's image after an accident and limiting the various costs associated with restoring the site and possible legal fines and liabilities.
f. Example plants in Egypt
This measure is applied in all dairy plants in Egypt.

4.6.17 G17: Investigate all accidents and near misses

Database reference: technique number 74
Relevant process(es): general measure
a. Description
Lessons can be learned from investigating all accidents and near misses. The reasons for accidents and near misses occurring can be identified and action can be taken to prevent them from happening again.
b. Applicability
Generally applicable.
c. Environmental benefit
Reduced risk of accidents which may pollute the environment.
d. Financial aspects
No high investment costs, but potentially limiting costs when there has been an accident.
e. Driving force for implementation
Reduced risk of accidents which may pollute the environment.
f. Example plants in Egypt
This measure is applied in all dairy plants in Egypt.

4.6.18 G18: Management of water, energy and detergents used

Database reference: technique number 75
Relevant process(es): general measure

a. Description

If the consumption of water and detergents, and the cleanliness is recorded on a daily basis, it is possible to detect deviations from normal operation and then to monitor and plan ongoing efforts to reduce the future consumption of both water and detergents without jeopardising hygiene.

b. Applicability

Generally applicable.

c. Environmental benefit

Potentially reduced consumption of water and detergent and of the energy required to heat the water.

d. Financial aspects

Can result in reduced water, energy and detergent costs.

e. Driving force for implementation

Reduced water, energy and detergent costs.

f. Example plants in Egypt

This measure is applied in all dairy plants in Egypt.

4.7 Horizontal techniques

Some environmental issues are common for many industries. For these issues, standard 'horizontal' candidate BAT are selected. The techniques presented here, are gathered by screening the European horizontal BREF documents.

Important to notice is that some of the horizontal techniques are mentioned more specifically for the dairy sector in the paragraphs above. Therefore, in this paragraph, only the *additional* candidate BAT are highlighted. For more information on the measures, we refer to the candidate BAT database and the original BREF documents. In chapter 5, only the vertical techniques will eventually be evaluated. These horizontal techniques are given here because of their importance for all sectors. It is however too difficult to evaluate these general techniques and measures for the specific sector. Important techniques for the dairy sector will be mentioned under vertical techniques and thus also evaluated.

The structure as used for the other techniques above (vertical techniques) will not be kept here. Only specific local issues, e.g. reasons for applicability problems or legislation related to the measure, are added. For further information on the applicability, environmental benefit, economic viability, etc. we again refer to the candidate BAT database.

4.7.1 Emissions from storage and handling[18]

4.7.1.1 *H1: Prevention and control of emissions from storage of liquids and liquefied gases in tanks through general measures*

The emissions of liquid and liquefied gases from tanks can be prevented and controlled taking into account various criteria that consider the recipient characteristics, surroundings and handling.

Some general measures to do this are:

- **Tank design**: the design or retrofit of a plant for a given substance is a multi-step approach in which elimination is performed starting from all possible storage modes. A proper design should take into account many factors, e.g. physico-chemical properties of the substance, how the storage is operated, what equipment has to be installed, etc.
- **Inspection, maintenance and monitoring**: According to national regulations, there are different approaches to performing inspection work, e.g. official surveillance, surveillance by experts and internal company control (operator). To optimise inspection and maintenance, the application of risk-based tools is gaining attention. Another common aspect of inspections is the monitoring of diffuse emissions to air and the monitoring of leakages. In addition to general inspection techniques, some specific gas-leak detection techniques exist as gas detection systems. This is mainly a safety feature instead of a preventative tool for leakages.
- **Location and layout**: The location and layout of a storage plant have to be selected with care. Each location – underground, aboveground or in mounds – has different advantages and disadvantages.

4.7.1.2 *H2: Prevention and control of gas emissions from storage of liquids and liquefied gases in tanks*

To prevent and control gas emissions occurring during the use of the tanks to store liquids and liquefied gases, several techniques are available. Each of these will shortly be described. For more information we refer to the candidate BAT database.

Emissions minimisation principle in tank storage is a principle that, within a certain time frame, aims to abate all emissions (from air, soil, water, energy consumption and waste) from tank storage, transfer and handling before they are emitted. The environmental benefit lies mostly in the fact that unabated operational emissions from the tanks will become negligible. Although the principle was originally developed for tank terminals, it is also applicable to tank storage in general. The economics depend strongly on the prevention and reduction measures that are currently applied.

Different types of covers might be used to avoid vapours to escape from open storage tanks. Covers considered are floating covers, flexible covers or tent covers and

[18] For more information, see the Horizontal Reference Document on Best Available Techniques on Emissions from Storage (ESB BREF), European Commission, 2006.

fixed/grid covers. Another possibility is to install a fixed or **domed roof** on an external floating roof tank. This however is, particularly in retrofit, a high cost option. Significant costs are involved on a site-specific basis.

The **tank colour** influences the amount of thermal or light radiation absorbed by above-ground tanks and, therefore, the temperature of the liquid and vapour contents inside. A white tank has the lowest emission level compared with other paint colours. The application of **sunscreens or sunshields** around tanks is newer. The idea is that one will reduce/prevent an increase in temperature of the vapour/product within the tank and this in turn will lead to the potential for lower emissions. In order to keep the storage temperature under a certain limit, also during summer conditions, it is advantageous to use all **natural** possibilities for **cooling** the tank. This might be done by using floating roof tanks for example.

Other examples of techniques are:

- Roof seals for external and internal floating roofs;
- Internal floating roof (IFR);
- Pressure and vacuum relief valves;
- Closed drain systems;
- Vapour balancing;
- Vapour holders;
- Vapour treatment.

4.7.1.3 H3: Prevention and control of <u>liquid</u> emissions of storage of liquids and liquefied gases

Liquid emissions control measures divide into two main groups: ECM for potential releases to soil from planned activities and those for unplanned releases. Here, only those measures for potential releases from regular operation are considered.

Manual draining of tanks can be done successfully with due care and attention. Careful manual draining is still a viable option at many sites, however it can be an extremely time-consuming process. Automation is therefore often introduced. **Semi-automatic tank drain valves** are categorised as such because they need to be reset at the start of each draining operation. **Fully automatic tank drain valves** are designed to require minimal operator intervention and, as such, are significantly more expensive than semi-automatic systems. A power source at the tank is also needed.

Dedicated systems include tanks and equipment that are dedicated to one group of products. This means no changes in products. This makes it possible to install and use technologies specifically tailored to the products stored.

4.7.1.4 H4: Prevention and control of <u>waste</u> from storage of liquids and liquefied gases

Sludge deposition in tanks occurs by the mechanisms of molecular diffusion, gravity and chemical reactivity and depends on operating conditions. Sludge deposition is not usually even and does not necessarily build at the same rate. Reducing sludge can be done in two ways:

- **Tank mixing**: this is the best technology for reducing sludge. The mixer prevents sludge deposition, either by using impeller mixers or jet mixers.
- **Sludge removal**: where sludge in tanks becomes unacceptably high and cannot be reduced by mixing technologies, tank cleaning will be necessary.

4.7.1.5 H5: Incidents and (major) accidents emission control measures for tanks

Companies should take all measures necessary to prevent and limit the consequences of major accidents. **Safety and risk management system** gives shape to the so called major accident prevention policy. The system includes i) a statement of tasks and responsibilities, ii) an assessment of the risks of major accidents, iii) a statement of procedures and work instructions, iv) plans for responding to emergencies, v) the monitoring of the safety management system and vi) the periodical evaluation of the policy adopted. An important tool is the **risk assessment** , which is an organised view of the activities on-site. Incidents and (major) accidents can be prevented and controlled taking into account different measures. Several techniques have to be considered, for example:

- Operational procedures and training;
- Leakage and overfill;
- Corrosion and erosion;
- Instrumentation and automation to prevent overfill;
- Impervious barriers under above-ground tanks;
- …

In some areas, flammable atmospheres may occur either during normal operation or due to accidental spills or leakages. These **flammable areas** are hazardous and measures to prevent these areas or control the induction of sources of ignition are required. **Fire protection** may be necessary. Measures can be provided by fire resistant cladding or coatings, firewalls, water cooling systems, and so on. Another element is the **fire-fighting equipment,** which depends on the quantity and type of liquid and on the conditions of storage. It can either be dry powder, foam or CO_2 extinguishers. An adequate water supply is needed in case larger fires occur. In case of fire water run-off, an adequate interceptor or special draining system may be applied to minimise the risk of contamination of local watercourses, thus **containment** of contaminated extinguishant.

4.7.1.6 H6: Incidents and (major) accidents emission control measures for storing containers

Operational losses do not occur in storing packaged dangerous materials. The only possible emissions are from incidents and (major) accidents. Three main events have the potential to cause significant harm or damage: fire, explosion and/or release of dangerous substances.

Again, **safety and risk management** is advisable. Also, adequate construction and ventilation is important.

For more information, see 4.7.1.5.

4.7.1.7 H7: Management tools to reduce emissions from transfer and handling of liquids and liquefied gases

Emissions might occur when transferring liquids and/or liquefied gases (e.g. in aboveground closed piping transfer systems, aboveground open piping transfer systems, underground closed piping transfer systems, unloading hoses) or during handling. The most significant potential emission sources are filling of piping systems, cleaning of open systems and fugitives in all modes. The use of Emission Control Measures (ECM) is therefore advisable.
Management tools for transfer and handling (general measures) include:

- Operational procedures and training;
- Inspection, maintenance and monitoring;
- Leak detection and repair (LDAR) programme;
- Safety and risk management.

4.7.1.8 H8: Operational techniques to reduce emissions from transfer and handling of liquids and liquefied gases – piping, loading/unloading, product handling systems

Specific measures are available depending on the mode of the system (above-ground or underground, closed or open system). Some of the measures per system are listed below. For more information on the different available techniques, we refer to the BREF and the candidate BAT database.

