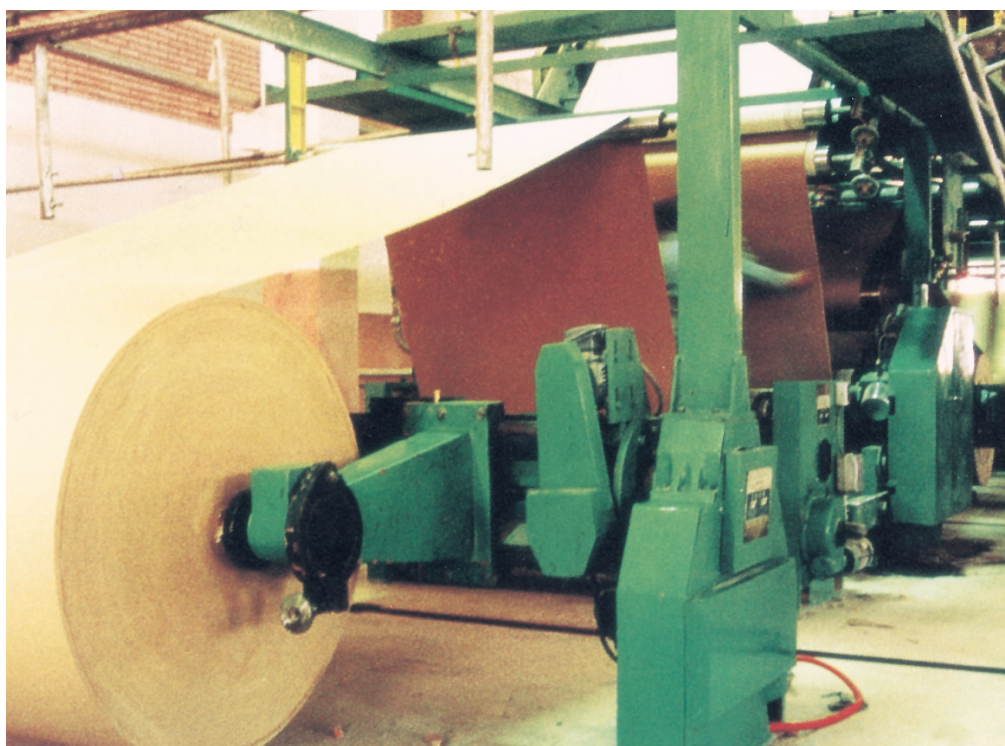


**Ministry of State for Environmental Affairs**  
Egyptian Environmental Affairs Agency (EEAA)

# **Inspection Manual Pulp and Paper Industry**



# Table of Contents

## Glossary of Terms and Abbreviations

<b>1. Preface</b>	<b>1</b>
1.1 Introduction	1
1.1.1 Project Objectives	1
1.1.2 Organization of the Inspection Manual	2
1.2 Industry Overview	3
<b>2. Description of the Industry</b>	<b>5</b>
2.1 Inputs to Industry	5
2.1.1 Fibre raw materials	5
2.1.2 Chemicals	6
2.1.3 Energy	7
2.1.4 Water Characteristics and its Cycle	8
2.1.5 Storage and Handling of Raw Materials and Fuels	8
2.2 Production Processes	9
2.2.1 Raw Materials Preparation	9
2.2.2 Pulping Operations	10
2.2.3 Papermaking and Related Processes	17
2.3 Service Units	23
2.3.1 Boilers	23
2.3.2 Water Treatment Units	24
2.3.3 Laboratories	25
2.3.4 Workshops and Garage	25
2.3.5 Storage Facilities	25
2.3.6 Wastewater Treatment Plants	25
2.3.7 Restaurants, Washrooms and Housing Complex	26
2.4 Emissions, Effluents and Solid Wastes	28
2.4.1 Air Emissions	28
2.4.2 Effluents	31
2.4.3 Solid Wastes	35
2.4.4 Hazardous Wastes	35
2.5 Characteristics of Pulp and Paper Industry	36
<b>3. Environmental and Health Impacts of Pollutants</b>	<b>37</b>
3.1 Impact of Air Emissions	37
3.2 Impact of Effluents	38
3.3 Environmental Impact of Solid Wastes	39
<b>4. Egyptian Laws and Regulations</b>	<b>40</b>
4.1 Concerning Air Emissions	40
4.2 Concerning Effluents	41
4.3 Concerning Solid Waste	41
4.4 Concerning Work Environment	41
4.5 Concerning Hazardous Materials and Wastes	44
4.6 The Environmental Register	44

<b>5.</b>	<b>Methods and Techniques for Pollution Abatement</b>	<b>45</b>
5.1	Emissions to Air	45
5.2	Wastewater Discharges	46
5.3	Solid Waste	48
5.4	Pollution Prevention & Cleaner Production	48
5.4.1	Handling of Fiber Raw Materials	49
5.4.2	Handling of Spent Liquors	50
5.4.3	Kraft Puling	51
5.4.4	Recovered Fiber	52
5.4.5	Paper Making	52
5.5	Description of Cleaner Production Techniques	53
5.5.1	Raw Materials & Chemicals	53
5.5.2	Washing and Screening	53
5.5.3	Delignification	53
5.5.4	Bleaching (Optional)	54
5.5.5	General Recommendation	55
5.6	Pollution Prevention Options in Egypt	55
5.6.1	Pulping	55
5.6.2	Screening and Cleaning	56
5.6.3	Thickening	56
5.6.4	Paper Drying	57
5.6.5	General Recommendations	57
<b>6.</b>	<b>Industrial Inspection</b>	<b>59</b>
<b>7.</b>	<b>Inspection Planning (Inspectorate)</b>	<b>60</b>
7.1	Size of Pulp and Paper Mills	60
7.2	Facility Information	60
7.3	Providing Resources	60
<b>8.</b>	<b>Preparation for Field Inspection</b>	<b>62</b>
8.1	Information Gathering and Reviewing	62
8.2	Preparation of the Inspection Plan	62
8.3	Preparation of the Required Checklists	63
8.4	Legal Aspects	63
<b>9.</b>	<b>Performing Field Inspection</b>	<b>64</b>
9.1	Starting the Field Visit	64
9.2	Proceeding With the Field Visit	64
9.3	Ending the Field Visit	67
<b>10.</b>	<b>Conclusions of Field Inspection</b>	<b>68</b>
10.1	Preparing the Inspection Report	68
10.2	Supporting the Enforcement Case	68
10.3	Following-Up on Compliance Status for Violating Facility	68

## **Annex: Inspection Checklist for a Pulp and Paper Facility**

# GLOSSARY OF TERMS AND ABBREVIATIONS

## I – TERMS OF PULP&PAPER INDUSTRY

**Air dry:** Air dry ton of pulp (Adt) meaning dry solids content of 90 %.

**Bleaching:** the process of brightening the fibre by removal of the coloured substance or by decolorizing it.

**Broke:** Paper that has been discarded anywhere in the process of manufacture.

**Brownstock:** the **suspension** of unbleached pulp.

**Chemical pulp:** Fibrous material obtained by removal from the raw material by chemical treatment (cooking, delignification, bleaching).

**Consistency:** The weight percent of air-dry (or oven dry) fibrous material in a stock or stock suspension. Low consistency (3% - 5%, LC), medium consistency (10% - 15%, MC) and high consistency (30% - 50%, HC) are distinguished.

**Cross media effects;** Possible shift of environmental pressure from one environmental media to the other.

**Deinking:** The process of removing ink from printed wastepaper, but also involving general removal of other undesirable materials.

**Disperging:** Mechanical treatment of wastepaper fibers to disperse ink particles.

**Dry end:** Part of the papermaking process after formation of the paper web.

**Fillers:** Papermaking additives, usually mineral clays or calcium carbonates.

**Fines:** Small particle sized material in papermaking usually defined as material below 75 microns.

**Furnish:** The mixture of various materials that are blended in the stock suspension from which paper or board is made. The main constituents are the fibrous material (pulp), fillers, sizing agents, wet-strength or other additives, and dyes.

**Grammage:** The real mass of the paper/board, usually expressed as g/m<sup>2</sup>.

**Head box:** Pulp feed to the paper machine starts here.

**Integrated production:** An installation in which the production of paper and/or board is directly connected with the production of pulp.



**Kappa number:** A measure of residual lignin content in unbleached pulp, determined after pulping and prior to bleaching. The lower the Kappa number the less associated lignin.

**Kraft pulp:** Chemical pulp which has been manufactured using sodium sulfate as the main cooking chemical.

**Lignin:** This is the binding substance in natural fibers and is a complex organic polymer with an irregular structure.

**Magnefite:** Magnesium base sulfite pulping process.

**Mechanical pulp:** Papermaking pulp made entirely by mechanical means from various raw materials i.e. by grinding wood against an abrasive or by processing wood chips or sawdust through a refiner.

**MF resin:** Melamine formaldehyde resin.

**Non Integrated Production:** An installation in which the production of paper and/or board is not directly connected with the production of pulp.

**Paper:** Sheet of fibers with a number of added chemicals. According to the basic weight it can be distinguished: Paper  $< 150 \text{ g/m}^2 < \text{paper-board (or board)} < 250 \text{ g/m}^2 < \text{cardboard}$ .

**Pitch:** A resinous material in virgin pulps.

**Pulping:** The process of converting raw fiber or recycled fiber to a pulp usable in papermaking with minimal further treatment.

**Refining:** Process of mechanically treating fibers to develop strength.

**Save-all:** An apparatus used for reclaiming fibers and fillers from white water. It usually operates on a filtration, sedimentation, flocculation, or flotation principle.

**Soap:** The product of reaction between the alkali in kraft pulping liquor and fatty acid portions of the wood, which precipitate out when water is evaporated from the spent pulping liquor.

**Specific water consumption:** The amount of fresh water consumed during production (surface water, ground water), that is taken out from external resources. This fresh water demand is related to air dry net production and is expressed as  $\text{m}^3/\text{t}$ .

**Stickies:** Materials that stick together; adhesive contaminants in recovered paper.

**Stock:** The mixed suspension of fiber and other materials used to form the paper.

**Sulfite pulp:** Chemical pulp where various sulfites or bisulfites are used as main cooking chemical.

**Thermo-mechanical pulp:** Papermaking pulp made entirely by mechanical means from various raw materials, but usually wood. In the thermo-mechanical pulping process the raw material is subjected to thermal pre-treatment.

**UF resin:** Urea formaldehyde resin.

**Recycled fiber pulp:** Fibrous material that has already passed through paper and/or board production.

**Wet-end:** Part of the papermaking process prior to formation of the paper web.

**White water:** A general term for all waters of a paper mill that have been separated from the stock or pulp suspension, either on the paper machine or accessory equipment, such as thickeners, washers, save-alls, and from pulp grinders. It carries a certain amount of fiber and may contain varying amounts of fillers and dyestuffs.

**Wood-containing paper and/or board:** Paper and board having considerable part of non-cellulosic compounds (more than 5%) as an essential constituent of its fiber composition.

**Wood free paper and/or board:** Paper and board having in principle only chemical pulp in its fiber composition; (less than 5% non-cellulosic compounds).

**Yankee cylinder:** Large single cylinder used mainly to dry tissue/towels.

**Yield:** The amount of useful fiber after pulping and/or bleaching or deinking expressed as a percentage of the raw fiber.

## II - ABBREVIATIONS

**Adt:** Air dry metric ton of pulp meaning dry solids content of 90 %. Note that an air-dry ton of paper is defined as paper with 6% moisture content.

**AOX:** Adsorbable Organic Halides measured according to the ISO 9562: 1998 standard method for wastewater.

**BOD5/BOD7:** Biological Oxygen Demand indicating the amount of biodegradable organic matter in the wastewater assessed using a standard 5 day or 7 day test.

**COD:** Chemical oxygen demand indicating the amount of chemically oxidisable organic matter in the wastewater (normally referring to analysis with dichromate oxidation)

**CTMP:** Chemi-thermo-mechanical pulp

**DAF:** Dissolved Air Flotation

**D/C:** Bleaching stage with chlorine dioxide and chlorine where chlorine dioxide dominates over chlorine.

**DIP:** Deinked pulp – pulp produced from recovered printing paper, e.g. newsprint, through de-inking process.

**DS:** Dry solids

**ECF:** Elemental Chlorine Free (bleaching).

**EDTA:** Ethyl Diamine Tetra Acetic acid, complexing agent.

**E/O:** Extraction bleaching stage using sodium hydroxide with subsequent addition of gaseous oxygen as a reinforcing agent.

**EOP:** Extraction bleaching stage using sodium hydroxide with subsequent addition of oxygen and hydrogen peroxide solution as a reinforcing agent.

**E/P: Extraction** bleaching stage using sodium hydroxide with subsequent addition of hydrogen peroxide solution as a reinforcing agent.

**ESP:** Electrostatic precipitator.

**HC:** High consistency - pulp concentration in the interval 30 - 50% dry solid content.

**H2O2:** Hydrogen peroxide

**% ISO:** Brightness unit according to ISO, the International Organization for Standardization.

**LC:** Low consistency - pulp concentration in the interval 3 - 5% dry solid content.

**LWC:** Lightweight coated paper

**MC:** Medium consistency - pulp concentration in the interval 8 – 15% dry solid content

**Mg:** Magnesium.

**MLSS:** Mixed Liquor Suspended Solids.

**MWC:** Medium weight coated paper.

**NCG:** Non-condensable gases referring to malodorous gases of chemical pulping.

**Ndg:** Normal dry gas related to standard conditions.

**Nox:** The sum of nitrogen oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) expressed as NO<sub>2</sub>.

**O:** oxygen-bleaching stage

**P:** Alkaline bleaching stage with hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) as liquid

**Q** Acid bleaching stage where chelating agent EDTA or DTPA has been used for removal of metals.

**RCF:** Recycled fiber(s); pulp obtained from recovered paper processing.

**S:** 1) Sulfur 2) Acid bleaching stage with sodium hydrosulphite (NaHSO<sub>3</sub>).

**SO<sub>2</sub>:** Sulfur dioxide.

**SS:** Suspended solids.

**TCF:** Totally chlorine free (bleaching).

**TRS:** Total reduced sulfur meaning the sum of the reduced malodorous sulfur compounds generated in the pulping process: hydrogen sulfide, methyl mercaptan, dimethylsulphide and dimethyldisulphide expressed as sulfur.

**TSS:** Total suspended solids (in wastewater).

**TSP:** Total solid particulates (in flue gases), dust.

**VOC:** Volatile Organic compounds.

**WWTP:** Wastewater treatment plant.

**Z:** Ozone bleaching stage using gaseous ozone (O<sub>3</sub>)

# **1. Preface**

The Egyptian Pollution Abatement Project (EPAP) sponsored by FINIDA has assigned Finish and Egyptian consultants for the task of developing Sector specific inspection and monitoring guidelines. This task is based on a previous collaboration between FINIDA and EPAP that resulted in the development of four Inspection Guidelines:

- Fundamentals and Background Manual that provides basic information about air pollution, wastewater characteristics, solid waste, hazardous materials and wastes and work environment.
- Guidelines for Inspectorate Management that discusses the strategy, objectives and tasks of the Inspectorate management.
- Guidelines for Team Leaders that identifies the team leader responsibilities and tasks.
- Guidelines for Inspectors that presents a methodology for performing all types of inspection. Tasks during the various phases of planning, performing field inspection, report preparation and follow-up are discussed. Several checklists are included.

The three guidelines were later summarized into one that will be referred to as the Inspection Guidelines. A General Inspection Manual, GIM, is being developed covering aspects common to all sectors. On the other hand, a Self-Monitoring manual was also developed to present the industrial community and government officials with the general principles, both managerial and technical, to be followed for self-monitoring. The textile industry was chosen as a case study for implementing and testing the manual and a self-monitoring manual for this industry was developed.

## **1.1 Introduction**

The developed manuals were tested through a number of training programs that targeted RBOs and EMUs. The inspectors involved in the training used these manuals to inspect a number of industrial facilities. Feedback from the concerned parties led to the improvement of these manuals and their continuous update. There was clearly a need for sector-specific guidelines and EPAP took the initiative to develop such manuals. Five sectors were chosen:

- Food Industry with specific reference to the five sub-sectors of Dairy products, Vegetables and Fruit processing, Grain Milling, Carbonated Beverages and Confectionery.
- Pulp and Paper Industry
- Metallurgical Industry with specific reference to the two sub-sectors of Iron and Steel and Aluminum.
- Engineering Industry
- Textile Industry.

### **1.1.1 Project Objectives**

The project aims at the development of sector-specific guidelines for inspection and monitoring to be used by inspectors and plant personnel

respectively. These manuals are meant to be simplified but without abstention of any information necessary to the targeted users. Flowcharts, tables and highlighted notes are used for easy representation of information.

The purpose of this manual is to provide the necessary background information for inspectors and/or regulatory auditors. In general, inspectors and regulatory auditors may not have industry-specific background, as they are dealing with a variety of industrial sectors. Therefore, it is quite important for them to overall understand the Pulp and Paper industry, unit operations, main processes, raw materials, products and typical emissions. The manual has been designed to be a “working document” that provides the necessary background for inexperienced user.

### **1.1.2 Organization of the Inspection Manual**

The inspection manual for the Pulp and Paper industry includes ten chapters. The first chapter represents an introduction to the whole project and to the specific sub-sector of the industry. Chapters two to five deal with the Pulp and Paper industry and its environmental impacts.

The description of the industry in chapter 2 includes the inputs and outputs, a description of the main production processes, a brief description of the service and auxiliary units that could be present at the industrial establishment and the various emissions, effluents and solid wastes generated from the different processes.

Chapter three describes the emissions from the industry and the environmental impacts of the various pollutants. Whereas chapter four gives a summary of the articles in the Egyptian environmental laws relevant to the Pulp and Paper industry. Chapter five gives examples of the general pollution abatement techniques the Pulp and Paper industry, as well as the measures applicable to this industry in Egypt.

The inspection procedures are described in chapters 6 to 10 starting with a brief description of the inspection process in chapter 6 then the planning aspects that should be considered at the Inspectorate level are explained in chapter 7. The different tasks at the inspectors level specific to the Pulp and Paper industry are described in chapters 8 to 10. The tasks before field inspection are presented in chapter 8 whereas the inspection tasks for actually performing the field visit are defined in chapter 9. Chapter 10 is concerned with the conclusion of the field visit including inspection report writing, supporting the enforcement case and following-up the compliance status of the facility. Finally, the appendix includes a number of checklists that can be used in conducting the inspection activities.

The main references for this manual include:

*Environmental Impacts of Pulp and Paper Industry”, UNEP 1996, ISBN: 92-807-1589-5*

*Integrated Pollution Prevention and Control (IPPC), U.K:*

*Best Available Techniques in the Pulp and Paper Industry, July 2000*

*Technical Guidance for the Pulp and Paper Sector, November 2000*

On the other hand, Egypt's industry – specific information has been included in the relevant sections. Information on Egypt's Pulp and Paper industry is based on a survey that is included the entire public sector companies, as well as examples of private sector companies. The surveyed companies produce about 70% of the total National production of this sector.

## **1.2 Industry Overview**

The Pulp and Paper Industry is one of the growing industries allover the world, including Egypt. In 1998, the annual production of paper and paper products in Egypt was about 314,000 tons. Additional projects with production capacities of 240,000 tons were being established

Paper is a sheet of cellulose fibers with a number of added constituents to affect the quality of the sheet and its fitness for intended end use. In addition to the differences in the production processes, the two terms of paper and board generally refer to the weight of the product sheet (grammage) with paper ranging up to about 150 g/m<sup>2</sup> and a heavier sheet regarded as board (paperboard).

In the pulping process the raw cellulose-bearing material is broken down into its individual fibers. Wood is the main raw material but straw, bagasse, cotton and other cellulose-bearing material can be used.

In chemical pulping, chemicals are used to dissolve the lignin and free the fibers. The lignin and many other organic substances are thus put into solution from which the chemicals and the energy content of the lignin and other organics may be recovered. In mechanical pulping processes, mechanical shear forces are used to pull the fibers apart and the majority of the lignin remains with the fibers although there is still dissolution of some organics.

The production of chemical pulp is the major source of environmental impacts in the pulp and paper industry. It could also be noted that the significance of raw materials preparation has been increased as source of environmental impacts. Pulps produced in different ways have different properties, which make them suited to particular products. Most pulp is produced for the purpose of subsequent manufacture of paper or paperboard. Some is destined for other uses such as thick fiberboard or products manufactured from dissolved cellulose.

Paper produced by the use of recovered paper as fiber source will involve some cleaning of contaminants prior to use, and may involve de-inking depending upon the quality of material recycled and the requirements of the end product. The fibers are reusable for a number of times depending on the quality of the recycled material and the purpose of the end product.

