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

Inspection Manual
Textile Industry

2002

List of Acronyms

BOD	Biological Oxygen Demand
CAPMAS	Central Agency for Public Mobilization and Statistics
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
EMS	Environmental Management System
O&G	Oil and Grease
SIC	Standard Industrial Classification
SM	Self-Monitoring
SMS	Self-Monitoring system
SO_x	Sulfur Oxides
TDS	Total Dissolved Solids
UHT	Ultra High Temperature
WWTP	Wastewater Treatment Plant
µm	Micro meter 10^{-6} m
VOCs	Volatile Organic Compounds
NO_x	Nitogen Oxides
CFCs	Chloro-fluoro carbon
MHUUC	Ministry of Housing, utilities and urban Communities
CP	Cleaner Production
Eop	End-of-pipe

P2	Pollution Prevention
HACCP	Hazardous Analysis& Critical Control Point
CIP	Clean in Place

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1. Introduction

This manual has been prepared to guide the industrial inspector to carry out his work in the textile industry regarding the environmental pollution caused by the different sources in the different subsectors of this industry. The information in this manual introduces the inspector to the technical knowledge of the different production lines of textile manufacturing; spinning, weaving, knitting, finishing, garment manufacturing and man-made fiber manufacturing. This technical information helps the inspector to know the possible pollution due to air emissions, wastewater and solid waste, and the health impact due to the different pollutants.

The manual also provides the relevant data from the Egyptian Environmental Law, number 4 of 1994 and its executive regulation, regarding the permissible limits of air pollutants and noise data are given from the regulation of Ministry of Housing, law 44/2000 regarding the specifications of industrial wastewater to be discharged to public sewage system. These limits and specifications provide the inspector with the basis to judge the facility compliance to environmental laws.

The manual also provides the inspector with information about a number of proposals for pollution abatement which may be applied in the different textile processes to minimize the pollution due to air emissions in the working environment and the pollution in the facility wastewater to be discharged to surface water or to public sewage system.

Because of the continuous development in the textile industry, regarding the types of raw material, the types of chemicals used and the type of technology of the process, the types of pollutants and their concentrations are also liable to change. This justifies that this manual is subjected to the updated when the situation necessitates the needs of alterations

1.1 Preface

The textile industry is considered one of the greatest industries in Egypt regarding the number of labor, the value of exports, and the value of local production. The Egyptian textile industry comprises 31 public sector companies and about 3500 private sector and joint venture companies. The availability of the high quality Egyptian cotton represents a great support in the international competition for the Egyptian textile products especially the extra fine quality. The textile industry is the fifth largest source of foreign earnings, after oil, remittances, tourism and Suez Canal earnings.

The public sector dominates nearly 100% of the spinning, 70% of weaving, 40% of knitting and 30% of the finished goods. The private sector currently dominates the market in terms of knitted fabrics and manufactured garments.

The exports of the textile industry represent about 43% of the total Egyptian industrial exports. The largest share of the textile exports is that for cotton yarns. Other exports also a cotton for grey fabrics, finished fabrics, and manufactured garments, which are obtaining an increasing share of total exports of the present time.

The textile industry causes pollution to the environment through air emissions, effluents and solid waste. the liquid wastes tend to dominate over air emissions and solid wastes in terms of severity of environmental impacts. Wastewater resulting from various washing operations contains substantial pollution load represented in organic matter and suspended matter such as fibers and grease. This wastewater also contains alkaline and toxic chemicals, which if discharged into aquatic bodies can cause lowering of dissolved oxygen, damage to aquatic life and expose downstream water users to possible toxic effects. The wet processes in the textile industry use large volumes of water that generate large volumes of wastewater containing a wide variety of chemicals used throughout processing.

The major source of pollution in the dry processes, such as cotton spinning, weaving, knitting ,..etc., is the cotton dust, lint, and particulates which have pollution and health impact in the working environment and affect the respiratory system.

Another important source of pollution in both the dry and wet textile processes is the noise, especially when high speed machines are used such as ring spinning machines, winding machines, air-jet looms, ..etc. the textile production lines usually contain a large number of machines in each stage, so that the pollution load is expected to be great and needs much effort to control to keep it as low as possible.

2. Description of Industry

The textile industry deals with fibrous materials in a form depending on the type of process, chemicals and other inputs, as shown in the following .

2.1 Raw material, chemicals and other inputs

tables (1-11) presents the different processes, the raw materials and products from each process and the related pollution sources.

2.1.1 Raw material for the following textile subsectors

Cotton Spinning	Raw cotton fibers, man-made fibers with specifications similar to cotton, or blends of cotton and man-made fibers. The raw fibers are supplied in bales.
Wool Spinning	Raw wool fibers, man-made fibers with specifications of wool, or blends of wool and man-made fibers. The raw fiber material is supplied in bales.
Weaving	Cotton yarns, woolen yarns, man-made yarns, blended yarns, textured yarns, stretch yarns, …etc.
Knitting	Cotton yarns, woolen yarns, man-made yarns, blended yarns, textured yarns, stretch yarns, …etc.
Nonwoven	Man-made fibers, wool fibers, or blends
Tufting	Acrylic yarns, polypropylene yarns, blended yarns with the wool-type.
Garment	Woven or knitted fabrics, from cotton, wool, man-made fibers, blends of natural and man-made fibers, interlining fabric and lining fabric, buttons, zebs, …etc.

2.1.2 Chemicals for the following wet processes

Sizing	Polyvinyl alcohol, carboxymethyl Cellulose, oils, waxes, adhesives, urea, diethylene glycol, ..etc.
Desizing	Enzymes, Sulpheric acid, detergents and alkali
Scouring	Sodium hydroxide, Sodium Carbonate, surfactants, chlorinated solvents
Bleaching	Hypochlorite, hydrogen peroxide, acetic acid.
Mercerization	Sodium hydroxide, surfactants, acid, liquid ammonium
Dyeing	Dyestuffs, auxiliaries, reductants, oxidants
Printing	Dyes (acids or alkalis), pigments, kerosene, binders, ammonia, xylenes.
Chemical finishing	Formaldehyde, phosphorus, ammonia, silicone, fluorocarbon resins, toluene, zircon salts, ..etc.

2.1.3 Water

The textile industry includes many wet processes within the production operations, such as sizing, scouring, desizing, bleaching, dyeing, finishing, …etc. These wet processes consume large amounts of water which are estimated to be at a rate of 200 liters/ kg of product. So, water is an important input to the textile industry. The required characteristics of the input water may need to treat the water in a special plant to remove hardness from water before being used in the wet processes.

2.2 Production operations

The textile industry covers the following different production processes and service units:

Production Processes	Service units
Spinning	Boilers
Cotton spinning (and blends)	Cooling towers
Wool spinning (and blends)	Laboratory
Fabric formation	Mechanical and electrical workshop
Weaving	Garage
Knitting	Storage facilities
Nonwoven	Water treatment plant for water to be used in production units
Tufted carpet	
Finishing	Wastewater treatment plant
Preparation for finishing (singeing, bleaching, …etc.)	Scavenging system for cotton dust
Dyeing	
Printing	
Chemical finishing	
Garment manufacturing	
Man-made fiber manufacturing	
Viscose production	
Nylon production	
Polyester production	

2.2.1 Spinning Industry

Tables (1 &2) presents the different processes, the raw materials and products for each process and the related pollution sources.

The two main technologies for spinning are explained in the following:

Cotton spinning

Fig (1) shows the production line for cotton spinning. In this line cotton from bales is processed through successive machines to be cleaned from dust, trashes and foreign matters, opened, mixed, carded, then drafted to a thin thread and twisted to produce the yarn. This line could also be used for spinning man-made fibers with characteristics similar to cotton, or blends of cotton and man-made fibers. The produced yarn is wound on large packages with conical shape on winding machines producing cone packages.

Wool spinning

Fig (2) shows the production processes for wool spinning. In this line, wool fibers from bales are scoured to be cleaned from grease, carbonized to remove the plant matter, carded, combed then drafted to a thin thread and twisted to produce woolen or worsted yarns. The produced yarn is wound on large package as final product for weaving or knitting, or for carpet production. The same line may be used to process man-made fibers of the type similar to wool, or blends of wool and man-made fibers.

Table (1) Cotton Spinning

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Opening and cleaning	Raw cotton different man-made fibres (cotton – type), or both	Opening and cleaning cotton	Flow of cleaned and opened cotton	Cotton dust particulates	______	Fibers	Particulates, cotton dust, noise
Carding	Layer of cleaned cotton	Further opening and cleaning	Card sliver	Particulates	______	Fibers	Particulates
Combing	Card sliver	Further cleaning removing neps parallelizing the fibers	Combed sliver	Particulates	______	Fibers	Particulates, noise
Drawing	Card slivers or combed slivers, cotton , man-made, or both	Improving regularity, blending different fibers	Drawn sliver	Particulates	______	Fibers	Particulates, noise
Roving	Drawn silver	Reducing thickness, inserting some twist to strengthen resulting roving	Roving	Particulates	______	Fibers	Particulates, noise
Ring – Spinning	Roving	Drafting roving to yarn and inserting final twist	Ring-spun yarn on bobbin	Particulates	______	Yarns	Particulates noise
Open-end spinning	Drawn sliver	Drafting sliver to yarn and inserting final twist	Open –end yarn on cheese package	Particulates	______	Yarns	Particulates, noise
Cone –package winding	Ring-spun yarn on bobbin	Removing yarn defects and Winding yarn to cone packages	Finished Ring – spun yarn on cone packages	Particulates	______	Yarns	Particulates, noise

Table (2) Wool Spinning

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Selection and Sorting	Raw wool	Classifying wool according to quality	Required quality of raw wool	Particulates	______	Wool fibers waste	Particulates
Scouring	Raw wool warm soapy water	Cleaning wool from natural grease, suint, dirt and dust	Clean wool from grease suint and dust	VOCs (solvents)	High solids, BOD,COD, grease, solvent and detergent residues neutral to high pH, temperature.	Wool fiber waste	Particulates, VOCs (from drying)
Carbonizing	Scoured wool - sulpheric acid (low concentration)	Removing vegetable matter	Wool cleaned from vegetable matter	Acid fumes	Normal pH below 7 occasional acid bath dumps	Little charred carbon residue	Acid fumes
Mixing and oiling	Pretreated wool oil	Mixed and oiled wool ready for Carding	Wool	VOCs	______	Wool fibers wastes	Particulates
Carding	Cleaned and oiled wool	Fiber separation and forming fiber rope (roving)	Wool roving	Particulates	______	Fiber waste (typically reused)	Particulates
Gilling and combing	Carded wool	Parallelism fibers, separate entanglement	Combed sliver	Particulates	______	Fiber waste (reused)	Particulates
Roving	Combed sliver	Drafting sliver to form roving	Roving (or top)	Particulates	______	Fiber waste	Particulates, noise
Spinning	Roving	Draft roving and insert twist to form yarn	Woolen yarn (without combing) or worsted yarn (combed)	Particulates	______	Fiber waste	Particulates, noise

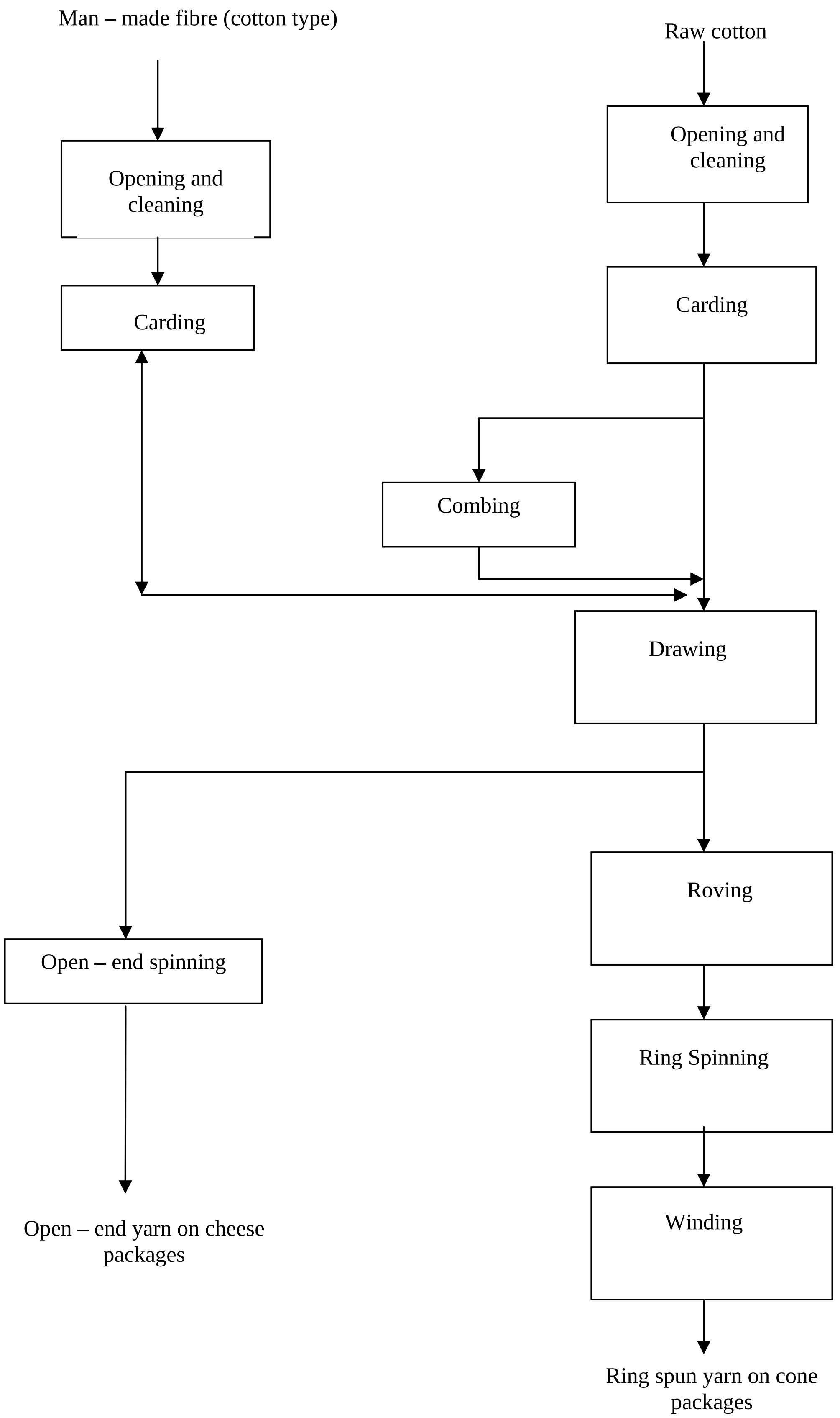


Fig (1) Production Line For Cotton Spinning System

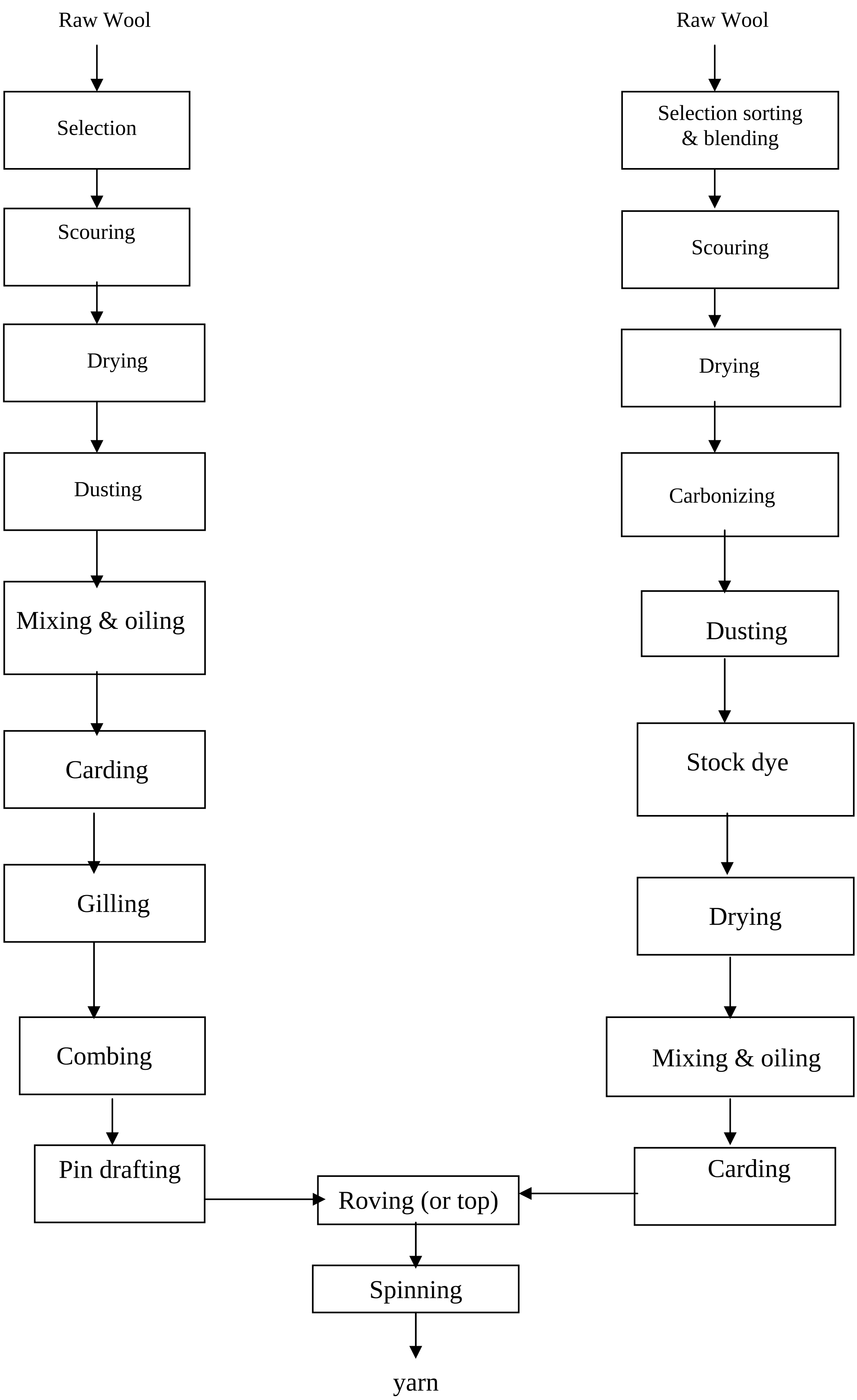


Fig (2) Wool Spinning Systems

2.2.2 Fabric Formation Industry

Tables (3 to 6) present the different processes, raw materials and products from each process and the related pollution sources.

Different processes for fabric formation are explained in the following:

Weaving Fig (3) shows the production processes for weaving yarns into fabric. In this line a large number of parallel threads are arranged with the required length, wound on a beam, strengthened and smoothed by sizing, and interlaced with weft threads on the loom to produce a woven fabric, which is wound on another beam (cloth beam).

Knitting Fig (4) shows the production processes for knitting yarns into fabrics. In both circular and flat knitting, yarn packages feed the knitting machine which forms a fabric by interlooping the threads together, using knitting needles. But in warp knitting, a large number of warp threads are arranged in parallel and wound on a beam to feed the knitting machine. The warp knitting machine forms a fabric by interlooping the threads, using knitting needles.

Nonwoven Fig (5) shows the production line for needle punched nonwoven fabric. In this line, man-made fibers are opened to form a fiber web with the required weight, then passed through the needle punching machine, where the fibers are pushed depthwise by barbed needles and get entangled, to produce a felt-like fabric with high coherence and strength. To strengthen the needle punched nonwoven, it may be treated with adhesive to give more bonding between fibers. This may be achieved by spraying the fabric with a chemical adhesive.