<u>Piping</u>

- ECM for above-ground/underground <u>closed</u> piping
    - Operational-gas emissions
        - **Reduction in number of flanges and connectors**: the more flanges and connectors there are, the higher the risk of leakage through for example thermal stress or misalignment;
        - **Selection and maintenance of gaskets**: correct selection is very important as well as regular control and replacement if needed;
        - **Improved flanges**: for plants with a high potential for environmental pollution, flanges with tongue and groove or with projection and recess are common practice;
        - **Vapour collection**: vapours displaced during pipeline filling can be collected and either ‘balanced’ back to the tank or treated.
    - Incidents and (major) accidents
        - **Internal corrosion and erosion**: an internal coating may be applied to achieve a high quality protection, welded areas need additional coating or corrosion inhibitors can be considered to prevent corrosion and erosion;
        - **External corrosion – above-ground piping**: to prevent atmospheric corrosion, the system should be painted with a one, two or three layer coating system, taking into account site-specific conditions.
- ECM for above-ground/underground <u>open</u> piping

  - Operational – gas emissions
    - **Replacement** with closed piping systems;
    - **Reduced length**: reducing the length of above-ground open piping systems reduces possible emissions.
  - Incidents and (major) accidents (see explanation under closed piping)

Loading/unloading transporters

- ECM for the loading and unloading of transporters

Product handling systems

- ECM for product handling systems
  - Operational – gas emissions
    - **High quality equipment**: using better quality equipment can result in reduction of emissions. However for existing systems, replacing existing equipment with equipment of improved quality is often not economically justifiable;
    - **Elimination of open-ended lines and valves**: open-ended lines occur at the outlets from drains or sampling points. They are typically fitted with a valve, which should normally be closed;
    - **Variable speed pumps:** control valves open and close frequently and are more prone to leakage than shut-off valves. Using variable speed pumps instead of rising stem control valves reduces emissions to air;
    - **Double walled valves**: the outer secondary containment, which hermetically encapsulate all critical parts that represent a potential point for leakage or emission;
    - …
  - Incidents & (major) accidents
    - **Flanged connections in liquidtight pits**: for underground piping it is common to install all flanged connections in liquidtight pits making them accessible from the surface.

4.7.1.9 H9: Prevention and control of emissions from the handling of solids

During the handling of bulk materials, emissions may occur. Different ECM are available to limit these emissions and are listed below. For more information on the different techniques, we refer to the BREF and the candidate BAT database.
There are primary measures that can be taken to prevent dust emissions as much as possible.

- Primary organisational approaches to minimise dust from handling
  - **Weather conditions**, e.g. no unloading in open air when there is a lot of wind;
  - **Measures for the** crane **operator** when using a grab, a mechanical shovel and so on: these are very low cost measures that can be generally be applied;
  - **Layout and operation** of storage sites
    - Reduction of discontinuous transport and transport distances: it is important to make transportation distances as short as

possible to minimise the number of traffic movements and thus dust emissions;
        - Adjusting the speed of vehicles: this will reduce the amount of dust that is swirled up;
        - Roads with hard surface: concrete or asphalt roads can be cleaned easily and it eliminates dust from vehicles driving on sandy roads;
- Primary constructional techniques to minimise dust from loading and unloading
    - Loading/unloading in a **closed building:** to further prevent dust from escaping the building can be equipped with automatically opening and closing doors or curtains;
- Primary techniques to minimise dust from handling
    - **Optimised grabs:** e.g. closed at the top, smooth surface…;
    - **Closed conveyors**;
    - …

Secondary measures will focus on reducing the dispersion of dust emissions, once they are created, as much as possible.

- Secondary techniques to minimise dust from handling:
    - **Housing of the dust source**, possibly combined with a suction system;
        - Screens for open conveyor belts;
        - Housing or covering the emission source;
        - …
    - **Use of dust separators**;
        - Lamellae filters for pneumatic conveyors;
    - **Use of sprinkling plants**:
        - Jet spraying;
        - …

Of course, measures should also be taken when handling packaged goods. As always, safety and risk management in handling solids is important.

4.7.2 Energy efficiency

4.7.2.1 H10: Techniques to achieve energy efficiency at plant level

In order to achieve energy efficiency in a company, an integrated approach combining management systems, process-integrated techniques and specific technical measures is preferred. In this paragraph, the focus will be on techniques to be considered at the level of an entire plant with the potential to achieve optimum energy efficiency. All techniques from this paragraph may be used singly or as combinations with those of the next paragraph.

- All industrial companies can save energy by applying the same sound management principles and techniques they use elsewhere in the business for key resources such as finance. These management practices include full managerial accountability for energy use. The management of energy consumption and costs eliminates waste and brings cumulative savings over

time. Some important features for a successful **energy efficiency management system (ENEMS)** are:
  - Commitment of top management;
  - Definition of an energy efficiency policy;
  - Planning and establishing objectives and targets;
  - Implementation and operation of procedures;
  - …
- **Planning and establishing objectives and targets.** An important element of an environmental management system is **maintaining overall environmental improvement**, including energy efficiency. Additionally, it was shown that, while there are savings to be gained by optimising individual components (e.g. pumps), the biggest energy efficiency gains are to be made by taking a **systems approach**, starting with the plant, considering the component units and systems and optimising how these interact, and optimising the system. Only then should any remaining devices be optimised.
- Experience shows that, if energy efficiency is considered during the planning and design phase of a new plant, saving potentials are higher and the necessary investments to achieve the savings are much lower, compared with optimising a plant in commercial operation. **Energy efficient design** should therefore be performed.
- Intensifying the use of energy and raw materials by optimising their use between more than one process or system is called **process integration**. This is site- and process-specific.
- **Maintaining the impetus of energy efficiency initiatives** often creates problems. It is important that savings in energy efficiency due to adoption of a new technology or technique are sustained over time.
- **Other:** communication, effective control of processes, maintenance, monitoring and measurement, energy audits and energy diagnosis, pinch methodology, enthalpy and exergy analysis, thermo economics, energy models, benchmarking and so on.

4.7.2.2 H11: Techniques to achieve energy efficiency – combustion

The combustion installations discussed here are heating devices or installations using the combustion of a fuel (including wastes) to generate and transfer heat to a given process. Energy can be managed by control of the process parameters and control on the combustion side. Some possible techniques to improve energy efficiency in combustion are shortly described below.

- **Reduction of the flue-gas temperature** is one option to reduce possible heat losses in a combustion process. The lower the flue-gas temperature, the better the energy efficiency.
- **Installing an air or water pre-heater**: the air pre-heater heats the air which flows to the burner. This means flue-gases can be cooled down even more, as the air is often at ambient temperature. A higher air temperature improves combustion, and the general efficiency of the boiler will increase.

- **Recuperative and regenerative burners**: these burners have been developed for direct waste heat recovery through combustion air preheating. A recuperator is a heat exchanger that extracts heat from the furnace waste gases to preheat the incoming combustion air. This will increase combustion efficiency.
- **Reducing the mass flow of the flue-gases by reducing excess air**: excess air can be minimised by adjusting the air flow rate in proportion to the fuel flow rate. Depending on how fast the heat demand of the process fluctuates, excess air can be set manually or controlled automatically.
- **Burner regulation and control**: automatic burner regulation and control can be used to control combustion by monitoring and controlling fuel flow, air flow, oxygen levels in the flue gases and heat demand.
- **Fuel choice**: the type of fuel chosen for the combustion process affects the amount of heat energy supplied per unit of fuel used. The required excess air ratio is dependent on the fuel used and this dependence increases for solids. The choice of fuel is therefore an option for reducing excess air and increasing energy efficiency.
- **Oxy-firing (oxy-fuel)**: oxygen is used instead of ambient air is either extracted from air on the site, or more usually, bought in bulk. Energy requirement to concentrate the air is considerable, and should be taken into account in any energy calculations.
- **Reducing heat losses by insulation**: the heat losses through the walls of the combustion system are determined by the diameter of the pipe and the thickness of the insulation. An optimum insulation thickness which relates energy consumption with economics should be found in every particular case.
- **Reducing losses through furnace openings**: heat losses by radiation can occur via furnace openings for loading/unloading. Openings include furnace flues and stacks, peepholes used to visually check the process, etc.

4.7.2.3 H12: Techniques to achieve energy efficiency – steam systems

Steam is one of the possible energy carriers in fluid-based heating systems. Some techniques to improve steam system performance in generation, distribution and recovery areas are described below.

- **Throttling devices and the use of backpressure turbines**: throttling devices are very common in industry and are used to control and reduce pressure mainly through valves. Since the enthalpy up and down flows are equal in this process, no energy is lost and its efficiency is optimal.
- **Operating and control techniques**: this measure consists of improving operating procedures and boiler controls, using sequential boiler controls and installing flue-gas isolation dampers.
- **Preheating feed-water**: the steam boiler is fed with water to replace system losses and recycle condensate etc. Heat recovery is possible by preheating the feed-water, thus reducing the steam boiler fuel requirements.
- **Prevention and removal of scale deposits on heat transfer surfaces**: on generating boilers as well as in heat exchanging tubes, a scale deposit might

occur on heat transfer surfaces. Scale creates a problem because it typically possesses a thermal conductivity with an order of magnitude less than the corresponding value for bare steel. This causes the heat transfer of the surface to be reduced as a function of the scale thickness.

- **Minimising blowdown from the boiler** (see 4.3.8).
- **Optimising deaerator vent rate:** deaerators are mechanical devices that remove dissolved gases from boiler feed-water. Deaeration protects the steam system from the effects of corrosive gases.
- **Minimising boiler short cycle losses**: Losses during short cycles occur every time a boiler is switched off for a short period of time. For example installing multiple boilers with a smaller capacity instead of one boiler with a large capacity, can reduce short cycling and the resulting losses.
- **Optimising steam distribution systems**: the distribution system transports steam from the boiler to the various end-uses. Proper performance of the system requires careful design practices and effective maintenance.
- **Insulation on steam pipes and condensate return pipes** (see 4.4.2).
- **Implementing a control and repair programme for steam traps:** leaking steam traps lose significant quantities of steam, which result in large energy losses. Proper maintenance can reduce these losses in an efficient manner.
- **Collecting and returning condensate to the boiler for re-use:** where heat is applied to a process via a heat exchanger, the steam surrenders energy as latent heat as it condenses to hot water. This water is lost, or (usually) collected and returned to the boiler. Re-using the condensate creates the re-use of the energy contained in the hot condensate, saving cost of fresh water, saving the cost of boiler water treatment and saving the cost of wastewater discharge.
- **Re-use of flash steam** (see 4.4.14).
- **Recovering energy from boiler blowdown**: energy can be recovered from boiler blowdown by using a heat exchanger to preheat boiler make-up water.