Paper is manufactured by applying a watery suspension of cellulose fibers to a screen, which allows the water to drain, and leaves the fibrous particles behind a sheet. The production of this industry covers a range of products that may include newsprint, packaging paper boards, coated and non-coated printing



and writing papers, liner and fluting, tissue, packaging papers, and specialty papers. Each of these categories demands specific properties of the product and the most appropriate manufacturing route to these products may differ substantially. Thus, pulp and paper mills have a wide range of configurations, depending on the specifications of the final product, fiber raw materials and the applied techniques. In general, pulp and paper mills can be either integrated or non-integrated. Integrated mills comprise both pulp and paper production processes. While, non-integrated mills may produce either pulp or paper products.

This industry sector has been previously surveyed in 1998 through the Egyptian Pollution Abatement Project (EPAP). The total production of paper and paper products is about 500,000 tons. Chemical (kraft) pulp is mainly produced in three factories (Kous, Edfu and Rakta). Most of the paper and paperboard production is based mainly on secondary fibers, as well as imported fibers. Local pulp production includes 150,000 tons utilizing sugar cane waste (bagasse) and 35,000 tons from rice straw. The environmental impact due to bagasse pulp production is more controlled compared to rice straw pulping, due to the different chemical properties of the effluents. However, research activities and/or projects are being considered in order to improve the economic and environmental impacts of this industry.

The following table summarizes the production data as presented in other EPAP's reports.

**Table (1) Annual Pulp & Paper Production**

<b>Sector &amp; Company</b>	<b>Products</b>	<b>Annual Production (1000 tons)</b>
<b><i>Public Sector:</i></b>		
Rakta	Paper	40
	Board	15
	Rice Straw Pulp	30
National Paper	Printing Paper	10
	Kraft/sack paper	22
	Wrapping/Packing	9
	Board	7
Simo	Board	21
Kous	News-printing Paper	120
Edfu	Bagasse Pulp	25
<b><i>Private Sector:</i></b>	Wrapping/packing/Board	160
	Tissue	30
<b><i>Total</i></b>	Pulp	55
	Paper Products	434

In the next sections, the manual will focus on the raw materials and production processes which relevant to Egypt. More specifically, this will include kraft (sulfate) pulping of bagasse and rice straw, recovered paper recycling and paper and board production.

## 2. Description of the Industry

### 2.1 Inputs to Industry

#### 2.1.1 Fibre raw materials

Internationally, wood is the main fibre raw material for the Pulp and Paper industry. In Egypt, bagasse, rice straw and recycled paper are the main fiber raw materials being used.

**a) *Wood fibres:***

This includes those coming from natural forest (hardwoods, softwoods), forest plantations and residues from mechanical industry (mainly sawn mills). The most commonly used furnish material is wood. Wood logs, chips, and sawdust are used to make pulp. The sawdust fibres are shortened severely in the saw mill process prior to cooking.

Wood, as a raw fiber material is not used in Egypt. However, some plants may import bleached or unbleached pulps that are produced from wood fibers.

**b) *Non-wood fibres***

This can be subdivided as in table (2).

**Table (2) Types of Non-Wood Fibbers**

Group	Plant species used
Straws and esparto	Wheat, rye, rice, esparto
Canes and reeds	Sugar-cane, bagasse, cornstalk, reeds
Woody stalks	Kenaf, flax, hemp, cotton, soy-bean

In Egypt, bagasse (a by-product of sugar cane industry) is the main fiber raw material for pulp production. Also, rice straw is currently used as furnish for pulp production. Rice straw is available at a minimal cost. However, the economic effectiveness is relatively low due to unavailability of proven technology for chemical recovery, due to the silica content of the resulted black liquor.

- c) *Recycled fibres (Secondary fibres):*** This comprises a common furnish constituent in Egypt. Secondary fibres consist of pre-consumer fibres (e.g. mill waste fibres) and post-consumer fibre. Post-consumer fibre sources are diverse, but the most common are newsprint and corrugated boxes. Secondary fibres sources are seldom used as feedstock for high quality or grade paper products. Contaminants (e.g., inks, and paper colours) are often present, so production of low-purity products is often cost-effective use of secondary fibres, although decontamination technologies are available.

### 2.1.2 Chemicals

Chemicals are mainly used in the pulping processes as well as other complementary processes e.g. bleaching, coating and wastewater treatment. The commonly used chemicals and the consumption rates for the main pulping processes are herein presented. The consumption rates are based on the European data, because the databases for the mills in Egypt are not available.

**a) *Kraft Pulping:***

Typical chemicals and consumption [kg/t] for unbleached kraft pulp is in the range of NaOH: 10-20 and CaO: 5-10. On the other hand, the consumption [kg/t] of the main chemicals used in bleached pulp production is NaOH: 25-50, O<sub>2</sub>: 5-25, NaClO<sub>3</sub>: 20-50, H<sub>2</sub>O<sub>2</sub>: 2-30, MgSO<sub>4</sub>: 0-3, SO<sub>2</sub>: 2-10, CaO: 5-10.

**b) *Recovered Paper Recycling:***

Depending on the specific process, the chemicals may include: H<sub>2</sub>O<sub>2</sub>, NaOH, Na<sub>2</sub>SiO<sub>3</sub>. The consumption of chemicals in a typical mill including de-inking process [kg/t stock] is Sodium hydroxide: 10 – 20, Sodium silicate: 20 – 30, Soap: 5 – 8, Talc: 10 – 15, Hydrogen peroxide: 5 – 25, Chelating agent: 2 – 3, Sodium dithionite: 6 – 10 and Sulphuric acid: 8 - 10

**c) *Paper and Board Production:***

Chemical additives and auxiliaries are usually applied in paper and board production processes. Chemical additives are used to give paper various characteristics while chemical auxiliaries are used to increase efficiency and reduce disruption of the production process. The main chemicals being used can be summarized as follows:

- Fillers: China clay (kaolin), calcium carbonate, titanium dioxide, talc, and plastic micro-spheres.
- Sizing agents: resins, starch, alkyl ketene dimer (AKD) and other polymers, polyethylene waxes and fluoro-chemicals.
- Wet strength agents: Urea formaldehyde (UF) resins, melamine formaldehyde (MF) resins and polyamidoamine-epichlorhydrin based resins (PAA-E).
- Dry strength agents: Starch or modified cationic starches and cellulose derivatives.
- Coating chemicals: Pigments e.g. china clay (kaolin), ground/precipitated calcium carbonate, calcium sulfoaluminate (satin white) and titanium dioxide.
- Optical brighteners: Derivatives of 4,4'-diaminostilbene-2,2'-sulphonic acid.
- Dyes & Pigments: Dyes e.g. stilbene, xanthene, acridine, quinoline, azolidene, oxazolidine, thiazolidine, anthraquinone, indigo and phthalocyanine. Solid pigments e.g. iron oxides, carbon black.
- Retention aids: synthetic polymers as modified polyacrylamides (PAM), cationic polymers as polyethyleneimines (PEI),

inorganic chemicals as aluminum sulfate (alum), sodium aluminate and polyaluminium chloride.

- De-foamers: Mineral and vegetable oil products, fatty acids and derivatives, phosphoric acid esters, higher alcohols and silicone oils.
- Dispersion agents and surfactants: Tensides e.g. sulphonate, sulfate, polyoxyethylene, sucrose, peptides, quaternary ammonium, acid soaps or alcohols, paraffine hydrocarbons, olefine hydrocarbons, alkyl benzenes, naphthalene groups and polymerised propylene oxide.

The consumption of chemicals used for the production of sulfite pulp and chemi-mechanical pulping is not listed because these processes are not relevant for Egypt.

### 2.1.3 Energy

The pulp and paper industry is generally regarded as energy intensive industry. Some processes like paper making consume energy while, chemical-pulping process can produce excess energy from the spent cooking liquor.

In modern pulping processes the cooking liquor is used as a fuel in recovery boiler to generate steam. Often, the residuals coming with the raw material and the wastes from the material handling and chipping are also used as a fuel. If integrated, the excess steam and electrical power can be used at the paper mill.

In recycled fibre processing, the separation from the base (waste paper) into fibres is already done, and hence less energy is needed for pulping. Instead, electric power is necessary for different pulp cleaning processes. The heat consumption is normally very low and total energy consumption in production stage is considerably lower than for virgin pulps.

Heat is mainly used for the following purposes in pulp and paper industry:

- Heating water, pulp, air and chemicals to process temperature
- Evaporating water
- Covering heat losses to the surroundings
- Generating electricity

Electricity is then used for the following:

- Transports with pumps, fans, belt and screw conveyors
- Vacuum pumps and compressors
- Driving machines
- Recycled fibre pulpers
- Pulp heating
- Electrostatic precipitators
- Infrared drying
- Steam generation where inexpensive power is available

Energy needed for pulp and paper making processes is either produced on site (recovery boilers, auxiliary boilers) or imported as electric power. The share of fuels depends on the structure of the energy production.

Egypt: In a typical mill for kraft pulp using bagasse, recovery boilers are used for energy production in the form of steam and electricity.

#### **2.1.4 Water Characteristics and its Cycle**

Paper and board mills commonly use large quantities of water. In Egypt, both groundwater and surface water is used. Depending on the paper grade, the water must be pre-treated in order to fulfil the requirements set for process water and boiler water.

Water has various basic applications in the paper industry as process water, cooling water and boiler feed water. Generally, process water is extensively recycled in the production process. All paper and board mills recycle drainage water of the wire section (white water). White water is recycled untreated as diluent to the mixing chest (short circuit) or it is reused after clarification in the fibre recovery unit at specific locations in the process where higher water quality requirements are to be met. Excess flow from the fibre recovery unit is discharged to keep the water balance and to purge unwanted substances that should not enter the approach flow of the paper machine.

The possible rate of recycling depends on the quality requirements of production and on the quality of the treated process/wastewater. There is a difference in water management between integrated and non-integrated mills. In an integrated mill the wastewater from pulping and from papermaking are usually treated in one single treatment plant. In non-integrated pulp mills the market pulp has to be de-watered and dried. The water consumption varies considerably between different mills and it ranges between 15 and 100 m<sup>3</sup>/t. For example, the discharge of wastewater from unbleached kraft pulp mills ranges between 10-30 m<sup>3</sup>/ADT and 20-40 m<sup>3</sup>/ADT for bleached kraft pulp mills. Water consumption can be reduced in a pulp and paper mill by increasing internal water re-circulation and by increasing the operating consistencies in fiber line operations.

#### **2.1.5 Storage and Handling of Raw Materials and Fuels**

Raw fibre materials are usually transported to the mill and stored for the subsequent preparation processes. Minimising raw material storage should be a primary target in a pulp mill. Correct handling of fiber raw material is necessary when storing. Fluctuations in transport, harvesting, mill production, etc., may require using mill storage.

Bagasse has to be depithed as a preparatory step for pulp manufacturing. In Egypt, depithed bagasse is being produced in the sugar cane factory. Due to the seasonal harvesting of sugar cane, depithed bagasse has to be stocked for long periods. This is done under wet conditions. Stock is pressed to get rid of the air, and is kept 80% humidity. Prior to cooking process, bagasse is washed and de-watered. Rice straw is usually stocked in the form of dry piles. On the other hand, recovered papers (secondary fibres) are usually stocked in bales. In some cases it may be pre-sorted before they are sold to pulp and paper mill.

## 2.2 Production Processes

The main processes of the production line can be divided into raw materials preparation, pulping operations and papermaking operations. Raw materials preparation is strongly related to the raw material base of the mill. Pulping operations can be subdivided into chemical pulping (kraft and sulphite), mechanical and chemi-mechanical pulping and recovered paper processing with or without de-inking. Energy and chemicals recovery systems are related to chemical pulping while, auxiliary boilers are related to papermaking processes.

**Egypt:** Pulp is generally produced from bagasse and rice straw using chemical kraft technique.

Figures 1,2 show the sequence of the main processes in chemical and recovered paper pulping, respectively. The main processes for paper and paperboard production are illustrated in Figure 3.

### 2.2.1 Raw Materials Preparation

*a) Bagasse:*

Bagasse has to be depithed as a preparatory step for pulp manufacturing. Depithed bagasse is normally produced in the sugar cane factory. Due to the seasonal production of sugar cane, depithed bagasse has to be stocked for long periods. This is done under wet conditions. Stock is pressed to get rid of the air, and is kept 80% humidity. Prior to cooking process, bagasse is washed and de-watered.

*b) Rice straw:*

Rice straw is usually stocked in the form of dry piles. The first step in the preparation is cutting and conveying the straw piles for primary cleaning. Vacuum is used in this step for dust removal. Then, furnish is then wet cleaned (washing process). Impurities are separated during this process due stirring and friction forces.

*c) Recovered paper:*

For effective use of recovered paper it is necessary to collect, sort and classify the materials into suitable quality grades. Detrimental substances as e.g. plastics, laminated papers etc. are removed before balling as well as possible. The sorted recovered paper is usually compacted by baling machines. Recovered paper (secondary fibre) is normally delivered to the paper mill in the form of bales kept together by metal wires or straps. The bales are opened by cutting the wires or straps that are collected and sold as metal waste. In some cases recovered paper is delivered as loose material in big containers or by bulk dumping. Usually secondary fibres are processed to remove contaminants before pulping. Contaminants may include adhesives, coating, polystyrene foam, dense plastic, polyethylene films, wet strength resins, and synthetic fibres.

### 2.2.2 Pulping Operations

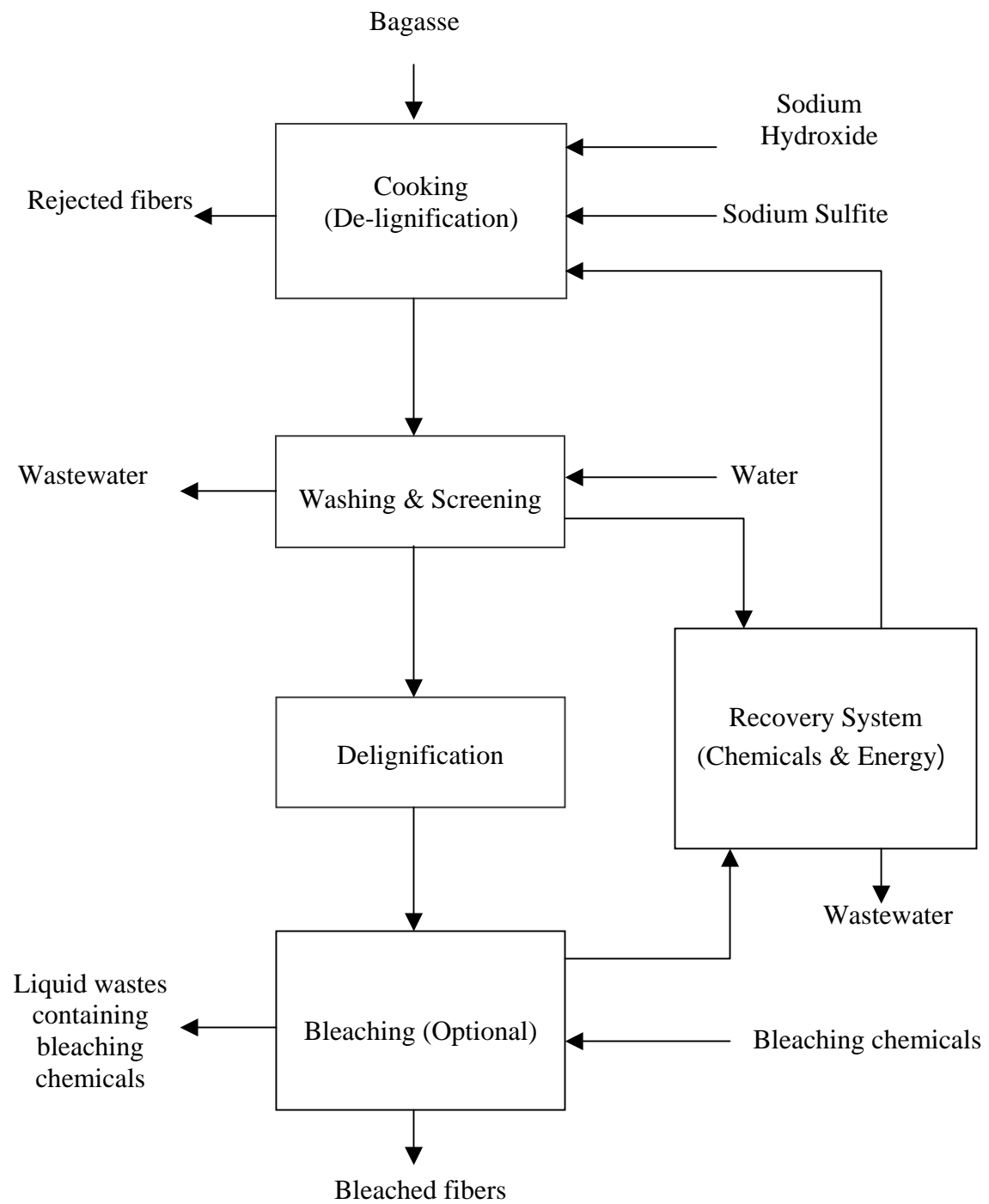
Pulping operations in the pulp and paper industry include chemical, chemi-mechanical and mechanical pulping. In addition, recovered paper is used for producing secondary pulps. Chemical pulping includes sulphite (kraft) and sulphate pulping processes. The sulphate (kraft) pulping is widely employed for wood and non-wood fiber materials e.g. bagasse and rice straw which is being used in Egypt. The main processes in kraft pulping will be explained in the next section.

In sulfite pulping, cooking is based on the use of aqueous sulfur dioxide ( $\text{SO}_2$ ) and a base-calcium, sodium, magnesium or ammonium. In mechanical pulping, bonds between fibers are broken by applying mechanical energy to release fiber bundles, single fibers and fiber fragments. Sulfite, Mechanical and Chemi-mechanical pulping techniques are generally applied for wood and ground-wood, which is not available in Egypt.

#### A) *Kraft (Sulfate) pulping*

The term "sulfate" is derived from the make up chemical sodium sulfate, which is added in the recovery cycle to compensate for chemical losses. In the chemical pulping process the fibers are liberated as the lignin is removed by dissolving in the cooking chemical solution at a high temperature. In the kraft pulping, the active cooking chemicals (white liquor) are sodium hydroxide ( $\text{NaOH}$ ) and sodium sulphide ( $\text{Na}_2\text{S}$ ). As a result of the large amount of sodium hydroxide used, the pH value at the start of a cook is between 13 and 14 (alkaline pulping process).

A kraft pulp mill can be divided into three main parts: raw material handling, chemical defibration (delignification) with more or less closed chemical and energy recovery system and bleaching with an open or partially closed water system. The main processes of a typical kraft pulping include cooking, washing and screening, oxygen delignification and bleaching. In kraft pulping, other delignification than cooking includes  $\text{O}_2$ - delignification and bleaching. See Fig (1).



**Fig (1) Main Process in Chemical Pulping  
(Craft and Sulfite Pulping)**



- ***Cooking***

In the Kraft process the fibers are liberated in the cooking plant by dissolving the lignin and part of the hemicellulose in the cooking chemical solution (white liquor), which contains sodium hydroxide and sodium sulfide as active chemicals. The cooking process can be performed either in batch digesters or in a continuous digester.

- ***Washing and screening***

The pulp coming from the digester contains both fibers and spent cooking liquor (black liquor). The black liquor contains inorganic chemicals and a large amount of organic substances. The black liquor is removed from the pulp in the subsequent washing and led to the chemical recovery system, where cooking chemicals and energy are recovered.

**Egypt:** Chemicals recovery from black liquor is not applicable in rice straw pulping plants. This is due to the presence of high concentration of silica.

The dissolved organic substances together with the spent cooking chemicals are washed away from the cellulose fibers in the brown stock washing stages. Washing the pulp coming from a conventional batch digester plant is normally carried out with drum washers, while a continuous digester plant utilizes the Hi-heat wash zone in the digester with additional drum washers or diffuser washers.

Before further processing, the pulp is screened with pressure screens and centri-cleaners. The objective of screening is to separate knots and fiber bundles from the main pulp stream with a series of vibrating equipment, filtration through pressure screens and centrifugal separation of fibers and other particles with different specific weights. Rejects from screening constitute a further waste stream to be dealt with.

- ***Oxygen-Delignification***

Delignification can be continued by oxygen in one-stage or in two stages with or without intermediate washing. Oxygen delignification takes place in alkaline conditions and is typically operated in medium or high consistency. In order to maintain the sodium balance of the mill, the oxygen stage normally uses the oxidized white liquor, where sodium hydroxide is the main alkaline chemical and sodium sulfide has been oxidized to thiosulphate. Due to relatively low solubility of oxygen to the alkaline liquor, the delignification reactor is pressurized and the temperature is elevated to about 100 °C. In oxygen delignification, preservation of pulp strength is achieved by additives e.g. magnesium salt ( $\text{MgSO}_4$ ).

Oxygen delignification is usually an intermediate stage in the pulp washing. The wash water is added onto the last washing stage after

oxygen delignification and led counter-current to the pulp flow. Washing after oxygen delignification is usually done with one or two wash presses alone or in combination with some other type of washer. The organic material that is dissolved during oxygen delignification can be recovered and led to the chemical recovery system without major changes in the process. The recovery reduces the amount of organic material ending up in the wastewater and the amount of chemicals needed.