Tufted Carpet Fig (6) shows the production processes of tufted carpet. In this technology, the tufting machine is fed with a large number of threads, and a spun-bonded nonwoven fabric, as the ground of the carpet. The needles of the tufting machine make tracks of parallel stitches through the ground fabric, creating a terry surface. The formed carpet is back coated with adhesive resin to bind the carpet pile to the ground fabric and the adhesive is covered with jute fabric as a back. Then, the carpet surface is sheared to improve the appearance and regulate it.

Table (3) Weaving Industry

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Warping	Yarn cones	Forming the longitudinal parallel arrangement of warp threads	Warp threads beam	Particulates	______	Yarns- packaging waste	Particulates Noise
Slashing (sizing)	- warp threads on warp beam size solution -	Treating warp threads with size solution	Sized warp	VOCs, (methanol from PVA) Particulates (from dry phases)	BOD,COD, metals, size washing residues	Fiber lint, yarn scarp size residues	VOCs (methanol from PVA Particulates
Preparing for the loom	Sized warp	Threading warp threads in harnesses, reed and drop wires to be ready for the loom	Warp beam ready for weaving	______	______	______	______
Weaving	Warp threads arrangement	Enterlacing warp threads with weft threads to from woven fabric	Woven fabric	Particulates	______	Yarn and fabric scrap	Particulates High level of noise

Table (4) Knitting Industry

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Warp knitting: Warping	Yarns (cotton, wool, blended) man-made, filament, textured)	Preparing warp yarns on warp beam	Warp beam	Particulates	______	Yarns packaging waste	Particulates
knitting	Warp beam	Interlooping the warp yarns to from knitted fabric	Warp knitted fabric	Particulates	______	Yarn and fabric scraps, packaging waste	Particulates Noise
Circular knitting or flat knitting	Yarns cones	Interlooping threads to form weft knitted fabric	Circular knitted fabric	Particulates	______	Yarn and fabric scraps, packaging waste	Particulates Noise

Table (5) Nonwoven Fabric Industry

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Web formation	Man-made fibers (polyester, nylon, etc.)	Opening and carding the fibers	Card web of fibers	Particulates	______	Fibers	Particulates
Web condensation	Card fiber web	Condensing fiber web to required weight	Multilayer fiber web	Particulates	______	Fibers	Particulates
Needle punching	Multilayer fiber web	Mechanical bonding of fibre web	Needled nonwoven felt	Particulates	______	Fibers	Particulates Noise
Adhesive spraying and drying	Needle punched fabric	Strengthening the fabric coherence	Needle punched nonwoven fabric	VOCs	______	Fibers, nonwoven fabric scraps	VOCs, fumes of adhesive chemicals

Table (6) Tufting Industry

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Tufting	-Carpet yarn (wool, man-made fiber) - ground fabric (spun-bonded nonwoven)	Inserting rows of tufts on ground fabric	Ground fabric tufted with carpet wool pile	Particulates	______	-Yarns - Packaging wastes. - Fabric scraps	Particulates Noise
Adhesive coating of tuft back	-Adhesive resin, - jute woven fabric	Fixing tufts to ground fabric	Tufted carpet backed with adhesive	VOCs	Chemiocals reducing the dissolved oxygen in water	Spills of adhesives	VOCs
Covering carpet back with jute fabric and drying	Woven Jut fabric and tufted carpet	Sticking the backing to the adhesive coating	Tufted carpet with finished back.	Particulates, VOCs (from resin drying)	______	Fabric scraps	- Particulates - VOCs
Shearing pile surface	Tufted carpet with solidified adhesive	Leveling the pile surface	Finished tufted carpet	Particulates	______	Fibers	- Particulates, noise

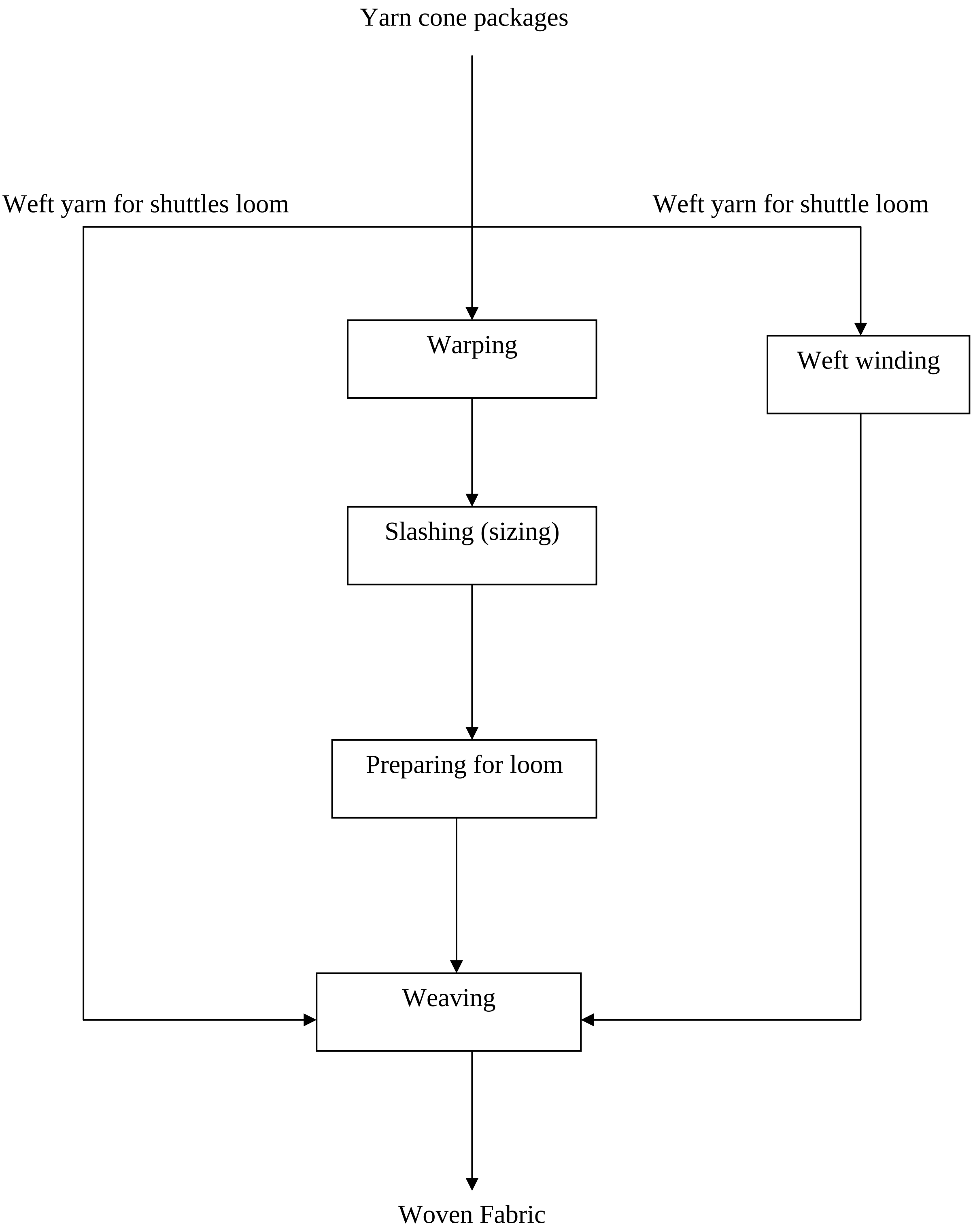
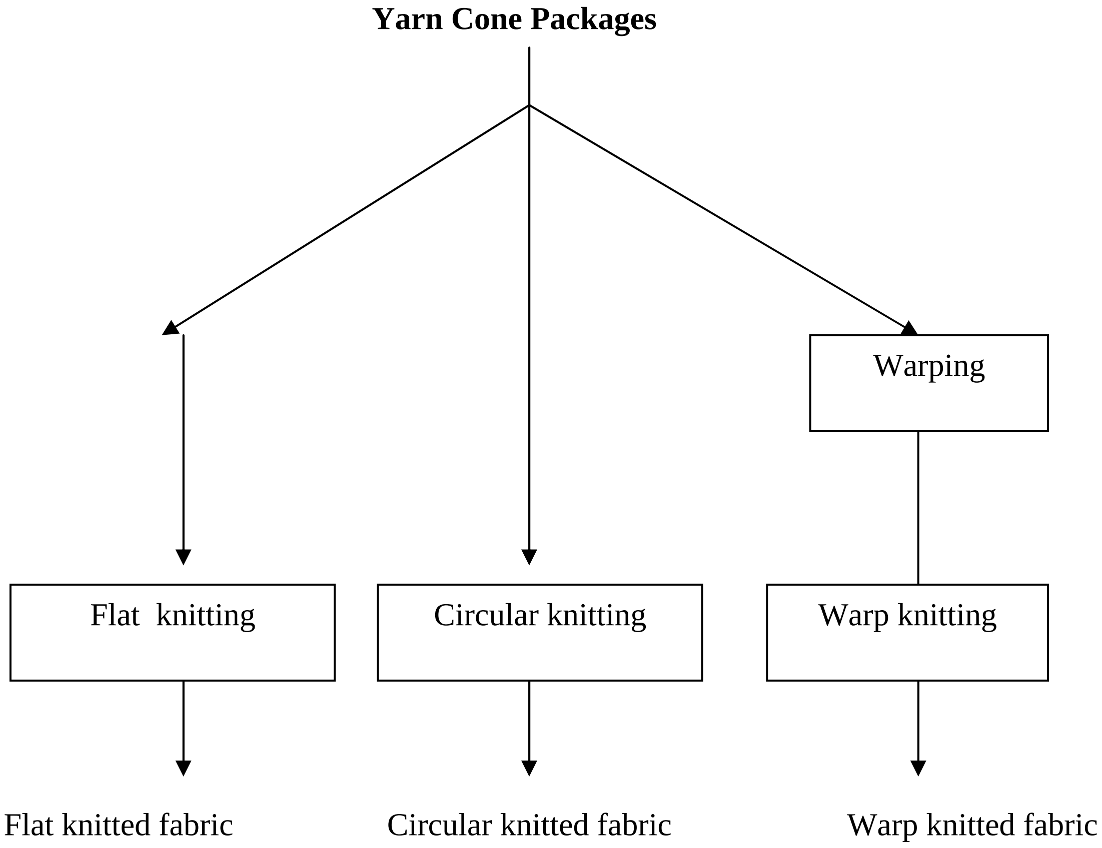
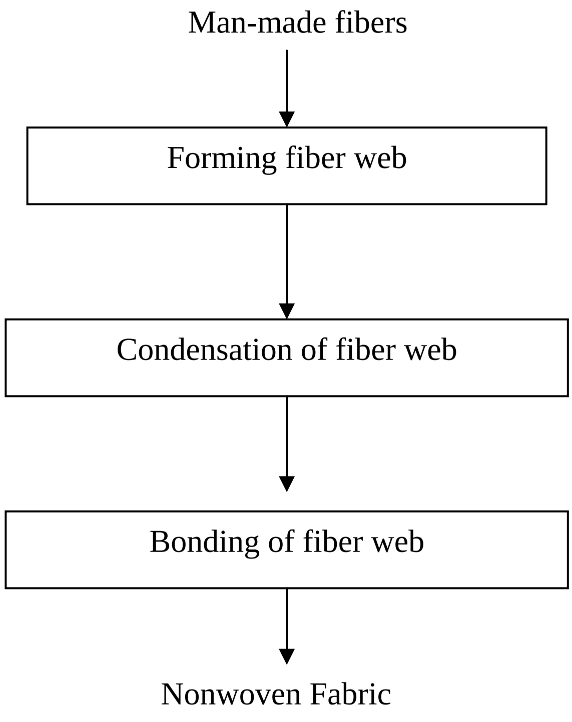


Fig (3) Production Line For Fabric Weaving



Fig(4) Production Line For Knitting Industry



Fig(5) Production Line For Nonwoven Fabric

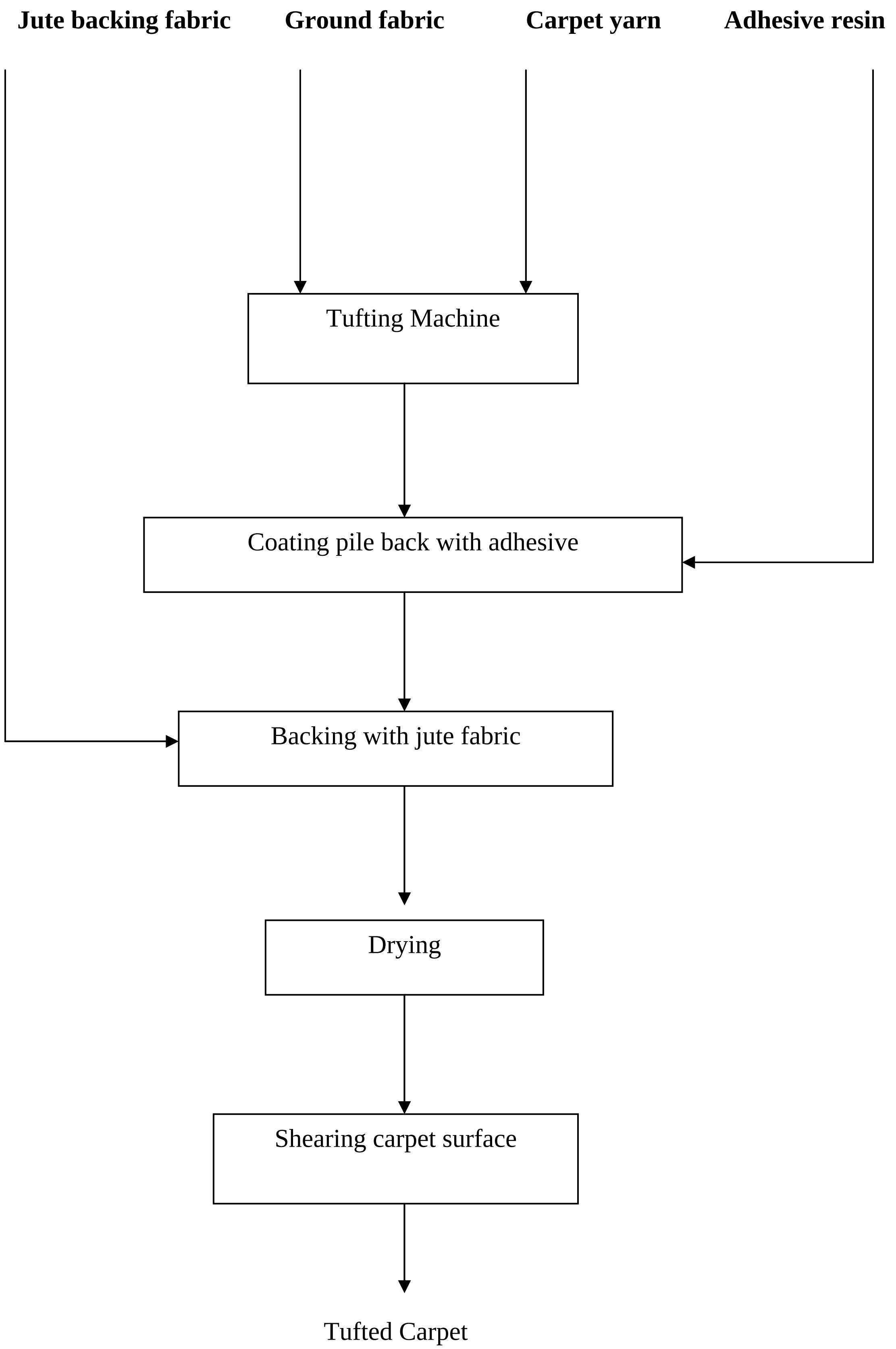


Fig (6) Production Line For Tufted Carpet

2.2.3 Finishing Industry

Table (7) gives the processes , the raw materials and products from the processes and the related pollution sources.

Fig (7) shows the production processes for finishing woven cotton fabrics and woven synthetic fabrics. Fig (8) shows the processing line for finishing cotton knitted fabrics and fig (9) shows the processing line for finishing wool woven or knitted fabrics.

The different processes are explained in the following:

Singeing This process ***(cotton only)*** is considered one of the processes for finishing preparation, and is only concerned with cotton woven fabrics. In this process the greige fabric surface on both sides is subjected to a gas flame which burns the protruding fibers and results in a smooth surface.

Desizing In this process the size materials on the warp threads of the fabric are removed, by passing the fabric in a bath of sulpheric acid or by using enzymes, soap or hot water depending on the sizing material. This process is also considered one of the preparation processes for finishing.

Scouring In this process, the desized fabric is passed through a cleaning bath, using alkaline or solvent solutions to dissolve any impurities or soiling on the fabric.

Desizing and scouring could be done in one operation in some plants. The operation is a preparation step for bleaching and dyeing. It is possible to do desizing by using hot water and soap.

Bleaching This process ***(for natural fibres)*** is also one of the preparation processes for finishing, to obtain white colour in the fabric, by using bleaches, such as hydrogen peroxide or hypochlorite.

Mercerizing This process ***(for cotton only)*** is also a preparation process for finishing, in which the fabric is treated with sodium hydroxide to create luster, more strength and higher affinity for dyes in the fabric. This process could be applied to woven or knitted cotton fabrics.

Dyeing This process is the finishing process in which the yarn, fabrics, or garments are treated to add color and intricacy to the product, using dye stuffs, auxiliaries, reductants, oxidants, …etc. This process is well known to be a major source of pollution due to the many chemicals used, and the large quantities of wastewater resulting from the process, and loaded with pollutants.

Printing	In this process the fabric is printed with color and patterns, using pigments, dyes, acids, alkalis, softener, binder and emulsifier solvents. Printing is also one of the major sources for pollution.
Carbonizing	In this process***(for wool)***, woven or knitted wool fabrics are treated with sulphuric acid to remove the vegetable cellulosic matter naturally existing in wool fibers.
Special finishing	In the special finishing process***(moth-proofing, water repellant, stain resist, …etc.)***, the fabric is chemically treated to achieve certain characteristics in the finished fabric giving it special performance, such as water-proof, crease resistance, …etc.
Brushing and napping	This process is considered as a mechanical finishing process, in which the fabric surface is subjected to a brushing action to raise fibers from the yarns and create a hairy surface in the fabric. This process may be applied to both woven and knitted fabrics.
Shearing	This process is also a mechanical finishing process that is applied to woven fabric, to shear the protruding fibers from fabric surface and create smooth surface fabrics. This process is a sources for fiber particulates
Softening by calendering	This is a mechanical finishing process simulating, the ironing process of fabric to produce smooth unwrinkled surface. The woven fabric is passed between smooth pressed rollers to remove surface fibers and reduce friction between fibers, resulting in soft feel in the fabric
Sanforizing	This is a mechanical finishing process applied to woven fabrics to compact the structure by passing the fabric between smooth heavy rollers, and produce compacted fabrics
Addition of lustre	In this process, the woven fabric is passed through calenders with three rolls, the center one of cotton or paper, and the two outside rolls of metal. The fabric is fed around the center roll while the two outside rolls revolve on the fabric face at a very high speed and develop a polished fabric surface by friction. To make this glazed surface relatively durable, resins are used.