4.7.2.4 H13: Techniques to achieve energy efficiency – heat recovery and cooling

Heat naturally flows from the higher temperature (heat source) to a lower temperature (heat sink). Heat flows from an activity, process or system may be seen by analogy to other emissions to the environment as i) fugitive sources (e.g. radiation, hot areas with poor or no insulation…) or ii) specific flows e.g. hot flue-gases, exhaust air, cooling fluids from cooling systems, etc. These heat losses are often called 'waste heat', although the term should be 'surplus heat') as heat may be recovered from the specific heat flows. The most commonly used heat recovery techniques are:

- **Heat exchangers:** direct heat recovery is carried out. A heat exchanger is a device in which energy is transferred from one fluid or gas to another across a solid surface.
- **Heat pumps (incl. mechanical vapour recompression):** the main purpose for heat pumps is to transform energy from a lower temperature level to a higher level. Heat pumps can transfer heat (not generate heat) from man-made heat sources such as industrial processes, or from natural or artificial heat sources in the surroundings such as air, ground or water. The most common use of heat pumps is in cooling systems.

- **Chillers and cooling systems:** these are systems to remove waste heat from any medium, using heat exchange with water and/or air to bring down the temperature of that medium towards ambient level.

4.7.2.5 H14: Techniques to achieve energy efficiency – cogeneration

Cogeneration can be defined as *the simultaneous generation in one process of thermal energy and electrical and/or mechanical energy* (Directive 2004/8/EC). There are different **types of cogeneration**: combined cycle gas turbines, steam turbine plants, gas turbines with heat recovery boilers, fuel cells, stirling engines, etc. There are significant economic and environmental advantages to be gained from CHP production, due to their high efficiency.

Trigeneration is generally understood to mean the simultaneous conversion of a fuel into three useful energy products: electricity, hot water or steam and chilled water. It is actually a cogeneration system with an absorption chiller that uses some of the heat to produce chilled water.

District cooling is another aspect of cogeneration, where cogeneration provides centralised production of heat, which drives absorption chillers, and the electricity is sold to the grid. Cogeneration can also deliver district cooling by means of centralised production and distribution of cooling energy.

4.7.2.6 H15: Techniques to achieve energy efficiency – electrical power supply

Public electrical power is supplied via high voltage grids. The voltage is high to minimise the current losses in transmission. Various factors affect the delivery and the use of energy, including the resistance in the delivery systems and the effects some equipment and uses have on the supply. To increase efficiency, different measures might be taken, such as power factor correction (real power versus apparent power), reduction of harmonics and optimising supply.

4.7.2.7 H16: Techniques to achieve energy efficiency – electric motor-driven sub-systems

The energy efficiency in motor-driven systems can be assessed by studying the demands of the (production) process and how the driven machine should be operated. This is a systems approach and yields the highest energy efficiency gains. Savings achieved by a systems approach as a minimum will be those achieved by considering individual components and can be 30% or higher. There are at least two different ways to approach the concept of energy efficiency in motor-driven systems. One is to look at individual components and their efficiencies and ensure that only high efficiency equipment is employed. The other is to take a systems approach.

The following measures may be taken:

- **Energy efficient motors**: energy efficient motors and high efficiency motors offer greater energy efficiency. Additional purchase costs may be up to 20-30% higher, however the energy savings of about 2-8% can be achieved.

- **Proper motor sizing**: often motors are oversized for the real load they have to run. The maximum efficiency however is obtained for the motors of between 60-100% of full load. Therefore proper sizing improves energy efficiency, may reduce line losses due to low power factors and may slightly reduce the operating speed and thus power consumption of fans and pumps.
- **Variable speed drives**: the adjustment of the motor speed through the use of variable speed drives can lead to significant energy savings associated with better process control, less wear in the mechanical equipment and less acoustical noise.
- **Reduce transmission losses**
- **Motor repair**
- **Rewinding**

4.7.2.8 H17: Techniques to achieve energy efficiency – compressed air systems (CAS)

Compressed air is air that is stored and used at a pressure higher than atmospheric pressure. It can be used as an integral component in industrial processes or as an energy medium. Compressed air systems (CAS) are important installations from an energy point of view. Optimising these to achieve energy efficiency is important. Again, depending on the specific characteristics of the system (new, refurbishment, old, size…) there are different techniques to improve energy efficiency:

- **System design:** nowadays, many existing CAS lack an updated overall design. The implementation of additional compressors and various applications in several stages during the installation's lifetime without a parallel redesign from the original system have frequently resulted in a suboptimal performance of a CAS.
- **Variable speed drives**: VSD for compressors find applications mainly when the users' process air requirements fluctuate. In VSD compressors, the speed of the electric motor is varied in relation to the compressed air demands, resulting in a high level of energy savings.
- **High efficiency motors**: these motors minimise the electrical and mechanical losses to provide energy savings.
- **CAS master control system**: often, CAS are multi-compressor installations. The energy efficiency of such multi-compressor installations can be significantly improved by CAS master controls, which exchange operational data with the compressors and partly or fully control the operational modes of the individual compressors.
- **Heat recovery:** most of the electrical energy used by an industrial air compressor is converted into heat and has to be conducted outwards. In many cases, a properly designed heat recovery unit can recover a high percentage of this available thermal energy and put to useful work heating either air or water when there is a demand.
- **Reducing compressed air system leaks**
- **Filter maintenance**
- **Feeding the compressor(s) with cool outside air**
- **Optimising the pressure level**
- **Storage of compressed air near high-fluctuating uses**

4.7.2.9 H18: Techniques to achieve energy efficiency – pumping systems

Pumping systems account for nearly 20% of the world's electrical energy demand. The energy and materials used by a pumping system depend on the design of the pump, the design of the installation and the way the system is operated. Different steps are important to identify energy saving measures:

- **Inventory and assessment of pumping systems**: the first step is to establish an inventory of the pumping systems in the installations with the key operating characteristics.
- **Pump selection**: the pump is the heart of the system. Its choice is driven by the need of the process which could be, first of all, a static head and a flow rate. The choice also depends on the system, the liquid, the characteristic of the atmosphere, etc.
- **Pipework system**: the pipework system determines the choice of the pump performance. Its characteristics have to be combined with those of the pumps to obtain the required performance of the pumping installation. The energy consumption directly connected to the piping system is the consequence of the friction loss on the liquid being moved, in pipes, valves and other equipment of the system.
- **Maintenance**: excessive pump maintenance can indicate i) pumps are cavitating, ii) badly worn pumps or iii) pumps that are not suitable for operation.
- **Pumping system control and regulation**: a control and regulation system is important in a pumping system so as to optimise the duty working conditions for the head pressure and the flow. It provides process control, better system reliability, energy savings.

4.7.2.10 H19: Techniques to achieve energy efficiency – heating, ventilation, air conditioning (HVAC) systems

A typical HVAC system comprises the heating or cooling equipment, pumps and/or fans, piping networks, chillers and heat exchangers. Studies have shown that about 60% of the energy in an HVAC system is consumed by the chiller/heat pump and the remaining 40% by peripheral machinery. To increase efficiency in HVAC, several elements are to be optimised:

- **Space heating and cooling**: energy savings can be achieved for example by reducing the heating/cooling needs or improving the efficiency of the system (by recovery of waste heat, heat pumps…);
- **Ventilation**: optimisation of design of a new or upgraded ventilation system is important, but also improving an existing system within a plant;
- **Free cooling**: can be used for cooling in order to increase energy efficiency. It takes place when the external ambient air enthalpy is less than the indoor air enthalpy.

4.7.2.11 H20: Techniques to achieve energy efficiency – Lighting

Artificial lighting accounts for a significant part of all electrical energy consumed worldwide. In some buildings over 90 percent of lighting energy consumed can be an unnecessary expense through over-illumination. Thus, lighting represents a critical component of energy use today. There are several techniques available to minimise energy requirements:

- Identification of lighting requirements in each area;
- Analysis of lighting quality and design;
- Management of lighting.

4.7.2.12 H21: Techniques to achieve energy efficiency – drying, separation, concentration processes

Drying is an energy intensive process. It is considered here with separation and concentration techniques, as the use of different techniques or combinations offers energy savings.
Techniques to optimise energy efficiency are:

- Selecting the optimum technology or combination of technologies: the choice depends on the characteristics of the feed and the required outputs and other constraints.
- Surplus heat from other processes might be used;
- Use of a combination of techniques;
- Thermal processes, e.g. directly heated dryers…
- Process automation in thermal drying processes;
- …

4.7.3 Cooling systems

4.7.3.1 H22: Integrated heat management

Cooling of industrial processes can be considered as heat management and is part of the total energy management within a plant. It's important to follow an integrated approach to reduce the environmental impact of industrial cooling systems maintaining the balance between both the direct and indirect impacts. Another important aspect is to reduce the level of heat discharge by optimization of internal/external heat reuse. Once the level and amount of waste heat generated by the process is established and no further reduction of waste heat can be achieved, an initial selection of a cooling system can be made in light of the process requirements.

4.7.3.2 H23:Techniques for the reduction of the energy consumption of cooling

In the design phase of a cooling system, energy consumption can be reduced when:

- Resistance to water and airflow is reduced;
- High-efficiency/low-energy equipment is applied;
- The amount of energy-demanding equipment is reduced;
- …

In an integrated approach to cooling an industrial process, both the direct and indirect use of energy are taken into account. It is preferred to use a once-through system when possible.