**Egypt:** Oxygen - delignification is used for bleaching. Chemicals recovery system is available in bagasse pulping factory.

- ***Bleaching***

The purpose of bleaching chemical pulp is to obtain better pulp quality criteria with respect to brightness, brightness stability, cleanness and strength. The bleaching of kraft pulp is carried out in several stages, usually four to five. Because of the different reaction mechanisms, different types of bleaching chemicals are utilized in a bleaching sequence. The most commonly used chemicals are chlorine dioxide, oxygen, ozone and peroxide. Acid and alkaline stages are used to complement each other.

Whereas delignification can be carried out within closed water systems, bleach plants tend to discharge effluent to external treatment. These effluents from the bleach plant cannot easily be re-circulated into the chemicals recovery system mainly due to the fact that these bleach plant effluents would increase built-up of chlorides and other inorganic elements to the chemical recovery system which can cause corrosion, scaling and other problems.

**Egypt:** Bleaching processes are applied for unbleached bagasse and straw pulps as well as imported unbleached wood pulps. The main chemicals used for bleaching are: sodium hypochlorite, chlorine, sodium hydroxide, calcium hypochlorite, and calcium hydroxide.

- ***Chemical and Energy Recovery***

The recovery system in a kraft pulp mill has three functions:

- Recovery of the inorganic pulping chemicals
- Destruction of the dissolved organic material and recovery of the energy content.
- Recovery of valuable organic by-products

The fuel value of the recoverable black liquor may be enough to make the kraft pulp mills more than self-sufficient in heat and electrical energy. Organic by-products play a limited economic role in most kraft pulp mills. The main process units in the chemical recovery system are the evaporation of the black liquor, incineration of the evaporated

liquors in a recovery boiler and causticizing, including lime regeneration.

In a typical Egyptian kraft mill using bagasse as the fiber raw material, the recovery system includes the following processes:

- Evaporation of black liquor
- Saltcake ( $\text{Na}_2\text{SO}_4$ ) makeup to liquor
- Burning of concentrated black liquor in recovery boiler
- Dissolving of boiler smelt form green liquor
- Incineration of limestone
- Lime slaking and mixing with green liquor
- White liquor clarification and lime mud filtering

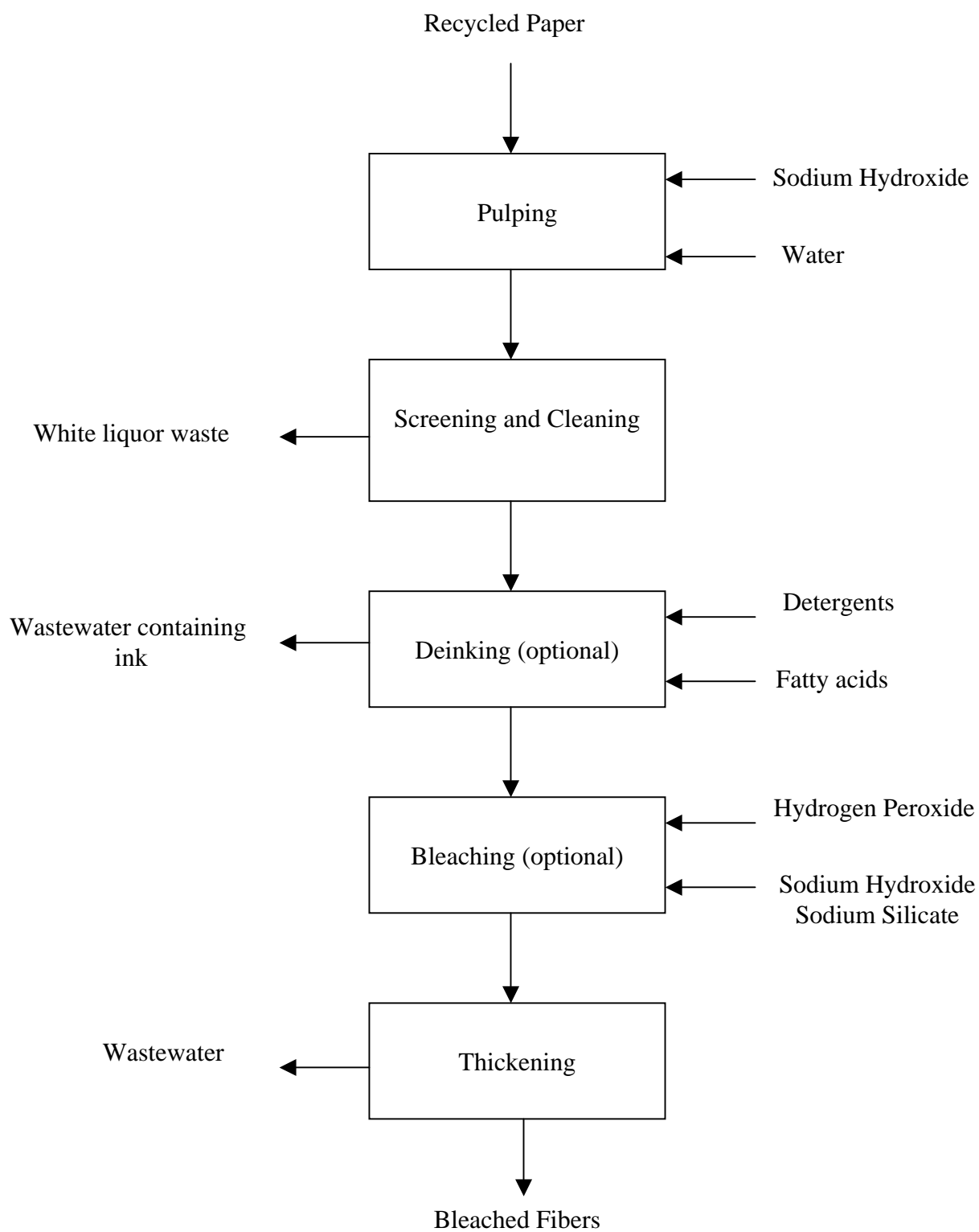
**b) Recovered paper processing**

Recovered fiber has become an indispensable raw material for the paper manufacturing industry. The recovered paper processing system varies according to the paper grade to be produced e.g. packaging paper, newsprint or tissue paper and the type of furnish used. Generally, recycled fiber (RCF) processes can be divided in two main categories:

- Processes with exclusively mechanical cleaning i.e. without de-inking comprising products like uncoated board and cartonboard
- Processes with mechanical cleaning and de-inking comprising products like newsprint, tissue, printing and copy paper, magazine papers, coated board and cartonboard.

**Egypt:** Pulp and paper mills apply mechanical cleaning whether de-inking processes are utilized or not.

Many different recovered paper-processing systems are being employed. All process systems are aiming at defibration, deflaking and removal of impurities. The typical stages of recycled fiber processing include re-pulping, mechanical removal of impurities, de-inking (optional), bleaching (optional) and cleaning and de-watering.



**Fig (2) Main Process in Recovered Paper Pulping**

- ***Re-pulping***

The recovered paper is put into a pulper together with hot water or white water, and pulped with mechanical and hydraulic agitation resulting in their disintegration into fibers. Some chemicals such as de-inking agents and NaOH are often added as pulping additives. Usually the detachment of inks already begins in the re-pulping stage using different technical solutions, according to types of raw materials and products. Contaminants and clusters are removed continuously during operation by a dirt trap (e.g. screen plate) and are sent to a reject conveyor. Normally, the water for disintegration is totally re-circulated process water that comes as white water from the paper machine.

- ***Mechanical removal of impurities***

Mechanical removal of impurities is based on the differences in physical properties between fibers and contaminants, such as size and specific gravity compared to fibers and water. Basically there is screen-type equipment with different dimensions of screen opening (holes and slots) and various types of hydrocyclones (high consistency cleaners, centrifugal cleaners etc.). The partially cleaned pulp slurry is pumped from the pulper to hydrocyclones (high-density cleaners) in which centrifugal forces remove smaller heavy weight particles. The rejects of these cleaners as well as of the pulper disposal system usually have to be disposed of by landfilling (high content of inorganic material).

The next process stage is screening to separate contaminants, by the pressurized screens. Coarse screening (3-4% consistency) is applied during stock preparation. Then, the stock is fine screened in the approach flow (1% consistency) of the paper machine. The reject has to be deposited or further treated.

Depending on the required furnish quality, the stock preparation plant for recovered paper processing has to be equipped with additional machines such as fractionators, dispergers or refiners. A fractionator separates the pulp in two fractions rendering it possible to treat short and long fibers of the pulp slurry in different manners. A stock preparation plant for the processing of recovered paper can be optionally equipped with refiners to improve optical and strength characteristics of the paper.

**Egypt:** Installations in pulp and paper mills include de-flakers, pressurized screens, steam dispergers, and refining equipment e.g. disk and conical refiners.

- ***Processes with flotation de-inking (optional)***

The main objectives of de-inking are increasing of brightness and cleanliness and reduction of stickies. In addition to mechanical cleaning of furnish, a chemical pretreatment of the pulp and a removal of printing inks in flotation cells is carried out. De-inking chemicals such as NaOH, sodium silicate, hydrogen peroxide, soaps or fatty acids

and chelating agents may be added in the pulping sequence. The dispersed ink particles are then separated from the fiber slurry by means of (multi-stage) flotation techniques. After de-inking the pulp is thickened and sometimes washed using sieve belt presses, (disc) thickeners, screw presses, and washers. The remaining impurities can be dispersed so finely with a disperser.

- ***Processes with wash de-inking and ash removal (optional)***

Flotation de-inking is efficient for particle sizes from 5-100  $\mu\text{m}$ . In case of smaller ink particles, de-inking can be applied by washing de-inking which is basically a multistage de-watering. Besides inks, fillers and fines are removed by washing. Washing is often carried out in several stages with counter-current water flow i.e. the filtrate of the secondary stage is used for dilution of the stock in the preliminary stage. If ash removal is required as for tissue paper or for market de-inked pulp (DIP), the system must always include a washing stage.

- ***Bleaching (optional)***

Before entering a storage tower, the pulp is often bleached by use of bleaching chemicals. Generally, hydrogen peroxide, hydrosulphite or formamidine sulfuric acid are used. Bleaching chemicals are added directly in the disperger to maintain or increase the brightness. The reaction itself takes place in a bleaching tower ensuring a sufficient dwell time. Hydrogen peroxide bleaching is carried out in the presence of NaOH, sodium silicate and sometimes chelating agents.

**Egypt:** Installations in some pulp and paper mills using recovered paper (secondary fibers) include bleaching process.

- ***Final cleaning and dewatering***

Different types of fine screens and cleaners remove residual contaminants before the highly diluted pulp slurry is fed to the paper machine. De-watering/thickening may be done by disc filters and screw presses in order to achieve the pulp consistency needed as well as to keep the white water loops separated.

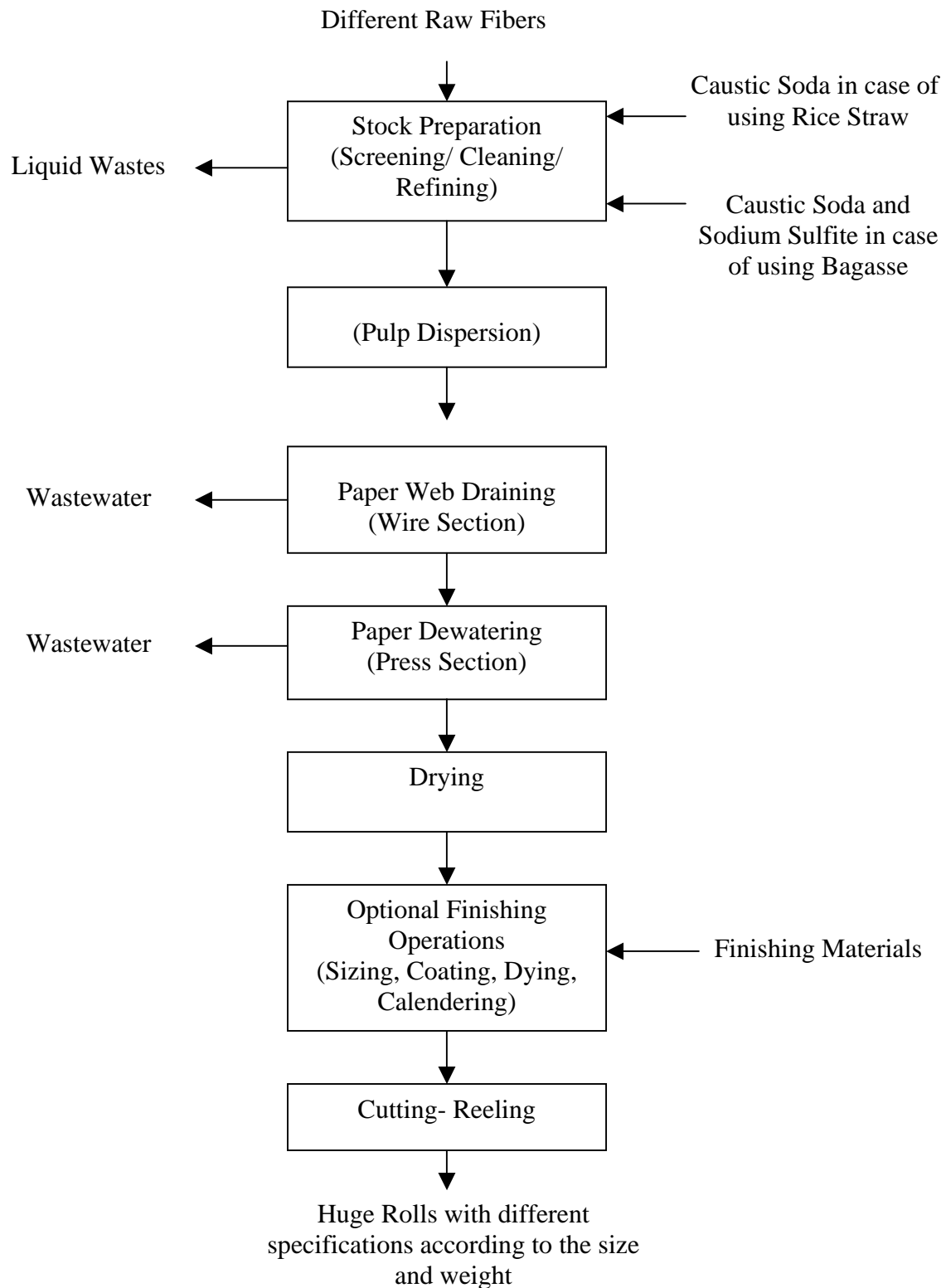
**Egypt:** Pulp and paper mills include disc filters, screw presses, high-density cleaners and filter washing and thickening installations.

### **2.2.3 Papermaking and Related Processes**

During the production of different paper grades, either virgin fibers (chemical or mechanical pulps) or recycled fibers are used as main raw materials. The composition of raw materials used for paper manufacturing (e.g. fibrous material, mineral fillers, coating) has a major effect on the product quality and the environmental impact of the process.

The basic units in a typical paper mill include stock preparation, approach flow system, and the paper or board machine. In addition, some other optional

processes can exist e.g. calenders, coating, winders, re-winders and a roll wrapping station, Figure (3).



**Fig (3) Main Processes in Paper & Paperboard Production**



**a) *Stock preparation***

Stock preparation is conducted to convert raw stock into finished stock (furnish) for the paper machine. This operation includes blending of different pulps, dilution and addition of chemicals. The main process steps in stock preparation are fiber disintegration, cleaning, fiber modification and storage and mixing. The fibers are suspended in a pulper to create a suspension that can be pumped. Then, un-dissolved impurities are removed from the slurry by screening (screens) and cleaning (centrifugal cleaners).

To improve the bonding ability of the fibers, a refining process may be carried out (optional). Refining is carried out in refiners equipped with e.g. a rotating disk that is pressed on a stator. The processing of broke from the paper machine is also part of this process. Finally, the pulp is pumped to the storage chests or mixing chests. In the mixing chests, prepared stocks are mixed in proportions appropriate for producing a particular grade of paper, the required additives are added and the correct fiber consistency is adjusted.

**b) *Paper machine***

The paper making process is essentially a very large drainage operation or a dehydration process. Consistency of the stock flow entering the paper machine headbox is typically 0.2%-1.0% (2-10 g fibre per kg water). After drainage on the wire or forming section using gravitation, pulsation, or vacuum, the web consistency increases to 15%-25%. Mechanical compression removes water on the press section. The web consistency (dry solids content) then increases to 33% -55% depending on the paper grade and press section design. After the press section, the web enters the dryer section where a thermal operation, i.e., evaporation, removes the remaining water. A small amount of moisture (5%-9%) remains in the paper even after the dryer section. Web shrinkage primarily occurs in the dryer section. The drying process is therefore a critical parameter for the final paper qualities.

The paper machine dryer section and its operating principle have remained almost unchanged since their initial development. Contact drying with steam-heated cylinders is still the dominant method for drying paper and board. The following are the drying methods frequently used in paper and board machine applications:

- Multi-cylinder drying
- Yankee cylinder drying
- Through drying
- Airborne drying or nozzle drying (Air jets blown through nozzles support the web travel.)
- Infrared drying (electric and gas)
- Induction drying

**Egypt:** Generally, existing pulp and paper mills utilize steam in the drying process. However, newly established mills may use other drying media.

In the dryer section the web is dried to the final dry content of 90 - 95%. In a simple machine the paper may then be reeled and sent for cutting and finishing. In other cases, a variety of different stages are incorporated within the machine. A size press is a section of the machine where starches and other chemicals are applied to the surface of the paper by dipping or spraying, with residual water being removed in a short after drying-section. In most applications the edges of the web are continually trimmed with cutting water jets, into the couch pit, as it leaves the wire.

Energy consumption on a paper machine varies with the paper grade produced. On printing paper machines, the share of steam in total energy consumption is 70%-75%. For tissue machines, the share is approximately 50%. Energy consumed for paper drying is primarily thermal energy or steam especially when using multiple cylinders drying. The dryer section is definitely the largest consumer of thermal energy on a paper machine as steam. A typical paper machine uses approximately 4 GJ of thermal energy per ton of paper produced as low-pressure steam. Electricity has primary use for dryer section drives and fans and for electric infrared systems on some machines.

**c) *Water circuits and fibre recovery***

Typically, there are three process water circuits in a paper mill. In the primary circuit (short circulation), the fiber, fines and filler-rich water obtained in the sheet-forming zone of the wire section (white water I) is recycled for stock dilution in the stock approach flow system. Excess water from the sheet-forming section, suction and press water, as well as cleaning water is called white water II and is circulated in the secondary circuit (long circulation). The white water draining from the wire is typically treated through a so-called save-all, which may be sedimentation or flotation plant or a filtration unit as a drum or disc filter. The tertiary circuit contains excess water from the secondary circuit and all other process water, which is not directly reusable because of its degree of contamination. It is treated in chemi-mechanical and/or biological wastewater treatment plants.

**Egypt:** Generally, pulp and paper mills include white water recycling installations. However, this water may be partly or fully discharged due to improper maintenance and housekeeping procedures.

**d) *Broke system***

The term “broke” refers to any formed paper from the beginning of the papermaking process to the finished product that is never shipped to the customer. The main goal of a broke system is to return the paper fiber back to the process with no disruption to the uniformity and quality of the stock flowing to the paper machine.

Broke pulp is pumped from the storage towers to the thickeners where excess water is removed. Thicker broke is fed to the broke dosage

chest, where the coated and uncoated broke are mixed together. After the broke dosage chest, the broke is cleaned in several stages to minimize the waste broke which can not be re-circulated to the process. The cleaned broke is discharged to the main line mixing chest, from where the final papermaking furnish is pumped through additional cleaning to the paper machine.

e) ***Optional Finishing Operations***

- ***Sizing (optional)***

In sizing, starch or other sizing agents is applied to the fiber matrix to increase the strength of the base paper web and to modify the surface properties with respect to liquid uptake during writing, printing or coating. Film size presses involve the application of a controlled amount of water based size mixture evenly to the paper sheet by first creating a uniform film thickness on an adjacent roll and then transferring the film onto the paper sheet as if printing the size film onto the paper. The water applied in the size press is evaporated in the after-dryer section.

**Egypt:** Starch is utilized in the sizing process for some types of paper products.

- ***Coating (optional)***

The term "coating" describes the application of a mixture of water, white pigments, binder, and various additives to one or both sides of the surface of the paper in order to create specific surface qualities. Paper may be coated either on equipment that is an integral part of the paper machine (on-machine) or on separate coating equipment (off-machine). A short steam-heated cylinder section dries the coated sheet by infrared radiation, by hot air or a combination. Coatings can be complex mixtures of ingredients and usually require preparation before use.