Table (7) Finishing Industry (Textile wet processes)

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Singeing (cotton only)	Unfinished woven cotton fabrics.	To burn the surface fibers of greige goods to give smooth surface	Fabric with smooth surface, and no protruding fibers	Small amounts of exhaust gases from burners	______	Little or none	Small amount of burning fumes
Desizing	-Singed fabric - enzymes, - acids (sulphuric)	To remove size material from woven fabric	Fabric free from size	VOCs from glycol ethers	BOD from sizes, lubricants, biocides, anti-static compounds	fiber lint, yarn waste, cleaning materials.	VOCs (from glycol ethers)
Scouring	- Knitted, or desized woven fabric, -alkaline or solvent solutions	Cleaning fabric from impurities	Clean fabric	VOCs from glycol ethers and scouring solvents	High BOD and temperature very high pH, fats, waxes, detergents, size mix residues, solvent residues	Little or no residual waste	VOCs (from ethers or scouring chemicals)
Bleaching (for natural fibres)	Scoured fabric, hydrogen peroxide, hypochlorite	Eliminating unwanted coloured matter decolorizing coloured impurities.	White bleached fabric	Chlorine chemical fumes, acetic acid fumes	Low to moderate BOD, high pH and temperature, bleach and additives residues	Little or none	Chlorine chemical fumes; acetic acid fumes
Mercerizing	- Woven or knitted cotton fabric - caustic soda (15-20%) - acid	To give luster, more strength, and higher affinity for dyes	Mercerized woven or knitted fabric	Little or none	Very high pH, dissolved solids , some, BOD, NaOH	Little or none	______
Dyeing	Woven or knitted fabric, dye stuffs, auxiliaries, reductants And oxidants	Add colour and intricacy to fabrics	Dyed fabric	VOCs (ethylene glycol), amonia	Depending on type of dye, dissolved solids, COD heavy metals causing toxicity, BOD.	Chemical residues, fabric scrap	VOCs (ethylene glycol)

Table (7) cont. Finishing Industry

Process	Input materials	Function (purpose)	Product	Air emissions	Effluents	Solid wastes	Work environment
Printing	Woven or knitted fabric, pigments, and dyes, acids or alkalis, softener, binder, emulsifier solvents	Printing colour and patterns on fabric	Printed fabric	VOCs (e.g. ethylene glycol, urea, formaldehyde, kerosene) amonia, combustion exhausts	High COD and salt content solvents toxic metals BOD, foam, heat	Chemical residues	VOCs, ethylene glycol, Urea formaldehyde kerosene amonia, noise
Carbonizing (for wool)	Woven or knitted wool fabric sulphuric acid	Removing vegetable matter	Wool fabric cleaned from cellulosic matter	Acid fumes	Normal pH below 7 occasional acid bath dumps	Little charred carbon residue	Acid fumes, noise
Special finishing (moth-proofing water repellant stain rest, etc)	Woven or knitted fabric - Mitin, Dieldrin and Boconize for moth-proofing fluoro chemicals for water and oil repellent	Giving fabric special property	Fabric with special finish	Particulates VOCs formaldehyde combustion exhausts	BOD,COD suspended solids, toxic materials, spent solvents.	Chemical residues fabric scrap	Particulates VOCs Formaldehyde, noise
Brushing and napping	Woven or knitted fabric	Raise surface fiber and change feel and texture of fabric	Fabric with hairy surface	Particulates	______	Fiber waste	Particulates, noise
Shearing	Woven fabric	Removing surface fibers	Fabric with smooth surface	Particulates	______	Fiber waste	Particulates, noise
Softening by calendering	Woven fabric	Removing surface fibers friction between fibers	Stoft fabric	______	______	______	Noise
Sanforizing	Woven fabric	Compacting the fabric	Fabric with compressed structure	______	______	______	______
Addition of luster	Woven fabric	Adding luster to fabric surface	Fabric with Lustrous flattened and smoothed yarns	______	______	______	Noise

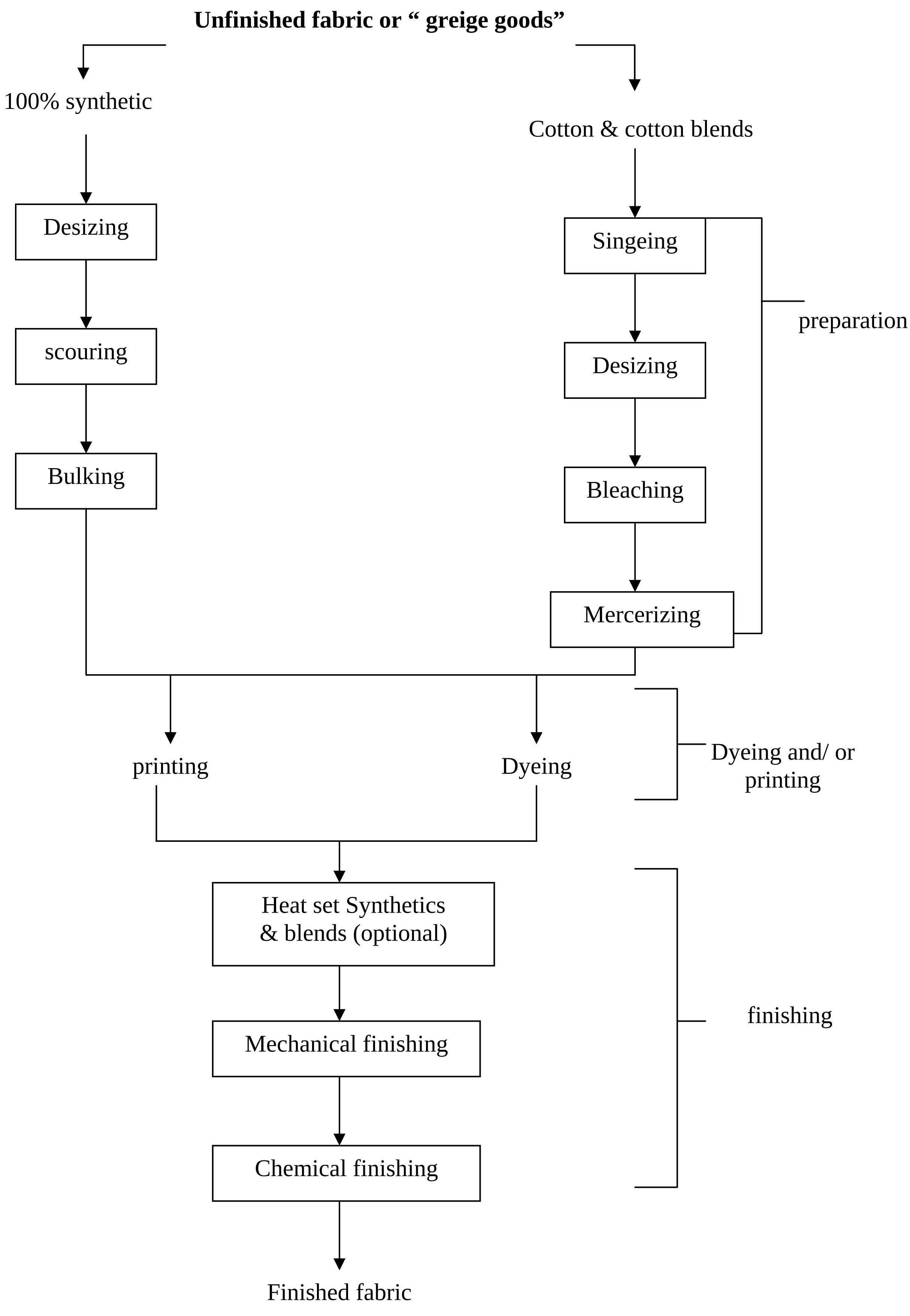


Fig (7) Finishing Of Woven Cotton And Synthetic Fabrics

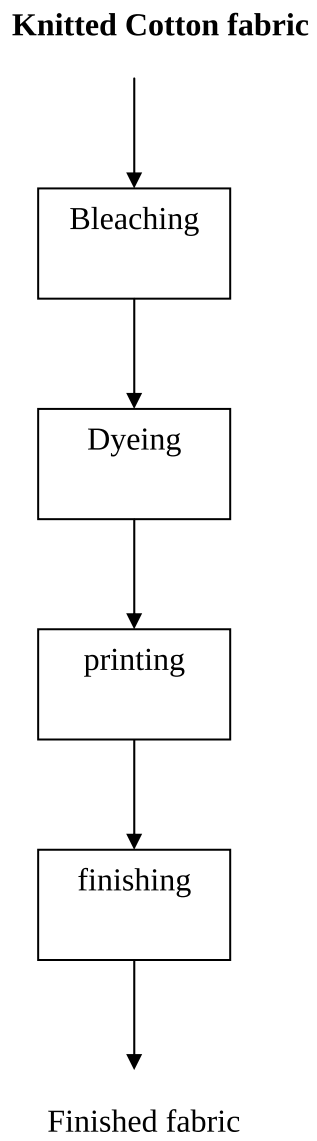


Fig (8) Finishing Knitted Fabric

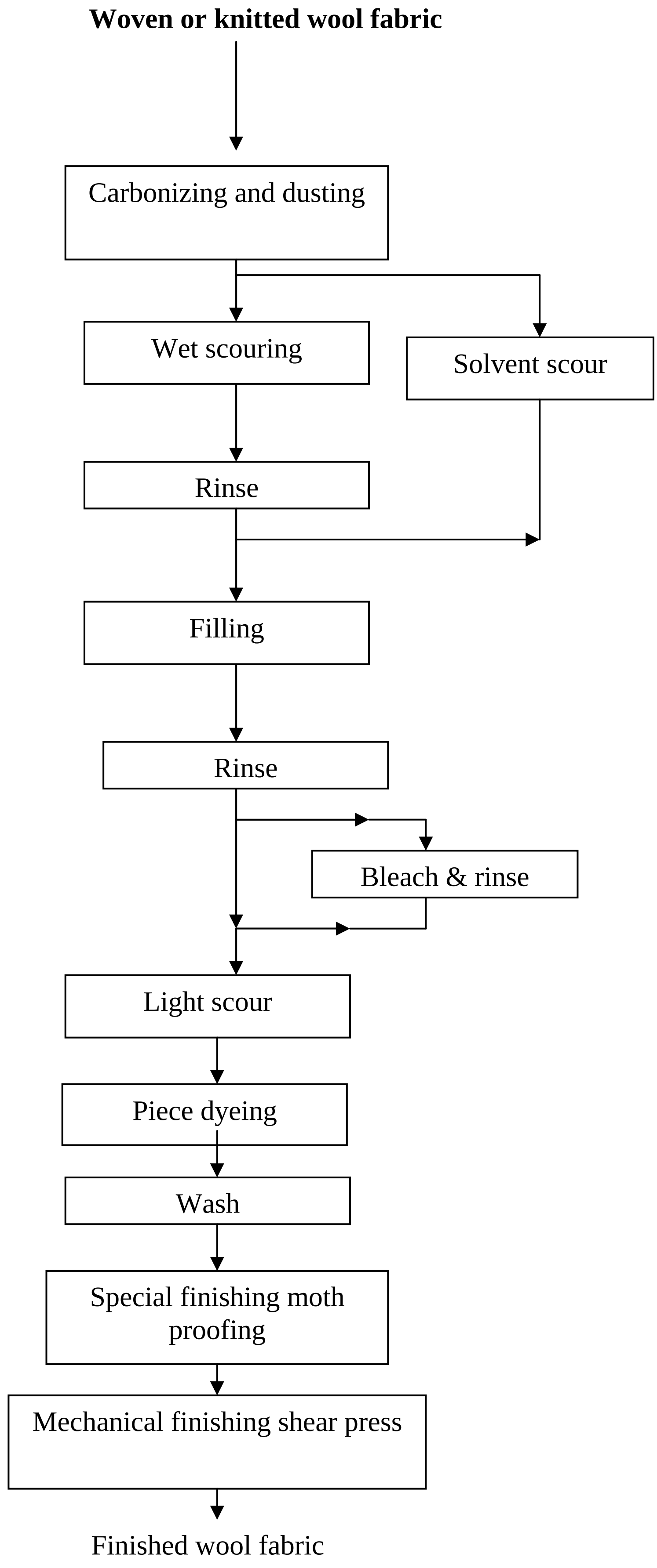


Fig (9) Finishing Wool Fabrics

2.2.4 Garment Industry

Table (8) shows the processes, the raw materials and the products from the processes and the related pollution outputs.

Fig (10) shows the production processes for transforming woven or knitted fabrics into garments, and are explained in the following:

Fabric laying	In this process the fabric is laid on a long table in multilayer arrangement, using a special machine with reciprocating carriage. This process is applied for the main garment fabric, and also the lining fabric.
Placing patterns	After collecting the number of fabric layers, the patterns of the garment are placed on top of the layers, and fixed by special pins.
Cutting	The multilayers are cut according to the patterns by using electric cutter which moves around the patterns to produce garment parts and, similarly lining parts and interlining parts
Sewing	In this process, the garment parts are assembled together by stitching on sewing machines. Also, the lining parts are assembled by sewing operation.
Sticking interlining	In this process, stiffening interlining pieces are heat pressed on some garment pieces, using a special heat press.
Ironing	This is a finishing process to remove wrinkles from garment and give a neat appearance
Packaging	In this process, finished garments are packed in plastic bags, then in carton boxes according to the size.

Table (8) Garment Industry

Process	Input materials	Function	Product	Air emissions	Effluents	Solid wastes	Work environment
Fabric laying and pattern placing (for garment fabric, interlining, and lining	Garment fabric Lining fabric Interlining fabric	Forming multilayer of fabric and fixing pattern on fabric	Arrangement of multilayer fabric with patterns positioned and fixed on.	——	——	——	Particulates dust
Cutting	Multilayer fabric with patterns on	Cutting fabric according to patterns	Garment pieces Lining pieces Interlining pieces	Particulates VOCs from fabrics	——	Fabric scrap Lining scrap Interlining scrap packaging waste	Particulates, VOCs from fabrics and noise
Sticking interlining pieces to garment pieces	Garment pieces and interlining fabric pieces	Heat pressing interlining to fabric pieces	Garment pieces with interlining stuck on.	Adhesive fumes	——	Fabric scrap	Heat and fumes
Sewing	Garment pieces Lining pieces Sewing threads Buttons Zippers etc	Assembling each of garment and interlining, and the two together	Complete assembled garment	Particulates VOCs from fabrics	——	Yarn scrap	particulates Noise
Ironing	Complete garment	Finishing the appearance	Finished garment	——	——	——	Steam Noise
Packaging	Finished garments	Packaging garments	Different sizes of carton boxes	——	——	Carton scrap, plastic bags	——

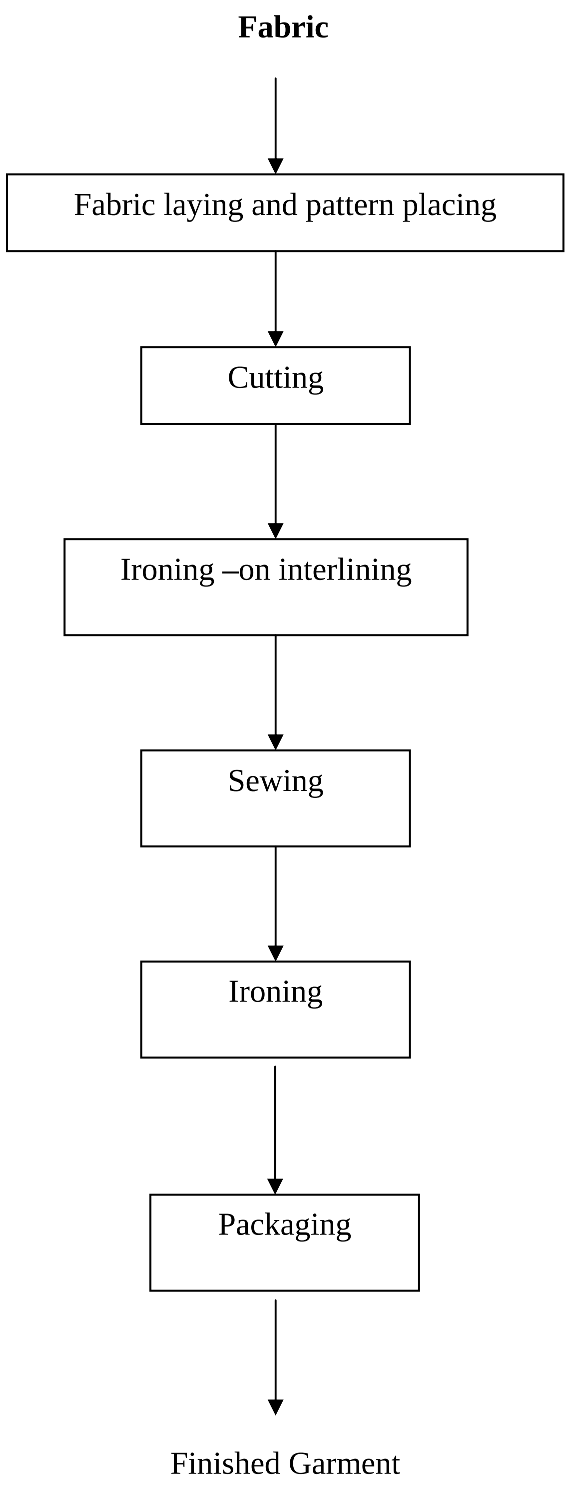


Fig (10) Production Line Of Garment Manufacturing

2.2.5 Man-made Fibre Industry Viscose Rayon

Table (9) gives the processes, the raw materials and products from the processes and the related pollution output.

Fig (11) shows the successive production processes for viscose fibers and filament yarns, as explained in the following :

Soaking in caustic soda	In this process the wood pulp is soaked in sodium hydroxide to produce soda cellulose which is squeezed to remove the extra caustic soda solution .
Shredding	The crumbs of soda cellulose are shredded to produce small flakes.
Ageing	In this process, the shredded soda cellulose is aged for a certain time to adjust the molecular structure.
Xanthating	The aged cellulose is mixed with carbon disulphide to produce by chemical reaction xanthate
Dissolving	The xanthat is dissolved in sodium hydroxide to produce xanthate solution for spinning.
De-aeration and filtration	In this process, the xanthate solution is stored in tanks under vacuum to remove any air bubbles, and is passed through multi stage filters to remove any trash particles, and when the viscose solution is ready for extrusion after a period of ageing, it is pumped to the extrusion spinnerettes
Spinning	Viscose solution is pumped to the spinnerettes, which are Immersed in dilute sulphuric acid bath, and when the solution emerges it reacts with the acid and is solidified to a continuous filament that is subjected to stretching and wound inside a rotating pot to form the viscose yarn package.
Scouring	The viscose yarn packages are scoured and washed to remove residual salts and acid.
Winding	The finished viscose filament yarn is then wound on winding machines to the required forms of packages.
Scouring and crimping	This process***(for filament tows)*** is especially for the production of viscose fibers, and is carried out on a separate production line, where the tows of continuous filaments coming out of spinneretts, are collected scoured, washed, crimped and dried.
Cutting and pressing	At this stage a layer of viscose crimped filaments transforms the filaments to fibers with length similar to cotton or similar to wool. The resulting fibers are pressed into bales as final product.