4.7.3.3 H24: Techniques for the reduction of water requirements in cooling

In order to reduce water requirements in cooling, several measures can be taken. In general, for new systems, for example it is advised to reduce the cooling demand by optimising heat reuse or a site should be selected for the availability of sufficient quantities of (surface) water in the case of high cooling water demand.

For existing water cooling systems, increasing heat reuse and improving operation of the system can reduce the required amount of cooling water.

Other techniques are available to further reduce water requirements, like the application of recirculating systems, application of dry cooling or the optimization of concentration cycles.

4.7.3.4 H25: Techniques for the reduction of entrainment of organisms in cooling

The adaptation of water intake devices to lower the entrainment of fish and other organisms is highly complex and site-specific. Changes to an existing water intake are possible but costly.

4.7.3.5 H26: Techniques for the reduction of emissions to water in cooling

Whether heat emissions into the surface water will have an environmental impact strongly depends on the local conditions. Prevention and control of chemical emissions resulting from cooling systems have received a lot of attention as well. Measures should be taken in the design phase of wet cooling systems:

- Identify process conditions;
- Identify chemical characteristics of the water source;
- Select the appropriate material for heat exchangers;
- Select the appropriate material for other parts of the cooling system;
- Identify operational requirements of the cooling system;
- Select feasible cooling water treatment;
- …

4.7.3.6 H27: Techniques for the reduction of emissions to air in cooling

Air emissions from cooling towers have not been given much attention yet. Lowering concentration levels in the circulating cooling water will obviously affect the potential emission of substances in the plume. Some reduction techniques are plume emission at sufficient height and with a minimum discharge air velocity at the tower outlet, application of hybrid technique or other plume suppressing techniques, design and positioning of tower outlet to avoid risk of air intake by air conditioning systems.

4.7.3.7 H28: Techniques for the reduction of noise emissions in cooling

Noise emissions have local impact. Noise emissions of cooling installations are part of the total noise emissions from the site. A number of primary and secondary measures have been identified that can be applied to reduce noise emissions where necessary. The primary measures change the sound power level of the source, where the secondary measures reduce the emitted noise level. The secondary measures in particular will lead to pressure loss, which has to be compensated by extra energy input, which reduces the overall energy efficiency of the cooling. The ultimate choice for a technique will be an individual matter, as will the resulting associated performance level. Possible measures include for example application of an earth barrier or noise attenuating wall, and application of low noise fans.

4.7.3.8 H29: Techniques for the reduction of risk of leakage in cooling

To reduce the risk of leakage, attention must be paid to the design of the heat exchanger, the hazardousness of the process substances and the cooling configuration. The following general measures to reduce the occurrence of leakages can be applied: i) select material for equipment of wet cooling to the applied water quality, ii) operate the system according to its design, iii) select the right cooling water treatment programme and iv) monitor leakage in cooling water discharge by analysing the blowdown. Other techniques include among others constant monitoring, the application of welding technology and changing technology to indirect cooling for example.

4.7.3.9 H30: Techniques for the reduction of biological risk in cooling

To reduce the biological risk due to cooling system operation, it is important to control temperature, maintain the system on a regular basis and avoid scale and corrosion. All measures are more or less within the good maintenance practice that would apply to a recirculating wet cooling system in general. The more critical moments are start-up periods, where system operation is not optimal, and standstill for repair or maintenance. For new towers, consideration must be given to design and position.

CHAPTER 5 SELECTION OF THE BEST AVAILABLE TECHNIQUES (BAT)

In this chapter, the environmentally friendly techniques of chapter 4 are evaluated with respect to their environmental benefit, their technical and their economic viability. It is also suggested whether or not a discussed technique can be regarded as a BAT for the dairy industry.

The BAT selected in this chapter are considered BAT for the dairy sector as a whole. This does not imply that every single company belonging to the sector is capable of applying each of the selected techniques without experiencing any significant problems. For drawing company-level conclusions, the company specific circumstances always need to be taken into account.

The BAT selection in this chapter is not to be considered as a separate matter, but should be viewed in the global context of this study. That is, the discussion of the environmentally friendly techniques in chapter 4 should always be taken into account.

5.1 Evaluation of the available environmentally friendly techniques

In Table 7 the available environmentally friendly techniques of chapter 4 are each tested on a number of criteria. This multi-criteria analysis allows for judging whether or not a technique can be considered a Best Available Technique. The criteria are not only related to the environmental media (water, air, soil, energy, noise/vibrations), but also cover the technical viability and the economic aspects. In that way, an integrated assessment, consistent with the BAT definition (cf. Chapter 1) is allowed for.

The following aspects are qualitatively evaluated and reflected in the table:

Technical viability

- **proven**: indicates whether the technique has a proven use in industrial practice ("-": not proven, "+": proven);
- **applicability:** indicates whether a technique can truly be applied under all circumstances. Sometimes, there might be technical or regulatory limitations that hinder the application of a certain technique ("-": not applicable, "-/+": applicable under certain circumstances, "+": applicable). Limiting circumstances need to be clearly described;
- **safety and working conditions**: indicates whether the technique, when properly applying the appropriate security measures, is expected to lead to an increased risk of fire, explosions or accidents in general and thus affecting the safety and working conditions ("-": increased risk, "0": no increased risk, "+": reduced risk);
- **quality**: indicates whether the technique is expected to influence the quality of the end product ("-": reduced quality; "0": no quality effect; "+": increased quality);
- **global**: estimates the global technical viability of the technique for the sector as a whole ("+": if all the above aspects are "+" or "0"; "-": if at least one of the above aspects is "-").

Environmental benefit

- **water use**: reuse of wastewater and reduction of the total water use;
- **wastewater**: addition of polluting substances to the water as a result of the operation of the facility (BOD, COD, nutrients, other emissions to water);
- **energy**: energy savings, use of renewable energy sources and energy reuse;
- **air/odour**: addition of polluting substances to the atmosphere as a result of the operation of the facility (dust, NO_X, SO_X, NH_3, VOC, other emissions to air);
- **waste**: prevention and control of waste flows;
- **use of raw and auxiliary materials**: influence on the amount and the kind of raw/auxiliary materials (e.g. chemicals) used;
- **soil**: addition of polluting substances to soil and groundwater as a result of the operation of the facility;
- **global**: estimated influence on the environment as a whole;
- **noise/vibrations.**

Per technique, for each of the above criteria a qualitative assessment is carried out in which:

- "-": negative effect, e.g. expected increased emissions to air or water, reduced use of materials, …;
- "0": no/negligible impact;
- "+": positive effect, e.g. reduction in emissions to air or water, reduced use of materials, …;
- "+/-":sometimes positive, sometimes negative effect.

The single score for global environmental benefit is determined based on the individual scores, using different criteria. Due to the qualitative approach used in this study, a possible criteria is the weighting of the different environmental scores based on priorities set in legislation, based on environmental quality standards for water, air, etc. (see Chapter 2 for the legislative and socio-economic framework). In this study, this weighting is part of the expert judgement by the TWG members involved, but is seldom explicitly described.

Economic viability

- "+": the technique reduces the costs;
- "0": the technique has a negligible impact on the costs;
- "-": the technique increases the costs, but the additional costs are considered bearable for the sector (i.e. for an average company) and reasonable compared to the environmental benefit;
- "- -": the technique increases the costs, the additional costs are not considered bearable for the sector (i.e. for an average company) or reasonable compared to the environmental benefit.

Finally in the last column it is decided whether the considered technology can be selected as Best Available Technique (BAT: 'yes' or BAT: 'no'). When this decision is highly dependent on the company and/or the local circumstances, the technique gets a 'BAT' score, but with a clear description of the specified conditions.

Important remarks for using Table 7

Whenever using the table below, keep the following remarks in mind:

The table should not be considered as a separate matter, but should be viewed in the global context of the study. That is, the discussion of the environmentally friendly techniques in chapter 4 should always be taken into account.

The evaluation of the different criteria is, among other things based on:
- The operators' experience with the technique;
- BAT-selections carried out in other (foreign) comparable studies;
- The sector working group's advice (expert judgement);
- The author's considerations.

Where needed, footnotes are inserted for additional clarification. The meaning of the criteria and the scores is explained in section 5.1.
The BAT conclusions in the table are based on discussion in the Technical Working Group. The final BAT conclusions and conditions (in case of conditional BAT) can differ from these in other MPCs. These differences are explained (made clear) by the individual scores for the technical viability, environmental benefit and economic viability and accompanying footnotes in the BAT evaluation matrix. When determining/setting the scores, the local situation in the MPC was taken into account. Differences in scores, like differences in environmental scores, might also be caused by differences in background and focus of the members of the TWG in the different MPCs. However, these smaller differences (often not at all contrary) will not directly influence the final BAT conclusion.

The assessment of the criteria is indicative and not necessarily applicable in each individual case. Thus, the appreciation in no way relieves the operator from the responsibility to investigate if e.g. the technique is technically viable in his/her specific situation, if it does not hamper safety and working conditions, cause unacceptable environmental nuisance or entail excessive costs. Additionally, for the assessment of each technique it is supposed that appropriate safety/environment protection measures were taken.
The table assesses in a general way if the discussed environmental techniques are to be considered BAT for the dairy sector. The scoring is thus purely a qualitative scoring, not a score compared to a certain reference situation as you might do for a single company. The resulting evaluation does therefore not necessarily mean that every company belonging to the sector is capable of applying each of the selected techniques. The companies' specific circumstances should always be taken into account.

Table 7: Evaluation of the available environmentally friendly techniques and selection of the BAT

Water consumption

The scoring in this table is purely based on a qualitative evaluation and thus not compared with a reference situation. The scores merely indicate what overall effect a technique is expected to have.