**Egypt:** Coating of some paper products is applied using various additives to achieve specific surface qualities.

- ***Dyeing of paper (optional)***

Colored papers are obtained by dyeing the paper stock or the paper surface (size press, paper coating). Optically brightened papers can be produced in the same manner. Stock dyeing is the most widely used type of paper dyeing. Dyes, pigments, and optical brighteners are added either batch-wise in the pulper or mixing chest or introduced continuously into the stock flow.

Surfaces of papers can also be colored by coating, where the starting material is the white coating mixture. Adding dispersions of organic or inorganic pigment attains the desired shade.

**Egypt:** Dying of some paper products is applied using some pigment and additives to produce colored paper products.

- ***Calendering (optional)***

The objective of calendering is to produce a smooth paper surface that meets the printing and writing requirements. In calendering, the web is fed through counteracting press rolls where the surface roughness is influenced by the action of pressure and very often temperature. Machine calender consists of two or more chilled cast-iron rolls with very smooth surfaces that are arranged one on top the other. The web is passed through the nips of these rolls, which are heated by, hot water, steam or heating oil.

The paper web is often subjected to a further finishing treatment called super-calendering. Super-calendering increases printability that is necessary in case of picture printing. The super-calendering system consists of the reel-off stand, the actual super-calender, and the reel-up stand.

**Egypt:** Paper machines include calendering process that use steam heated calenders.

- ***Reeling / Cutting / Dispatch***

The final paper product will be made to customer specifications in terms of roll or sheet sizes, paperweight, color and finish. Most paper machines will produce large rolls of paper where the width of the paper web has been determined by trimming the sides of the web at the wet end of the machine. It is usual to finish products with sharp rotary knives and guillotines off machine by trimming rolls to exact widths and cutting to sheets before wrapping for dispatch.

There may also be a stage of conditioning the paper product to a specified moisture content so it is consistent throughout, dimensionally stable and fit for intended use such as printing or packaging.

**Egypt:** Paper mills include different types of finishing equipment e.g. reeling, rewinding and cutting to specific sheet sizes.

## **2.3 Service Units**

Medium and large size mills will have some or all of the following service and auxiliary units. These units can be pollution sources and therefore should be inspected and monitored. Fig (4) shows the service units and their related pollution sources.

### **2.3.1 Boilers**

The pulp making mills are characterized by the recovery systems e.g. recovery boils. In paper making mills, boilers are essential. In all cases, boilers are used to produce steam for:

- Heat supply to the processes

- Electric power generation

Conventional steam-producing thermal power plants generate electricity through a series of energy conversion stages. Fuel is burned in boilers to convert water to high-pressure steam, which is then used to drive the turbine to generate electricity. The gaseous emissions generated by boilers are typical of those from combustion processes. The exhaust gases from burning fuel oil (Mazot) or diesel oil (solar) contain primarily particulates (including heavy metals if they are present in significant concentrations in the fuel), sulfur and nitrogen oxides (SO<sub>x</sub> and NO<sub>x</sub>) and volatile organic compounds (VOCs).

The concentration of these pollutants in the exhaust gases is a function of firing configuration (nozzle design, chimney height), operating practices and fuel composition.

Gas-fired boilers generally produce negligible quantities of particulates and pollutants.

Wastewater is generated as blowdown purged from boilers to keep the concentration of dissolved salts at a level that prevents salt precipitation and consequently scale formation. The blowdown will be high in TDS.

In the case of power plants, water is used for cooling the turbines and is also generated as steam condensate. The amount of wastewater generated depends on whether cooling is performed in open or closed cycle and on the recycling of steam condensate. Contamination may arise from lubricating and fuel oil.

### 2.3.2 Water Treatment Units

There are different types of water used in industry. Depending on the application and the water source, different treatment processes are applied.

**a) *Water Softening for medium hardness water:***

Calcium and magnesium ions are removed from hard water by cation exchange for sodium ions. When the exchange resin has removed the ions to the limits of its capacity, it is regenerated to the sodium form with a salt solution (sodium chloride) in the pH range of 6-8. This is performed by taking the softener out of service, backwashing with the salt solution, rinsing to eliminate excess salt, then returning it to service. The treated water has a hardness level of less than 1 ppm expressed as calcium carbonate.

**b) *Water softening for very high bicarbonate hardness:***

Water from wells and canals is pre-treated before softening. Water is treated first by the lime process, then by cation exchange. The lime process reduces dissolved solids by precipitating calcium carbonate and magnesium hydroxide from the water. It can reduce calcium hardness to 35 ppm if proper opportunity is given for precipitation. A coagulant such as aluminum sulfate (alum) or ferric sulfate is added to aid magnesium hydroxide precipitation. Calcium hypochlorite is added in some cases. Currently the use of organic polyelectrolytes is replacing many of the traditional inorganic coagulant aid. Sludge precipitates and is discharged to disposal sites whereas the overflowing water is fed to a sand filter followed by an activated carbon filter that removes any substances causing odor and taste. A micro filter can then be used to remove remaining traces. A successful method to accelerate

precipitation is contacting previously precipitated sludge with the raw water and chemicals. The sludge particles act as seeds for further precipitation. The result is a more rapid and more complete reaction with larger and more easily settled particles.

c) ***Reverse Osmosis:***

Demineralization can also be performed by reverse osmosis. In this process water is forced through a semi-permeable membrane by applying pressure.

### **2.3.3 Laboratories**

Laboratories may have an important role in the pulp and paper industry, as they can perform the following functions:

- Testing raw materials, chemicals, water, wastewater, ... etc.
- Quality control of the different products and comparing the findings with the standard specifications for raw materials and final products.

Chemicals used for testing could be hazardous. Proper handling and storage are required for compliance with environmental law.

### **2.3.4 Workshops and Garage**

Large facilities have electrical and mechanical workshops for maintenance and repair purposes. Environmental violations could be due to:

- Noise
- Rinse water contaminated with lube oil

Pollution in the garage area will depend upon the services offered. The presence of a gasoline or diesel station implies fuel storage in underground or over the ground tanks that require leak and spill control plans.

Replacing lube oil implies discharge of spent oil to the sewer lines or selling it to recycling stations.

### **2.3.5 Storage Facilities**

The specifications for the storage facilities depend on the stored material.

Raw fiber materials are usually stored in open areas under specific environmental conditions i.e. humidity.

Paper and board products are stored in the form of reels or packaged according to customer requirements. In some cases, products may be stored under certain drying conditions to ensure specific moisture content.

Chemicals are used extensively in the chemical pulping mills. Also, paper mills may use some chemicals for the finishing processes. In all cases, some of the chemicals could be hazardous and require special handling, storage and management procedures as required by law.

Fuel is used for the boilers and for the cars and delivery trucks. It is stored in underground or over ground tanks. The types of fuel usually used are fuel oil (Mazot), gas oil (solar), natural gas and gasoline.

### **2.3.6 Wastewater Treatment Plants**

Although a WWTP is a pollution abatement measure, it has to be inspected and monitored for potential pollution. Pollution may be due to malfunctioning or improper management. Pulp and paper mills discharge wastewater of high organic load, in addition to SS. From time to time peak loads may be

discharged. They may be due to internal processes, to lack of control or incidental situations such as power collapse.

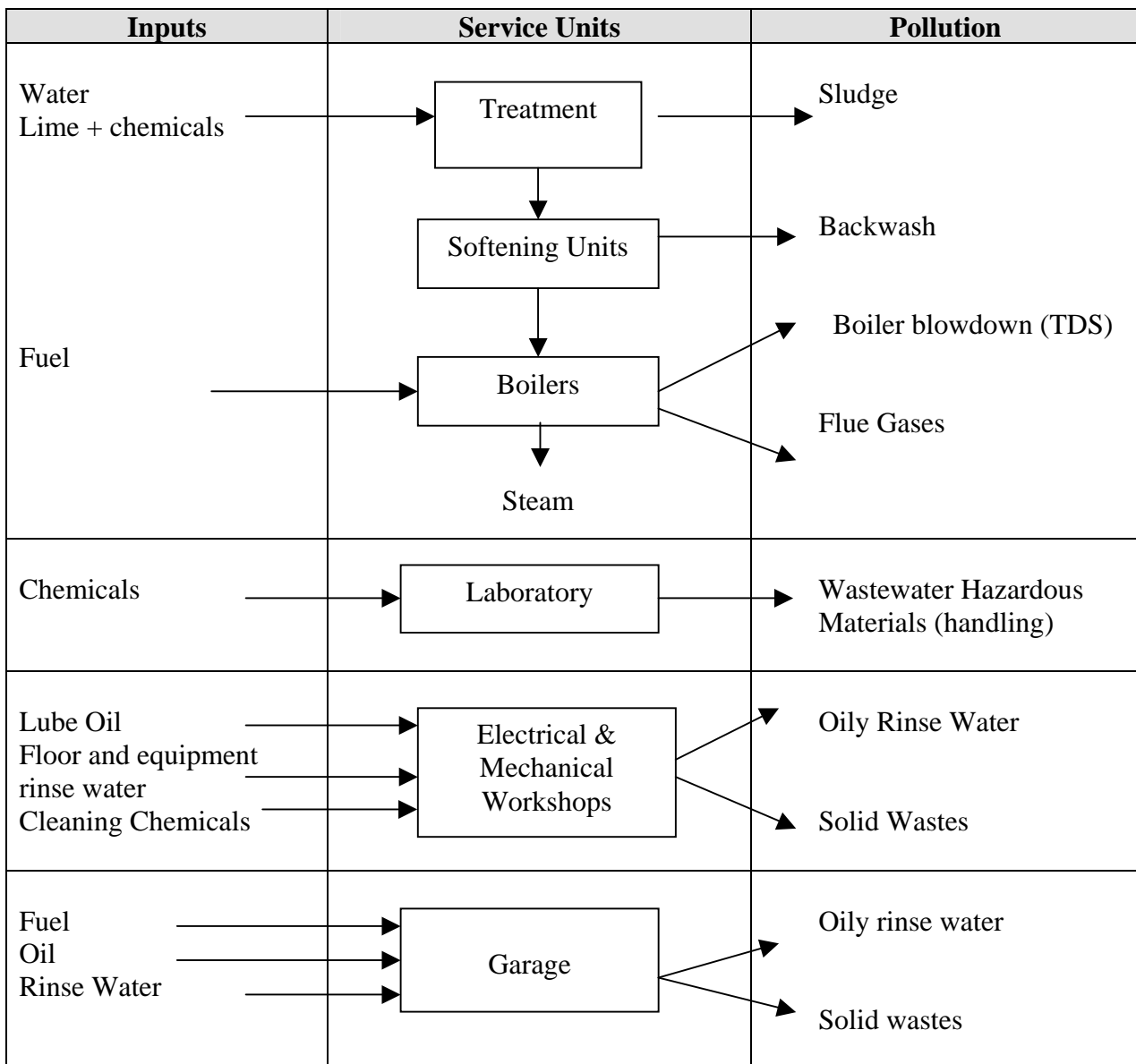
The potential pollution sources are:

- Sludge which represents a solid waste problem
- Treated water could represent a water pollution problem if not complying with relevant environmental laws

#### **2.3.7 Restaurants, Washrooms and Housing Complex**

These facilities will generate domestic wastewater as well as domestic solid waste.

**Fig (4) Service Units and Their Related Pollution Sources**





## 2.4 Emissions, Effluents and Solid Wastes

In the following sections, estimates of pollution loads from the pulp and paper industry are presented. If not mentioned otherwise, the reference of the presented information and figures is:

*“Environmental Impacts of Pulp and Paper Industry”, UNEP 1996, ISBN: 92-807-1589-5*

These estimates are based on the monitoring databases for the European mills. Such data sources are not available for the Egyptian industry. However, some data from the EPAP’s reports of two major Egyptian paper mills. These two mills are designated in the following sections as Mill I, and Mill II.

### 2.4.1 Air Emissions:

Emissions to air from the pulp and paper industry to a large extent originate from the combustion of fuels. Transport vehicles, auxiliary boilers and recovery boilers related to chemical pulping processes all emit sulfur and nitrogen oxides, gases which acidify the atmosphere and in turn contribute to regional environmental impacts. Particulates as well as odorous compounds are pollutants which have an environmental impact in the vicinity of pulp mills.

#### a) *Kraft (sulfite) pulping:*

Most air emissions from a soda or sulfate pulping line originate from the recovery boiler, the limekiln and any auxiliary boiler. They consist of particulates, sulfur compounds derived from fuels, process chemicals in sulfate pulping and nitrogen oxides from combustion processes. In addition, foul smelling emissions (reduced sulfur compounds originating from the spent cooking liquor) arise from the fiber line washers, liquor tanks etc. in a sulfate pulping line. An overview of typical amounts is given in Table (3). The ranges reflect differences in the applied control measures.

**Table (3) Gaseous Emissions from the Kraft Pulping Process**

Emission parameter	Value range (kg/t pulp)
Reduced sulphur compounds	0,005-10
Sulfure dioxide	0,01-10
Nitrogen oxides	0,02-5
particulates	0,02-12

#### b) *Papermaking:*

Emissions to air from paper and board mills originate mainly from energy generation (steam and electricity) and not from the manufacturing process itself. Major pollutants in case of gas firing are CO<sub>2</sub> and NO<sub>x</sub>, in case of oil or coal firing CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, dust and low concentrations of heavy metals. These emissions occur at the site of generation. Steam is normally generated at the paper mill in dedicated boilers, so the emissions occur at the site. In many cases,

electricity is purchased from the grid, so the emissions occur at the power plant. The electricity/steam consumption ratio at paper mills enables the co-generation of heat and power (CHP). Many paper mills apply CHP and then all emissions to air associated with the energy consumption occur at the site.

In some special cases, emissions of organic carbon from the dryer section of the paper machine may occur. If so, they are caused by the use of additives (coating chemicals) or by not well designed water circuits and wastewater treatment plants respectively but in most cases they are of negligible concern. Therefore, atmospheric emissions from paper mills are mainly related to energy generation. If incinerated, the solid wastes that include a high organic content (e.g. paper, rejects, de-inking sludge, and bio-sludge) may produce air emissions. Examples of measured emissions from incineration of different types of RCF paper mills residues are compiled in table (4), (Ref. Best Available Techniques in the Pulp and Paper Industry, July 2000).

**Table (4) Gaseous Emissions from Incineration of Different Types of RCF Paper Mills Residues**

Parameter	Unit	Average values Rejects from a RCF Packaging mill (Without de- inking)	Average values Rejects from a RCF newsprint mill (with de-inking)
Dust	mg/Nm <sup>3</sup>	3.2	6.6
SO <sub>2</sub>	mg/Nm <sup>3</sup>	26.0	1.2
NO <sub>x</sub>	mg/Nm <sup>3</sup>	195	“95:271;“96:227;
CO	mg/Nm <sup>3</sup>	14.1	“97:176
HCl	mg/Nm <sup>3</sup>	1.7	14
HF	mg/Nm <sup>3</sup>	0.06	2.6
Total-C	mg/Nm <sup>3</sup>	1.4	no data (n.d.)
Cd, TI	µg/Nm <sup>3</sup>	< 17.0	1.1
Hg	µg/Nm <sup>3</sup>	5	(n.d.)
Sb, As, Cr, Co,	µg/Nm <sup>3</sup>	71.0	(n.d.)
Cu, Mn, Ni, V,			(n.d.)
SN	ngI-TE/Nm <sup>3</sup>	0.097	(n.d.)
Dioxins/Furans			

Tables (5, 6, 7) show the gaseous emissions and noise in different production lines for mill (I) for pulp and paper.

**Table (5) Air Emissions and Noise Measurements  
in Pulp Production Line for Mill (I)**

Process	Dust mg/m <sup>3</sup>	Chlorine ppm	Noise decibels
Straw cutting	1.27 – 4.83	-	81.7
Pulp washing	0.92	-	85.2
Pulp bleaching	0.98 – 1.06	0.02 – 0.09	71.1

Straw storage	2.80	-	71.0
Max. allowable	10	1	90

**Table (6) Air Emissions and Noise Measurement  
in Papermaking Line for Mill (I)**

Process	Sulphuric acid vapour mg/m <sup>3</sup>	Temperature °C	Noise, decibels
Stock preparation	0.54	-	85.7
PM dryers	0.14	25.8	83.1
Rewinder & Cutter	-		87.2
Max. allowable	1	29.5	90

**Table (7) Air Emissions in Bleaching Chemical Production  
For Mill (I)**

Chlorine production	Cl ppm	Dust mg/m <sup>3</sup>
Cells	0.33	-
Outside control rooms	0.014	-
Inside control rooms	0.011	
Hypo production		
Pumping section	0.01 – 0.29	0.25 – 0.89
Lime store	-	1.16
Max. allowable	1	2

The dust emissions of the mill were also measured outside the mill (I) from four different locations, see table (8).

**Table (8) Dust Ambient Air Measurement  
Outside the Mill (I)**

Locations	Dust µg/m <sup>3</sup>
Location 1	136.2
Location 2	88.3
Location 3	104.9
Location 4	83.3
Max. allowable	230

Tables (9 and 10) give the emissions from the chimneys of mills (I and II).

**Table (9) Emissions from Boiler Chimneys for Mill (I)**

Boiler	CO mg/m <sup>3</sup>	SO mg/m <sup>3</sup>	Nitrogen dioxide mg/m <sup>3</sup>	Dust, mg/m <sup>3</sup>
No 2	415.8	189.8	Not detectable	16.9
No 3	473.2	382.2	-	22.6
No 4	392.4	223.6	-	12.8
No 5	389.8	509.6	-	33
Max. allowable	5000	4000	3000	200

**Table (10) Emissions from Boiler Chimneys for Mill (II)**

Parameter	Boiler 1	Boiler 2
Combustion efficiency/%	87.8	82.0
Carbon monoxide/ppm	81	82
Carbon dioxide/%	11.4	2.8
Oxides of Nitrogen/ppm	120	21
Sulfur dioxide/ppm	206	60

**2.4.2 Effluents:**

Effluents to wastewater will depend on the production processes and operational standards. Pulp and paper processes discharge organic matter and nutrients originating from raw materials and also from chemicals used in different stages. The highest load of organic matter comes from the residual cooking liquor produced in chemical sulfate pulping. This is usually regenerated for re-use and for use as fuel. The recovery of spent pulping liquors in mills using non-wood raw materials is less common due to the lack of feasible recovery systems and silica removal technology. This spent liquor is therefore often discharged without treatment leading to a very significant environmental impact.

**a) *Raw fiber Material Handling:***

The effluent from wet depithing must be treated to remove suspended solids and to reduce BOD. Discharges vary depending primarily on how much of the depithing is done at the mill but also on the depithing process and the condition of the bagasse. The following effluent characteristics for wet bagasse handling including depithing indicate the magnitude and the variability:

BOD5 20-60 kg/t bagasse  
 COD 30-180 kg/t bagasse  
 SS 300-400 kg/t bagasse

**b) *Sulfate (kraft) pulping :***

Spent cooking liquor from the digester contains the largest amounts of dissolved organic material of all process liquors. The detailed composition and the environmental impact of the liquor (if not recovered) depend on the fiber raw material, the pulping yield and the process conditions. Part of the dissolved material is volatile, it will be released from the liquor and appear as condensates when lowering the digester pressure. Typical BOD and COD values for the spent liquor (considered as discharge if no recovery exists) from kraft pulping are given in table (11).

**Table (11) Typical BOD and COD Values for the Spent Liquor**

Process	Fibre raw material	Pulp yield %	BOD7 Kg/t	COD Kg/t
Soda	Straw	50	250	930
Soda	Cotton	55	340	970

Soda	Bagasse	80	256	750
Sulphate	Bagasse	48	350	1340

c) ***Bleaching Chemical Pulps:***

In a typical pulp and paper mill in Egypt, the bleaching process is performed for chemical pulp that are produced locally (bagasse/rice straw) and/or imported pulp that may be produced from wood or non-wood fiber materials. Bleaching effluents contain dissolved chlorinated material if chlorine, hypochlorite or chlorine dioxide has been used as the bleaching agent (conventional bleaching). Bleaching effluents also contribute to the BOD, COD, toxicity and colour of the total mill effluent. The environmental load increases with the increase of lignin content of the unbleached pulp, amounts of dissolved material entering from the cooking, charged chemicals and bleaching temperature. In conventional bleaching the effluent characteristics are not markedly changed by different processes or raw materials as seen in table (12), but the intense alkaline conditions in viscose pulp bleaching produce high BOD/COD effluents.