Table (9) Manufacturing of Viscose

Process	Input materials	Function	Product	Air emissions	Effluents	Solid wastes	Work environment
Soaking in caustic soda	- Purified wood pulp - Caustic soda solution	Chemical treatment	Soda cellulose	Caustic soda vapor	______	Wood pulp scrap	Caustic soda vapor
Shredding	Soda cellulose	Cutting into crumb	Crumb of soda cellulose	______	_____	Spills of crumb	______
Ageing	Crumb of soda cellulose	Adjustment of molecular structure	Aged soda cellulose	______	_____	______	______
Xanthating	Aged soda cellulose, carbon disulphide	Chemical change to xanthate	Xanthate	Carbon disulfide gasses	Cooling water	_____	Sulfide gasses
Disolving	Xanthate, sodium hydroxide solution	Disolving xanthate	Xanthate solution	_______	_____	_____	______
De-aeration and filteration	Xanthate solution	Removing air bubbles from solution, filtering any foreign particularities	Viscose solution ready for spinning	______	_____	_____	______

Table 9 (cont.) Manufacturing of Viscose

Process	Input materials	Function	Product	Air emissions	Effluents	Solid wastes	Work environment
Spinning	- Spinning solution - Sulpheric acid - Sodium sulphate , zinc sulphate	Forcing Viscose solution through spinnerett	Viscose filaments	Sulpheric acid vapour	______	Filament scrap	Acid vapour, noise
Scouring and finishing (for filament yarn)	Cake of filament yarn, sodium sulphide	Scouring and washing from salts and acid	Finished cakes of filament yarn	Water and acid vapour	Wastewater with salts and acid	yarn scrap	Spills of wastewater, noise
Scouring and finishing, and crimping (for filament tows)	Collected filament tows, sodium sulphide	Scouring, washing, and crimping	Scoured, finished, and crimped tows	Water and acid vapour	Waste water with salts and acid	_____	Spills of wastewater, noise
Cutting and pressing into bales	Collected finished filament tows	Cutting filaments into staple fibres cotton – type or wool – type	Bales of staple fibres cotton or wool type	Particulates	_____	Fibres	Particulates, noise

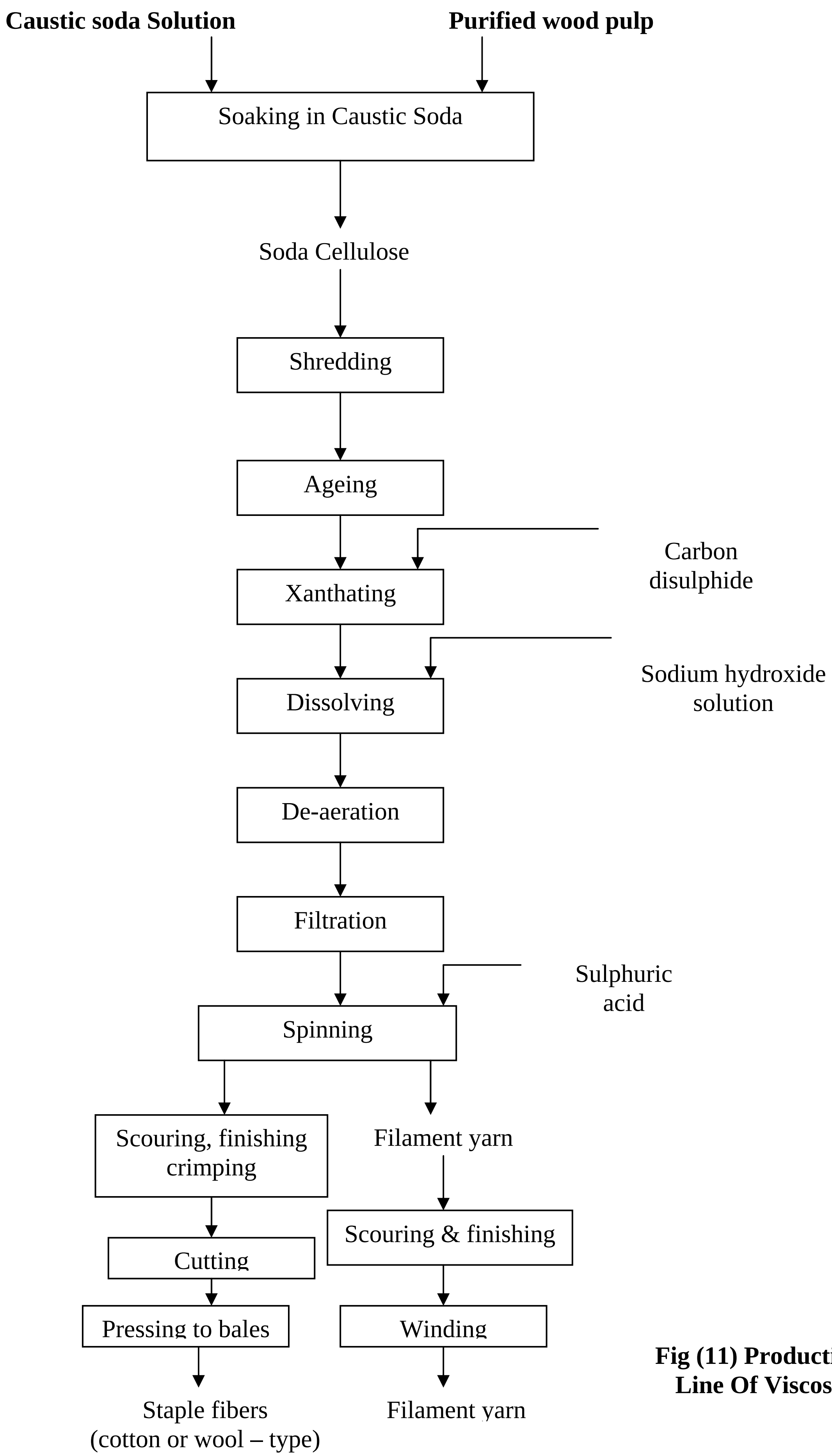


Fig (11) Production Line Of Viscose

a) Nylon Production

Table (10) gives the processes, the raw materials and products from the processes and the related pollution outputs.

Fig (12) shows the production processes for manufacturing nylon fibers and nylon yarns, as explained in the following:

Polycondensation	This is a chemical process to produce the nylon polymer using caprolactum and acetic acid.
Chipping	The nylon rope produced from the polymerization process is cut into chips.
Melting	In this stage nylon chips are melted to reach the viscosity suitable for pumping to the spinning process.
Spinning	In this process, molten nylon is pumped to spinnerettes, and the polymer streams coming out are cooled by blown air that let the polymer solidifies and form continuous nylon filament.
Drawing and twisting	The nylon yarn produced in the previous process is subjected to stretch, is given twist and is wound on a bobbin .
Texturing	This process subjects the filament yarn to heating, then inducing crimp in the filament and then cooling the filament, thus forming a textured nylon yarn.
Drawing and crimping	This process ***(for fibre production)*** is in the production line of nylon fiber in which filament tows from spinnerettes are collected to form a sheet which is subjected to stretch and crimping to give the required degree of crimp and fineness.
Cutting and pressing	In this process the collected tows of nylon filaments pass through a cutting machine which cuts the filaments into fibers with length similar to wool fibers. The resulting nylon fibers are pressed into bales with polyethylene cover

Table (10) Manufacturing of Nylon

Process	Intput materials	Function	Product	Air emissions	Effluents	Solid wastes	Work environment
Polycondensation	Caprolactum, acetic acid	Forming the polymer	Nylon polymer rope	Acid vapour	Wastewater for cooling nylon polymer, acetic acid	_____	Acid vapour, heat
Chipping	Nylon polymer rope	Cutting polymer rope into chips	Nylon chips (or pellets)	_____	_____	Nylon chips	Noise
Melting	Nylon chips	Heating up chips to melt	Molten Nylon	_____	_____	Nylon chips residual monomers	Heat
Spinning	Molten nylon	Pumping polymer into spinnerette	Nylon filaments on spools	Nitrogen, volatilised additives, organic finishes	Water contaminated with additives, other organic	Filaments, residual finishes, empty containers	Nitrogen, heat, noise
Drawing and twisting for yarn production	Nylon filament	Drawing filaments, twisting to yarn	Filament yarn	_____	_____	Yarn scrap	Yarn scrap, noise
Texturing	Filament yarn	Changing from silky yarn to textured yarn	Textured filament yarn	_____	_____	Yarn scrap	Noise
Drawing and crimping	Collected filament tows	Adjusting filament fineness, and crimping	Drawn and crimped filament tows	_____	Wastewater with chemicals	_____	Noise
Cutting	Collected filament tows	Cutting filaments into staple fibres	Nylon staple fibres (wool- type)	_____	_____	Fibres	Noise
Pressing into bales	- Bulk of staple fibres - Polyethylene sheets -Polypropylene strips	Packaging fibres in bales	Bales of nylon fibres (wool – type)	Particulates	_____	Fibres	Particulates, noise

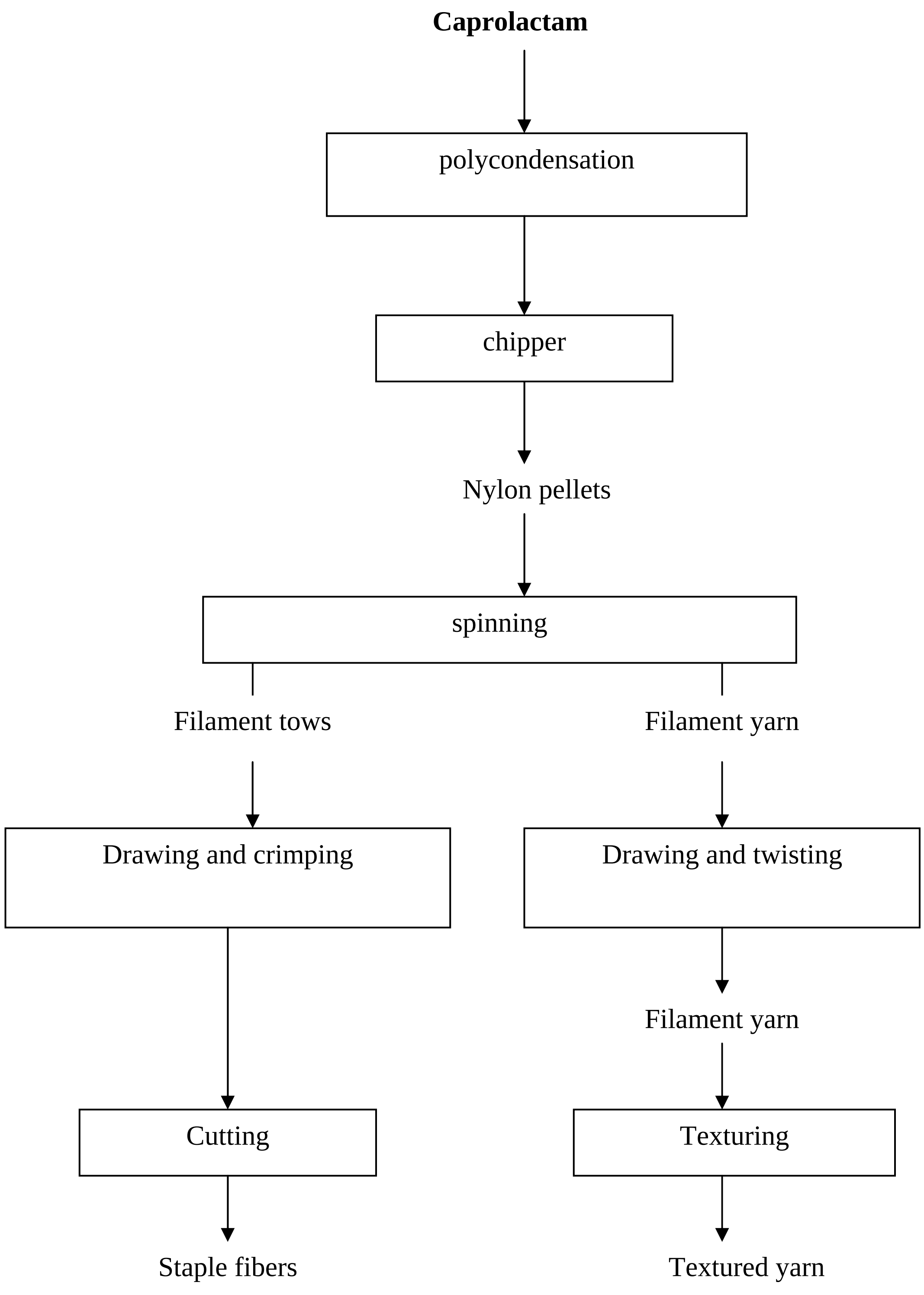


Fig (12) Production Line Of Nylon

b) Polyester Production

Table (11) gives the processes, the raw materials and products from the processes and the related pollution outputs.

Fig (13) shows the production processes for manufacturing polyester fibers and yarns, as explained in the following:

Production of ester building unit	In this process a chemical reaction is carried out between monoethylene glycol and dimethyl terephthalate to produce diglycol terephthalate.
Polymerization	In this process ***(for fiber production)*** polymerization occurs to diglycol terephtalate to produce polyester polymer.
Spinning	In this process, molten polyester polymer is pumped to the spinnerettes and the filaments come out to meet a stream of cold air and get solidified. The resulting filament tows collected in cans feed the next stage. The fineness of the resulting filaments depend on the size of the spinneret holes.
Tensioning and crimping	In this operation, the large number of tows are fed as a layer to a stage of tensioning and crimping, to adjust the fiber fineness and crimp.
Cutting and pressing	The filament sheet is introduced in this stage to a cutting machine which transforms the polyester filaments to fibers with length similar to cotton length or similar to wool length. The resulting fibers are pressed into bales and covered with polyethylene sheets.
Spinning	In this process ***(for filament yarn)*** the number of filaments coming out of the spinneret is much less than in the case of fiber production. The produced yarn in this process is known as “poy” yarn which needs further processing to produce the required yarn
Ring-twisting	In this stage poy yarn is drawn, twisted and wound to produce polyester filament yarn.
Texturing	In this process the polyester “poy” (preoriented yarn) is passed in a texturing machine which induce crimp in the filaments, resulting polyester textured yarn.

Table (11) Manufacturing polyester

Process	Intput materials	Function	Product	Air emissions	Effluents	Solid wastes	Work environment
Production of ester building unit	- Monorthylene glycol - Dimethyl terephthalate	Reacting the exchange of ester	Diglycol terephthalate	_____	Methanol Glycol	_____	Heat
Polymerization	- Diglycol terephthalate	Forming the polymer	Polyester polymer	- Methanol vapour - Glycol vapour	_____	Waste polymer	Radiation of Cs,or Co volatile monomers
Spinning (for producing tow)	- Molten Polyester polymer	Pumping polymer through spinnerette	Polyester filament tow	Volatile finishes other organics	Wastewater with oils additives, finishes organics	Filament waste chemicals, oil residues	VOCs, noise
Tensioning and crimping	- Collected filament tow - Finishing oils	Adjusting filament denier, and crimping the filaments	Drawn and crimped Collected filament tow	Volatilised finishes	Wastewater with finishing chemicals	Filament waste	VOCs, noise
Cutting	- Finished collected tows	Cutting filaments into staple fibres	staple fibres (cotton typeor wool – type)	Particulates	____	Fibre waste	Particulates, noise
Pressing into bales	- Bullk of staple fibres - Polyethylene sheets - Polypropylene strips	Pressing polyester fibes into bales	Bales of polyester fibres (cotton – type, or wool – type)	Particulates	_____	Fibre and ethylene Wastes	Particulates, packaging waste
Spinning (polyester filament yarn)	- Molten polyester polymer	Pumping molten polymer through spinnerette	Preoriented filament yarn (POY)	Vapour of finishing oil	Wastewater and finishing oils	Yarn scrap	VOCs, noise
Ring – twisting	- POY filament yarn	Drawing andtwisting filament yarn	Polyester filament yarn	_____	_____	Yarn scrap	Noise
Texturing	- POY yarn	Crimping the filaments in the yarn	Textured yarn	_____	_____	Yarn scrap	Noise

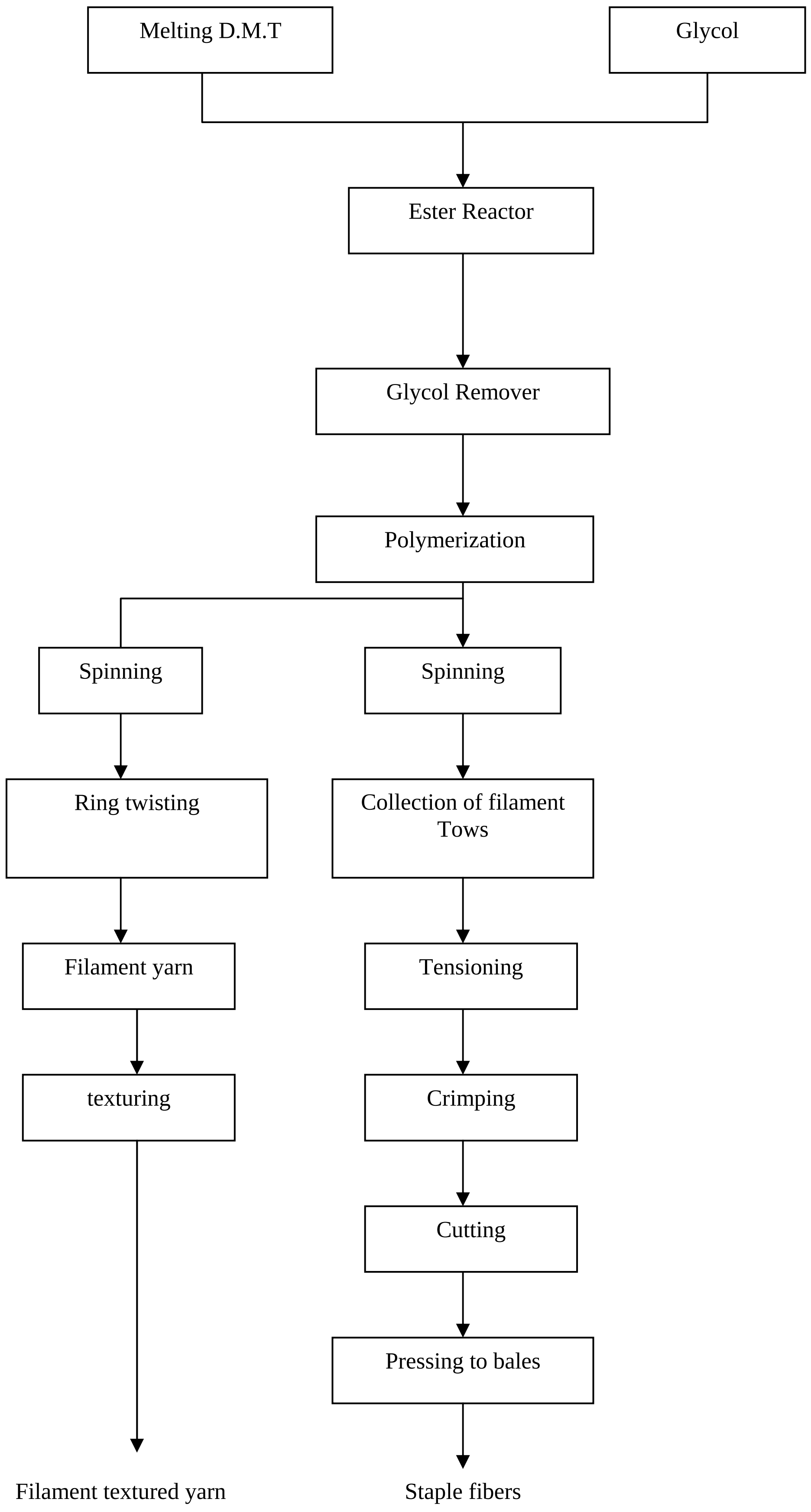


Fig (13) Production Line Of Polyester

2.3 Service Units: Description and Potential Pollution Sources.

Medium and large size facilities will have some or all of the following service and auxiliary units. Very small garment manufacturing facilities may not have any of these service units. These units can represent sources of pollution and should be inspected and monitored accordingly.

2.3.1 Boilers

Boilers are used to produce steam for:

- heat supply to the processes (scouring, sizing, dyeing, drying, ..etc.)
- electric power generation (in some large plants)

Fuel is burned in boilers to convert water to high pressure steam, which is used to drive the turbine to generate electricity. Steam can also be developed at lower pressures for the industrial processes. The gaseous emissions, due to boilers 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 (SOx and Nox) and volatile organic compounds (VOCs)

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

Wastewater is generated due to the 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. The steam condensate from the production processes, may return to the boiler (closed circuit) or discharged as wastewater causing pollution source to effluents.