Technique		**Technical viability**					**Environmental benefit**									**Economic viability**	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
W1	Transport solid materials dry	+	-/+[19]	0	-/0[20]	-/+	+	+	-	+	0	0	-	+	-/+	-	Yes[21]
W2	Dry cleaning of equipment and installations	+	+	+	0	+	+	+	-[22]	+	0	0	-[23]	+	+	-/0	Yes
W3	Selecting water sources in function of the required quality	+	-[24]	0	-/0	-	+	+	0[25]	0[26]	0	0	0	0[27]	+	-	No
W4	Minimise/optimise water consumption	+	+	0	0	+	+	+	+	0	0	0	0	0	+	-	Yes

[19] This technique could indeed be applicable, but is hardly relevant for the dairy industry in Egypt.
[20] Unless transport using water (gutter system) is needed to avoid product decay, e.g. in cheese production.
[21] Restrictions: This technique is a BAT when it is applicable (relevant) and doesn't negatively affect the quality of the product.
[22] A vacuum is needed for this: generating a vacuum and using such a system requires energy.
[23] A vacuum system might create additional nuisance due to noise/vibrations.
[24] Egyptian legislation does not allow the reuse of any purified water in a dairy plant, not even for sanitary purposes. Alternative water sources, such as groundwater or rainwater, are not available in Egypt for companies to use. Therefore, this technique is not applicable.
[25] Treating water in some cases requires energy.
[26] Treating water can generate waste streams, like sludge.
[27] Treating water in some cases requires the use of certain chemicals.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
W5	Pre-soak floors and open equipment to loosen dirt before cleaning	+	+	0	0	+	+	+	+	0	0	0	0	+	+	-/0	Yes
W6	Minimisation of centrifugal separator waste discharges	+	+	0	0	+	+	+	+	0	0	0	0	+	+	-	Yes
W7	CIP and its optimal use	+	+[28]	0	0	+	+	+	+	+	0	0	0	+	+	-	Yes

[28] Only applied by medium and large companies, but since CIP is a general measure, the way it is implemented can be less extensive in smaller companies.

Wastewater

The scoring in this table is purely based on a qualitative evaluation and thus not compared with a reference situation. The scores merely indicate what overall effect a technique is expected to have.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety and working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air and odour	Soil and groundwater	Noise and vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
WW1	Minimising the use of EDTA	+	+	0	-/0	+	0	+	0	0	0	0	0	+	+	0	Yes
WW2	Prevent use of halogenated oxidizing disinfectants and sterilizers	+	-/+[29]	0	-/0	-/+	0	+	0	0	0	0	0	+	+	0	Yes[30]
WW3	Provision and use of catchpots over floor drains	+	+	0	0	+	0	+	0	-	0	0	0	+	+	-/0	Yes
WW4	Segregation of effluents to optimise use, reuse, recovery, recycling and disposal	+	-/+[31]	0	0	-/+	+	+	+	0	0	0	0	+	+	--/-[32]	Yes[33]
WW5	Use of self-neutralisation	+	-/+[34]	0	0	+	0	+	0	0	0	0	0	+	+	-/0	Yes[35]

[29] Applicable in case there are alternatives that guarantee the same quality.
[30] Restriction: BAT for all dairy companies when the alternative products are effective enough to guarantee the quality of the product.
[31] Applicable in new installations, or on a very simple scale e.g. when the output of a process is (partly) reused as input to the same process. Retrofitting an existing installation is often complex: current design might offset reuse, e.g. when the two processes which need to be linked for reuse are far apart in the plant layout.
[32] According to the TWG, economically viable for new dairy installations or when on a very simple scale in existing, not for retrofitting: an entire installation: requires too high capital costs.
[33] Restriction: BAT for new dairy installations or refurbished ones. Only BAT for existing dairy installations in case it is a minor change, not when it is implemented of a full segregation system.
[34] Applicable whenever there are suitable variations in pH of wastewater (strongly acidic and alkaline wastewater).
[35] Restriction: BAT when there is the required variation in pH of the wastewater.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety and working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air and odour	Soil and groundwater	Noise and vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
WW6	Use of proper wastewater treatment techniques	+	-/+[36]	0	0	-/+	0/+[37]	+	-/0[38]	-/0[39]	-/0[40]	0	0	-/0[41]	+	-[42]	Yes[43]
→	Aerobic processes	+	-/+[44]	0	0	-/+	0	+	-	0	0	0	0	+	+	--/-[45]	Yes[46]
WW7	Minimise the production of acid whey and its discharge to the WWTP in **cheese production**	+	+	0	0	+	0	+	0	0	0	0	0	+	+	-/0	Yes
WW8	Minimise the blowdown of a boiler	+	+	0	0	+	+	+	+	0	0	0	0	0	+	-	Yes
WW9	Maximise condensate return	+	+	0	0	+	+	+	+	0	0	0	0	0	+	-	Yes

[36] The required wastewater treatment technique(s) need to be determined on a plant level, depending on the specific situation e.g. discharge into surface water or sewer, quality of the receiving surface water, contamination of the wastewater, etc.
[37] The effect on water use is positive when the treated water is reused as process water.
[38] Some of the water treatment techniques require additional energy.
[39] Some of the water treatment techniques create a residue (sludge) during the treatment process.
[40] When the water treatment system doesn't function optimally, odour might become a problem.
[41] Some of the water treatment techniques require the use of chemicals, e.g. physicochemical removal of phosphorous.
[42] Wastewater treatment will always require an additional cost, but this cost is highly dependent on the type, design and size of the system and the receiving medium.
[43] Overall, one can say that there will always be a treatment system suitable for each situation: whether it's a fully equipped primary+secondary+tertiary treatment system for large companies discharging their wastewater into surface water, or a simple primary treatment for small companies discharging into the sewer. Depending on the company specific situation, an evaluation should be made on the economic viability.
[44] A technical limitation on applicability might be space requirements of the technique.
[45] The technique will be cost effective when the wastewater is readily biodegradable. Cost feasibility however will depend a lot on the technique chosen and the company specifics.
[46] Restriction: A technical limitation on the applicability might be space requirements of the technique. Costs might also make it impossible to apply the technique.

Energy

The scoring in this table is purely based on a qualitative evaluation and thus not compared with a reference situation. The scores merely indicate what overall effect a technique is expected to have.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
E1	Switch off equipment when not needed	+	+	0	0	+	0	0	+	0	0	0	0	0	+	0/+	Yes
E2	Insulation of pipes, vessels and equipment	+	+	0	0	+	0	0	+	0	0	0	0	0	+	0/+	Yes
E3	Avoid excessive energy consumption in heating and cooling processes	+	+	0	0[47]	+	0	0	+	0	0	0	0	0	+	0/+	Yes
E4	Implement and optimise heat recovery	+	+	0	0	+	0	0	+	0	0	0	0	0	+	0/+	Yes
E5	Use a plate heat-exchanger for precooling ice water with ammonia	+	+	0	0	+	0	0	+	0	0	0	0	0	+	-/0	Yes
E6	Partial homogenisation of market milk	+	-/+[48]	0	-/0[49]	+	0	0	+	0	0	0	0	0	+	-/0[50]	Yes[51]
E7	Use of continuous pasteurizers	+	+	0	0	+	0	0	+	0	0	0	0	0	+	0/+	Yes

[47] Of course, product quality is to be guaranteed.
[48] The technique is applicable in Egyptian dairy plants that have microfiltration.
[49] In some cases, creaming the final product might become problematic.
[50] When the costs of product losses (due to creaming problems for example) are higher than the reduced energy costs, the net cost effect becomes negative.
[51] Restrictions: BAT for the whole sector, when microfiltration is used and when replacing the homogenisation installation, in case the technique doesn't create quality problems or induce additional costs due to product losses.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
E8	Optimise evaporation processes	+	+	0	0	+	0	0	+	0	0	0	0	0	+	-/0	Yes
E9	Two-stage drying in **milk powder production**	+	+	-[52]	0	+	+[53]	0	+	0	+[54]	0	-	0	+	-/0	Yes
E10	Use CHP	+	-/+[55]	0	0	-/+	0	0	+	0	+	0	0	0	+	--[56]	No[57]
E11	Improve steam collection	+	+	0	0	+	+	0	+	0	0	0	0	0	+	-/0	Yes
E12	Isolate unused/infrequently used pipework	+	+	0	0	+	+	0	+	0	0	0	0	0	+	-/0	Yes
E13	Repair steam leaks	+	+	0	0	+	+	0	+	0	0	0	0	0	+	-/0	Yes
E14	Avoid losses of flash steam from condensate return	+	+	0	0	+	+	0	+	0	0	0	0	0	+	-/0	Yes

[52] An explosive mixture of dust/air may form when using this technique. An appropriate fire alarm is therefore a necessary precaution.
[53] Water use can be reduced when using two-stage drying.
[54] Dust emissions are reduced when using this technique.
[55] Applicable where there is both a high consumption of heat as electricity and this during a certain period of time (at least 4000 hours a year). In Egyptian dairy installations, this is often not the case, except maybe in milk powder installations.
[56] According to the TWG the current circumstances in Egypt (prices of fuels and electricity) don't facilitate the use of CHP in an economically viable way.
[57] Not BAT for installations in Egypt according to the TWG members, because of the current market prices for fuels. Also the demand for heat and electricity in Egyptian dairy installations is not high enough to make the technique preferable. Evolution of fuel prices in the future might of course influence the BAT conclusion.

Waste and by-products

The scoring in this table is purely based on a qualitative evaluation and thus not compared with a reference situation. The scores merely indicate what overall effect a technique is expected to have.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
BP1	Automated filling incorporating recycling of spillages	+	+[58]	0	0	+	+	+	+	+	0	0	0	0	+	-/0	Yes
BP2	Restrict loss of raw materials and products in pipes	+	+	0	0	+	0	+	0	+	-/0[59]	0	0	0	+	-/0	Yes
BP3	Minimisation of losses during **butter making**	+	+[60]	0	0	+	+	+	+	+	0	0	0	0	+	-/0	Yes
BP4	Separate outgoing flows to optimise use, reuse, recovery, recycling and removal	+	+	0	0	+	+	+	0	+	0	0	0	0	+	-/0	Yes
BP5	Recovery and use of whey in **cheesemaking**	+	+	0	0	+	0	0	0	+	0	0	0	0	+	-/0	Yes
BP6	Segregation of packaging materials to optimise use, reuse, recovery, recycling and disposal	+	+	0	0	+	-/0[61]	-/0	-/0	+	0	0	0	-/0	+	-/0	Yes

[58] Applicable in plants where filling is relevant.
[59] In the case when dry cleaning techniques are used for piping, it is important to maintain the dust in working areas limited.
[60] Applicable in plants where butter is produced.
[61] When return packaging (going back to supplier) is used and the cleaning of this packaging material is to be done by the dairy company, this cross-media effect increases.