**Table (12) The Effluent Characteristics from Fibers Bleaching Process**

Pulping process	Fibre raw material	BOD (kg/t)	COD (kg/t)
Soda	Straw	16	60
Sulphate	Bamboo	17	90
Sulphate	Eucalyptus	14	60
Sulphate	Pine	15	80
Sulphite (paper)	Softwood	15	60
Sulphite (viscose)	Softwood	30-40	-

Effluents from conventional bleaching contain a complex mixture of chlorinated organic compounds corresponding to 4-10 kg AOX/t pulp (adsorbable chlorinated organics). Most of that material is in a form with high molecular mass and a low degree of chlorination. A small fraction of the chlorinated material is low molecular, slowly degradable and may bio-accumulate and show biological activity. If the raw material contains relatively high amounts of easily dissolved matter, e.g. remaining sugar in bagasse, the pollution load will increase.

d) ***Recycled Fiber Pulping:***

Wastepaper collected from landfills, as often the case, may have some polluting effect. Pollution from landfill comes primarily from methane or other hydrocarbons generated as the cellulose decomposes anaerobically. Wastepaper pulping processes give rise to a certain amount of pollution in the form of materials contained in the process water discharged from the plant, in the material collected during processing and in the gases discharged to the atmosphere by burning waste material. Some typical figures relevant to polluting materials generated during RCF pulping (kg/ton of pulp) are given in table (13).

**Table (13) Typical Figures Relevant to Polluting Materials Generated During RCF Pulping (kg/ton of pulp)**

Type of waste paper	BOD kg/t	COD kg/t	Comment
Mixed waste paper	5-15	10-40	Depends on contaminants
Commercial waste paper	5-10	10-30	Little contamination, depends on starch content
Old newspapers	20-40	40-90	De-inking increases loads
Old corrugated containers	5-15	10-40	Depends on starch and glue
Selected wood free waste papers	5-50	10-100	Wide range depends on starch

*e) Papermaking Process:*

In the Table below, typical numbers are given for the net flow of excess water from the papermaking process in m<sup>3</sup>/ADt of paper, not including the water from other sources. The measurements for suspended solid, BOD and COD in kg/ADt are taken from before any effluent treatment plant so that they represent what is actually discharged from the paper mill. The emissions also include the discharges that are not directly related to the uninterrupted paper production such as overflows, spillage leaks, washouts of chests and wet ends, cleaning and washing size presses and coater heads. In table (14), two classifications of paper machine are considered, low environmental status and medium/high environmental status.

**Table (14) Two Classifications for Wastewater Flow Rate from Paper Making**

Discharge parameter	Low env. status	Medium/high env. status
Excess flow (m <sup>3</sup> /t)	50-200	5-50
Suspended solids SS (kg/t)	30-70	10-30
BOD <sub>7</sub> (kg/t)	4-10	2-10
COD (kg/t)	8-25	4-20
P (g/t)	3-300	3-300
N (g/t)	10-500	10-500

Tables (15 and 16) show the pollution loads resulting from two mills (I and II) for paper making.

**Table (15) Wastewater pollution loads for Mill (I)**

DESCRIPTION	M <sup>3</sup> /D	BOD Kg/d	COD Kg/d
Straw preparation	15600	4513	37487
Disgesters/washing (black liquor)	20440	71042	263174
Screening	1322	22	326
Bleaching	12400	1689	29094
PMs 1, 2 and 3	13000	914	5578
Board mill	3000	1260	9006
Chlor – alkali plant	1000	272	4757
Water / boiler plant	1000	155	4065
Total	67762	79868	350487

**Table (16) Wastewater pollution loads for Mill (II)**

DESCRIPTION	Load Kg/day
Straw pulping/COD	5000
Paper mill/COD	30000
Paper mill/BOD	11000
Paper mill/SS	24000

Table (17) presents the detailed analyses and quantities of wastewater from 6 various paper machines in mill (II). While table (18) gives the overall pollution sources resulting from paper making.

**Table (17) Wastewater pollution loads for Mill (II) from Six Machines**

Paper Machine	Drain Liter/min.	Load Ton/Day		
		S. S	COD	BOD
1	2428	3.46	3.12	1.25
2	2383	4.84	3.25	1.3
3	1887	3.04	1.41	0.56
4	3210	2.98	2.05	0.83
5	1935	2.96	1.95	0.78
6	2060	1.1	4.18	1.67

**Table (18) Overall Wastewater Pollution Sources  
for Pulp and Paper Industry**

<b>Process</b>	<b>Wastewater Pollution Sources</b>
1. Raw materials preparation	Removal of fibers by the wet process and straw washing
2. Pulping	Condensate of acids, black liquor, cooling water, pulp washing water, rejected fibers and filtration liquors from pulp thickening process.
3. Bleaching	Pulp washing liquors after bleaching
4. Paper making	Chemicals and additives, liquors containing cellulose fibers and the white liquor from paper making machine.
5. Utilities	Boilers condensates liquors and water treatment chemicals.
6. Chemicals recycling	Steam condensate, dry solutions from residues washing operations, cooling liquids and scales constituents condensate.

#### **2.4.3 Solid Wastes**

Waste is formed at all stages in the pulp and paper life cycle. Solid wastes generated from a waste paper pulping operation vary considerably depending upon the degree of cleaning set up within the process. The yield of the pulp is inversely proportional to the amount of material removed. Sludge constituents from waste paper pulping vary with the type of waste paper used. They most often include clay and other fine inorganic fillers, fine plastic debris and organic materials from inks. Also fibre from the paper is always present. When dry, these materials landfill quite satisfactorily. Waste paper sludge is often difficult to de-water. A significant amount of water is sufficient to accommodate bacteria, which rapidly produce hydrogen sulphide and other noxious or dangerous gases. Landfilling of wet sludge can produce considerable odour problems.

#### **2.4.4 Hazardous Wastes:**

The amount of hazardous waste generated in the pulp and paper industry is limited. Examples of substances that may be generated or that may result from the operations in the industry and that have to be classified as hazardous waste are:

- Heavy metals such as cadmium, chromium and mercury
- Polychlorinated biphenyls (PCBs) being used as coolant – insulation fluids in transformers and capacitors and sometimes as additives to some epoxy paints
- Cyanides
- Herbicides



- Solvents, in particular chlorinated ones like dichloromethane (DCM), trichloromethane or chloroform, and tetrachloromethane also referred as carbon tetrachloride
- Chlorofluorocarbons (CFCs) commonly called “freons”, which are used as process media in refrigerators and heat pumps
- “Halon” that are bromine (together with chlorine and / or fluorine) containing substances that are being used in fire extinguisher systems
- Paints and varnishes
- Glue
- Acids and alkalis
- Oil and grease
- Radioactive sources (from instruments like level controls)

In addition, printing inks contain a variety of materials some of which, mainly heavy metals, are listed as hazardous. Some dioxins have been also reported. Burning waste paper sludge is considered as an environmentally acceptable option for heat generation to replace of fossil fuels. However, there is a potential of airborne dispersion of heavy metals and other pollutants.

## **2.5 Characteristics of Pulp and Paper Industry**

The following characteristics of the Pulp and Paper industry should be considered in the planning and conducting the inspection activities.

- Mills can be either integrated or non-integrated. The configuration of each mill depends on the combination of the employed processes, equipment and installations.
- Integrated and non-integrated mills have different features of the water management system in terms of re-circulation of process water, discharges, and pollution loads.
- Integrated and non-integrated mills that include chemical pulping process have to have effective wastewater treatment plants. This is due to the expected high pollution loads.
- Kraft pulping mills using rice straw as a fiber raw material need a special focus on the practices for dealing with black liquor. Wastewater may be contaminated with the spent liquor.
- Kraft pulping mills using bagasse as a fiber raw material need a special focus on the air emissions from the recovery boilers.

### 3. Environmental and Health Impacts of Pollutants

The main environmental impacts arising from pulp and paper making stem from the use of resources at the mills themselves. Significant impacts also arise from other associated activities e.g. chemicals manufacture and the use which generate residuals that often enter the environment. Residuals of process chemicals and fiber raw materials are also released to air or water and appear as solid waste streams. In addition, fibers and fiber fragments appear in the aqueous waste streams and have an impact both on the visibility of the receiving waters and on the bottom structure. By altering the color of receiving waters, dissolved components can reduce light penetration and endanger the aquatic life. Other dissolved components exert toxic properties on the aquatic fauna. An important air quality problem is the release of smelling reduced sulfur and noxious compounds from the sulfate (kraft) pulping process.

#### 3.1 Impact of Air Emissions

- |                                      |  |
|--------------------------------------|--|
| <b>a) <i>Particulate matters</i></b> | Recent epidemiological evidence suggests that much of the health damage caused by exposure to particulates is associated with particulate matters smaller than $10\mu\text{m}$ ( $\text{PM}_{10}$ ). These particles penetrate most deeply into the lungs, causing a large spectrum of illnesses (e.g. asthma attack, cough, bronchitis). Emissions of particulates include ash, soot and carbon compounds, which are often the result of incomplete combustion. Acid condensate, sulfates and nitrates as well as lead, cadmium, and other metals can also be detected. |
| <b>b) <i>Sulfur Oxides</i></b>       | Air pollution by sulfur oxides is a major environmental problem. This compound is harmful to plant and animal life, as well as many building materials. Another problem of great concern is acid rain which is caused by the dissolution of sulfur oxides in atmospheric water droplets to form acidic solutions that can be very damaging when distributed in the form of rain. Acid rain is corrosive to metals, limestone, and other materials.   |
| <b>c) <i>Nitrogen Oxides</i></b>     | Nitrogen oxides also dissolve in atmospheric water droplets to form acid rain.   |
| <b>d) <i>Carbon dioxide</i></b>      | Combustion of fossil fuels to produce electricity and heat contribute to the green house effect caused by the formation of carbon dioxide. The greenhouse phenomenon occurs when heat radiation from earth is absorbed by the gases causing a surface temperature increase.  |

- |                                  |  |
|----------------------------------|--|
| e) <i>Water Vapor (Humidity)</i> | Humidity in workplace is regulated by law 4/1994 due to its effect on the respiratory system especially for people suffering from asthma.  |
| f) <i>VOCs</i>                   | VOCs emitted from the processing, storage and handling of raw material and from all combustion processes, consist of various substances which can contribute to the formation of tropospheric or low level ozone which has a direct environmental impact on vegetation and crops.  |
| g) <i>Odor</i>                   | Odor is caused by inorganic and organic sulfides formed in the process. They have a characteristic, unpleasant smell but do not constitute a health hazard at the typical levels at which they occur. Odor is not a health issue but the disturbance and aesthetic implications are such that this problem should be considered. |

## 3.2 Impact of Effluents

Discharges of organic matter will result in oxygen consumption by degradation reactions in the receiving waters. The organic material in wastewater stimulates the growth of bacteria and fungi naturally present in water, which then consume dissolved oxygen. The environmental impacts of this depend on the characteristics of such water bodies.

Discharge of polluted wastewater high in BOD into lakes and sea can cause eutrophication and impact bio-diversity.

Sudden discharge of high BOD loads to the public sewer system will have an indirect environmental impact. Shock loads can cause malfunction of the domestic wastewater treatment plant.

Bleaching with high charges of chlorine compounds causes a specific environmental problem by generating persistent (long-lived) toxic polychlorinated compounds that can bio-accumulate in living organisms.

The colour of effluent is associated with the high molecular weight organic compounds; i.e. lignin derivatives from the cooking and bleaching. The main effect of colour is the reduction of the light transmission in the water phase, which decreases the productivity of the receiving water. The impact of colour changes in each particular case depends very closely on the overall productivity and original color of the receiving waters.

Inorganic compounds in the effluents from pulp production seldom give rise to environmental effects. One exception is chlorate, formed during bleaching with chlorine dioxide. It is highly toxic to algae and cause indirect effects on other organisms living in the algal communities. Chlorate can be removed effectively by external biological treatment. Discharges of nitrogen and phosphorus may increase nutrient levels in receiving waters, leading to increased biomass production, higher oxygen consumption and, eventually, eutrophication. Several levels in the ecosystem are usually affected when the nutrient balance is disturbed.

Spent lube oil from garage and workshops could be a cause for concern if discharged into the sewer system.

### **3.3 Environmental Impact of Solid Wastes**

Organic waste from production processes, such as sludge from external treatment, may cause environmental impacts at disposal. Ashes, slag and other inorganic process waste usually go to landfill. To minimise environmental impacts and optimise disposal it is important to fractionate waste generated and find new use for residual materials that can be re-used. On the other hand, the amount of hazardous waste generated in the pulp and paper industry is limited.

## 4. Egyptian Laws and Regulations

There are a number of laws and regulations that address the different environmental violations. The following are the laws applicable to the dairy industry.

### 4.1 Concerning Air Emissions

Article 40 of Law 4/1994, article 42 of the executive regulations and annex 6 deal with gaseous emissions from combustion of fuel. The statutes relevant to the fuel combustion are:

- The use of solar oil and other heavy oil products, as well crude oil shall be prohibited in dwelling zones.
- The sulfur 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 sulfur dioxide shall be emitted through chimneys, which are rising sufficiently high, in order that these gases become lighter before reaching the ground surface. Otherwise, using fuel that contains high proportions of sulfur in power generating stations, as well as in industry and other regions lying away from inhabited urban areas. This will provide 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.
- Chimneys from which a total emission of wastes reaches 7000 – 15000 kg/hr, shall have heights ranging between 18 – 36 meters.
- Chimneys 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 (19).

**Table (19) Maximum Limits of Emissions  
from Sources of Fuel Combustion in Boilers**

<b>Pollution</b>	<b>Maximum limit, kg/m<sup>3</sup> of exhaust</b>
Sulfur Dioxide.	3400
Carbon Monoxide.	250
Smoke.	50

## **4.2 Concerning Effluents**

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

Table (20) presents the permissible limits for discharges to the different recipients (sea, Nile, canals, agricultural drains, public sewer) according to the different relevant laws.

Spent lube 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.

## **4.3 Concerning 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, which provides guidelines from domestic and industrial sources, including specifications for collection, transportation, composting, incineration and land disposal.
- Law 31/1976, which amended 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 4/1994 regulates incineration of solid waste

## **4.4 Concerning Work Environment**

Violations of work environment could be encountered:

- In the boiler house: gas emissions, regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8. The limits for the relevant pollutants are presented in Table (21).
- Wherever heating is performed: temperature and humidity are regulated by article 44 of Law 4/1994, article 46 of the executive regulations and annex 9.
- Near heavy machinery: noise is regulated by article 42 of Law 4/1994, article 44 of the executive regulations and table 1, annex 7.
- Ventilation is regulated by article 45 of Law 4/1994 and article 47 of the executive regulations.
- Smoking is regulated by article 46 of Law 4/1994 and article 48 of the executive regulations, and Law 52/1981.
- Work environment conditions are addressed in Law 137/1981 for Labor, Minister of Housing Decree 380/1983, Minister of Industry Decree 380/1982

**Table (20) Egyptian Environmental Legal Requirements for Industrial Wastewater**

Parameter (mg/1 unless otherwise noted)	Law 4/94: Discharge 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)	Drains	
					Municipal	Industrial
BOD (5day,20 deg.)	60	<600	20	30		
COD	100	<1100	30	40	60	60
pH (Grease)	6-9	6-9.5	6-9	6-9	80	100
Oil & Grease	15	<100	5	5	6-9	6-9
Temperature (deg.)	10C>avg. temp of receiving body	<43	35	35	10	10
Total Suspended Solids	60	<800	30	30	35	35
Settable Solids	—	<10	—	20	50	50
Total Dissolved Solids	2000	—	800	1200	—	—
Chlorine	—	<10	1	1	—	—
PO <sub>4</sub>	5	30	1	1	—	10
Total phosphorus		25				
Fluoride	1	<1	0.5	0.5	—	0.5

Parameter (mg/1 unless otherwise noted)	Law 4/94: Discharge 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)	Drains	
					Municipal	Industrial
Cadmium	0.05	0.2	0.01	0.01	—	—
Chromium	1	0.5	—	—	Total concentration for theses metals should be: 1 for all flow streams	
Chromium Hexavalent	—		0.05	0.05		
Copper	1.5	1.5	—	1		
Iron	1.5		1	1		
Lead	0.5	1	0.05	0.05		
Mercury	0.005	0.2	0.001	0.001	—	—
Nickel	0.1	1	0.1	0.1	—	—
Silver	0.1	0.5	0.05	0.05	—	—
Zinc	5	<10	1	1	—	—
Cyanide	0.1	<0.1	—	—	—	0.1
Total heavy metals	—	Total metals should not exceed 5 mg/l	1	1	1	1



**Table (21) Permissible Limits as Time Average and for Short Periods**

Material	Threshold			
	Time average		Exposure limits for short periods	
	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>
Ammonia	25	18	35	27
Carbon dioxide	5000	9000	15000	27000
Carbon monoxide	50	55	400	440
Sulfur dioxide	2	5	5	10

## **4.5 Concerning Hazardous Materials and Wastes**

Law 4/1994 introduced the control of hazardous materials and wastes. The dairy industry does not generate any hazardous wastes. 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 makes 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 338/1995) specify the necessary precautions for handling hazardous materials. Storing of fuel for the boilers is covered by the Law 4 as hazardous material. There is no explicit articles in Law 4/1994 or in decree 338/1995 (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 the application for a license.

## **4.6 The Environmental Register**

Article 22 of Law 4/1994 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 as stated in part 4.5.

## 5. Methods and Techniques for Pollution Abatement

The pulp and paper industry has historically been considered a major consumer of natural resources, including water and energy, and a significant contributor of pollutant discharges to the environment. Measures for reducing the environmental impact of pulp and paper mills have been developed. For example, there is a development to close up water circuits in pulp and paper mills and a further reduction of discharges can be expected. Also, the sulfur air emissions has been reduced considerably by large progresses of process technology. A marked reduction of both chlorinated and non-chlorinated organic substances in the effluents of pulp mills has been achieved by in-process measures. The installation of external treatment plants has mostly decreased the organic load (COD, BOD). In addition to process changes, treatment plants decreased emissions of AOX and unchlorinated toxic organic compounds into receiving waters. The emissions and the common abatement measures for the main processes in the pulp and paper industry are herein summarized.

### 5.1 Emissions to Air

The main sources for air emissions to the atmosphere from pulp and paper mills include chip storage, cooking digester, pulp washing, bleaching plant, chemicals recovery, evaporation, bark furnace, recovery boiler, white liquor preparation, lime kiln, tanks and pulp drying (only for market pulp). Air emissions consist mainly of sulfur-containing compounds such as sulfur dioxide and malodorous reduced sulfur compounds. From furnaces nitrogen oxides are also emitted and furthermore small amounts of dust (solid particulates) as fly ash. From bleach plants and from bleaching chemical preparation, chlorine compounds may leak to the atmosphere. The fuels used in the boilers may include fuel oil, natural gas, fibrous sludge, and other fiber raw material residues from effluent treatment. The emissions from power production are dependent on the fuel, the fuel mixture and the impurities content.

- ***Control Techniques***

In kraft mills, concentrated gases come from digester, evaporation plant and condensate stripper. Concentrated gases are collected and burnt either in the limekiln, the recovery boiler or in a separate burner. If a dedicated burner is used, a scrubber is normally added to control emission of the SO<sub>2</sub> formed. Diluted gases come from screening, pulp washing, smelt dissolver and ventilation of various tanks that contain black liquor etc. Diluted gases at some mills are collected and burnt in the recovery boiler, in the limekiln, or scrubbed.

The recovery boiler is equipped with an electrostatic precipitator in order to remove the large amount of particulates (mainly Na<sub>2</sub> SO<sub>4</sub>) from the flue gases. The dust is fed back into the furnace by mixing into the strong black liquor. In order to decrease the SO<sub>2</sub> emissions from the recovery boiler, it is often equipped with a flue gas scrubber operating at pH 6-7. Reduced NO<sub>x</sub> can normally be achieved by modifications to the air feed system and optimizing

combustion conditions. In pulp production mills, fossil fuel is the main fuel in auxiliary boilers. If the fuel contains sulfur, sulfur emissions can be prevented by the addition of lime to the bed.

In sulfite mills, sulfur emission levels and the potential of further reductions are highly mill dependent. Cyclones, scrubbers, and recovery boilers can be found in sulfite pulp mills for collecting and purifying emissions to the atmosphere.

## 5.2 Wastewater Discharges

In kraft pulping, emissions to water are dominated by oxygen consuming organic substances, which are measured as COD and BOD. Effluent from bleach plant, where chlorine-containing bleaching chemicals are used, contains organically bound chlorine compounds, measured as AOX. In addition, the effluents may also include lower concentrations of metals extracted from the wood. The main sources of wastewater are:

- Wastewater from raw material handling
- Condensates from cooking and evaporation
- Spills from different process departments
- Black liquor residues (washing losses) from the handling of unbleached pulp
- Discharges from the bleach plant

Wastewater from a RCF paper mill is mainly generated during cleaning steps. It is common practice to withdraw wastewater at locations where the process water is mostly polluted. The process water is mainly contaminated during cleaning, deinking and fiber recovery. Therefore, wastewater from RCF based paper mills consists of water from reject separation by screens and centrifugal cleaners; filtrates from washers, thickeners and sludge handling; and excess white water depending on the rate of recycling.

### • *Control Techniques*

In general, any water passing through an industrial process is degraded by the addition of pollutants. Therefore, closing the water circuit and reducing the fresh water input, which reduces the water reaching the water treatment plant, can reduce polluting emissions. The principles for reducing the use of fresh water include reducing the gross requirements, avoiding inhibiting interactions to the closure of the water circuits, and recycling water specially unclarified whitewater, clarified whitewater generated usually in the save-all, and fresh water generated by purification of clarified water.