2.3.2 Water Treatment Units

There are different treatment processes, depending on the water source and the application in the industry.

i) ***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.

ii) ***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 trorditional 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.

iii) ***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 Cooling Towers

Cooling water is used in some textile processes especially man-made fibers, such as in the production of viscose during mixing soda cellulose with carbon disulphide and the chemical reaction creates large amount of heat in the mixer which should be cooled by water. Cooling towers provide the means for recycling water and thus minimizing its consumption. The cooling effect is performed through partial evaporation. This causes an increase in the concentration of dissolved salts which is controlled by purifying some water (blowdown). The blowdown will be high in TDS and will represent a source of pollution to the wastewater to which it is discharged.

2.3.4 Laboratories

Laboratories are responsible for:

- Testing raw materials (fibers, yarn, fabrics), chemicals (dyes, detergents, …etc.), water, wastewater, …etc. to check compliance with required standards
- Quality control of product during processing and of the final product to check agreement with standard specifications
- The textile industry involves many tests dealing with chemicals that may be hazardous and need proper handling and precautions when dealing with these chemicals.

2.3.5 Workshops and Garage

Large textile facilities have electrical and mechanical workshops for maintenance and repairs of machines. Environmental violation could be due to:

- Noise
- Rinse water contaminated with lube oil

Pollution in the garage 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 system or selling it to recycling stations.

2.3.6 Storage Facilities

The specifications for the storage facilities depend on the nature and properties of the stored material

- Textile raw materials are fibrous, which are flammable and should be stored under fire precautions. If cotton bales are stored outdoor of the facility, they should be covered with fire resistant tarpaulins.
- The textile wet processes use a large number of chemicals, many of them are hazardous and require special storage, handling and management procedures as required by law.
- Powder dye storage should be equipped with a ventilation system to draw air polluted with powder dye away from the breathing zone of the worker preparing a dye dose from dye container. Powder dye is recommended to be stored in small containers so that the worker can avoid putting his face into large containers to take the required dose and exposing his breath to hazardous air emissions.
- The storage of the finished products should also be equipped with fire precautions, because yarns fabrics and garments are flammable fibrous materials. When storing resin-coated fabrics, they should be packaged to avoid the release of formaldehyde and the storage should be ventilated.
- In the production of polyester, methanol is obtained as a by-product, and as it is flammable, it should be stored in a separate storage with fire precautions.
- Fuel used for boilers, cars and trucks should be stored in underground or over ground tanks but at locations away from the textile processes or the material and product stores, and they should be equipped with fire precaution system.

2.3.7 Wastewater Treatment Plants (WWTP)

The textile industry has many wet processes which consume large quantities of chemicals and result in large amounts of polluted wastewater. This wastewater needs to be treated before being discharged to surface water, or to the public sewer. The wastewater treatment unit can remove the suspended matter, the heavy metals, …etc. so that the specifications of the treated wastewater are in compliance with the regulations of the law. In the textile wet processes, the condition of the process is steady, in a continuous manner, and there is no peaks of pollution except in rare situations. This helps to control and inspect wastewater and to treat it properly.

The potential pollution sources from WWTP are:

- Metal bearing sludge which could represent a hazardous waste problem. Proper disposal management is required.

- Treated water could represent a water pollution problem if not complying with relevant environmental laws.

2.3.8 Cotton Dust Scavenging Unit

The major source of pollution in the textile dry processes, such as spinning, weaving, knitting, ..etc., is the cotton dust and fiber particulates. In case of high speed machines, the concentration of this pollution increases. So, scavenging systems are necessary to withdraw the polluted air from the working environment and collect it in filters enclosed in a special room. When this system is out of order, the concentration of cotton dust and fuzz may exceed the limit allowed by law.

2.3.9 Restaurants, Washrooms and Housing Complex

These facilities if exist will generate domestic wastewater as well as domestic solid waste that needs scheduled disposal.

2.4 Emissions, Effluents and Solid Waste

The previous tables (1 to11) summarize the major pollutants in the textile industry processes.

2.4.1 Air emissions

Although the textile industry is a relatively minor source of air pollution as compared with other industries, it emits a wide variety of air pollutants, especially from the wet processes, such as resin coating, printing, dyeing, ..etc, and from the dry processes such as cotton dust and fiber particulates. The textile mills usually generate nitrogen and sulphur oxides from boilers. This wide range of pollution makes sampling, analysis treatment, and prevention more complex.

The main sources of air emissions in the textile industry are:

- Cotton dust and fiber particulates are generated in the dry processes, such as cotton spinning, weaving, knitting, ..etc. Cotton dust contains bacteria, fungi, pesticides, soil, vegetable matter, ..etc.
- Volatile organic compounds (VOCs) from solvents used in scouring, methanol from PVA used in sizing, formaldehyde emitted from resin coated fabrics, glycol ethers used in desizing, and ethylene glycol, urea, kerosene emitted in printing.
- Nitrogen oxides, sulphur oxide and carbon monoxide resulting from sizing of natural cellulose fabrics
- Chlorine, chlorine dioxide, resulting from the bleaching process
- Oil and acid fumes, emitted from carbonizing process used in wool yarn manufacturing as sulphuric acid fumes. Formic acid fumes from finishing wool fabrics.
- Hydrocarbons and ammonia emitted from the printing process.
- Formaldehyde emitted from resin finishing of fabrics, and is also released from bulk resin storage tanks, finished fabric warehouses, dryers and curing ovens.

- Methanol vapor from the polymerization process in the manufacturing of polyester fibre, and it may also be emitted from finishing operations where methanol-etherated formaldehyde resins are used.
- Toluene may be emitted when used in solvent coating operations.
- Xylenes are emitted when used in printing operations.
- Ammonia is emitted when used in printing, preparation and dyeing processes.
- Methyl ethyl ketone may be used in solvent coating operations for fabrics, and causes polluting emissions.

2.4.2 Effluents

The textile industry uses high volumes of water throughout the wet processes, for sizing, scouring, bleaching, dyeing and washing of finishing products. This will result in large volumes of wastewater loaded with a wide variety of chemicals used throughout processing, and represents a major source of pollution if not properly treated before discharge to the environment.

The main sources of effluent pollution are:

- Hazardous organic materials, such as pentachlorophenol (PCP) which is anti-mildew preservative agent, used in size recipe and is removed from the fabric during scouring and finishing operations and discharged into the wastewater.
- Biological Oxygen Demand (BOD), due to the size substances removed in the desizing process, which often contributes to 50% of the BOD load in wastewater from wet processing
- Chemical Oxygen Demand (COD), due to dye bath chemicals which contribute 25-35% of COD in the wastewater
- Residual dyes and auxiliary chemicals in spent dye bath and wastewater.
- Salts, used in direct and fiber reactive dyes on cotton can produce wastewater with salt level well above the regulatory limits.
- Heavy metals, such as copper, cadmium, chromium, nickel, and zinc may be found in textile mill effluents, caused by fiber, incoming water, dyes, plumbing, and chemical impurities. Dyes may contain metals such as zinc, nickel, chromium, and cobalt. These metals are functional in some dyes, and as oxidizing agent for sulphur dyes. In dye house effluent, heavy metals arise as a consequence of heavy metal salts used in dying.
- Natural and synthetic polymers are generated in wastewater of the finishing processes, together with a range of other potentially toxic substances.
- Suspended fibers, grease, suspended material, resulting from the scouring processes.
- Color remainder from dyeing and printing processes is a source of pollution in the effluents, because in typical dyeing and printing processes, 50-90% of color is fixed on the fiber, while the remainder is discarded in the form of spent dye baths or in wastewater from subsequent textile-washing operations.
- High temperature in effluents due to desizing, scouring, washing, …etc.

- High pH in the effluents resulting from scouring and mercerization, due to the use of alkalis and surfactants
- Toxic metals and chemicals in effluents resulting from dyeing processes of both cotton and wool fabrics, and printing and finishing of cotton fabrics.

2.4.3 Solid Wastes

- The primary residual wastes generated from the textile industry are non-hazardous, such as fiber flocks, scraps of fabric and yarn, off-specification yarn and fabric and packaging waste.
- Wastes associated with the storage and production of yarns and textiles, such as dye and chemical storage drums, cardboard reels for storing fabric and cones used to hold yarns for dyeing.
- Cutting room waste in garment industry, generated at high volume of fabric scraps, and flock waste, resulting from shearing process of tufted carpets.
- Cotton dust, trash, fiber particulates, resulting from opening and carding processes, and withdrawn by air suction from machines to bag filters.
- Dirt, wool fibers, vegetable matter, grease and waxes, resulting from wool scouring.
- Fiber, wasted sludge and relained sludge, resulting from wastewater treatment plant.

2.5 Noise Pollution

The textile industry uses a wide variety of machines, running at high speeds and causing high level of noise which may violate the limit allowed by law (90 decibel). The dry textile processes causing noise pollution are such as preparation for spinning, ring-spinning, winding, weaving, sewing, ..etc. Modern machines run at very high speeds and are expected to violate the environmental laws for noise. The textile wet processes, although they generate less level of noise relative to the dry processes, but they still cause noise pollution

3. Environmental and Health Impacts of Pollutants

The major sources of pollution in the textile industry, causing health impacts are the cotton dust and fiber particulates from the dry processes, the vapors and fumes of acids and chemicals used in the wet processes, and the nitrogen and sulphur oxides from boilers. These polluting sources have health impacts on the workers, and environmental impacts due to the discharge causing lowering of dissolved oxygen, damage to aquatic life, and exposure to toxic effects for downstream water users.

Tables (12 to17) Summarize the environmental and health impacts in the different textile processes.

Table 12 Health and Environmental Impacts in Spinning Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Cotton Spinning				
Opening	Cotton dust(soil, particulates, bacteria, fungi, pesticides	Byssinosis (brown lung) diseuse, risk of chronic bronchitis	_____	_____
Spinning	_____	_____	_____	_____
Wool spinning				
Scouring	Detergents, NaSO4, soaps, alkalis, H2SO4 (for grease recovery)	VOCs (solvents) may cause bloating, Diarrhoea. Irritant to eyes and skin. Cationic detergent is more toxic	High BOD, high pH disturbance of aquatic life. Not readily degradable, COD	Sludge containing toxic substances
Carbonizing	H2SO4, Na2CO3 (for neutralization)	Acid fumes cause irritation of the eyes, nose and throat	Occasional acid bath dumps, stains the skin brown to yellow.	Charred carbon residue, which affects respiratory system
Spinning	Noise (causes hearing problems)	Particulates	_______	________

Table 13 Health and Environmental Impacts in Fabric Formation Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Sizing	Natural starch, polyvinyl alcohol, carboxymethyl cellulose, oils, waxe s, adhesives Urea, diethylene glycol, etc.	VOCs, methanol from PVA, is toxic at high levels, causing central nervous system damage and blindness Higly flamable, forms air pollutants	Washing residues cause high BOD and COD, metals (from size additives) causing disturbance of aquatic life	_______
Weaving	Noise causes hearing disabling, particulates	Particulates cause respiration and hearing problems	_______	_______
Knitting	Particulates, noise, but less than weaving, not causing much problems in hearing	Particulats affect health	_______	_______
Nonwoven	Chemical adhesive and particulates	VOCs, cause respiratory troubles	_______	_______
Tufted	Resin coating causing formaldehyde	Formaldehyde kills tissues, intense irritation of eyes and nose and headaches carcinogenic.	_______	_______

Table 14 Health and Environmental Impacts in Finishing Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Singeing	Small amounts of exhaust gases, negligable impact	_______	_______	_______
Desizing	- Enzymes or H_2SO_4 for starch, detergents and alkali for PVA and CMC	May cause bloating and Diarrhoea. Irritant to eyes and skin	High BOD or COD, high temperature, size impurities, lubricants, metals.	Residues of solvents
Scouring	NaOH,Na_2CO_3, surfactants, chlorinated solvents	Non-ionic detergents may cause bloating and Diarrhoea, Irritant to eyes and skin.	High BOD and temperature, very high PH, fats, waxes, size residues, causing disturbance of aquatic life	_______
Bleaching	-Hypochlorite - Hydrogen - peroxide - Acetic acid	Chlorine gas released, causing severe irritation of respiratory tract and eyes tract and eyes Toxic gases	Low to moderate BOD, high pH and temperature	_______
Mercerization	NaOH, surfactants, acid, liquid ammonium	_______	Very high pH and dissolved solids, some BOD	_______

Table 14 (cont.) Health and Environmental Impacts In Finishing Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Dyeing	- Dyestuffs - Auxiliaries - Reductants - Oxidants - Dye dust is a main source of pollution for breathing or skin	- Amonia is irritating to the skin, eyes nose, throat, and upper respiratory system. Basic dye is generally toxic (e.g. crystal violet) - Potassium dichromate can cause dermatitis and ulceration, it is carcinogenic - Exposure to dye dust through breathing or skin can result asthma, eczema, and severe allergic reactions.	- Heavy metals e.g. (Cu,Cr) - Carcinogenic amines - Toxic compounds, e.g. carriers - H_2S - Corrosion, - Irritant - For wool dye, high BOD, possibly toxic, and pH low	Chemical residues can cause allergic reactions to skin or respiratory system.
Printing	-Dyes(acids or alkalis), pigments, kerosene, binders, other additives - Ammonia - Xylenes	- Formaldehyde causes intense irritation of eyes and nose, and headaches. It is carcinogenic - Kerosene causes nausea, vomiting coughing, leading to respiratory paralysis - Amonia vapour is severe irritant to eyes, causes vomiting, diarrhoea, sweating and coughing. High concentration can cause respiratory arrest.	- Heavy metals (toxic) - Carcinogenic - Irritants - Fire hazard - High BOD& COD depending on type of thickener - Disturbance of aquatic life, eg. urea and phosphate	Chemical residues can be irritant and toxic.
Chemical finishing: - Anticrease - Flame proofing - Softening	- CH_2O - Phosphorus - Softeners - Fluorinated chemicals - Catalyst - Formaldehyde - Amonia	Intense irritation of eyes and nose and headaches. Carcinogenic. Causing vomiting, and coughing. High concentration can cause respiratory arrest.	- BOD and COD - Carcinogenic - Skin allergies - Heavy metal toxicity	Chemical residues can be hazardous and toxic
Water-proofing	- Paraffin - Aluminium salts - Zircon salts - Silicone - fluorocarbon resins	- Toluene may be used in solvent coating operations can cause, headaches, confusion weakness, and memory loss, and affects function of kidney and liver , formation of ozone which causes asthma	Fluorocarbon resins may cause disposal problems BOD,COD	Chemical residues may contain hazardous chemicals.

Table 14 (cont.) Health and Environmental Impacts In Finishing Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Antistaic finishing	Surface- active substances	Possibly skin allergies	BOD,COD, additive residues	Resin residues may be skin allergy
Anti-felt finish (for wool)	- Chlorine - Polyamide - Epich chlorohydrin resin	Chlorine vapour is hazardous, and can cause respiration problems	Large quantities of effluent with COD	_______
Moth and beetle protection (for wool)	- Chlorinated sulphonamide derivatives - Biphenyl ether - Urea derivatives - Pyrethroids	Pyrethroids may cause neuro toxic effects	COD	Chemical residues may be hazardous
Weighting	- Stannic chloride - Sodium phosphate - Water glass	VOCs, combustion exhausts have effect on skin	Large quantities of effluent with COD	Chemical residues may be hazardous
Hydrophilising	- Polyamide - Polyacrylic - Silicon	VOCs, possibly skin allergies	Large quantities of effluent with COD	Chemical residues may be hazardous
Delustering	- Phenol - Turpentine - Pine oil - Glauber salt - Barium chloride -Resins containing formaldehyde - Alkali sulphide	- Allergy inducing - In some cases carcinogenic substances	COD, heavy metals	Chemical residues may be hazardous
Abrasion resistant finish	- Silica gel - Plastic resins	VOCs, causing irritation of respiratory system. Skin allergies	Large quantities of effluent with COD, toxicity	Chemical residues may be hazardous
Sanforizing	- Urea formaldehyde - Melamine formaldehyde	- Skin allergies - Carcinogenic properties	- Wastewater, BOD - Toxicity,	Resin residues may be carcinogenic

Table (15) Health and Environmental Impact in Garment Industry

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Cutting fabrics	No chemicals Particulates	Little effect on respiratory system	_______	_______
Fusing the interlining to fabric pieces	Fumes of interlining adhesive resin, and fabric finish	Slight effect of adhesive fumes on respiratory system (VOCs)	_______	_______
Sewing	Particulates	Negligable effect on respiratory system	_______	_______
Ironing	Fumes from fabric	Negligable effect on respiratory system	_______	_______

Table (16) Health and Environmental Impacts in Man-made Fiber Manufacturing

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Viscose Rayon				
Soaking in caustic soda	Caustic soda solution	Vapour of caustic soda causes some allergies	_______	_______
Xanthating	Carbon disulphide	Vapour of carbon disulphide and Hydrogen sulphide may affect respiratory system	_______	_______
Spinning	Sulpheric acid, sodium sulphate, zinc sulphate	Vapour of acid and chemicals irritate respiratory system	_______	Yarn scrap with acid and chemical may be hazardous
Scouring and finishing	Sodium sulphide	Vapour of acid, and chemicals may affect respiratory system	Wastewater containing acids, low pH and organic substances	_______
Nylon				
Polymerization	Caprolactum, acetic acid	Exposure to acetic acid gas or spray can cause intense irritation of the eyes, nose, throat and skin damage	_______	_______
Spinning	Finishing oils, mineral oils, Nitrogen gas. Noise	Negligable effect on health. Nitrogen may have an effect. Noise may affect hearing	Wastewater containing oils, reducing the dissolved oxygen	_______
Texturing	- Low molecular fractions of polymer - Spin finishes - Additives	Exhaust air may be hazardous to respiratory system	Wastewater containing finishing chemicals and sdditives	_______

Table (6) cont. Health and Environmental Impacts in Man-made Fiber Manufacturing

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Polyester				
Polymerization	- Cobalt 60, for level control of cotton type polyester - Cesium 137 for level control of wool-type polyester - Methanol results from easter- exchange reactor	- Level of radiation may have serious effect. - Volatilised monomers and additives - Methanol is toxic to humans. At high dose levels causes central nervous system damage and blindness.	———	———
Spinning	———	———	———	———
Tensioning	Finishing olis, and water	———	Wastewater containing chemicals, reducing the dissolved oxygen	———

Table (17) Health and Environmental Impacts In Service Units

Process	Chemicals used	Impact of gaseous emissions	Impact of effluents	Impact of solid wastes
Transportation	- Vehicle exhausts, gasoline fumes	Gasoline fumes cause irritation of respiratory system	Oils reduce dissolved oxygen	_____
Boilers and steam system	- Naphtha, coal, natural gas, oil fuel	Particulates, burning exhausts, cause irritation of respiratory system	Wastewater with precipitated salts reduces the dissolved oxygen	_____
Water treatment	- H2So4 / Hcl and NaOH (for ion exchange) - NaCl (water softening), trisodium phosphate (boiler water), chlorine or hypochlorite (for water disinfiction)	_____	_____	Chemical residues may be allergic.
Wastewater treatment.	- Alum or ferric salts, flocculant polymers, H2SO4 / HCl and NaOH / CaO, - Nutrients (urea, phosphoric acid, ammonium phosphate)	VOCs from fabric chemicals, vapours and mists, may cause, irritation of respiratory system	_____	Wastewater sludge may cause skin irritation

3.1 Impacts of the Main Pollutants on Health

Cotton dust	Cotton dust can result in serious health problems. The first symptoms of disease are difficulty in breathing. If exposure above the legal limit continues, workers may develop byssionsis, also known as “brown lung” disease. Damage at the advanced stages of the disease is permanent and disabling. Exposure to cotton dust also leads to increased risk of chronic bronchitis and emphysema.
Formaldehyde	Formaldehyde kills tissues and depresses cell functions. It causes intense irritation of eyes and nose and headaches. Formaldehyde also causes carcinogenic effects.
Methanol	Methanol is toxic at high levels, causing damage to central nervous system, and may cause blindness. Methanol is highly flamable, causing risk of fire. In the body, methanol is converted into formaldehyde and formic acid.
Detergents & solvents	Volatile organic chemicals may cause bloating, and diarrhoea, and they are irritant to eyes and skin. Cationic detergent is more toxic.
Acid fumes	Acid fumes, such as fumes of sulphuric acid cause irritation of the eyes, nose and throat
Sodium hypochlorite	This bleaching chemical is highly toxic and is now strictly limited or banned in many countries. It can also break down to form absorbable organo-halogen compounds, which are both toxic and carcinogenic. Many cotton processing factories use hypochlorite as it is cheaper than the other more safe substitue hydrogen peroxide. Hypochlorite also causes severe irritation, skin and mucous membrane damage. Chlorine gas released from hypochlorite causes servere irritation of respiratory tract and eyes.
Hydrogen peroxide	Strong solutions can produce burns if left on skin
Toluene	Inhalation or ingestion of toluene can cause headaches, confusion, weakness, and memory loss. Toluene may also affect the way the kidneys and liver function.
Xylene	Xylenes are rapidly absorbed into the body after inhalation, ingestion, or skin cotact. Short-term exposure of humans to high levels of xylenes can cause irritation of the skin, eyes, nose, and throat, difficulty in breathing, imparied lung function, impaired memory, and possible changes in the liver and kidneys. Both short and long term exposure to high concentrations can cause effects such as headaches, dizziness, confusion, and lack of muscle coordination.