Technique		**Technical viability**					**Environmental benefit**									**Economic viability**	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
BP7	Optimisation of packaging design to reduce quantity	+	+	0	0	+	0	0	0	+	0	0	0	0	+	-	Yes

General

The scoring in this table is purely based on a qualitative evaluation and thus not compared with a reference situation. The scores merely indicate what overall effect a technique is expected to have.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
G1	Identification of potential accidents	+	+	+	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G2	Optimise the use of chemicals	+	+	0	0	+	0	0/+	0	0	0	0	0	+	+	0/+	Yes
G3	Environmental management system	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes[62]
G4	Collaboration with downstream and upstream partners	+	+	0	0	+	+	+	+	+	+	+	+	+	+	0	Yes
G5	Optimise operation by providing training	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G6	Design equipment to minimise consumption and emission levels	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G7	Maintenance	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G8	Methodology for preventing and minimising consumption of water and energy and production of waste	+	+	0	0	+	+	0	+	+	0	0	0	0	+	-/0	Yes
G9	Analysis of production processes	+	+	0	0	+	+	+	+	+	+	+	+	+	+	0	Yes

[62] The scope and nature of the environmental management system depends on the nature, scale and complexity of the installation and the range of environmental impacts it may have.

Technique		Technical viability					Environmental benefit									Economic viability	
		Proven	Applicability	Safety & working conditions	Quality	Global	Water use	Wastewater	Energy	Waste/by-products	Air & odour	Soil & ground water	Noise & vibrations	Raw/auxiliary materials	Global	Cost feasibility and cost effectiveness	BAT?
G10	Apply production planning to minimise associated waste production and cleaning frequencies	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G11	Good housekeeping	+	+	+	0	+	+	+	+	+	+	+	+	+	+	0	Yes
G12	Limit emission from storage	+	+	0	0	+	0	+	0	0	+	+	0	0	+	-/0	Yes
G13	Process control techniques	+	+	0	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G14	Risk assessment	+	+	+	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G15	Identify and implement control measures needed	+	+	+	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G16	Develop, implement and test an emergency plan	+	+	+	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G17	Investigate all accidents and near misses	+	+	+	0	+	+	+	+	+	+	+	+	+	+	-/0	Yes
G18	Management of water, energy and detergents use	+	+	0	0	+	+	0	+	0	0	0	0	+	+	0/+	Yes

5.2 BAT conclusions

Based on Table 7, the following conclusions can be formulated for the dairy sector in Egypt.

Remarks:
Unless otherwise stated, the BAT conclusions presented in this section are generally applicable to the dairy sector.

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques that ensure (at least) an equivalent level of environmental protection can be used.

Usually, in a BAT study, emission levels associated with the best available techniques (BAT AELs) are determined. These are the range of emission levels obtained under normal operating conditions using a BAT or a combination of BAT, expressed as an average over a given period of time, under specified reference conditions.

These BAT AELs are considered as the ultimate goal, whether it is by applying one or a combination of technique: as long as the environmental performance of an installation is in line with BAT AELs. In the present study however, the determination of BAT AELs was impossible due to lack of performance data. BAT are simply listed according to the environmental medium to which they apply. Depending on the environmental performance level one envisages, one or a combination of techniques might have to be applied. Combinations of techniques were not evaluated in this study.

5.2.1 BAT for *all* dairy companies

5.2.1.1 BAT to reduce water consumption

BAT is to reduce water consumption by using one or a combination of the following techniques:

- *Dry cleaning of equipment and installations (W2)*
- *Minimise/optimise water consumption (W4)*
- *Pre-soak floors and open equipment to loosen dirt before cleaning (W5)*
- *Minimisation of centrifugal separator waste discharges (W6)*
- *Cleaning In Place (CIP) and its optimal use (W7)*

Besides these techniques, there is one additional technique which was evaluated as a BAT, but only under certain circumstances:

- *Transport solid materials dry (W1)*
  The transportation of solid raw materials, products, co-products, by-products and waste dry – whenever there is the opportunity – is BAT, except when it

negatively affects the quality of the product. However, it is hardly applicable to the dairy sector.

5.2.1.2 BAT related to wastewater

BAT for wastewater management is to implement one or a combination of the following techniques:

- *Minimising the use of EDTA (WW1)*
- *Provision and use of catchpots over floor drains (WW3)*
- *Minimise the blowdown of a boiler (WW8)*
- *Maximise condensate return (WW9)*

Wastewater treatment (WW6) is a way to control water pollution. Preventive measures minimizing … and , should be applied in first instance (see above). If the result is insufficient, wastewater treatment techniques can be used. In this report, no general BAT conclusion on wastewater treatment is made. A number of criteria will influence the ideal choice in treatment techniques. These criteria are, amongst others,:

- The type and amount of contamination;
- The amount of wastewater to be treated;
- The receiving medium;
- …

BAT is to treat wastewater using one or a suitable combination of proper wastewater treatment techniques.

There were also 3 techniques identified as BAT, but only under certain circumstances:

- *Prevent the use of halogenated oxidizing disinfectants and sterilizers (WW2)*
  This technique will only be BAT when the alternative products used guarantee the quality of the product.
- *Use of self-neutralisation (WW5)*
  This technique is only a BAT in companies where the wastewater has the required variation in pH: strongly acidic or alkaline wastewater.
- *Aerobic processes (sub-technique to WW6)*
  Wastewater of dairy companies mostly contains high BOD, which needs to be reduced in case of discharge to surface water. Aerobic processes can be used for this, but on average these techniques have high space requirements as well as high investment cost, making it not economically viable for certain companies.

One technique was identified as BAT to reduce wastewater, only for *new* plants:

- *Segregation of effluents to optimise, use, reuse, recovery, recycling and disposal (WW4)*

5.2.1.3 BAT to reduce energy consumption

It is BAT to reduce the energy consumption in dairy companies by applying one or a combination of the following 11 techniques:

- *Switch off equipment when not needed (E1)*
- *Insulation of pipes, vessels and equipment (E2)*

- *Avoid excessive energy consumption in heating and cooling processes (E3)*
- *Implement and optimise heat recovery (E4)*
- *Use a plate heat-exchanger for pre-cooling ice water with ammonia (E5)*
- *Use of continuous pasteurizers (E7)*
- *Optimise evaporation processes (E8)*
- *Improve steam collection (E11)*
- *Isolate unused/infrequently used pipework (E12)*
- *Repair steam leaks (E13)*
- *Avoid losses of flash steam from condensate return (E14)*

One technique was identified as a BAT to reduce energy consumption, but only under certain circumstances:

- *Partial homogenisation of market milk (E6)*
  The technique is only BAT for dairy plants, when using microfiltration and when replacing the homogenisation installation, in case the technique doesn't create quality problems or induce additional costs due to product losses.

5.2.1.4 BAT to prevent waste

It is BAT to prevent waste by applying one or a combination of the following 5 techniques:

- *Automated filling incorporating recycling of spillages (BP1)*
- *Restrict loss of raw materials and products in pipes (BP2)*
- *Separate outgoing flows to optimise use, reuse, recovery, recycling and removal (BP4)*
- *Segregation of packaging materials to optimise use, reuse, recovery, recycling and disposal (BP6)*
- *Optimisation of packaging design to reduce quantity (BP7)*

5.2.1.5 General BAT

The following 18 techniques were identified as BAT for all industrial, Egyptian dairy plants. These general BAT enclose techniques related to (operational) management of a plant, that can improve environmental performances (different environmental compartments) in the dairy industry. It is BAT to apply one or a combination of the following 18 techniques:

- *Identification of potential accidents (G1)*
- *Optimise the use of chemicals (G2)*
- *Environmental management tools (G3)*
- *Collaboration with downstream and upstream partners (G4)*
- *Optimise operation by providing training (G5)*
- *Design equipment to minimise consumption and emission levels (G6)*
- *Maintenance (G7)*
- *Methodology for preventing and minimising consumption of water and energy and production of waste (G8)*
- *Analysis of production processes (G9)*

- *Apply production planning to minimise associated waste production and cleaning frequencies (G10)*
- *Good housekeeping (G11)*
- *Limit emissions from storage (G12)*
- *Process control techniques (G13)*
- *Risk assessment (G14)*
- *Identify and implement control measures needed (G15)*
- *Develop, implement and test an emergency plan (G16)*
- *Investigate all accidents and near misses (G17)*
- *Management of water, energy and detergents used (G18)*

5.2.2 BAT for dairy companies with specific activities

Besides the techniques that are BAT for all dairy companies, some techniques were evaluated as BAT which are applicable for dairy companies with specific activities, i.e. cheese production, butter production and milk powder production. These techniques are listed below, per activity type.

5.2.2.1 BAT specific for cheese-producing installations

For all dairy companies producing cheese, there are 2 additional BAT:

BAT related to wastewater:

- *Minimise the production of acid whey and its discharge to the wastewater treatment plant (WWTP) in cheese production (WW7)*

BAT to prevent waste:

- *Recovery and use of whey in cheese production (BP5)*

5.2.2.2 BAT specific for butter producing installations

For all dairy companies producing butter, there is one additional BAT to prevent waste:

- *Minimisation of losses during butter making (BP3)*

5.2.2.3 BAT specific for milk powder producing installations

For all dairy companies producing milk powder, there is one additional BAT to reduce energy consumption:

- *Two-stage drying (E9)*

CHAPTER 6 RECOMMENDATIONS

In this chapter, a number of general conclusions related to the BAT report are formulated. Also, experiences and limitations encountered during the process of writing this study are highlighted. Based on these elements, this chapter serves as a valuation of the report and its results.