Discharges from a pulp and paper mill before treatment are mainly dependent on the employed processes and chemicals used. Typically, the treatment of wastewater includes primary treatment, sedimentation and secondary biological treatment. Aerated lagoon can be modified to incorporate sludge recycling. In that case, the treatment efficiency approaches that of an activated sludge plant.

- ***Primary treatment:***

The objective of this stage is the removal of particulate solids. Settlement and dissolved air flotation systems are used at most types of mills. Settlement systems can produce well-clarified waters, but can suffer from operating difficulties (floating solids and odor), particularly when treating stronger, warmer wastewater. High-rate settlement units are used for treating specific streams such as coating wastewater. Chemical pre-treatment (e.g. polyelectrolytes, inorganic coagulants and bentonite) is often practiced to enhance the removal of colloidal solids and/or to increase settlement velocities.

- ***Secondary treatment:***

The objective of this stage is the removal or reduction of BOD and COD, which can be achieved by genuine degradation or by adherence of the pollutants to the sludge. The latter mechanism will also remove non-biodegradable materials such as heavy metals. Dioxins, furans and DDT would be expected to bind to the biomass and fiber sludge almost totally. Hexachlorobutadiene, aldrin, dieldrin, hexachlorobenzene, endrin, PCBs, trichlorobenzene and heavy metals will also be partially removed by this mechanism. The basic alternatives are aerobic and anaerobic biological systems. There are many designs of each. In an aerobic plant, air, oxygen or a combination can be utilized. The use of oxygen improves performance and control and can be retrofitted to existing plants.

- ***Tertiary treatment:***

Tertiary treatment, as a control technique, can more be associated with emerging techniques than normal control regarding pulp and paper wastewater. Irrespective of the type of treatment provided, all operators should assess the possibility of recycling the treated wastewater in a partially or fully closed system taking the following factors into account:

- In large mills, treated wastewater is being recycled to the mill in a tertiary loop for use in specific areas or after blending with fresh water. This technique allows the use of fresh water to be reduced
- Membrane or possibly evaporative plant could avoid the need for conventional abatement plant, and by generating all the fresh water needs from the recycled water, an effluent-free system can be created with fresh water make-up required only to balance evaporative losses.

In order to optimize the treatment of wastewater plant, the following general principles should be applied in sequence to control emissions to water:

- Water use should be minimized and wastewater reused or recycled. Uncontaminated roof and surface water, which cannot be used, should be discharged separately.
- Techniques to minimize contamination risk of process or surface water should be implemented.
- Generally, effluent streams should be kept separate, as treatment will be more efficient.

- Systems should be engineered to avoid effluent by-passing the treatment plant.
- With regard to BOD, the nature of the receiving water should be taken into account.

### 5.3 Solid Waste

In pulp and paper industry, chemical processes generate various amounts of solid waste: inorganic sludge from the chemical recovery; residues from raw material handling; sludge from effluent treatment; dust from boilers and furnaces; ashes and miscellaneous material. In general, the waste streams may comprise:

- Sludge comprising mainly fibers, fillers and inks from any de-inking plant
- Raw material wastes e.g. rice straw.
- Reject pulp fibers from cleaning stages and miscellaneous trash
- Boiler plant ash.
- Containers of Chemicals and general industrial waste.

- ***Control of Solid waste***

Many organic substances, which might be considered waste products, are burnt for energy recovery. The sludge is usually thickened before being de-watered in a filter press, screw press or on a vacuum filter. Disposal of sludge depends on the amount, moisture content and other characteristics. The general techniques for improved solid waste management systems include the following:

- A system should be maintained to record the quantity, nature, origin and where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste which is disposed of or recovered.
- Wherever practicable, waste should be segregated and the disposal route identified which should be as close to the point of production as possible.
- Records should be maintained of any waste sent off-site.

### 5.4 Pollution Prevention & Cleaner Production

The concept of pollution prevention is widely accepted in the industry due to its economic and environmental benefits. For example, most conventional, end-of-pipe treatment technologies are not effective in destroying many chlorinated compounds and often merely transfer the pollutants to another environmental medium. Efforts to prevent chlorinated releases have, therefore, focused on source reduction and material substitution techniques such as defoamers, bleaching chemical or wood chip substitution to reduce the industry's use and releases of chlorinated compounds. Such source reduction efforts and material substitutions usually require substantial changes in the production process. In addition, the industry is implementing a number of pollution prevention techniques to reduce water use and pollutant releases

such as: improved spill control, bleach filtrate recycle, closed screen rooms, and improved storm water management.

The chemical recovery systems used in chemical pulping processes are an example of pollution prevention technologies that have evolved alongside process technologies. Many recent pollution prevention efforts in the pulp and paper industry have focused on reducing the releases of toxics, in particular, chlorinated compounds. Pollution prevention techniques have proven to be more effective in controlling these pollutants than conventional control and treatment technologies. Because the pulp and paper industry is highly capital intensive and uses long-established technologies with long equipment lifetimes, major process-changing pollution prevention opportunities are expensive and require long time periods to implement. On the other hand, the pulp and paper industry is a dynamic one that constantly makes material substitutions and process changes to increase productivity and cut costs. The relevant pollution prevention and cleaner production techniques for the main processes in the pulp and paper industry are herein summarized. Regarding the local conditions, the focus will be on applicable techniques for non-wood raw fiber material handling. Also, the most common practices being used in kraft, recovered paper and paper manufacturing processes are described. In addition, a number of recommendations for pollution prevention that are relevant to the Egyptian industry are presented.

#### **5.4.1 Handling of Fiber Raw Materials**

Non-wood fibre comes predominantly from agricultural residues and is thus a by-product of crops planted, harvested and used for other purposes than papermaking. The main environmental impacts from using these residues as a raw material relate to the use of land, water, fertilisers and pesticides during cultivation and so, precautions that can be taken to minimise impacts during harvesting and handling should carefully be considered.

Generally, an integrated sugar-pulp-paper mill could be highly advantageous. Such a plant would minimise transportation, maximise the use of the energy generated from the residuals or spent pulping liquors and use common resources for maintenance, management etc.

##### ***a) Straws***

- The objective is to minimise environmental impacts mainly related to minimising the silica content of the raw material:
- Keep the material clean and avoid contamination from soil and stones in the field
- Cover and pack the material in bales to protect from dust and for ease transportation.
- Straw should be stored in 8-15% moisture to avoid self-combustion.
- Wet de-dusting is recommended before cutting to remove sand and other impurities. The effluent from de-dusting should pass into the sedimentation basin of the mill.

**b) Bagasse**

When handling bagasse, focus should be placed on removal of the pith, the thin walled non-fibrous parenchyma cells that contain the sugar juice. Pith contamination leads to higher chemical consumption during pulping and to disturbances during washing and papermaking. These process problems also have negative environmental impact i.e. higher discharges and/or energy use. Also, the pith constitutes a valuable fuel that should be used, primarily in the sugar mill. Guidelines for the clean processing of bagasse deal mostly with pith handling.

- Dry the pith before burning to increase the thermal efficiency of the boiler.
- Efficient removal of tops and leaves also helps to minimise the input of silica.
- Baling is recommended to facilitate handling and for storage bales should be stacked in layers with suitable intervals to aid drying.
- In wet piling, leachate from the pile must pass primary and secondary treatment before discharge.

#### **5.4.2 Handling of Spent Liquors**

The properties of non-wood black liquors differ in many respects from those of wood-based black liquors and place special demands on the design of evaporation and combustion equipment. If compared to wood-based liquors, non-wood liquors are characterised by:

- High viscosity at given solids content and temperature
- High silica content
- Low heat value per kg of dry solids for straw liquors
- Low “swelling index” resulting in harder-to-burn liquor particles in the recovery furnace
- High content of organic fines

For evaporation of non-wood liquors, short tube vertical evaporators (STV) are considered to be more efficient than long tube vertical evaporators (LTV) which used to be standard for wood black liquors. Control of pH at around 11 helps avoid hydrolysis of dissolved silicate into silicic acid (silica) as well as lignin precipitation, keeping heat transfer surfaces clean. The total evaporation load is usually high, as the initial concentration of non-wood weak black liquor is low, typically 8-10 % dry solids. Thus, a primary requirement would be to accomplish a higher initial concentration by efficient brown stock washing.

A common problem in all non-wood pulping processes is the relatively high levels of silica resulting from the raw materials e.g. straw, bagasse, etc. Typical concentrations of silica in black liquor solids are presented in table (22); which shows that its percentage is much higher when rice straw is used:

**Table (22) Silica Concentrations in Suspended Solids for Black Liquor**

Raw material	Silica % (Range)
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Rice Straw	3-16
Bagasse	1-3

High silica levels cause fouling/deposits on heat transfer surfaces and difficulties in pumping and concentration of black liquor due to increased viscosity. High concentration of silica also increases the smelt melting temperature. Silica in green liquor is to large extent transferred to the lime during causticsication and will accumulate in the lime cycle. At moderate silica levels a two-stage causticising process has been suggested, assuming that a large proportion of silica precipitates in the initial causticising stage from which then lime mud is removed, while the second stage lime mud is re-burned.

Controlled precipitation and silica removal can be achieved by lowering the pH of the black liquor e.g. by carbonation with the flue-gas. The silica enriched sludge product removed may be used for other industrial processes (cement, porcelain). After the de-silication of black liquor it is necessary to restore the residual alkali by increasing the pH of the liquor again.

Besides chemicals and energy recovery there are alternative uses for black liquor, not least in the case of small, non-wood pulp mills:

- Unconventional energy production
- Utilisation of separated black liquor lignin
- Utilisation of lignin compounds
- Utilisation of other black liquor compounds

In cases where no recovery process is technically or economically feasible, external methods of effluent treatment or disposal must be applied.

### 5.4.3 Kraft Puling

The following are the recommended techniques for pollution prevention and cleaner production in the kraft chemical pulping processes. These recommendations can be grouped in three categories: general recommendations, process specific opportunities and pollution control practices.

#### a) *General Recommendations:*

- Collection of almost all spillage
- Stripping and re-use of condensates
- Buffer tanks for concentrated liquids

#### b) *Process Specific Opportunities*

- Washing and Screening:
  - Closed screening
  - Efficient washing and process control
- De-lignification:
  - Oxygen de-lignification
- Bleaching:
  - Ozone bleaching
  - ECF bleaching technique



- TCF bleaching technique
- Partly closure of the bleach plant + increased evaporation
- Recovery System:
  - Installation of scrubbers on the recovery boiler
  - Incineration of odorous gases in the recovery boiler
  - Incineration of odorous gases in the lime kiln
- Pollution Control Practices
  - Biological treatment
  - Tertiary treatment (precipitation)

#### **5.4.4 Recovered Fiber**

The following are the recommended techniques for pollution prevention and cleaner production in recovered paper processing. These recommendations can be grouped in two categories: general recommendations and pollution control practices. Other process specific options will be explained in section “5.6 *P2 opportunities in Egypt*”, which mainly focuses on improving the current processes to meet the recommended industry practices.

##### **a) General Recommendations:**

- Separation of less contaminated water from contaminated one and recycling
- Optimal water management (water loop arrangement) and water clarification
- Reduction of fresh water consumption by strict separation of water
- Co-generation of heat and power
- Reject and sludge handling and processing on-site
- Environmentally sound residue utilization and disposal

##### **b) Pollution Control Practices**

- Closed water loop with in-line biological process water treatment
- Aerobic biological wastewater treatment
- Anaerobic techniques as first stage of biological wastewater treatment
- Generation of clarified water for de-inking plants

#### **5.4.5 Paper Making**

The following are the recommended techniques for pollution prevention and cleaner production in paper making processes. These recommendations can be grouped in two categories: general recommendations and pollution control practices.

##### **a) General Recommendations:**

- Upgrading of stock preparation plants with decreased energy consumption and emissions.
- Water management and minimizing water usage for different paper grades
- Recovery and recycling of coating-color containing water
- Separate pre-treatment of coating wastewater

- Measure to reduce frequency and effects of accidental discharges
- Automation of process control
- Substitution of potentially harmful substances
- Optimization of de-watering in the press section of the paper machine
- Energy savings through energy efficient technologies
- Use of combined heat and power generation

**b) *Pollution Control Practices***

- Control of potential disadvantage of closing up the water
- In-line treatment of white water by use of membrane filtration
- Installation of low NO<sub>x</sub> technology in auxiliary boilers
- Wastewater treatment, including:
  - Equalization basin and primary wastewater treatment
  - Aerobic biological treatment
  - Chemical precipitation
  - Pre-treatment of sludge

## **5.5 Description of Cleaner Production Techniques**

The main options for cleaner production and/or pollution prevention in kraft pulping processes are herein explained. These options are classified according to the relevant process as previously explained in Chapter 2.

### **5.5.1 Raw Materials & Chemicals**

***Chlorine Dioxide Substitution.*** The substitution of chlorine dioxide for elemental chlorine as a bleaching agent is gaining widespread use due to its beneficial impacts on pulp and effluent quality. The use of chlorine dioxide in place of chlorine increases the proportion of oxidative reactions thereby reducing the formation of residual chlorinated organic pollutants. The use of chlorine dioxide, however, is two to four times more expensive than the equivalent oxidizing power using elemental chlorine.

### **5.5.2 Washing and Screening**

***Improved Brown-stock and Bleaching Stage Washing.*** Improved washing can reduce the required amount of bleaching chemicals and the subsequent reductions in chlorinated compounds as well as conventional pollutants. State-of-the-art washing systems include atmospheric or pressure diffusion washers, belt washers, and pulp presses. Effluent flows and water use in the bleaching plant can be reduced by counter current systems. Acid filtrates from hypochlorite or chlorine dioxide stages can be used as dilution and wash water for the first bleaching stage. Similarly, second extraction stage filtrates can be used as dilution and wash water in the first extraction stage.

### **5.5.3 Delignification**

**a) *Extended Delignification.***

Extended delignification further reduces the lignin content of the pulp before it moves to the bleach plant. Because the amount of bleaching

chemicals required to achieve certain paper brightness is proportional to the amount of lignin remaining in the pulp after the pulping process, extended delignification can reduce the amounts of bleaching chemicals needed. The developed processes involve: increasing the cooking time; adding the cooking chemicals at several points throughout the cooking process; regulating the cooking temperatures; and carefully controlling the concentration of hydrogen sulfide ions and dissolved lignin. Applying this approach would result in marked reduction of lignin content of the brownstock pulp, chlorinated compounds generated during bleaching and wastewater pollutants e.g. BOD<sub>5</sub>, COD and color.

**b) *Oxygen Delignification.***

Oxygen delignification also reduces the lignin content in the pulp. The process involves the addition of an oxygen reactor between the kraft pulping stages and the bleach plant. The brownstock pulp from the digester is first washed and then mixed with sodium hydroxide or oxidized cooking liquor. The pulp is fluffed, deposited in the oxygen reactor, steam heated, and injected with gaseous oxygen wherein it undergoes oxidative delignification. The pulp is then washed again to remove the dissolved lignin before moving to the bleaching plant. Oxygen delignification can reduce the lignin content in the pulp by as much as 50 percent resulting in a potentially similar reduction in the use of chlorinated bleaching chemicals and chlorinated compound pollutants. In addition, the effluent from the oxygen reactor can be recycled through the pulp mill recovery cycle, further reducing the non-pulp solids going to the bleaching plant and the effluent load from the bleach plant. The net effect is reduced effluent flows and less sludge generation.

**c) *Ozone Delignification.***

Ozone delignification (ozone bleaching) is now being used in the pulp and paper industry. The technology has the potential to eliminate the need for chlorine in the bleaching process. Ozone delignification is performed using processes and equipment similar to that of oxygen delignification. Oxygen delignification and/or extended delignification processes are considered a prerequisite for successful ozone bleaching. When used in combination, the two processes can result in a high quality bright pulp that requires little or no chlorine or chlorine dioxide bleaching. Overall emissions from the combination of the oxygen and ozone processes are substantially lower than conventional processes because effluents from each stage can be recycled.

#### **5.5.4 Bleaching (Optional)**

**a) *Oxygen-Reinforced/Peroxide Extraction.***

Oxygen-reinforced extraction (oxidative extraction) and peroxide-reinforced extraction processes used separately or together have been shown to reduce the amount of elemental chlorine and chlorine dioxide

needed in the bleaching process while increasing the pulp brightness. Gaseous elemental oxygen (in the case of oxygen-reinforced extraction) and aqueous hydrogen peroxide (in the case of peroxide extraction) are used as a part of the first alkaline extraction stage to facilitate the solubilization and removal of chlorinated and oxidized lignin molecules.

**b) *Improved Chemical Controls and Mixing.***

Avoiding excess concentrations of chlorine-based bleaching chemicals within reactor vessels can minimize the formation of chlorinated organics. This can be accomplished by carefully controlling the chemical application rates and by ensuring proper mixing of chemicals within the reactor. Modern chemical application control and monitoring systems and high-shear mixers have been developed which decrease formation of chlorinated organic compounds.

**5.5.5 General Recommendation**

***Black Liquor Spill Control and Prevention.*** Spills of black liquor can result from overflows, leaks from process equipment, or from deliberate dumping by operators to avoid a more serious accident. Spills of black liquor can have impacts on receiving waters, are a source of air emissions, and can shock the microbial action of wastewater treatment systems. Black liquor losses also result in the loss of the chemical and heat value of the material. The elements of an effective spill control system include: physical isolation of pieces of equipment; floor drainage systems that allow spills to be collected; backup black liquor storage capacity; sensors that provide immediate warning of potential or actual spills; and enclosed washing and screening equipment.

**5.6 Pollution Prevention Options in Egypt**

Environmental audits for the existing mills in Egypt have shown a very high potential for improved environmental performance, reduced consumption of water, chemicals and energy, and a better quality of the final product. Preliminary cost analysis for some cases indicated that a considerable number of the opportunities have a relatively short payback period. Waste minimization and improved process control could obtain most of the technical and financial benefits. Also, effective wastewater treatment facilities would markedly reduce water consumption and increase the yield. Examples of the recommended pollution prevention and cleaner production options are herein presented. These options are classified according to the relevant process as previously explained in Chapter 2.

**5.6.1 Pulping**

**a) *Increase the consistency in the pulper.***

The tendency in paper recycling industry is to increase the consistency in the pulper to increase the throughput productivity. The pulping in such facilities is conducted at a consistency range of 4% - 6%. However, advances in this field increased consistency to a value in the order of 16%. The existing consistency is very low (2.5%).

Therefore, a resultant increase in throughout productivity can be achieved and the efficiency of the pulping process will be improved.

**b) *Add Caustic Soda (NaOH) to pulper.***

Most of the recycled waste paper being used in the pulping process is contaminated. Addition of caustic soda in pulping process is known to improve separation and removal of contaminants. Therefore, addition of caustic soda will markedly improve the quality of the final product. Determination of the proper amount and concentration of caustic soda are subject to experimental investigation.

**c) *Add dispersant in the pulping process.***

In the existing process, the paper being contaminated with ink is not separated for special treatment (de-inking). The use of a proper dispersant will break down inks and colors for easy removal of such contaminants in the water clarification process. The use of the dispersant at the proper amount will improve the quality of the final product and enables efficient reuse of the clarified water.

**d) *Install a steam sparger to increase the pulping temperature.***

The pulping process is performed at the ambient temperature, about 23 °C. The practice in paper recycling industry shows that the higher pulping temperature the better and faster pulping and easy removal of contaminants. Practically, the pulping temperature can be increased up to 70 °C, by installing a steam sparger. The proper operating temperature can be experimentally determined through simulated lab tests.

## **5.6.2 Screening and Cleaning**

**a) *Re-pipe screens to be ahead of cleaners.***

Screens are used to remove contaminants by size, according to the size of holes in the mesh whereas, cleaners remove contaminants according to their density. Cleaners are usually operated at comparatively lower consistency levels, i.e. higher load volumes. In the existing system, the screening process is performed after the cleaning process, for the diluted liquor. This overloads the screens and adversely affects screening efficiency. Re-piping of the screens to be ahead of the cleaners will reduce its volume load and improve screening efficiency. In practice, liquor is cleaned by removing contaminants of big sizes using screens and then, removing contaminants by density.

**b) *Change to a 3-stage cascade cleaning system.***

The cleaning process is performed by a single stage system. It is recommended to modify the existing system to a 3-stage cascade system, with second stage accepts to broke chest and third stage rejects to sewer. The new system has a higher efficiency in recovering

the fibers from the rejects and saves 90% of the losses in the cleaning process.

### 5.6.3 Thickening

***Improve water removal in the decker thickeners.*** Decker thickeners are being used in the factory in order to increase consistency by removing water. Samples of the liquor before and after thickeners indicated low and unstable operating efficiency. This is because of the plugging of the screens due to scale precipitation. The following process changes were recommend in order to improve the efficiency of water removal for better utilization of this water. In addition, the resulting improvement in water dilution will improve the product quality and increase throughput productivity.