Acetic acid	Exposure to gas or spray can cause intense irritation of the eyes, nose and throat can cause skin damage.
Ammonia	Anhydrous ammonia is irritating to the skin, eyes, nose, throat, and upper respiratory system. 100 ppm causes irritation, vomoting, diarrhoea, sweating and coughing
Methyl Ethyl Ketone	Breathing moderate amounts of methyl ethyl ketone (MEK) for short periods of time can cause adverse effects on the nervous system ranging from headachs, dizziness, nausea and numbness in the fingers and toes, to unconciousness. Its vapours are irritating to the skin, eyes, nose and throat, and can damage the eyes. Rebeated exposure to moderate to high amounts may cause liver and kidney defects.
Carbon disulphide	Contact for more than a few minutes can cause second degree burns. Inhalation of 100-1000 ppm can cause fatigue, vomoting, headaches and constipation.
Carbon monoxide	Reduces blood oxygen-carrying capactiy, causing dizziness, weakness, headache. Concentrations above 1000 ppm can be fatal within one hour.
Carbon dioxide	Carbon dioxide is generated due to combustion of fossil fuels to produce steam for electricity generation and for the wet textile processes. This gas absorbs the heat radiation from earth, thus causing heat to be trapped and surface temperature of earth to increase.
Nitrogen oxides	Cause severe irritation of eyes and respiratory tract. High concentrations can cause immediate asphyxia.
Sulphur oxides	Inhalation of low concentrations causes burning pain in chest.
Particulates	Cause irritation of respirtory system. Fever and coughing are frequent symptoms. Powder dye particulates may be hazardous during preparation of dye recipe from large dye containers
Kerosene	Kerosene causes vomiting, coughing, leading to respiratory paralysis.
Chlorinated aromatics	Have carcinogenic effects

3.2 Impacts of the Main Pollutants on Environment

The huge volumes of water and the wide range of chemicals used in the wet textile processes generate high load of polluted wastewater. These large volumes of effluents can cause damage to the environment if dischared into aquatic bodies without treatment. The discharge of polluted watewater into surface water lowers the dissolved oxygen, damages the aquatic life and exposes downstream water users to possible toxic effects.

The watewater resulting from the wet processes contains suspended solids, fibres, solvents, metals, urea, foam, BOD, COD, toxic materials, …etc. These polluted effluents need to be treated chemically to remove the hazardous materials and chemicals so that the wastewater will comply with the limits in the law and can be discharged into the public sewer or into aquatic bodies.

3.3 Impacts of the Main Solid Wastes

The majority of textile solid wastes are fibres, yarns, fabrics, packaging waste, dye containers, chemical containers, dirt, vegetable matter, waxes, wasted sludge and retained sludge, paper, cartons,...etc.

The hazardous solid wastes are the sludge, and the dye and chemical containers, as they contain toxic material, and dealing with wastes for disposal may expose the workers to toxic effects.

3.4 Impact of Noise

The noise level resulting from the machines used in the textile industry, especially from the dry processes, may violate the limit allowed by the law and cause hearing diseases or damage of hearing ability for workers around the machines. The ring spinning machines, the open-end spinning machines, the winding machines, the looms, the sewing machines, …etc. are used with a large number and at very high speeds, thus expected to exceed the allowed level of noise (90 decibel) and cause hearing troubles to the production workers.

3.5 Impacts on Ambient Environment

- The ambient environment in the surrounding area of the textile facility is affected by the emissions from the boiler station, such as carbon monoxide, nitrogen oxides, sulphur oxides, and other particulates depending on the type of fuel. The people living around the facility are exposed to respiratory diseases
- The surrounding area is also affected by the fiber fuzz in case of facilities not using scavenging systems, and depending on ventilation through factory windows. This situation may have effect on the respiratory diseases of people living in the area.
- The dry processes of the textile industry generate a high level of noise that may have impact on the ambient environment, causing hearing problems for people living in the area.

3.6 Summary of the Emissions and their Degree of Pollution I mpact

Tables (18) , (19), (20) and (21) summarize the emissions (wastewater, gaseous, particulates and solids) and their degree of pollution impact for the different textile processes (H=high, L=Low)

Table (18) (World Bank, Paris Commission, Helsinki Commission)

Process	Major Constituents	Characteristics	Pollution impact Low, Medium, High
Sizing	- Starch derivatives	BOD	H
	- Semi-synthetic sizing agents (CMC, CMS)	COD	M
	- Synthetic sizing agents (PVAs, polyacrylates)		
	- Additives :		L
	>urea	Temperature	M
	>glycerin		H
	>waxes and oils		H
	>preserving agents		H
Desizing	- Acids or Enzymes	BOD (30-50% of total)	H
		COD	
		Temperature (70-80^{o}C)	H
Scouring	- Saponified waxes, oils, fats	Oily fats	H
	- Surfactants	BOD (30% of total)	H
	- Alkali	pH (high)	H
	- High temperature	Temperature (70-80^{o}C)	
		Dark colour	
Bleaching	- Residual bleaching agents		L
	- Stabilisers		
	- Surfactants		
	- Wetting agents		M
	- Mild alkalinity		
			H
Mercerisation	- Alkali (NaOH)	BOD	H
	- Surfactants	pH (high)	H
	- Dissolved matter		H
Dyeing	- Dyestuffs (direct, vat, reactive, sulphur, pigment)	Toxicity	H
	- Electrolytes	BOD (6% of total)	H
	- Carriers	Suspended solids	H
	- Acids and alkali	pH	H
	- Heavy metals	Strong colour	H
	- Oxidising agents		
	- Reducing agents		
	- Surfactants and Levelling agents		

Table (18) cont. (World Bank, Paris Commission, Helsinki Commission)

Process	Major Constituents	Characteristics	Pollution impact Low, Medium, High
Printing	- Dyestuffs	Toxicity	M/H
	- Alkali	COD	H
	- Acids	BOD	H
	- Reducing agents	pH	H
	- Thickeners	Suspended solids	H
	- CH_2O	Strong colour	M
	- Urea and Salts		H
Finishing	- Acid catalysts	Alkalinity	L
	- Surfactants, Softeners, Lubricants and Metal salts	BOD (low)	L
		Toxicity	H

Table (19) Major Constituents and Characteristics of Wastewater from Wet Processing of Wool and Blends (World Bank, Paris Commission, Helsinki Commission)

Process	Major Constituents	Characteristics	Pollution Impact Low, Medium, High
Scouring	- Alkali, grease, coloured material	BOD (high)	H
		Grease	
		High alkalinity	H
		Temperature (40-50oC)	
Bleaching	- SO_2 or H_2O_2	BOD (low)	L
	- Optical brighteners		
Dyeing	- Acid or metal dyes	pH (low)	H
	- Acetic acid or H_2SO_4	BOD (medium)	M
	- Salts	Toxicity	H
	- Surfactants		
	- Insect-proofing agents		
Washing		BOD (high)	H
		Hydrocarbons (high)	
		Temperature (40-60oC)	

Table (20) Major Gaseous and Particulate Emissions in the Textile Industry (World Bank, Paris Commission, Helsinki Commission)

Source	Pollutants	Pollution Impact Low, Medium, High
Cotton treatment (carding, combing, preparation and fabric manufacturing)	Particles	H
Sizing of natural cellulose fabrics	Nitrogen oxides Sulphur oxides Carbon monoxide	L
Bleaching with chlorine compounds	Chlorine Chlorine dioxide	M
Dyeing:		
Disperse dyeing using carriers	Carriers	H
Sulphur dyeing	H_2S	H
Aniline dyeing	Aniline vapours	H
Printing	Hydrocarbons, ammonia	H
Finishing:		
Resin finishing	Formaldehyde	H
Heat setting of synthetic fibres	Carriers Polymers, lubricating oils	H

Table (21) Sources of Solid Waste in Textile Manufacturing

Source	Type of Solid Waste	Pollution Impact Low, Medium, High
Mechanical operations of cotton and synthetics:		
Yarn operations	Fibres and yarns	L
Knitting	Fibres and yarns	L
Weaving	Fibres, yarn, cloth scraps	L
Dyeing and Finishing of Woven Fabrics:		
Sizing, desizing, mercerising,		
Bleaching, washing,	Cloth scraps	L
Chemical finishing	Flock	
Mechanical finishing	Dye containers	
Dyeing and/or printing		L
		H
Dyeing and Finishing of Carpets:		
Tufting	Yarns and sweepings	L
Selvage trim	Selvage	L
Fluff and shear	Flock	L
Dyeing, printing and finishing	Dye and chemical containers	H
Dyeing and Finishing of Yarn and Stock	Yarns, dye and chemical containers	H
Wool scouring	Dirt, wool, vegetable matter, waxes	H
Wool fabric dyeing and finishing	Flocks, seam, fabric, fibres, dye and chemical containers	H
Wastewater treatment	Fibres, sludge	H
Packaging	Paper, cartons, plastics, ropes	L
Workshops	Scrap metal, oily rags	L
Domestic	Domestic wastes	L

4. Egyptian Laws for Maximum Limits of Pollutants

Threshold limits are the concentrations of air born chemical substances to which workers can be exposed day after day without adverse effects to their health and are divided into three kinds :

- The average time of an ordinary working day (8 hours) to which the worker may be exposed for 5 days a week throughout the period of his employment without suffering any damage to his health
- Threshold limits – Limits of exposure for a short period. They are limits to which the workers may be continuously exposed for a short period.
- The threshold limits for short periods, are the limits of exposure for an average period of 15 minutes and which may not be exceeded under any circumstances during the working period. The period of exposure may not exceed 15 minutes nor be repeated more than four times during the same day. The period between each short exposure and the next must be at least 60 minutes
- The ceiling limit may not be exceeded even for a moment when absorption through the skin is a factor in increasing exposure. The sign " + skin" shall be placed before the critical threshold. In case of dust that merely causes annoyance without having tangible harmful health effects, the threshold limits shall be 10 milligrams / cubic meter for inhalable particles.

Concerning simple asphyxiate gases which have no significant physiological effects, the decisive factor shall be the concentration of oxygen in the atmosphere which may not be less than 18%.

Table (22) shows the recommended international limit values for pollution concentration from textile industry (World Bank, Paris Commission, Helsinki Commission).

Table (22) International Limits for Pollution Concentration from Textile Industry

Parameter	World Bank	PARCOM	HELCOM
Water consumption (m^3/t fabric)	100 - 150		
VOC-air, kg C/t fabric VOC-air, mg/N m^3	 1		 150
Chlorine-air m mg/N m^3			5
pH - wastewater	6 - 9		
Maximum concentrations in wastewater, mg/l			
BOD5	50		
COD	250	160	160
AOX	8	1	1
Total suspended solids	50		
Oil and grease	10		
Pesticides (each)	0.05		
Organic pest. mg Cl/l		0.0003	
Organic pest. mg P/l		0.0003	
Cr total	0.5	0.5	0.7
Cr VI		0.1	0.2
Co total	0.5	0.5	
Ni total	0.5	0.5	
Zn total	2	2	2
Pb total		0.1	
Sn total		1	
Phenol	0.5		
Sulfide	1		
P total			2

4.1 Maximum Limits of Air Pollutants

Table (23) shows the maximum limits of air pollutants in the different textile industries

Table (23) Limits of Air Pollutants (Environment Law 4/1994)

Process	**Source of pollution**	**Threshold Limits**				**Remarks**
		Mean time		**Limits of exposure for a short period**		
		ppm	mg/m^3	ppm	mg/m^3	
In cotton spinning Industry						
Opening, carding, Combing	Cotton dust and fluff		0.2		0.6	
In Wool Spinning						
Scouring	Alkalis sulphuric acid		2 1			Ceiling
Carbonising	H_2SO_4		1			
In Weaving						
Sizing	Methanol					
Weaving	Cotton fluff		0.2		0.6	
In Knitting						
Knitting	Cotton fluff		0.2		0.6	
In Nonwoven						
Opening & carding	Particulates		0.2		0.6	+ Skin
Adhesive bonding	Acrylonitrile	2				
In tufting						
Tufting	Particulates		0.2		0.6	
Resin coating	Vinyl chloride	5	10			

Table (23) cont. limits of Air pollutants

Process	Source of pollution	Threshold Limits				Remarks
		Mean time		Limits of exposure for a short period		
		ppm	mg/m^3	ppm	mg/m^3	
In Finishing Industry						
Singeing	Burning exhausts		50			
Desizing	Sulpheric acid		1			
Scouring	Caustic soda		2			
Bleaching	Chlorine	1	3	3	9	
Mercerizing	Sodium Hydroxide		2			Ceiling
Dyeing	Ethylene glycol Ammonia Aniline	50 25 2	125 18 10	 35 5	 27 20	Ceiling + skin
Printing	Xylene (mixed isomers) Ammonia Formaldehyde	100 25 2	435 18 3	150 35 	655 27 	+ skin Ceiling
Water proof finish	Paraffin wax Silicone		2		6 20	
Flame–proofing	Yellow phosphorus		0.1		0.3	
Anti- felt finish	Chlorine	1	3	3	9	
Coating finish (solvent coating)	Toluene Ammonia	100 25	375 18	150 35	560 27	+ skin
	Ozone	0.1	0.2	0.3	0.6	
Abrasion resistant Finish	Acrylonitrile Vinyl chloride	2 5	 10			 + skin
Hydrophiling finish	Silicon				20	
Delustering finish	Formaldehyde	2	3			Ceiling

Table (23) Cont. Limits of Air Pollutants

Process	Source of pollution	Threshold Limits				Remarks
		Mean time		Limits of exposure for a short period		
		ppm	mg/m^3	ppm	mg/m^3	
In Garment Industry						
Cutting and sewing	Particulates		0.2			
In Viscose Industry						
- Soaking in Caustic soda	Sodium hydroxide		2			Ceiling
- Xanthating	Carbon disulphide	10	30			+ skin
- Spinning	Sulpheric acid		1			
In Nylon Industry						
Polymerization	Acetic acid	10	25	15	37	
	Monomers					
In Polyester Industry						
Polymerization	Ethylene glycol		10			
	Methanol	2	3		20	
In Service Units						
Transportation (Lift trucks)	Gasoline fumes	300	900	500	1500	
Boiler and	Carbon monoxide	50	55	400	440	
steam systems	Carbon dioxide	5000	9000	15000	21000	
Wastewater	H2SO4/HCI		1			
Treatment	NaOH/CaO		2			Ceiling
Mechanic workshop	Manganese dioxide		1		3	
Powder dye handling	Aniline,	2	10	5	20	+ skin
	formaldehyde					
	ethylene glycol					

Table (24) shows the max. limits for the ambient air pollutants according to the Egyptian laws (mg/ m3)

Table (24) Max. Limits for Air Pollutants

Pollutants	Max. Limits	Exposure Limits
SO_2	350	1 hr
	150	24 hrs
	60	1 yr
CO	30	1 hr
	10	8 hrs
NO_2	400	1 hr
	150	24 hrs
Ozone	200	1 hr
	120	8 hrs
Suspended Particulates	150	24 hrs
	60	1 yr
Total Suspended Particulates	230	24 hrs
	90	1 yr
Inhaled Particulates	70	24 hrs
Lead (Pb)	1	1 yr

4.2 Pollutant effluents

The wet processes produce pollutant effluents that may be discharged to public sewer after treatment or without treatment. In any of these cases the limits of pollutants should not exceed the specifications regulated by the Egyptian ministry of housing (law 44/2000) shown in table (25):

Table (25) Specifications of industrial effluents for discharge to public sewage

(Regulation from Ministry of Housing in Egypt 44/2000)

Parameters	Maximum Limits
Temperature	43^{o} C
PH	Not less than 6, not more than 9.5
BOD_5	600 PPM
COD	600 PPM
Daicromat	1100 PPM
Susbended substance	800 PPM
Oil and grease	100 PPM
Soluble sulphides	10PPM
Total nitrogen	100 PPM
Total phosphor	25 PPM
Cyanide	0.2 PPM
Phenol	0.05 PPM
Presipitated substances per liter	

After 10 minutes	8 cm^3 / liter
After 30 minutes	15 cm^3 / liter
Heavy metals (total content should not exceed 5 mg / liter)	
Chromium	0.5 mg/ liter
Cadmium	0.2 mg /liter
Lead	1 mg / liter
Mercury	0.2 mg / liter
Silver	0.5 mg / liter
Copper	1.5 mg / liter
Nickel	1 mg / liter
Zinc	2 mg / liter
Cyanide	2 mg / liter
Boron	1 mg / liter

4.3 Concerning Work Environment

4.3.1 Noise Pollution

Table (26) shows the maximum permissible noise levels inside places of productive activities.

Table (27) shows the processes causing relatively high sound intensity in the different textile processes.

Table (26) Permissible noise levels (law 4/1994)

No	Type of place and activity	Maximum permissible noise decibel (A)
1	Work place with up to 8 hour and aiming to limit noise hazards on sense of hearing	90 dB
2	Work place where acoustic signals and good audibility are required	80 dB
3	Work rooms for the follow up, measurement and adjustment of high performance operations	65 dB
4	Work rooms for computers, typewriters or similar equipment	70 d.B
5	Work rooms for activities requiring routine mental concentration	60 dB

Table (27) Sources of Noise In Textile Industries

Type of Processes	Operations with high level of noise
Cotton spinning	Opening, carding, roving, spinning, winding
Wool spinning	Scouring, carbonizing, carding , spinning winding
Weaving	Weaving
Knitting	Knitting
Nonwoven	Web forming, needle punching
Tufted	Tufting, shearing
Finishing	Desizing, bleaching, dyeing, printing, finishing
Garment	Cutting, sewing, heat pressing
Viscose	Xanthating, spinning, winding
Nylon	Polymerization, chipping, spinning, twisting, winding
Polyester	Polymerization, chipping, spinning, tensioning, crimping texturing.