The chapter contains a reflection on the quality of data, evaluation and general contents of the report by the author as well as the TWG members. Also, since the regulatory framework of the MPC currently does not include the use of BAT, members of the TWG reflected on the priorities in the outcome of the study, the BAT.

6.1 Priorities in BAT conclusions

In general, one can say that the main aim of environmentally friendly measures/techniques should be the prevention of emissions. According to the Industrial Emissions Directive (IED), preventative measures should be given priority. However, in some cases preventative measures are not available or don't fulfil the needs. Therefore, control measures are sometimes required. These process integrated or end-of-pipe techniques, to control the emissions once they've occurred, will often require significant investment, space and operational knowledge.

A general priority, when it comes to BAT, is the need for implementation of monitoring systems. In order to determine BAT and BAT associated emission levels, and to translate those into emission limit values, monitoring data are needed. When implementing these emission limit values, it is only possible to have control on implementation and compliance of legislation when adequate monitoring systems are used. Since monitoring is a basis in order to implement the BAT-principle, it is important to mention that good monitoring systems often require significant investments as well.

According to the TWG members, environmental issues in the Egyptian dairy industry vary depending on the size of the plants. Large companies, whether multinational or national, use up-to-date technology with efficient control systems. On the other hand, small producers use mainly manual processes with less emphasis on environmental and health related issues. The very small, traditional companies are not included in this study due to the fact that we only focus on industrial activities.

Some important actions for both small, medium and large companies that should be given a priority (or have a high priority) according to the TWG are listed below. These include different techniques/measures described in chapter 4.

- **Good manufacturing practices**
    - Small and medium facilities should implement good manufacturing practices, e.g.
        - Workers to wear protective clothing and gloves;
        - Proper raw material and product handling;
        - Smooth flooring and screens on windows and doors;
        - Repair leaking milk valves or install stainless steel control valves;
        - …
- **Water monitoring and control**
    - In most SMEs, contrary to large facilities, water consumption is neither monitored nor controlled. Different options for hydraulic load reduction of wastewater can be considered, e.g.:
        - Install water meters and monitor water use;
        - Use of CIP;
        - Recycle cooling water through cooling towers;
        - Repair leaks;

        - Handle solid wastes dry;
        - …
- **Energy conservation issues**
    - Several measures can be applied in order to reduce energy consumption and improve energy efficiency overall. Some examples are:
        - Regulation of steam pressure (optimal level, e.g. 2 bar i.s.o. 4 bar);
        - Regularly planned boiler tune-up to maintain high boiler efficiency;
        - Insulation of steam lines, chiller connections etc.
        - Pressure control on the boilers;
        - …
- **Switch from manual processes to automated processes**
- **Switch from batch processes to continuous processes**
- **…**

6.2 Limitations to the BAT evaluation and report

In this paragraph, different findings and experiences encountered during the elaboration of the BAT sector report are discussed (as experienced by EEAA and VITO). This is important since it offers a valuation of the report and its conclusions: data gaps are highlighted and difficulties in applying the BAT methodology (evaluation) are mentioned.

Chapter 2:

- Difficult to obtain *recent* figures:
  Not a real problem since members of the TWG agree that situation hasn't changed significantly.
- *Financial data* on the different companies in Egypt:
  Information on turnover and other financial ratios is not readily available. Companies are overall reluctant to publish or provide this information. This of course hampers qualitative analysis of economic viability. Therefore, the BAT evaluation in Chapter 5 was exclusively based on qualitative analyses, not on any quantitative analyses.
- …

Chapter 4 and chapter 5:

- *Information on local issues* is crucial for a good, country specific BAT evaluation. In chapter 4 this information was provided by the members of the TWG, for each of the candidate BAT suggested based on information from the BREF FDM and the Flemish BAT study. Valuable information was provided by the members of the TWG. Information was useful in evaluating the technical and economic viability as well as the environmental benefit of candidate BAT.
- *Cost information specific to the situation in Egypt* was not provided during this study. Neither was other quantitative information, such as *reference values for cost effectiveness*. This of course made it impossible to make a quantitative

evaluation of the candidate BAT. The expert opinion of the TWG members was therefore essential.
For some techniques this issue did create some difficulties: when economic viability was mentioned as the crucial aspect in the BAT evaluation, this was of course impossible to double check or compare with, for example, the situation in Tunisia or Morocco. The expert opinion of the TWG members was thus kept as the sole input on these matters.

- Due to lack of information for the situation in Egypt, it was also quite difficult to *quantify the environmental benefits* of the candidate BAT. This again made qualitative analysis the only option to evaluate BAT.

6.3 Value of the report

In this paragraph, the feedback of the TWG members was summarized in order to reflect their opinion on the value of the report.

6.3.1 Value of information

According to the TWG members, the report can be considered as comprehensive, including sufficient information serving the dairy industry in Egypt. It is based on a systematic approach describing dairy processes, identifying and evaluating actual and potential environmental aspects, then suggesting applicable BAT.

Although not all techniques apply as easily for small companies, this is not really a drawback in the value of the information. The small companies constitute a considerable percentage of the dairy facilities in Egypt only in terms of number. However, in terms of production, the medium and large facilities are the main producers and have the largest potential for environmental improvement.

6.3.2 Purpose and use of the report

The report can be used by different entities in the future:

- Facility owners and operators can use it (if translated to Arabic), to identify areas of potential non-compliance and measures for pollution reduction and cleaner production. It could support development and implementation of Environmental Sound Technologies, Cleaner Production and Environmental Management System programs in the dairy industry;
- Consultants may use the report to advise facilities on issues related to cleaner production, energy efficiency and pollution abatement and reduction. They can use it as a model for developing BAT reports for other sectors or new BAT measures in the same sector;
- Environmental agencies and institutions (like EEAA) could use it in developing policies, strategies, legislative framework required to improve dairy sector efficiency, competitiveness and compliance. Also, the report can help EEAA inspectors to understand the dairy processes and consequently where to look

for non-compliance. The report can also help, when disseminated properly, in developing and implementing environmental training and awareness programs provided to the dairy sector.

6.3.3 Possibilities for future legislation

Currently, in Egypt, there is a lack of incentives as driving forces of implementation of environmentally friendly techniques/measures. This is reflected as:

a. No monitoring equipment for measuring water and electricity consumption at the different production lines;
b. No development of benchmarks for water and energy use per ton of product produced;
c. ‘Poor housekeeping’ in SMEs.

Therefore it is also very important that legislation and regulation are adjusted in order to facilitate environmentally friendly initiatives.
Besides legislation, other driving forces for implementation could be specific local conditions, safety and other requirements or non-environmental triggers such as increased yield, improved product quality or economic incentives like subsidies or tax breaks.

Possible limitations to the application of the recommended BAT may include the low cost of water and energy, lack of environmental awareness and inefficient technology used in SMEs.

6.4 Further recommendations[63]

Today in Egypt, only general emission limit values (ELVs) are used in environmental permitting. This can of course create discrepancy between different sectors. As ELV should be based on the BAT. And BAT might differ depending on the sector envisaged. For one sector it might thus be impossible to comply with the ELVs (have to go beyond BAT), while another sector can easily comply with the ELVs, perhaps even without taking any measure at all.

In order to have efficient environmental legislation, a sector specific approach in regulation (permitting) is preferred. This is to facilitate improvements in each sector, according to the relevance and seriousness of the environmental issue for that sector, a sector-specific approach in setting ELVs can be considered. The following paragraphs describe some important elements and points of attention when performing a BAT analysis.

Collection of high quality data is essential in drawing up BAT sector reports.

[63] Guidance document EIPPC Bureau, Seville (2012/119/EU).

In accordance with art. 13(1) of the IED, the European Commission organises an exchange of information between itself, Member States, the industries concerned, and non-governmental organisations promoting environmental protection in order to draw up BAT reference documents (BREFs).

A guidance document on the practical arrangements for the exchange of information as referred to in art. 13(3), points (c) and (d) of the IED on the following issues:

- the collection of data,
- the drawing up of BREFs and their quality assurance including the suitability of their content and format.

Is available, and can be used as a reference in the further development of BAT sector reports in Egypt.

Concerns raised by the Egyptian TWG on data collection and submission (type of data, format of data and quality of data) and confidentiality issues are being addressed in this guidance document.

According to the guidance document the quality of a BAT reference documents depends upon both the quality of the participants involved in the process (high level of technical expertise and involvement) and also the quality of the information exchange process itself. To guarantee this quality, Member States, industries concerned, non-governmental organisations promoting environmental protection and the European Commission are each expected to have in place a quality system that includes:

- clear definitions of responsibilities and allocation of tasks;
- methods and procedures;
- the allocation of sufficient resources (in particular staff);
- an internal control system leading to continuous improvements.

According to the guidance document the quality of the BAT reference documents is a day-to-day activity which is based on the personal commitment of all those involved in the exchange of information. Generally at the origin of the information collected, each individual TWG members has, as a first level controller, a special role to play to guarantee the quality of his/her contributions. The EIPPCB staff which drafts the BREFs based on contributions from the TWG is a second level controller of the quality of the information submitted.

Specific information on environmental performance and operational data is of utmost importance in determining BAT-AELs, and ELVs. According to Polders, C et al., 2012 to date, methodologies for determining BAT-AELs have not been described in literature. BAT-AELs are determined in most of the European BAT reference documents, but their determination relies to a large extent on expert judgement. The BAT-AELs determined in the BREFs are the basis for setting ELVs for a limited number of parameters, but not for all relevant parameters. This is especially the case for industrial wastewater, which can contain numerous different pollutants. To support the permitting authorities in the

Flemish region of Belgium in setting ELVs for all relevant parameters, VITO has developed a practicable, objective and transparent methodology for determining BAT-AELs for industrial wastewater, which can be useful in determining BAT-AELs and ELVs in Egypt. For the translation of BAT-AELs into ELVs (how done in Flanders), the guideline by Dijckmans et al. by VITO also touches on this.