- Install a vacuum leg to increase rate of water removal.
- Re-pipe the delivery of decker thickener to before pressure screens and cleaners.
- Collect water from decker to saveall.

### 5.6.4 Paper Drying

***Dry to the maximum specified moisture content.*** The moisture content in the final product was specified to be 8 - 9%. The assessment indicated that the final product is over dried and the lab showed that the moisture content is 6.5%. It is known that the yield proportionally decreases with the decrease of moisture content, in addition to the increase in energy consumption. Controlling the drying process to the higher specified limit of moisture content will also help in avoiding over-drying due to the expected temperature rise in the system because of the continuous operation.

### 5.6.5 General Recommendations

#### ***a) Eliminate contamination for counter-current flow.***

The counter-current flow of water is one of the main waste minimization techniques being used in paper recycling industry. In other words, water is flowing in such a way that the dirtiest water is used at the early stages of the production while the cleanest water is used in the final stages of the production. In practice, two loops are considered. The hot loop including decker thickener, clarifier and pulper, as well as the machine loop which involves showers and fresh water into felt showers and white water for illusion of cleaners. Applying this concept will markedly reduce water consumption, fiber losses and chemicals consumed.

#### ***b) Use proper chemicals for efficient use of water.***

Chemicals are being used in paper recycling plants for improved equipment operation, better product quality, and reduced water consumption. Proper selection of chemicals would help in achieving these objectives. The following are the recommended chemicals.

- Treat shower water by adding inhibiting and cleaning chemicals. This would improve operations of felts and increases the

throughput productivity, by shortening formation time, for prolonged service times.

- Use proper sequestriant in the fresh water tank. This would improve the operation of equipment by preventing scale formation that plugs screens.
- Use proper chemicals (polymers) in the saveall air floatation system. This would improve removal of inks and other contaminants. Consequently, the product quality will improve and the recycled water will increase.

**c) *Optimize operating parameters of the key processes.***

The quality of the final products, as well as the overall productivity of a recovered paper recycling plant is much dependent on the operating parameters of some key processes and/or equipment. The following are the identified areas to be considered by the plant management.

- Improve the cleaning efficiency by optimizing delivery pressure, number, size, and configuration of shower nozzles.
- The discharge of sealing water with respect to the condition of the sealing, replace if necessary.
- The feed and reject rates of the cleaners for optimum cleaning and minimum fiber losses.
- The size of the slots in the screens.
- The rejection timing (frequency and duration) of the high-density cleaners.
- Optimum pulp refining as related to the specified strength of the final product.
- The negative pressure (vacuum) in the forming and drying processes.

## 6. Industrial Inspection

The inspection of the pulp and paper industry will follow the procedures described in the General Inspection Manual GIM (EPAP 2002). This chapter presents a summary of the inspection process regarding the purpose and scope of various types of inspection, and the proposed inspection procedure for the Pulp and Paper Industry.

The overall purpose of inspections is to enforce environmental laws. Table (23) lists the various types of inspections and the objectives that have to be fulfilled for each type.

**Table (23) The Different Types of Inspections and their Objectives**

Inspection type	Objectives
<b><i>Site Inspection</i></b>	
1. Comprehensive	Evaluate compliance status regarding all aspects of Law 4
2. Specific	Evaluate compliance status regarding some aspects of Law 4 (usually complaint driven) Review special conditions set by EEAA in EIA studies. Investigate complaints
3. Follow-up	Check environmental register and implementation of compliance measures
<b><i>Inspection campaign</i></b>	
1. Geographic	Check pollution sources to specific receiving media Check pollution sources from facilities in a specific area
2. Sector specific	Check aspects relevant to specific sector

As evident from the above table, comprehensive inspection deals with all aspects of environmental laws and therefore is considered in this manual. Other inspection types can be tailored accordingly.

Developing an inspection strategy and quarterly and/or monthly plans are the responsibility of the inspectorate management. Developing site-specific inspection plans for carrying out the scope of work that fulfills inspection objectives is the responsibility of the inspection team. Planning for inspections is presented in more detail in the General Inspection Manual GIM (EPAP 2002).



## **7. Inspection Planning (Inspectorate)**

The responsibilities of the inspectorate management regarding the specific inspection are to state clearly, in writing, the type of inspection and related objectives as well as the time schedule necessary to carry out inspection. The inspectorate management is also responsible for providing preliminary information about the facility, inspection tools, and logistics.

### **7.1 Size of Pulp and Paper Mills**

Taking the comprehensive inspection as an example, the objectives stated in Table (23) dictate the activities required for covering all aspects of compliance with environmental laws and regulations. The required personnel, equipment and logistics are determined accordingly.

As evident from Chapter 2, the pulp and paper mills can be integrated or non-integrated. The smallest mill may comprise a single production line for pulp and/or paper, while large mills may include a number of production lines for one or more final product. In all cases, mills would need pollution abatement measures to comply with the regulations. The size, main processes (chemical pulping/recovered paper recycling) and the production mix (e.g. printing paper, newspaper or board) need to be considered when planning for the inspection.

### **7.2 Facility Information**

Chapters (2-5) present the technical aspects regarding the pulp and paper industry, its pollution sources and relevant environmental laws. Information regarding compliance history related to other inspecting parties (irrigation inspectors, occupational health inspectors, etc.) can be helpful in anticipating potential violations and preparing necessary equipment. Compliance action plans, Environmental Impact Assessment (EIA) studies and IPIS data bases are also important sources of information.

Other sources of information can be found on the Internet at the following sites:

- <http://es.epa.gov/oeca/sector/sectornote/pdf/pulppasn.pdf>
- [http://www.worldbank.org/nipr/work\\_paper/1447/index.htm](http://www.worldbank.org/nipr/work_paper/1447/index.htm)
- [http://webdirectory.com/Recycling/Recycle\\_Paper\\_Products](http://webdirectory.com/Recycling/Recycle_Paper_Products)
- [http://www.emcentre.com/unepweb/publication/pulp\\_paper.html](http://www.emcentre.com/unepweb/publication/pulp_paper.html)

### **7.3 Providing Resources**

The required personnel, tools and equipment depend on the size of the facility to be inspected. The inspection team leaders, in coordination with the inspectorate management, are responsible for assessing the inspection needs. The number of inspectors required depends on the size of the facility and the planned activities. Usually the team members are split and assigned different tasks during the field visit to allow the required activities to be performed in

parallel. Each task is rotated among the inspectors to diversify their experience.

***Recovered Paper Mills***

Small pulp and paper facilities will probably produce paper, paperboard and other relevant products. Such facilities may include one or more production lines. The major pollution problem would be the discharge of untreated wastewater and air pollution. Unless an inspection campaign is planned, one or two inspectors is required for measuring or estimating wastewater discharges, identifying the receiving body, sampling, reviewing the licenses, establishing the violation if any, and preparing the legal report.

***Kraft Pulp Mills***

There is a limited number of mills that produces bleached and/or unbleached pulp. In addition to the produced solid waste and air emissions, these facilities are characterized by its chemical processes that produce black liquor. Such mills may include chemical and energy recovery systems. An inspection team comprising the relevant expertise is needed.

***Integrated Pulp and Paper Mills***

Large facilities will typically have many production lines with large production capacity. Planning for the comprehensive multi-media inspection will require several inspectors, sampling equipment to provide proper samples for analysis as well as measuring devices.

## 8. Preparation for Field Inspection

As presented in the General Inspection manual GIM (EPAP-2002), tasks necessary for preparation for field inspection, are:

- Gathering information about the specific facility to be inspected
- Preparing of the inspection plan
- Preparing the checklists and other inspection tools.

This manual presents the case of a comprehensive multi-media site-inspection for pulp and paper mills applying any of the common processes i.e. chemical “kraft” pulping and/or wastepaper recovery.

### 8.1 Information Gathering and Reviewing

The inspection team should review the general information prepared for the pulp and paper industry, Chapters (2-5) and then check - if possible - what production lines and service units are present at the targeted facility. In addition to the required information listed in Annex (C) of the General Inspection manual GIM (EPAP-2002), it is important at this stage to determine the following:

- The type of receiving body for the industrial wastewater and review relevant Egyptian laws (Chapter 4).
- The scope of inspection and related activities based on the type and objectives of inspection required by the inspectorate management.
- The potential pollution hazards as addressed in section 2.4, and accordingly, define measurement and analyses needs.
- The characteristics of the pulp and paper industry as presented in section 2.5, and their implications on the inspection process of the targeted facility.

*Note to inspector:*

- *Some facilities dilute wastewater before discharging to sewer. There is no explicit environmental law that prohibits this behavior.*

### 8.2 Preparation of the Inspection Plan

An example of an inspection plan is included in Annex (E) of the General Inspection manual GIM (EPAP-2002). The plan should take into account the following:

- For large Pulp and Paper mills, the inspection team could be divided into smaller groups. Each group will be responsible for inspecting a number of production lines and service units.
- At the beginning of the field visit, the inspection team should check the environmental register for completeness using the checklist provided in Annex (G) of the General Inspection manual GIM (EPAP-2002).
- At the end of the field visit, the information included in the environmental register should be checked based on the field visit observations. If not confident with measurements and analyses results, the inspector should make his own.

*Notes to inspector:*

- *When the final effluent is expected to be in violation of environmental laws, sampling should be planned.*
- *Because of possible shock loads a grab sample at the time of discharge should be performed. If grab samples are taken when no shock load is discharged the results will not reflect the actual pollutants loads.*
- *To prove that a shock load has been discharged, a composite sample over the shift duration should be analyzed. If the results show higher pollutant concentrations than those of the grab sample, then a shock load was discharged.*
- *Make sure that the polluting production lines are in operation since some factory management resort to halting the polluting lines during the inspection.*

### **8.3 Preparation of the Required Checklists**

The inspection checklist for the Pulp and Paper industry is presented in Annex (1) of this manual. The checklist has been prepared in such a way that it starts with general information about the facility and its operation. Separate checklists are then filled for each production line/service unit independently for relevant environmental aspects and media. The inspection team will compile the checklists relevant to the targeted facility.

The development of the inspection checklists goes through the following steps:

- Draw the block flow diagrams for the production lines with their pollution sources as explained in Chapter (4).
- Identify the areas of possible non-compliance and the parameters that need checking. For example, noise should be checked where the employees are located, near the
- paper machine and temperature and humidity where steam leaks occur.
- Identify what to observe, check the raw materials and chemicals used, process water circulation and leaks. This information might indicate the type of pollutants and estimates for expected concentrations.

*Note to inspector:*

*Law 4 does not specify standards for effluent from production lines but only for final disposal points. However, effluent quality from production lines is an important indicator of the final discharge.*

### **8.4 Legal Aspects**

As evident from chapter (2), a large Pulp and Paper mill is expected to produce large amounts of pollution loads that are regulated by several environmental laws, specifically with respect to wastewater if no treatment is performed. The inspection team should be prepared for legally establishing violations for such effluents.

*Note to inspector:*

*The information about the nature and cause of the violation must be well documented and the evidence sound. The case could be contested in court and the inspector will be asked to defend his technical judgment.*

## **9. Performing Field Inspection**

### **9.1 Starting the Field Visit**

The General Inspection Manual, GIM (EPAP-2002), describes the procedures involved for entering an industrial facility. The inspector's attitude and behavior are very important from the start and will dictate the factory's personnel response to the inspection tasks.

*Note to inspector:*

- *It is better at this stage not to ask direct questions about the expected violations. Interviewing the workers on-site in an indirect manner can give better results.*
- *Check the results of effluent analyses, time and place of sampling. If suspicious make your own analyses.*
- *The types of chemicals used for pulp and paper processes are important information for determining the type of pollutant in the effluent. In this case a direct question is preferred.*
- *Get a sketch of the factory layout with sewer lines and final disposal points.*

### **9.2 Proceeding With the Field Visit**

Information gathered during the facility tour is dependent on interviews of facility personnel and visual observation. Annex (H) of the General Inspection Manual, GIM (EPAP-2002) presents some useful interviewing techniques.

At the beginning, the inspector should focus on collecting some basic information about the processes, emissions and the available control equipment. Such information may include the following:

- *In the Process*
  - Generation of pollutants (effluent, air emission, solid and hazardous waste, noise) in different parts of the process
  - Type and nature of the pollutants
  - Destiny of the pollutants (what happens to them after the point of generation)
- *Pollution Abatement and Control*
  - Effluent fractions to be treated and the treatment method (mechanical, chemical, biological, other).
  - Methods for preventing accidental emissions and possible actions in the case of an accident.
  - Type and efficiency of control method (cyclone, electrical precipitator, bag filter, washer etc.) for different air emission

components. Is there any method for reducing diffuse emissions?

- Waste management for different types of waste fractions, utilization and re-use, land filling, methods for fibre recovery etc.
  - Methods for noise control if any.
- *Self Monitoring Activities*
    - Methods for waste water analysis, air emission measurement, waste measurement etc.
    - Measures for quality control and quality assurance for the self-monitoring data.

Using the facility layout, start by checking the final disposal points and the various plants and/or service units connected to each point. This will determine where and how to take the effluent samples. Visual observations about the condition of the sewer manholes should be recorded. In some facilities the discharge to the receiving body is performed through a bayyara (cesspit), septic tanks or holding tanks.

*Note to inspectors:*

*Cesspits, septic tanks and holding tanks are a form of pre-treatment that generates settled sludge. Check:*

- *The presence of accumulated sludge and related hygienic conditions*
- *The disposal of the sludge*

Inspection of the production lines should start with the feeding of raw materials and end with the product packaging and storage. The following information is important to identify the size of the mill, as well as the main activities involved:

### **Production Lines**

#### ***Chemical “Kraft” Pulping***

- Determine the daily consumption of fiber raw material.
- What happens to rejects of the fiber raw material?
- What happens to the black liquor?
- Is there any leak of the cooking and washing fluids?
- Is there any steam leak from evaporators?
- What happens for washing effluent after delignification?
- What happens for the rejects of the screening process?
- What happens for the effluents from the bleaching process?
- What happens for the effluents from the drying process?
- What happens for the green liquor from the recovery boiler?

***Wastepaper Processing***

- Determine the daily amounts of waste paper consumption and final product (s).
- What happens to the rejects of the wastepaper preparation?
- What happens to the rejects of the screening and cleaning processes?
- What happens to the de-inking sludge?
- What happens to the effluents from the de-watering stages?

***Paper/Paperboard Production***

- Determine the amount of broke and the finished product(s).
- What happens for the effluent from the de-watering process?
- What happens for the white water?
- What happens for the effluent from the “save-all” process?
- Is there any steam leak from drying section?
- Determine the amounts of sizing, coating and dyeing materials.

***For all lines***

- Check for steam leaks, which affect humidity and temperature in the work environment.
- Check the insulation of steam pipes.
- Check for losses and spill prevention measures.
- Check for noise near machines.
- How is solid waste managed?
- Is the sewer system in the plants made of open gutters covered with a grill or closed pipes with drains? Open gutters contribute to the foul smell in the plant.

**Service Units**

***Water treatment units***

- If chemicals and coagulants are used, such as lime, alum and ferric sulfate, inorganic sludge will be generated. Check the amount and method of disposal.
- In case of ion-exchange units and reverse osmosis the effluent wastewater will be high in dissolved solids.

***Boilers***

- Check the height of the chimney in relation to surrounding buildings.
- Perform flue gas analysis if mazot is used as fuel or if suspicious about results of analysis presented by facility management in the opening meeting.
- Check for fuel storage regulations and spill prevention.

***Garage, and Workshops***

- Check for noise and take measurements if necessary.
- Check solid waste handling and disposal practices.
- Check for spent lube oil disposal method. Ask for receipt if resold.

- Storage facilities**
- Check storage of hazardous materials and fuel as per Law 4.
  - Check spill prevention and containment measures for storage of liquids.

- WWTP**
- Inputs: incoming load (COD, BOD, TSS, N, P, AOX), used chemicals (nutrients, pH-control, defoamers), WW flow
  - Outputs: concentrations for pollutants, WW flow
  - Reduction rates for organic load and suspended solids
  - Visual checking of the equipment (condition, operation)
  - Operation of fiber recovery, if arranged from the primary clarifier in the case of paper mill.
  - Sludge formation and method for handling and disposal.

### **Effluent analysis**

- Receiving body**
- The nature of the receiving body determines the applicable laws.
  - Check if effluent discharge is to public sewer, canals and Nile branches, agricultural drains, sea or main River Nile.
  - Accordingly, define applicable laws, relevant parameters and their limits.

- Sampling**
- A composite sample must be taken from each final disposal point over the duration of the shift. Each sample will be analyzed independently.
  - According to legal procedures in Egypt, the effluent sample is spilt and one of them is sealed and kept untouched.

## **9.3 Ending the Field Visit**

When violations are detected a legal report is prepared stating information pertaining to sampling location and time. Violations of work environment regulations should also state location and time of measurements. Other visual violations such as solid waste accumulation, hazardous material and waste handling and storage, and material spills should be photographed and documented. It is preferable that facility management signs the field-inspection report but this is not a necessary procedure. A closing meeting with the facility management can be held to discuss findings and observations.

### *Note to inspector:*

- *The less certain the team leader is about a specific violation the more reason not to discuss it at the closing meeting.*



## 10. Conclusions of Field Inspection

The activities performed during the site inspection are essential for preparation of the inspection report, for assessing the seriousness of the violations, for pursuing a criminal or civil suit against the facility, for presenting the legal case and making it stand in court without being contested, and for further follow-up of the compliance status of the facility.

### 10.1 Preparing the Inspection Report

An example of an inspection report is included in Annex (K) of the General Inspection Manual (EPAP, 2002). The inspection report presents the findings, conclusions, recommendations and supporting information in an organized manner. It provides the inspectorate management with the basis for proposing enforcement measures and follow-up activities.

### 10.2 Supporting the Enforcement Case

Many issues may be raised and disputed in typical enforcement actions. Enforcement officials should always be prepared to:

- Prove that a violation has occurred. The inspector must provide information that can be used as evidence in a court of law.
- Establish that the procedures were fairly followed.
- Demonstrate the environmental and health effect of the violating parameter.

*Note to inspectorate management:*

- *Although the inspector is not required to suggest pollution abatement measures, the inspectorate management should be able to demonstrate that a remedy for the violation is available.*

### 10.3 Following-Up on Compliance Status for Violating Facility

After performing the comprehensive inspection and detecting the violations the inspectorate management should:

- Decide on the sanctions and send the legal report to the judicial authority.
- Plan routine follow-up inspections. This type of inspection focuses on the violating source and its related pollution abatement measure. Self-monitoring results are reviewed during the visit.
- Follow-up the enforcement case (legal department)

## **Annex**

### **Inspection Checklist for a Pulp and Paper Production Facility**

**Ministry of State for Environmental Affairs  
Egyptian Environmental Affairs Agency  
Basic Data Sheet**



Date of visit:..... Visit number:.....  
Facility name:.....  
Commercial name:.....  
Licensed Activity:..... Days off:.....  
Legal status:.....

**Address of facility**

Area of facility:..... Governorate:.....  
City:..... Zone:.....  
Phone no. :..... Fax no.:.....  
.....  
Year of operation :..... Postal code:.....  
The Facility Representative:.....  
Environmental management representative:.....  
Chairman/Owner:.....

**Address of Administration**

e-mail:.....  
Phone no. :..... Fax no.:.....  
.....  
The industrial sector:.....  
No. of male employees: ..... No. of female employees:.....  
Do they work in production .....  
Total no. of employees: .....  
Number of shifts/day:.....shifts/day  
Duration of shift:.....hrs/shift  
Environmental register:..... Hazardous waste register:.....  
EIA:..... Self monitoring:.....

**Nature of Surrounding Environment**

Industrial ☐ Coastal ☐ Coastal/ Residential ☐  
Industrial/ Residential ☐ Residential ☐ Agricultural ☐  
Agricultural/ Industrial ☐ Agricultural/ Residential ☐ Desert ☐





## Water Consumption

Amount of water consumed in operation (day-month-year):

Process .....m<sup>3</sup>/ Boilers.....m<sup>3</sup>/

Domestic usage.....m<sup>3</sup>/ Cooling.....m<sup>3</sup>/

Other..... m<sup>3</sup> /

Total amount of water consumed (day-month-year).....m<sup>3</sup>/

Type of waste water:

Industrial ☐

Domestic ☐

Mixed ☐

Wastewater Treatment:

Treated ☐

Untreated ☐

Type of Treatment:

Septic tanks ☐

pH adjustment ☐

Biological treatment ☐

Chemical treatment ☐

Tertiary treatment ☐

Amount of treated water/ (day-month-year).....m<sup>3</sup> /

Amount of waste water/(day-month-year).....m<sup>3</sup> /

Final wastewater receiving body:

Nile ☐

Lakes (fresh water) ☐

Drain ☐

Groundwater ☐

Public sewer system ☐

Canals ☐

Agricultural Land ☐

Desert Land ☐

Other.....☐

## The Global Positioning System(GPS) reading for final disposal

1-LAT(Latitude):.....