Effect of exposure time and the noise level:

Maximum permissible period for exposure to noise in the work place (factories and workshops), depends on the of period exposure

The value given in table (26) is indicated on the basis of not affecting the sense of hearing.

Intensity of noise shall not exceed 90 decibels during a daily 8-hour work shift

In case of increasing noise level intensity over 90 dB, the period of exposure must be reduced according to table (28).

Table (28) Noise Intensity Level Related to the Exposure Period

Noise intensity level decibel (A)	95	100	105	110	115
Period of exposure (hour)	4	2	1	½	¼

The instantaneous noise intensity level during the working hours shall not exceed 135 decibels.

4.3.2 Emissions in 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.
- 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.

- 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

4.4 Concerning Hazardous Materials and Wastes

Law 4/1994 introduced the control of hazardous materials and wastes. The textile industry deals with raw materials and products as fibers, yarns, or fabrics, and these materials are considered flammable and require storage with fiber protection and precautions. The textile industry also uses a large number of hazardous chemicals, and fuel for the boilers that 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 regulation), 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

4.5 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.

5. Pollution Abatement In the Different Textile Industries

Regarding more information about pollution abatement in the textile industry the following sites on the Internet can help:

Hyperlinks http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp1.pdf

http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp1.pdf

Hyperlinks http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp2.pdf

http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp2.pdf

Hyperlinks http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp3.pdf

http://es.epa.gov/oeca/sector/sectornote/pdf/textilsnp3.pdf

Hyperlinks http://www./u.se/IIIEE/publications/theses-98/xir_abst.htm1

http://www./u.se/IIIEE/publications/theses-98/xir_abst.htm1

5.1 Pollution Abatement In Spinning

5.1.1 Pollution abatement in cotton spinning:

The major pollutant factor in cotton spinning is the cotton dust and cotton fuzz, especially in the opening carding processes. To minimize the intensity of these particulates, a ventilation system can be used to withdraw the air from work area to bag filters, which collect the dust and fuzz. These filters should be contained in an airtight room to prevent any escape of dust outside the room. These bag filters should be evacuated periodically to avoid overflow of dust to the atmosphere.

The intensity of particulates in the area of the ring-spinning machines depends on the negative pressure of the broken-end collector in the machine. This pressure should be maintained constant by the periodical evacuation of fiber waste box, otherwise, the broken ends of fiber strands delivered from the machines will not be sucked, but will be delivered to the atmosphere, thus increasing pollution. A standardized number of broken ends per 1000 spindles per hour should be monitored to control the cotton fluff concentration in the work environment.

5.1.2 Pollution abatement in wool spinning

a) ***Scouring:*** The processing of wool is considered to have the strongest wet processing wastes of all natural fibers, regarding the impurities in the raw wool fibers such as pesticides, herbicides and grease. The scouring process removes the wool wax from fibers, and the scouring liquor is treated to remove grit and separate the raw wool grease and purify it to produce lanolin. This treatment minimizes the pollution impact in the effluent (BOD, COD, grease, solvent, detergent.)

Another way for pollution abatement in scouring process is to neutralize high pH effluent streams before discharging to public sewers.

b) ***Carbonizing:*** The Carbonizing process causes air emission vapor of sulphuric acid, particulates, beside liquid waste (acid bath dumps). The air emissions could be extracted by a suction system to withdraw the charred carbon residue, the fiber particulates and the acid fumes and collect these emissions in a filter to keep a clear environment in the carbonizing area.

The resulting effluent from carbonizing is chemically treated to avoid BOD or COD for discharging to public sewers. The preferred option in carbonizing is to work in a medium without chlorinated solvents. Foreign materials are preferably removed by mechanical means to avoid pollution. Acids should be neutralized with alkaline wastewater streams or alkali. Concentrated sulphuric acid should be neutralized and precipitated with $CaCl_2$ and $Ca(OH)_2$ or waste alkali

c) Carding and Spinning: The emissions of particulates from the carding and spinning processes are collected by suction system and reprocessed to avoid pollution impact on the work environment.

5.2 Pollution Abatement In Fabric Formation Industry

5.2.1 Pollution abatement in weaving

a) Sizing: The use of natural starch in most of the companies cause high level of pollution in terms of increasing the organic load (e.g. BOD), and therefore spillages must be minimized. The following recommendations help in pollution abatement in sizing:

- Replacing the starches that have high BOD by other sizes such as acrylates or partially substituted by polyvinyl alcohol (PVA) or CMC. These substances are recoverable and can reduce the BOD load from the sizing unit by 90%. This technique may not be recommended for a non-vertical wet processor to buy expensive recovery equipment, anticipating the use of a recoverable size by the weaver. In Egypt, the number of vertical operations is decreasing as the present time.
- Avoiding damage of starch bags
- Avoiding washing spilled sizing materials down the drains.
- Avoiding disposal of unused sizing baths in the drains
- Collecting spillages for use in the process if possible

b) Weaving: Cotton fluff and particulates in the weaving area cause pollution which needs extraction system to withdraw the polluted air to filters, and replace it by fresh clean air from the outside atmosphere.

5.2.2 Pollution abatement in knitting

There are no effluents in knitting, but knitting yarns are oiled or waxed to lubricate the yarn to ease the knitting process. Also needle oil is used to lubricate the moving machine parts. Mineral oils are, used, often containing biodegradable emulsifying agents. For pollution abatement, these mineral oils can be substituted with degradable synthetic oils or vegetable oils, which do not contain hazardous preservatives.

5.2.3 Pollution abatement in nonwovens fabrics

The use of acetic acid (for adjusting pH in resin bonding bath) could be substituted with formic or mineral acids to reduce BOD load. The fiber lint caused by carding, web forming, and needle punching, and could be extracted from the working environment by air suction system to filters. Ventilation can be achieved by substituting the polluted air with fresh air from the outside atmosphere.

5.2.4 Pollution abatement in tufting

In preparing the resin for coating the back of the tufted carpet, formaldehyde can be substituted with polycarboxylic acid. This improves the environment because formaldehyde is an important pollutant and is considered hazardous chemical material. If formaldehyde could not be substituted, scavengers should be used during application and storage of resin-finished goods.

The particulates from the tufting action can be extracted by air suction system, which scavenges the polluted air and drives it to filters. Use of zinc as catalyst should be substituted where possible, e.g. by magnesium. Latex compounds, used as back coating of tufted carpets, should be reused as much as possible

Cleaning of latex machinery, recipients etc. with water giving rise to dilution of chemicals should be replaced by eg. mechanical, adsorbers or high pressure rinsing with minimal water consumption

Precipitation (chemical coagulation) of residues in effluents can be made by $Ca(OH)_2$, $CaCl_2$, iron, etc at pH where polymers, sulphur compounds and zinc have a low solubility or membrane techniques eg. microfiltration with ceramic membranes. Sludges can be dewatered with a filter press, and possibly reused.

5.3 Pollution Abatement In Wet Processes (Finishing)

The wet processing of textiles is considered the major pollutant source in the textile industry, due to the many different chemicals used in the different finishing processes. Most of the used chemicals are considered hazardous pollutants to air and wastewater.

5.3.1 Purchasing policy for raw materials

The textile company should deal with suppliers having less-polluting raw materials. The quality of raw material is controlled by prescreening and testing shipments as they are received to determine the proper type with least pollution impact. Some suppliers may change the chemicals to be delivered without notifying their customers, and if the material is not checked by testing, the company may have more hazardous pollution

The chemicals to be used in the wet finishing processes are recommended to be purchased in returnable, reusable containers to eliminate waste packing materials, and reduce spillage and worker exposure to chemicals.

5.3.2 Pollution abatement in desizing:

- Desizing operations represent large contribution to pollution, accounting for 40-50 % of the total pollution load from preparatory processing. The use of acrylates as a size in place of starch reduces the BOD, due to the recovery of size. The efficient sizes are degradable, recoverable, water soluble (for staple fibers), and universally applicable. Starches can be partially substituted by polyvinyl alcohol to reduce pollution in effluents.
- The use hydrogen peroxide instead of enzymes, to desize starch (known as oxidative desizing) reduces the pollution in effluents, because in this case the starch degraded to carbon dioxide and water.
- The use of low viscosity sizes, such as PVA, CMC enables the recovery instead of up to 50% of the size in the effluents of the desizing process.
- The use of newer enzymes which degrade the starch size to ethanol of anhydroglucose, enables the recovery of ethanol by distillation, thereby reducing the BOD load in the desized effluent considerably
- Recovery of sizes from the desizing plant should be considered as this technique is universally applicable using high pressure or vacuum technology in a pre-wash stage
- Wastewater from cleaning the machines should be purified by biological treatment or concentrated by ultrafilteration. Chemical coagulation or thermal precipitation transfers the environmental problem to the produced sludge.
- If recovery of size is not possible and degradation of the size is required, an integrated chemical pretreatment (scouring, desizing, bleaching all in one) is preferred; this will reduce the consumption of water and energy and minimize pollution.
- Acids should be replaced by enzymatic and/or oxidative desizing to render the vegetable or animal size water soluble (hydrolysis), starch from all sources can be removed.
- For PVA, PES, PAC and CMC membrane filtration should be carried out, if reuse is possible
- For starch and derivatives, galactmannate and PVA, biological treatment should be carried out (after sludge adaptation).
- For all polyacrylates, chemical coagulation (e.g. by iron) plus an appropriate waste treatment of the produced sludge should be carried out.

5.3.3 Pollution abatement in scouring:

- The optimum amounts of alkaline recipes should not be exceeded
- Alkalis should be recycled and reused as much as possible; rinsing water should be reused for preparing the scouring bath
- Combining the desizing and scouring processes can save water and energy and reduce processing time

- Rinse water can be reused following mercerizing rather than dumping the bath water after each use. The spent rinse water can be processed in an evaporator and concentrated caustic soda can be used in mercerizing. This technique reduces the wastewater drastically
- Using continuous horizontal washers, which operate by spraying clean washwater on the top pass of fabric as it makes a series of horizontal traverses upward in the machine. The unprocessed fabric enters of the bottom traverse, and the water enters at the top. This method conserves energy and water, thus reduces pollutant effluents.
- A reduction of 25% in sodium hydroxide can be obtained by substitution with sodium carbonate.
- The use of sodium acetate is recommended for neutralizing scoured goods so as to convert mineral acidity into volatile organic acidity
- Surfactants should have a high degree of ultimate biodegradability without producing metabolites that are toxic to aquatic species
- Alkylphenolethoxylates (APEO) in detergents and dispersants should be substituted by readily biodegradable surfactants, or should at least not reach the final effluent. Similar restrictions for other non-readily biod-egradable surfactants should be considered.
- solvents having environmental impact that is more damaging than available alternatives, should be avoided
- Alkalis should be recycled and reused as much as possible, rinsing water should be reconstituted (upgraded)
- Mineral acids (sulphuric acid, hydrochloric acid) should only be used for neutralisation when no better options are available.

5.3.4 Pollution abatement in bleaching:

- Fabrics that need to be colored in deep shades should not be bleached extensively, thus reducing the consumption of bleach and consequently reducing the pollution load.
- The use of continuous knit bleaching ranges, to replace batch preparation of knitted fabrics reduces the water and chemical consumption, and consequently contributes to less pollution load
- Peroxide bleaches should be used instead of reductive sculpture- containing bleaches which are more hazardous
- Hydrogen peroxide (H2 O2) should be used as the bleaching agent in preference to chlorine- containing compounds, such as hypochlorite. This will take the factory one step closer to obtaining an " ecolabel". Also, the use of hypochlorite is banned by many certifying agencies. Hydrogen peroxide also minimizes the content of hazardous organohalogen substance in the final effluent, and eliminates a toxic and hazardous chemical from the workplace and improve working environment.

- The use of the enzyme Terminox Ultra (of Novo) in place of a reducing agent such as thiosulphate can reduce the processing time by half, and reduce the water and energy considerably.
- The wetting agents, emulsifiers, surfactants and all other organic chemicals should be readily biodegradable without producing metabolites, which are toxic to aquatic species.
- The installation of holding tanks for bleach bath reuse, where the bath is reconstituted to correct strength after analysis by titration. Using this technique decreased BOD over 50%, and reduced the water use.
- In case of bluish and bright qualities (76% on Berger-scale) of fabrics, alternatives for chlorine bleach are not always available. Hazardous organohalogen substances production needs to be reduced or treated adequately
- Precursors (proteins and pectines) should be removed in order to prevent the formation of hazardous organohalogen substances in bleaching with chlorine
- H2O2 in effluents from bleaching can be reused in the treatment of the (combined) wastewaters as a clean oxidant in the activated sludge process or chemical oxidation processes

5.3.5 Pollution abatement in mercerizing

- Dilute alkali from mercerizing should be reused in scouring, bleaching or dyeing operations, so that discharges from alkaline treatment can be minimized, resulting less polluted effluents.
- Liquid ammonia is a low pollution substitution for conventional mercerization (NaOH)
- Heavy cotton fabrics treated with liquid ammonia require less dye for a given depth of shade, and consequently contribute to pollution abatement due to using less chemical for the same requirement.
- Alkali should be recovered and recycled or reused after regenerative treatment to remove dirt (coagulation, flotation, microfiltration, nanofiltration) and after concentration
- The non-recoverable fraction of the mercerizing wastewater should be neutralized by mixing with acid effluents or by Co2 as acid.

5.3.6 Pollution abatement in dyeing

- ***The use of low-liquor ratio dyeing***

The bath ratio is defined as the ratio of bath weight to the fabric weight. The lower the bath ratio, the less the amounts of chemicals required in the dye bath, and the less the pollution impact. So, low liquor dyeing machines are recommended for pollution abatement

- ***Salt management***

Although salt is cheap, effective and has very low toxicity, it has to be used with optimum dosage for each individual for each dyeing.

It is recommended to select dyes which exhaust with minimum salt, e.g. Cibachrone LS dye.

- ***Dyebath temperature***

The temperature of dyebath should be optimized to avoid overheating, and excess consumption of dye which helps to reduce pollution.

If dyebath is heated by direct steam, the heating should be gently, to avoid overflowing and subsequent loss of dyebath solution, which cause pollution.

- ***Reuse of dyebaths***

After the fabric is dyed, the dyebath is pumped to a holding tank, then the dyed fabric is rinsed in the same machine, and after removing the rinsed fabric, the dyebath is returned back to the dye machine. This technique reduces pollution concentrations, and effluent volume.

- ***Substitution of harmful dyestuffs***

  - Black dyeing is often carried out using sodium sulphide (the reducing agent) and dichromate (the oxidizing agent), and these two chemicals are toxic, hazardous to handle, generate effluents that damage the environment and they leave harmful residues in the finished fabric. So these chemicals should be substituted with glucose (for reduction) and sodium perborate (for woven fabrics) and hydrogen peroxide (for knitted fabrics) as oxidation agent.
  - Aniline black dyes, which require large quantities of potassium dichromate and sodium chlorate can be replaced by sulphur dyes, using glucose as a reducing agent and either sodium perborate or hydrogen peroxide as oxidizing agent. This substitution can reduce hazardous pollution considerably.
  - In vat dyeing, potassium dichromate, which is toxic and hazardous, can be satisfactorily replaced by peroxides or periodates for pollution abatement.

- ***Banned dyes***

A number of dyes should be banned from use due to their potentially

toxic , mutagenic or carcinogenic properties. These dyes release amines during processing, that are hazardous. These dyes are listed in the following table (29).

Table (29) Banned dyes

No	Banned Amine	No	Banned Amine
1	4- Aminodiphenyl	11	3,3- Dimethylbenzidine
2	Benzidine	12	3,3- Dimethoxybenzidine
3	4- Chloro –o- toluidine	13	3,3- Dimethyl 1-4,4 diaminodiphenylmethane
4	2- Naphthylamine	14	p-kresidin
5	o-Aminoazotoluidine	15	4,4 Methyene- bis- (2-chloraniline)
6	2- amino-4 nitroluene	16	4,4 Oxydianiline
7	p-Chloraniline	17	4,4 Thiodianiline
8	2,4- Diamonoanisol	18	o- Toluidine
9	4,4- Diaminodiphenylmethane	19	2,4- Toluylendiamine
10	3,3- Dichlorobenzidine	20	2,4,5- Trimethylaniline

Annex 1 shows a list of metal content values for assessment of dyes.

- ***Minimizing machine cleaning:***

In dyeing operations, startups, stopoffs, and color changes cause intensive cleanings and pollution in effluents. The ideal sequence is to run the same color repeatedly on a particular machine, or to group colors within families (red, yellow, blue), and then run the dyes within one color family from lighter to darker values and from brighter to duller chromes.

- ***Handling of powder dyes***

The manual transfer of powder dyes from bulk containers to smaller process containers generates significant amounts of dust. All operations concerning manual handling of powdered dyes should be in small special room and blow the current of sucked air for dust. A protective mask provided with filter must be used. This pollution causes breathing and skin diseases such as asthma, eczema, and severe allergic reactions. Ventilation booths are recommended. A vertical air shower pushes airborne dust out of the worker’s breathing zone, until the dust is captured and exhausted from the work area to a filter. All tasks associated with manual transfer of powdered dyes should be performed inside the booth under the air shower.

Most powder dyes are shipped in drums that range in height from 75 to 90 cm. When manually transferring dye from these drums, workers must lean forward and place their heads inside the drum to scoop out dye near the bottom. In this position, the worker is greatly exposed to airborne dye dust, even in a ventilated booth. So, shorter drums should be used to eliminate the need for workers to place their heads inside the drum. The drum height should be limited to 60cm.

- ***Safer alternatives for banned dyes.***

Environmental Quick Scan Textiles, compiled for CBI and SIDA by Consultancy and Research for Environmental Management, published by CBI, SIDA, VIVO, 1996.

This authority published lists for banned dyes and the corresponding safer alternative dye which contributes to pollution abatement. The lists are available for acid dyes, direct dyes, and disperse dyes.

- ***Important precautions in dyeing for pollution abatement***
  - Dyes found to be containing PCBs (e.g. certain sources of Cu-phtalocyanine) should be substituted immediately.
  - Cadmium containing pigments should not be used.
  - Benzidine-based azo-dyes should not be used at all
  - Carriers containing chlorine should not be used
  - Reduction of dyes by sulphide should be avoided. Dichromate oxidation of vat dyes and sulphur dyes should be substituted by peroxide oxidation
  - Azo-dyes which can, under reductive conditions, release aromatic amines, which are suspected carcinogens, should not be used.
  - Halogenated solvents and dispersants for dyes and chemicals
  - should be substituted where possible by water-based systems
  - Metal containing dyes (Cu, Cr, Ni, Co, etc.) should be
  - Substituted by other dyes or techniques
  - In order to minimize the discharges of BOD, COD, etc. as well as of colored substances in case of repeated dyeing, the rinsing bath should be used as next dye bath, it the after-treatment chemicals are compatible with the dye bath chemicals
  - Wastewater generated from dyeing, should receive a dedicated treatment to remove the persistent pollutants.