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LIST OF ABBREVIATIONS

AMF	Anhydrous Milk Fat
BAT	Best Available Techniques
BAT4MED	Boosting Best Available Techniques in the Mediterranean Partner Countries
BOD	Biological Oxygen Demand
BREF	BAT Reference Document
CAPMAS	Central Agency for Public Mobilization and Statistics
CHP	Combined Heat and Power generation
CIP	Cleaning In Place
COD	Chemical Oxygen Demand
CP	Cleaner Production
CV BREF	Cooling BREF
DIDA	Dairy Industry Development Association
DVI	Direct Vat Inoculation
EBP	Environmental Benefit Potential
EEAA	Egyptian Ministry of State for Environmental Affairs
EMS	Environmental Management System
ENE BREF	Energy Efficiency BREF
ENEMS	Energy Efficiency Management System
EOS	Egyptian Organisation for Standardization and Quality Control
ESB BREF	Emissions from Storage and Handling BREF
EST	Environmental Sound Technologies
FAPRI	Food and Agricultural Policy Research Institute
FBD	Fluidized Bed Dryer
FDM BREF	BREF Food, Drink and Milk
GCC	Gulf Cooperation Council
GMP	Good manufacturing practices
GOIEC	General Organization for Export and Import Control
GSO	Gulf Standards Organisation
IED	Industrial Emissions Directive
IPPCD	Integrated Pollution Prevention and Control Directive
MEMRB	Middle East Marketing Research Bureau
MPC	Mediterranean Partner Country
MSME	Micro, small and medium enterprises
OAA	Office of Agricultural Affairs
SME	Small and medium enterprises
SNF	non-fat solids
SS	Suspended solids
SWOT	Strengths, Weaknesses, Opportunities and Threats
TVR	Thermal Vapour Recompression
TWG	Technical Working Group
UAE	United Arab Emirates
UCL	GCC Unified Customs Law and Single Customs Tariff
UF	Ultra-filtration

UHT	Ultra High Temperature treatment
VITO	Flemish Institute for Technological Research
WWTP	Wastewater Treatment Plant

ANNEX

LIST OF THE ANNEXES

Annex 1: Participants to the BAT study

Annex 2: Technical Data Sheets

Annex 3: Comparison BAT evaluation in 3 Mediterranean Partner Countries

ANNEX 1: PARTICIPANTS TO THE BAT STUDY

Authors

Flemish Institute for Technological Research (VITO)
Evelien Dils
Katrijn Alaerts
Liesbeth Goovaerts
Caroline Polders
Boeretang 200
2400 MOL
Belgium
www.vito.be

Egyptian Ministry of State for Environmental Affairs (EEAA)
Mamdouh Higazy
Yasser Asker
Maysoun Nabil
30 Misr Helwan Rd., Maadi
11728 CAIRO
Egypt
www.eeaa.gov.eg

Members of the Technical Working Group

Osman Abd El Aleem Abd El Lateif Aita
Environmental Consultant
Egypt National Cleaner Production Center (ENCPC)
26 A Sherif St. – Cairo, Egypt
Cairo
Egypt

Shadia Elshishini Saad Elshishini
Environmental Consulant
ENVIGLOBE Environmental Consultancy Company
529 Abdel Moneim Riyad Street, Motamayez District
6th of October City
Egypt

Fatheya Abdel Hady Soliman
Environmental Consultant
ENVIGLOBE Environmental Consultancy Company
Ahmed Orabi, 8 South Street No. 424, Obour City
Cairo
Egypt

Samah Reda Mohammed Shaalan
Environmental Management and Cleaner Production Consultant
1A Okasha Street Dokki
12311 Giza
Egypt

ANNEX 2: TECHNICAL DATA SHEETS

For additional information on the different techniques described in chapter 4, different technical data sheets were made. These can be found through the BAT4MED website: http://databases.bat4med.org/.

ANNEX 3: COMPARISON BAT EVALUATION IN THE 3 MEDITERRANEAN PARTNER COUNTRIES

In the following cross-table, a comparison is made between the BAT conclusions for the dairy sector in the three Mediterranean Partner Countries involved in this project. Most of the time conclusions are the same. However, sometimes there are some differences in BAT conclusions, mostly due to the differences in TWG expert opinion on certain issues. Since the evaluation is (almost) entirely based on a qualitative approach, these differences were not straightforward to check. However, they were discussed during the last TWG meetings. When TWG members considered the conclusion to be correct, these differences sometimes remained, as can be seen in the overview table below.

Technique	Egypt	Tunisia	Morocco
Water consumption			
Transport solid materials dry	BAT When applicable (relevant) and doesn't negatively influence the quality of the product.	BAT When applicable (relevant) and doesn't negatively influence the quality of the product.	BAT When applicable (relevant) and doesn't negatively influence the quality of the product.
Dry cleaning of equipment & installations	BAT	BAT	BAT
Selecting water sources in function of the required quality	NO	BAT	BAT
Minimise/optimise water consumption	BAT	BAT	BAT
Pre-soak floors & open equipment to loosen dirt before cleaning	BAT	BAT	BAT
Minimisation of centrifugal separator waste discharges	BAT	BAT	BAT
CIP & its optimal use	BAT	BAT	BAT
Wastewater			
Minimising the use of EDTA	BAT	BAT	BAT
Prevent use of halogenated oxidizing disinfectants & sterilizers	BAT When alternative products are effective enough to guarantee the quality of the product.	BAT When alternative products are effective enough to guarantee the quality of the product.	BAT When alternative products are effective enough to guarantee the quality of the product.
Provision & use of catchpots over floor drains	BAT	BAT	BAT
Segregation of effluents to optimise use, reuse, recovery, recycling & disposal	BAT For new installations or refurbished ones.	BAT For new installations or refurbished ones.	BAT For new installations.
Use of self-neutralisation	BAT When required variation in pH of wastewater.	NO Not applicable in current dairy installations in Tunisia.	BAT When required variation in pH of wastewaters.
Use of proper wastewater treatment techniques	BAT	BAT	BAT
Minimise the production of acid	BAT	*Not studied*	BAT

Technique	Egypt	Tunisia	Morocco
whey & its discharge to the WWTP in cheese production			
Minimise the blowdown of the boiler	BAT	BAT	BAT
Maximise condensate return	BAT	BAT	BAT
Energy consumption			
Switch off equipment when not needed	BAT	BAT	BAT
Insulation of pipes, vessels & equipment	BAT	BAT	BAT
Avoid excessive energy consumption in heating & cooling processes	BAT	BAT	BAT
Implement & optimise heat recuperation	BAT	BAT	BAT
Use a plate heat-exchanger for precooling ice-water with ammonia	BAT	BAT	BAT For new, medium and large plants (economics: considered too expensive today in Morocco).
Partial homogenisation of market milk	BAT When microfiltration is used, when replacing the homogenisation installation and the technique doesn't create quality problems or induce additional costs due to product losses.	BAT When replacing the homogenisation installation and the technique doesn't create quality problems or induce additional costs due to product losses.	BAT When replacing the homogenisation installation and the technique doesn't create quality problems or induce additional costs due to product losses.
Use of continuous pasteurizers	BAT	BAT	BAT
Optimise the evaporation process	BAT	BAT For large companies or companies with high value-added products, for which the technique is economically viable.	BAT
Two-stage drying in milk powder production	BAT	*Not studied*	BAT For large plants due to economics.
Use of CHP	NO Current prices for fuels and electricity, combined with relatively low heat/electricity demand make this economically unviable for Egyptian dairy installations.	BAT For new installations and existing installations that adjust or renew their energy installation. A high demand for heat and electricity is needed.	NO Current prices for fuels and electricity, combined with relatively low heat/electricity demand make this economically unviable for Moroccan dairy installations.
Improve steam collection	BAT	BAT	BAT
Isolate unused/infrequently used pipework	BAT	BAT	BAT
Repair steam leaks	BAT	BAT	BAT

Technique	Egypt	Tunisia	Morocco
Avoid losses of flash steam from condensate return.	BAT	BAT	BAT
Waste and by-products			
Automated filling incorporating recycling of spillages	BAT	BAT	BAT
Restrict loss of raw materials and products in pipes	BAT	BAT	BAT
Minimisation of losses during butter making	BAT	BAT	BAT
Separate outgoing flows to optimise use, reuse, recuperation, recycling and removal	BAT	BAT When there is a demand for the products produced in this way.	BAT
Recovery and use of whey in cheese making	BAT	*Not studied*	BAT
Segregation of packaging materials to optimise use, reuse, recovery, recycling and disposal	BAT	BAT	BAT
Optimisation of packaging design to reduce quantity	BAT	BAT	BAT
General techniques/measures			
Identification of potential accidents	BAT	BAT	BAT
Optimise the use of chemicals	BAT	BAT	BAT
Environmental management system	BAT	BAT	BAT
Collaboration with downstream and upstream partners	BAT	BAT	BAT
Optimise operation by providing training	BAT	BAT	BAT
Design equipment to minimise consumption & emission levels	BAT	BAT	BAT
Maintenance	BAT	BAT	BAT
Methodology for preventing & minimising consumption of water & energy and production of waste	BAT	BAT	BAT
Analysis of production processes	BAT	BAT	BAT
Apply production planning to minimise associated waste production and cleaning frequencies	BAT	BAT	BAT
Good housekeeping	BAT	BAT	BAT
Limit emission from storage	BAT	BAT	BAT
Process control techniques	BAT	BAT	BAT
Risk assessment	BAT	BAT	BAT
Identify & implement control measures needed	BAT	BAT	BAT
Develop, implement and test an emergency plan	BAT	BAT	BAT
Investigate all accidents and near misses	BAT	BAT	BAT
Management of water, energy and detergents use	BAT	BAT	BAT