LONG(Longitude):.....

2-LAT(Latitude):.....

LONG(Longitude):.....

## Engineering Drawings for the Facility

Gaseous emissions map

Yes ☐

No ☐

Sewer map:

Domestic ☐

Industrial ☐

Mixed ☐

Factory Layout ☐

Production process flow diagram ☐

Ministry of State for Environmental Affairs  
Egyptian Environmental Affairs Agency  
Baseline Data



**Raw material consumption**

No.	Trade name	Scientific name	CAS no.	UN no.	Physical state	Type of container	Amount	Classification	
								Hazardous	Non-Hazardous



**Inspection Team Member:**

<b>Team member</b>	<b>Position</b>

Date:

Inspector signature:

**Annex (1- B)**

**Inspection Checklist for  
Hazardous Materials and Wastes**



**Annex (F-2)**  
**Inspection checklists for hazardous materials and wastes for a facility**

**1. Hazardous materials (to be filled in case the facility uses hazardous materials) <sup>(1)</sup>**

Fill the following table according to the codes below						
Hazardous material	Amount	Field of utilization	Storage method <sup>(2)</sup>	Method of disposal of the containers	Conformity of containers to specifications <sup>(3)</sup>	Presence of MSDS <sup>(4)</sup>

<sup>(1)</sup> To be filled from the list of used raw material and chemicals according to the hazardous material list issued by the Ministry of Industry, checking the presence of a valid license for handling

<sup>(2)</sup> According to law 4/1994, does the storage area have:

S<sub>1</sub>: alarm, precaution and fire fighting system?

S<sub>2</sub>: first aid procedures?

<sup>(3)</sup> Check containers' compliance with law4/1994:

C<sub>1</sub>: sealed and don't cause any threats while handling

C<sub>2</sub>: unaffected with along storing period

C<sub>3</sub>: labeled with hazard and toxicity signs

C<sub>4</sub>: labeled in Arabic (production, origin, utilization instruction)

C<sub>5</sub>: labeled with its content, the effective substance and its concentration

<sup>(4)</sup> Material safety data sheet

## 2. Hazardous wastes (to be filled in case the facility generates hazardous wastes )<sup>(1)</sup>

Fill the following table according to the codes below

Hazardous waste	Source	Amount generated/ year	Storing method			On-site treatment and disposal			Transportation method	Presence of documents indicating off-site disposal <sup>(6)</sup>
			Method of storage inside the facility	Compliance of containers' specifications and labels with law 4/1994 <sup>(2)</sup>	Compliance of storage areas with law 4/1994 <sup>(3)</sup>	Treatment <sup>(4)</sup>	Final disposal <sup>(5)</sup>	Compliance of treatment and disposal with law 4/1994		

<sup>(1)</sup> Hazardous wastes can be identified according to law 4/1994 and by using the hazardous wastes list of the Ministerial decree no.65 for 2002 as reference

Is there a hazardous wastes register?

Yes ☐

No ☐

<sup>(2)</sup> Does the facility take into consideration that the storage containers should be:

C<sub>1</sub>: with sealed covers to protect the container from rain water and dust and to prevent any wastes leakage during storage and/or transportation

C<sub>2</sub>: constructed or lined by impermeable material which doesn't react with the contained material

C<sub>3</sub>: of suitable capacity                      C<sub>4</sub>: labeled

<sup>(3)</sup> Specification of storage area: determining specified locations for storage of hazardous wastes where safety conditions are set up to prevent the occurrence of any harm to the public or to those persons exposed to the wastes

<sup>(4)</sup> Which of the following methods are used by the facility for the treatment of hazardous wastes?

N<sub>1</sub>: biodegradation                      N<sub>2</sub>: incineration                      N<sub>3</sub>: physical or chemical treatment

<sup>(5)</sup> Which of the following methods are used by the facility for the hazardous wastes final disposal?

F<sub>1</sub>: land filling in specially engineered landfill                      F<sub>3</sub>: other (specify).....

<sup>(6)</sup> Contracts with wastes' contractors and receipts.

**Annex (1- C)**

**Inspection Checklist for  
Production Lines and Service Units**

## Inspection Checklist for Pulp Production by Chemical Process (Kraft)

<b>1. General</b>	
<b>1.1 Housekeeping</b>  - Floor - Operation solutions leakage - Solid wastes accumulation - Steam leakage	----- ----- ----- -----
<b>1.2 Type of operation</b>	<input type="checkbox"/> Batch <input type="checkbox"/> Continuous
<b>2. Status of Ambient Air</b>	
<b>2.1 Check the presence of the following control equipment:</b> - Scrubbers - Electrostatic precipitators	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2.2 Check the type and quantity of the used fuel for the lime furnaces</b>	----- -----
<b>2.3 Check the stacks heights</b>	-----
<b>Note:</b> - <i>Evaporators: emits vapors</i> - <i>Recycling boiler: emits sulfur, particulates, bad odor compounds</i> - <i>Lime furnace: emits sulfur oxides, nitrogen oxides, sulfur compounds and particulates</i> - <i>Energy generating sources: emits sulfur oxides, nitrogen oxides, hydrocarbons and particulates</i>	
Check law 4/ 1994 for the stacks emissions	
Check the presence of the gaseous emissions in the environmental register	
<b>3. Status of Work Environment</b>	
<b>3.1 Check the presence of personal protective equipment</b>	-----
<b>3.2 Check the presence of work place emissions in the environmental register</b>	----- -----
<b>3.3 Check the presence of the noise measurements beside the raw materials preparation areas. In case of suspicious take your own measurements.</b>	----- -----
<b>3.4 Check the presence of ventilation system at the unit and its efficiency</b>	----- -----
<b>Note:</b> - <i>Preparation of raw materials include a possibility of washing water leakage, beside the presence of high noise</i> - <i>Chemicals recycling: results in wastewater containing organics in the condensate water</i> - <i>Bleaching: results in wastewater containing dissolved solids from bleaching and the remainders of the bleaching chemicals</i> - <i>Pulp drying operation: emits particulates</i>	
<b>4. Status of Effluents</b>	
<b>4.1 Specify the sources of effluents in the unit:</b>	<input type="checkbox"/> Pulping <input type="checkbox"/> Washing and cleaning <input type="checkbox"/> Recycling of bleaching chemicals
<b>4.2 Specify the final discharge point on which the unit discharges</b>	-----
<b>4.3 Identify the types and quantities of the spent oils in the unit</b>	-----
<b>4.4 What are the disposal methods for the liquid wastes other than wastewater?</b>	-----
<b>Note:</b> - <i>Raw materials preparation operation: generates dusts from the open storage areas, bad odors.</i> - <i>Sulfite operation: generates sulfur compounds which have a bad odor</i> - <i>Bleaching: generates volatile compounds</i> - <i>Pulp drying: generates particulates</i>	

5. Status of Solid Wastes	
5.1 Specify the disposal methods for each of the following: <ul style="list-style-type: none"> <li>- Boilers ashes</li> <li>- Lime mud</li> <li>- Sand and stones</li> <li>- Green liquor sludge</li> <li>- Raw materials wastes</li> <li>- Primary and biological sludge</li> <li>- Domestic wastes.</li> </ul>	----- ----- ----- ----- ----- ----- -----
5.2 Check the presence of wastes disposal documents in the environmental register	-----
<b>Note:</b> <ul style="list-style-type: none"> <li>- <i>Preparation of raw materials generates dust, ashes and rejected materials</i></li> <li>- <i>Recycling of chemicals generates inorganic sludge</i></li> <li>- <i>Water treatment generates biological sludge</i></li> <li>- <i>Boilers generate ashes</i></li> </ul>	

### Inspection Checklist for Processing Recycled Paper

1. General	
1.1 Internal Cleaning and maintenance <ul style="list-style-type: none"> <li>- Floor</li> <li>- Washing water leakages</li> <li>- Operation solutions leakage</li> <li>- Solid wastes accumulation</li> </ul>	----- ----- ----- -----
1.2 Type of operation	<input type="checkbox"/> Batch <input type="checkbox"/> Continuous
2. Status of Ambient Air	
2.1 Specify the presence of the following control equipment: <ul style="list-style-type: none"> <li>- Scrubbers</li> <li>- Electrostatic precipitators</li> </ul>	<div style="display: flex; justify-content: space-around;"> <div> <input type="checkbox"/> Yes      <input type="checkbox"/> No  <input type="checkbox"/> Yes      <input type="checkbox"/> No           </div> </div>
2.2 Specify the stacks height	-----
2.3 Check the presence of the gaseous emissions analysis readings in the environmental register	-----
If suspicious perform your own measurements	-----
<i><b>Note :</b> the gaseous emissions from power generating are: HC,CO<sub>2</sub>,NO<sub>x</sub>,SO<sub>2</sub>,particulates</i>	
3. Status of Work Environment	
3.1 Check the presence of personal protective equipment?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.2 Are there any measurements for emissions from the following sources: <ul style="list-style-type: none"> <li>- Screening and cleaning</li> <li>- Washing/ thickening and sludge handling</li> <li>- White liquor waste</li> <li>- De-inking operation</li> </ul>	<div style="display: flex; justify-content: space-around;"> <div> <input type="checkbox"/> Yes      <input type="checkbox"/> No  <input type="checkbox"/> Yes      <input type="checkbox"/> No  <input type="checkbox"/> Yes      <input type="checkbox"/> No  <input type="checkbox"/> Yes      <input type="checkbox"/> No           </div> </div>
3.3 Are these measurements included in the environmental register?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.4 Identify the ventilation system in the unit.	-----
3.5 Are there noise measurements beside the paper making machine. Are they included in the environmental register? In case of suspicious take your own measurements.	<div style="display: flex; justify-content: space-around;"> <div> <input type="checkbox"/> Yes      <input type="checkbox"/> No  <input type="checkbox"/> Yes      <input type="checkbox"/> No           </div> </div>
<i><b>Note:</b></i> <ul style="list-style-type: none"> <li>- Emissions in the work place of this unit include small quantities of volatile organic compounds (VOCs), visual smoke and odors</li> <li>- High noise exists beside the paper making machine</li> <li>- Vibrations with low frequency is harmful for workers</li> </ul>	
4. Status of Effluents	
4.1 Specify the sources of effluents in the unit:	<input type="checkbox"/> Screening/ cleaning <input type="checkbox"/> Washing/ thickening and sludge handling <input type="checkbox"/> Spent white liquor <input type="checkbox"/> De-inking
4.2 Specify the final discharge point on which the unit discharges	-----
4.3 Check the types and quantities and disposal methods for the spent oils in the unit	-----
4.4 What are the disposal methods for the liquid wastes other than wastewater.	-----
<i><b>Note:</b></i> <ul style="list-style-type: none"> <li>- Water recycling from paper making machine to the de-inking operation.</li> <li>- White liquor recycling to material preparation operation</li> <li>- Water recycling from the floating unit to fibers separation unit</li> </ul>	

5. Status of Solid Wastes	
5.1 Specify the quantities of solid wastes from the following sources: - Primary sludge (fibers and fillers) and dyes - Rejected fibers and de-inking sludge - Ashes from boilers	----- ----- -----
5.2 Identify the disposal methods for the solid wastes.	----- ----- -----
5.3 Check the presence of wastes disposal documents in the environmental register	-----

## Inspection Checklist for Paper and Paperboard Production

1. General	
1.1 Internal Cleaning and maintenance <ul style="list-style-type: none"> <li>- Floor</li> <li>- Washing water leakages</li> <li>- Operation solutions leakage</li> <li>- Solid wastes accumulation</li> </ul>	<div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px;"></div>
1.2 Type of operation	<input type="checkbox"/> Batch <input type="checkbox"/> Continuous
2. Status of Ambient Air	
2.1 Specify the presence of the following control equipment: <ul style="list-style-type: none"> <li>- Scrubbers</li> <li>- Electrostatic precipitators</li> </ul>	<div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Yes</div> <div><input type="checkbox"/> No</div> </div> <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Yes</div> <div><input type="checkbox"/> No</div> </div>
2.2 Check the stacks height	<div style="border-bottom: 1px dashed black; height: 15px;"></div>
2.3 Check the presence of the gaseous emissions analysis readings in the environmental register If suspicious perform your own measurements	<div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px;"></div>
<i><b>Note :</b> the gaseous emissions from power generating are: HC,CO<sub>2</sub>,NO<sub>x</sub>,SO<sub>2</sub>,particulates</i>	
3. Status of Work Environment	
3.1 Check the presence of personal protective equipment?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.2 Are there any measurements for emissions from the following sources? <ul style="list-style-type: none"> <li>- Fibers separation</li> <li>- Bleaching</li> <li>- De-inking operation</li> </ul>	<div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Yes</div> <div><input type="checkbox"/> No</div> </div> <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Yes</div> <div><input type="checkbox"/> No</div> </div> <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Yes</div> <div><input type="checkbox"/> No</div> </div>
3.3 Are these measurements included in the environmental register?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.4 Check the ventilation system at the unit.	<div style="border-bottom: 1px dashed black; height: 15px;"></div>
3.5 Check the presence of the noise measurements beside the paper making machine. In case of suspicious take your own measurements.	<div style="border-bottom: 1px dashed black; height: 15px;"></div>
3.6 Are these measurements included in the environmental register?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<i><b>Note:</b></i> <ul style="list-style-type: none"> <li>- Emissions in the work place of this unit include small quantities of volatile organic compounds (VOCs), visual smoke and odors</li> <li>- High noise exists beside the paper making machine</li> </ul>	
4. Status of Effluents	
4.1 Specify the sources of effluents in the unit:	<input type="checkbox"/> Surcharging from the main paper making circuit <input type="checkbox"/> Pressing section <input type="checkbox"/> Tanks overflow <input type="checkbox"/> Wastewater from the equipment chemical cleaning <input type="checkbox"/> Washing water from chemical preparation equipment
4.2 Specify the final discharge point on which the unit discharges	<div style="border-bottom: 1px dashed black; height: 15px;"></div>
4.3 Check the types and quantities and disposal methods for the spent oils in the unit	<div style="border-bottom: 1px dashed black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px dashed black; height: 15px;"></div>
<i><b>Note:</b></i> <ul style="list-style-type: none"> <li>- The main parameters in the wastewater from this unit are organic load (BOD, COD), chlorinated organics (AOX), nitrogen, Phosphorus, Suspended solids and salts</li> </ul>	



5. Status of Solid Wastes	
5.1 Specify the disposal methods for each of the following: <ul style="list-style-type: none"> <li>- Primary sludge (fibers and fillers) and dyes</li> <li>- Rejected fibers and de-inking sludge</li> <li>- Ashes from boilers</li> </ul>	----- ----- -----
5.2 check the presence of contracts and receipts for waste disposal	----- -----
5.3 Are the amounts included in the environmental register?	<input type="checkbox"/> Yes <input type="checkbox"/> No

## Checklist for Boilers and Water Treatment Units

<b>1. General</b>	
1.1 Number of boilers and capacity	----- -----
1.2 What is the method used for water treatment?	<input type="checkbox"/> Lime <input type="checkbox"/> Ion exchange <input type="checkbox"/> Reverse osmosis
<b>2. Status of Ambient Air</b>	
2.1 What is the height of the stack of each boiler	Boiler (--)----- Boiler (--)----- Boiler (--)-----
<i>Note: the height of the stack must be 2.5 times the height of adjacent buildings.</i>	
2.2 Type of fuel used for boilers	<input type="checkbox"/> Mazot <input type="checkbox"/> Solar <input type="checkbox"/> Natural gas <input type="checkbox"/> Other.....
2.3 In case of using Mazot for boilers, is the surrounding area residential?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<i>Note: The use of Mazot as fuel in the residential area is Prohibited by law.</i>	
2.4 If Mazot is used in non residential area, are there analysis of the flue gases for sulfur dioxide, carbon monoxide, and particulate matter	<input type="checkbox"/> Yes <input type="checkbox"/> No
2.5 If Yes Check the compliance of the analysis readings in the register with your observations	----- ----- -----
<i>Note : Whatever the fuel used ,if you notice any smoke, take a sample for analysis</i>	
<b>3. Status of Work Environment</b>	
3.1 Check the heat stress next to the boilers	-----
3.2 Check the noise next to the boilers and duration of exposure	----- -----
3.3 Are they included in the environmental register?	<input type="checkbox"/> Yes <input type="checkbox"/> No
<i>Note : In case of suspicious perform your own measurements</i>	
<b>4. Status of Effluent</b>	
4.1 What is the blow down rate from the boilers?	----- m <sup>3</sup> /d
4.2 What are the blow down and back wash rates for the treatment units?	----- m <sup>3</sup> /d ----- m <sup>3</sup> /d
4.3 Steam condensate is	<input type="checkbox"/> Recycled to the boilers <input type="checkbox"/> Discharged to sewer
<b>5. Status of Solid Wastes</b>	
5.1 If lime method is used, sludge is generated, what is the amount of sludge produced per day?	----- -----
5.2 What is the sludge disposal method?	-----
<b>6. Status of Hazardous Material</b>	
6.1 Check the storage method of chemicals used in the treatment process. Is it in compliance with law 4?	----- ----- <input type="checkbox"/> Yes <input type="checkbox"/> No
6.2 Is there any fuel leaks from fuel tanks	<input type="checkbox"/> Yes <input type="checkbox"/> No
6.3 Is there any fire extinguishing devices and fire fighting measures?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6.4 Is there a spill prevention plan?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6.5 Do you notice anything that can provoke a fire? Such as the presence of a pump underneath the fuel tank (the start-up of the engine can produce a spark)	<input type="checkbox"/> Yes <input type="checkbox"/> No Comment ----- -----

### Checklist for Garage

<b>1. General</b>	
1.1 Are detergents or solvents used for washing equipment, trucks, floor,...etc?	<input type="checkbox"/> Yes <input type="checkbox"/> No
1.2 What is the amount of oil and grease used per day?	-----
1.3 What is the amount of spent lube oil per day ?	-----
1.4 How does the facility dispose the spent oil ?	-----
<b>2. Status of Effluents</b>	
2.1 What is the amount of wastewater generated ?	-----
2.2 Do you observe any oil / foams / solid matter in the inspection manhole?	<input type="checkbox"/> Yes <input type="checkbox"/> No

### Checklist for Mechanical Workshops (Maintenance)

<b>1. Status for the Effluent</b>	
1.1 What is the amount of wastewater produced ?	-----
1.2 What is your visual observation for the inspection manhole of the workshop ?	-----
<b>2. Status of Solid Wastes</b>	
2.1 What is the amount of solid waste produced (scrap,...etc.)?	-----
2.2 what is the amount of the solid wastes generated?	-----
2.3 Are the solid wastes sorted?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2.4 what is the disposal method of the solid wastes?	-----
2.5 check the contracts and receipts	-----
<b>3. Status Of the Work Environment</b>	
Are there any noise in work place	<input type="checkbox"/> Yes <input type="checkbox"/> No
If yes	
Are there any measurements for noise	<input type="checkbox"/> Yes <input type="checkbox"/> No
Check the exposure time	<input type="checkbox"/> Yes <input type="checkbox"/> No
If not	
Perform measurements	-----

### Check list for Laboratories

<b>1. General</b>	
1.1 What is the amount of effluents generated per day?	-----
1.2 Check the disposal method of effluents	-----
1.3 List the chemicals used in the laboratories	-----
<b>2. Status of Work Environment</b>	
2.1 Are there any odor/ gases/ noise in the work environment?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2.2 Check the exposure time	-----
<b>3. Status of Hazardous Material</b>	
3.1 Check storage of hazardous material. Is it in compliance with the requirements of law 4/1994?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.2 Are there any first aid measures in place?	<input type="checkbox"/> Yes <input type="checkbox"/> No

## Inspection Checklist for Wastewater Treatment Plant

1. General	
1.1 What is the capacity of WWTP?	-----
1.2 Specify the units included in WWTP :	
Pumping station	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Equalization tank	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Aeration tank	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Sedimentation tank	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Sludge thickening tank	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Sludge drying	<input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span>
Others	-----
1.3 List any chemical and its quantity used for wastewater treatment (coagulants,.....)	----- -----
2. Status of Effluent	
2.1 Are there analysis readings for the effluent? If not make your own	<input type="checkbox"/> Yes <span style="margin-left: 100px;"><input type="checkbox"/> No</span>
2.2 Are the analysis readings included in the environmental register?	<input type="checkbox"/> Yes <span style="margin-left: 100px;"><input type="checkbox"/> No</span>
3. Status of Solid Wastes	
3.1 Determine the sludge disposal	-----
<i>Note : Sludge can be use in liquid or dry form in agricultural purposes, according to the Ministerial decree 214/97 issued by the Ministry of Housing</i>	
3.2 If a third party is involved in disposal, check the presence of contracts and receipts	<div style="text-align: right;"> <input type="checkbox"/> Found <span style="margin-left: 100px;"><input type="checkbox"/> Not found</span> </div> <u>Comment</u> ----- -----