5.3.7 Pollution Abatement In Printing

The following are some recommendations Contributing to pollution abatement in printing:

- The excess printing pastes can be recovered through optimized paste preparation and supplying systems, and they should be recycled and reused to reduce the pollution in effluents
- The use of urea in printing with reactive dyes should be reduced by (or in combination with) other techniques (e.g. pre- wetting of fabric) so that the nitrogen emissions do not increase. The printing paste should contain not more than 30 gm. of urea/kg of textile. Some approaches to eliminate or replace urea in cellulose printing are:
  - Adoption of two-phase flash printing
  - Complete or partial substitution of urea with an alternative Chemical Metaxyl FN-T
  - Mechanical application of moisture to printed fabric prior to entering the steamer
- Full or partial substitution of gum thickening by emulsion thickening in

- Textile printing.
- Replacement of the use of white spirit kerosene by water-based system
- The use of biodegradable natural thickening auxiliaries or highly degradable synthetic thickeners.
- Minimizing the use of copper and chrome salts to the extent possible
- Avoiding use of solvent-based pastes in pigment printing.
- Recovery of acetic acid, which is used to bond the two components of azoic dyes.
- The use of pigments, which give improved absorption and lower effluents for reducing COD.
- Some of the pigments are suspected to have toxic/ carcinogenic properties, and these are listed and the safer alternatives corresponding to each pigment is given. CBI, SIDA, VIVO, and Compiled publish this list by consultancy and Research for Environmental Management.
- When feasible, pigmentation is preferred over dyeing because this may reduce dyeing and printing operations, saving energy, water, and chemicals
- Biodegradable natural thickening auxiliaries or highly degradable synthetic thickeners should be chosen
- Printing screens should be replaced by non-contact techniques (e.g. ink-jet printing)
- Automation may lead to less pollution

5.3.8 Pollution Abatement In Finishing.

The following are recommendations for pollution abatement in chemical finishing:

- Finishing chemicals should be reused whenever possible
- Reducing the use of formaldehyde releasing chemicals as much as possible. Formaldehyde should be replaced with polycarboxylic. Alkylphenol should be replaced with fatty alcoholethoxylates
- Replacement of acetic acid (used for pH adjustment in resin finishing bath) with formic or mineral acids to reduce BOD load.
- Using formaldehyde- free cross-linking agents for cellulose textiles and formaldehyde-free dye-fixing agents.
- Using formaldehyde scavengers during application and storage of resin finished goods.
- Dimethylol or dihydroxythlene urea used in anti-wrinklefinishing should be substituted by polycarboxylic acids, mainly 1,2,3,4-butanetetracarboxylic acid or glyoxales.
- MAC Complexing agents like DTDMAC, DSDMAC, DHTDMAC used in softening finishing should be replaced with cellulose enzymes

- Asbestos, halogenated Compounds like bromated diphenylethers and heavy metal containing compounds used in flame retardant finishing should be replaced by inorganic salts and phosphonates.
- Biocides such as chlorinated phenols, metallic salts (As, Zn, Cu, or Hg), DDE,DDT and benzothiazole used in preservation finishing should be substituted by UV treatment and, or mechanical processes or by enzymatic finishing.
- In case of using fireproofing chemicals, the best technique is that which consumes minimal amounts of water (such as Vacuum, back coating, foam) or techniques leading to minimal of residues particularly (e.g. foam)
- The use of hazardous chemicals for the conservation of textiles should be minimized, either through substitution or through "tailor-made" selective use to only those textiles which are exposed to possible environmental degradation.
- Limitation of the chlorination stage in wool shrink proofing by substitution of other techniques (e.g. peroxygen treatment)
- It is more recommended to build in the finishing chemicals into the fiber
- during production or during spinning than applying the finish at a later stage
- Concentrated residues from finishing should not be discharged. They should be reused or treated as waste.
- In case of mothproofing agent-contaminated water, the volume of bath should be reduced by employing e.g. mini-bowls, modified centrifuges or foam treatment during back coating laminating or carpets.
- In case of mothproofing finish, wastewater should be treated in such a way that excessive sludge is avoided. This sludge should preferably be incinerated as chemical waste or detoxified by wet (catalyzed) oxidation

The following recommendations as general procedures are helpful:

- ***Pollution Abatement By Optimizing Process chemical Use .***

In preparing chemical formulations, a large margin of safety is adopted in order to avoid having to repeat the treatment. Any misformulation may cause high cost and high level of pollution. A careful evaluation of the processing steps to optimize the recipes can help to decrease the amounts of chemical to a minimum, without affecting the product quality. It is possible to reduce chemical consumption in textile wet processing by 20-40%, resulting about 30% decrease in pollution load.

- ***Adoption of worker Training for pollution Abatement***

Workers in the wet processing of textiles should be trained on the safety procedures for receiving, storing, and mixing chemical. The workers should be informed of the environmental impacts of chemicals and the most harmful chemicals to the environment. The training programs should include handling of chemicals, correct procedures for pasting, dissolving, and emulsifying of chemicals. These procedures should be subject to auditing and record keeping. In addition, policies regarding receipt, storage, and mixing, should be established. This training helps to keep wastage within the factory to minimum, and encourages workers to suggest other improvements which reduce pollution.

5.4 Pollution Abatement In Garment Industry

There is no effluents in garment industry, and the emissions to air also limited to some particulates due to cutting of fabrics, sewing, and heat pressing of interlining. But there is no hazardous pollution in this industry. Good ventilation or scavenging of factory air to the outside atmosphere can improve the working environment.

5.5 Pollution Abatement In Man-made Fiber Manufacturing

- ***Viscose Industry***

To minimize the emissions of sulphuric acid vapor from the spinning bath, the cover of the bath should be air tight to prevent any escape of acid vapor

In the process of mixing the soda cellulose with carbon disulphide, emissions of hydrogen sulphide gas results and it should be scavenged from the working area

In the finishing of viscose yarn cake using detergents and bleaches, these chemical should be selected to be safe and not causing pollution to the effluents (as previously shown in scouring and bleaching).

- ***Nylon Industry:***

Volatilized monomers should be scavenged from the working area. Finishing oils should be selected to be safe to environment. Chemical and oil residues should be minimized, and water containing solvents should be kept as low as possible.

Non-degradable spin finish (oils, antistatic, emulsifier) should be substituted by degradable alterative, e.g. substitution of non-degradable mineral oils, and mineral oils containing significant amounts of aromatics, by degradable synthetic oils, or (for integrated mills) vegetable oils without hazardous preserving agents.

- ***Polyester Industry***

Water containing monomer and additives should be treated chemically before draining to avoid effluent aquatic toxicity.

The level control equipment in the polyester reactor contains cobalt or Cesium , and care should be given to monitor these equipments to avoid any radiation that may cause hazardous environment. The level of radiation should be checked regularly to be sure that the environment is safe. The handling of Monoethylene glycol and DMT should be under care to avoid spills which cause pollution of effluents. The finishing oils and waste effluents should be kept as low as possible, and the finishing oils should be selected to satisfy the safety precautions.

It is more recommended to build finishing chemicals into the fiber during production (copolymerisation, extrusion) or during spinning rather than applying the finish at a later stage which causes waste effluents. Spin finish containing spinning oil, emulsifier, and antistatic agent, applied to the surface should be removed by water in a later production stage. Use of these spin finishes should be minimized and optimized to reduce the load of total organic carbon (TOC) and nitrogen.

- ***Chemical Substitution***

In addition to dyes which are banned and pigments, which are suspected to be toxic, some of the other chemicals used in textile processing can be substituted with safer alternatives and cleaner production are presented in table (30).

Table (30) Chemical Substitution For Cleaner Production

In Textile Processing

Process	Chemical	Substituted by
Sizing	Starch based warp sizes by PVA	Acrylates or partial substitution
Desizing, Scouring	Acid	Hydrogen peroxide and enzymes
Aqueous Scouring	Alkylphenol ethoxylates TSP, NaOH	Fatty alcohol ethoxylates sodium carbonate
Detergent Scouring	Alkyl, benzene sulphonates	Fatty alkyl sulphates polyglycolether
Light Scouring	NTA, EDTA	Zeolites (sodium aluminum silicate)
Bleaching	Reductive sulphur bleaches Chlorine Compounds	Peroxide bleaches Peroxide bleaches
Dyeing	Benzidine based dyestuffs and other amine releasing dyes	Mineral pigment dyes, single class dyes like indigsol, pigments, reactives
	Dichromate used for oxidation in vat and sulphur dyes	Peroxide, air oxygen, metal free agents
	Acetic acid in the dyeing bath	Formic acid
	Dispersants for dyes and chemicals	Water based system
Dyeing	Copper sulphate used to treat direct dyes	Polymeric compounds
	Dye powder in automatic injection	Liquid dyes
	Sodium hydrosulphite	Stabilised sodium hydrosulphite
	Aldehyde and toxic metallic salts used as auxiliaries	High molecular weight polymeric auxiliaries
	Sodium sulphide	Glucose based reducing agents
Printing	Kerosene or white spirit	Water based systems
Finishing	Formaldehyde Alkylphenol	Polycarboxylic acid Fatty alcoholethyoxylates
Anti- wrinkle finishing	Dimethylol dihydroxyethylene	Polycarboxylic acids (mainly 1,2,3,4 butanetetracarboxylic acid) Glyoxales
Softening finishing	MAC complexing agents like DTDMAC, DSDMAC, DHTDMAC	Cellulose enzymes
Flame retardant finishing	Asbestos, halogenated compounds, heavy metal containing compounds	Inorganic salts and phosphonates

Preservation finishing	Biocides such as chlorinated phenols, metallic salts (As, Zn, Cu, or Hg), Benzothiazole	UV treatment, mechanical or enzymatic finishing

5.6 Noise Pollution Abatement

The majority of the textile processes cause noise, especially; the opening line, the ring-spinning machines, the open-end spinning machines, the weaving looms, the chipping machine for polyester, and most of the finishing machines.

For minimizing the level of noise, the following points are recommended:

- Stressing on the exact mounting and setting of the rotating part at high speed such as ring spindles and open-end rotors. Any offsets in these part cause excess vibration and consequently cause high level of noise.
- Following periodical maintenance programs, especially the parts rotating at high speed, because any wear in the rotating parts causes excessive vibrations, resulting in high level of noise.
- The importance of lubricating the rotating and moving parts, as this helps to reduce the level of noise significantly
- The machines should be distributed in the factory in such a way to permit sufficient space to dissipate the noise and thus keep the level of noise below the allowed level (below 90 decibel)
- The mechanisms causing high level of noise could be enclosed in a specially designed container from a special material that absorbs the noise. For example, this idea could be applied to weaving looms
- The factory walls may be lined with a material that absorbs the noise and is considered as a damping down means for noise waves.
- Replacing, whenever possible, the old machines by newly developed machines, if they are designed to release lower level of noise. For example, replacing shuttle looms, which are known of their higher level of noise, by shuttles looms which are known of their lower level of noise
- The arrangement of machines in a certain area should be in a way that the sources of noise are evenly distributed in the whole area. This can avoid noise concentration in some places more than the others.

6. Industrial Inspection

The inspection of the textile industry will follow the procedures described in the Inspection Guidelines. 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 textile industry.

The overall purpose of inspection is to enforce the environmental laws to safeguard the workers, the people living in the surrounding environment, and the national surface water (lakes, canals, rivers ,..etc) and land. Table (31) lists the various types of inspection and the objectives that should be fulfilled for each type

Table (31) The different types of inspection and their objectives

Inspection type	Objectives
Site inspection	
1 – Comprehensive	• Evaluate compliance status regarding all aspects of law 4
2 – Specific	• Evaluate compliance status regarding some specific aspects of law 4 (usually, response to complaints) • Review special conditions set by EEAA in ETA studies • Investigate complaints
3 – Follow-up	• Check environmental register and implementation of compliance measures
Inspection campaign	
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

It is clear from the above table that comprehensive inspection deals with all aspects of environmental laws and is accordingly 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 to fulfill the objectives is the responsibility of the inspection team, based on their experience and knowledge. Planning for inspection is presented in more detail in the General Inspection Manual, (EPAP- GIM 2002).

7. Inspection Planning at the Inspectorate Level

It is the responsibility of the inspectorate management to state clearly, in writing, the type of inspection and related objectives as well as the time schedule necessary to carry out the inspection. The inspectorate management is also responsible for providing preliminary information about the facility (e.g. hazardous sources of pollution), inspection tools (e.g. decibel noise instrument), and logistics

7.1 Activities Related to the Textile Industry

For a certain type of inspection, for example, comprehensive, the objectives stated in table (31) dictate the activities required for covering all aspects of compliance with environmental laws and regulations. Also, the activities will depend on whether the facility of one or more subsectors, for example, spinning, weaving and finishing, are integrated together.

The facilities in the textile industry are generally large, and labor intensive comprising mostly a number of subsectors. These facilities, normally have quality control systems. The facilities that have wet processing production lines, such as preparation for finishing, bleaching, dyeing,..etc, may have units for treatment of wastewater resulting from these processes and represent an important source of pollution containing BOD, COD, heavy metals, toxic chemicals, oil residues, sludge, and heat. So, the inspectorate management should have a clear idea about how to proceed with inspection for each type of facility and according to the number of subsectors, the size of the wet processes, and the types of chemicals supposed to be used in the production lines. The textile wet processes represent a very excessive load of wastewater and pollutant effluents, which are normally discharged to canals, river or surface water after treatment to reach the limits allowed by the law. Some other facilities discharge the pollutant effluents to the public sewer either after treatment or without treatment. These facilities may violate the law, and the inspectorate management should have clear idea about the procedure for inspection in these situations.

7.2 Providing Information About the Facility

chapters (2-5) present the technical information regarding the different subsectors of the textile industry, their pollution sources, health impacts of the pollutants, and the relevant environmental laws. Also, the trials for pollution abatement is given in chapter (5). 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 (as in chapter 3) and IPIS data bases are also important sources of information.

7.3 Providing Required Personnel, Equipment and Method of Inspection

The required personnel, tools and equipment depend on the size of the facility to be inspected and the activities to be carried out, for example if the facility is a complex of spinning, weaving, finishing, and garment production lines, a large group of inspectors is required to carry out the inspection tasks on this number of subsectors . The inspection team leaders, in coordination with the inspectorate management, are responsible for assessing the inspection needs. 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.

- ***Small facilities***

These are garment manufacturing factories, with a small number of labours (10-30), using mainly sewing machines, and little or no emissions are expected. There is no expected violation of environmental laws in such dry processes.

- ***Dry processing facilities***

These are factories having a relatively long production line, but the processes do not include in general water or chemicals. These subsectors such as cotton spinning, weaving, knitting, nonwoven, tufting, ..etc. The major source of pollution in these facilities is the cotton dust and cotton fuzz. The second source is the noise level especially when modern high speed machines are used, and violation of the law is expected.

The only wet processes in these production lines are the scouring and carbonizing in wool spinning, and the sizing in weaving.

- ***Wet processing facilities***

These are factories using water and chemicals to treat yarns or fabrics in successive processes such as desizing, bleaching, dyeing, printing, finishing,. etc. These production lines are the major sources of pollution in the textile industry, due to the polluted air emissions, wastewater, and solid waste. The wet processing textile production lines are anticipated to violate the environmental laws, and the inspection team should provide the greatest care to assess the compliance of these processes with the law 4.

8. Preparation For Field Inspection

8.1 Gathering and Reviewing of Information

The scenario for carrying out an inspection in any facility is explained in details in the GIM, regarding the arrangement of the team and the collecting and reviewing of information.

8.2 Preparation of the Inspection Plan

An example of an inspection plan is included in Annex (E) of the General Environmental Inspection Manual (EPAP- GIM 2002).

The plan should take into account the following:

- For a large integrated textile facility (vertical type), having a number of production lines, e.g. spinning, knitting, and garment, the inspection team could be divided into smaller groups. Each group will be responsible for inspecting a certain production line or service unit, or more than one line if the group is enough for the job.
- At the beginning of the field visit, the inspection team should check the environmental register, using the checklist provided in Annex (G) of the General Environmental Inspection Manual (EPAP- GIM 2002)
- The results of the analysis in the environmental register should be checked at the end of the field visit (if suspicious about them) and copies of these results should be obtained

The following precautions should be noted:

- Since the cotton dust and cotton fuzz in the cotton spinning line is expected to be in violation of law 4/1994, sampling should be planned especially from the area of opening and cleaning machines.
- Since the noise level (decibel) in the area of the ring-spinning, or open-end spinning machines, or the winding machines, is expected to be in violation of environmental laws, the measurement of noise in these locations and the similar ones, should be planned.
- In the wet processes of the textile industry, it is expected that hazardous dyes and resins may be used, and high dye bath ratio (volume of dye bath to fabric weight) is also expected to be used. Sample of wastewater from the wet processes should be taken. Because of possible variation of the pollutant bath with time, a composite sample over the shift duration should be planned to give typical representation of the existing source of pollution.
- The inspector should make sure that all the machines in the polluting production line are working, since some factory management try to stop the polluting stages or processes during the inspection.

Arranging the required personnel, equipment and inspection method

The inspector may be a textile engineer, chemical engineer, chemist,.etc.).The required number of inspectors depends on whether the facility is a horizontal type, that is only one subsector (cotton spinning, wool spinning, weaving, knitting, finishing) or a vertical type, that is two or more subsectors, for example, cotton spinning, knitting, dyeing and garment manufacturing integrated together.

In the dry textile processes such as cotton spinning and weaving, cotton dust and cotton fuzz are the main source of pollution. Cotton dust can be measured by the vertical elutriator or an equivalent instrument. Measurements must be representative of an eight-hour period and must be performed for each shift and in each work area.

The noise level in the spinning and weaving processes is considered also a main source of pollution which is anticipated to violate allowed level of law 4/1994. The noise level is measured by decibel instrument.

The wet textile processes such as, scouring, bleaching, dyeing, finishing, ..ect, represent the major sources of pollution as air emissions and effluents or wastewater due to the different types of chemicals and heavy metals used in these processes. The vapors and fumes of the used chemicals represent hazardous air emissions, while the wastewater from the wet processes represents hazardous effluents to aquatic life when directed to public sewer. So, these pollutant effluents should be treated before being directed to the public sewer.

8.3 Preparation of the Required Checklists

The checklists for the textile industry are shown in Annex (1) of this manual. The checklist has been prepared in such a from that it starts with general information about the facility and its operation. Separate checklists are then filled for each production line or service unit independently for the concerned environmental aspects and media. The inspection team will compile the checklists relevant to existing production lines and service units in the concerned facility. It should be noted that law 4 does not specify standards for effluent from production lines, but only for final disposal points (e.g. locations where they join the public sewer). However, effluent quality from production lines serves as an important indicator of the final discharge of the facility. As evident from chapter (2), the textile wet processes (sizing, desizing, scouring, bleaching, ..etc) are most probably expected to be in violation of several environmental laws, specially with respect to wastewater if no treatment is performed. Also in these processes, air emissions, and hazardous resin residues and sludges cause serious health impacts which may violate the environmental regulations and laws.

8.4 Legal Response for any Violation of the Law 4/1994

In case when the inspection team finds any violation of the environmental laws, legal procedures should be performed as given in details in (EPAP- GIM 2002), Annex (L).

9. Performing the Field Inspection

The field inspection of the facility is important to find out whether the production line is in compliance with the environmental laws or not, and to determine the locations of non-compliance and their health impact on workers, and the surrounding environment. Also, inspection can discover the sources of pollutions in case of environmental problems. Field inspection also helps in assessing the application of an environmental management system and its controls.

9.1 Starting the Field Visit

The procedures involved for entering an industrial facility are explained in details in GIM, showing the precautions, advices, and important notes to be considered by the inspectors.

9.2 Proceeding with the Field Visit

The information collected during the facility tour will depend on the interviews of the facility personnel and the visual observations. Useful interviewing techniques are presented in Annex (H) of the Guidelines for inspection team (EPAP, GIM 2000)

The first step to be taken by the inspector is to define whether the facility includes one or more production lines, and whether these lines are within the dry processes category (cotton spinning, weaving, knitting,.etc.) or within the wet processes category (desizing, scouring, bleaching, dyeing, printing, ..etc). By the help of the facility layout the inspector starts to check the points of air emissions (such as cotton dust, cotton fuzz, particulates, chemical fumes and vapors,. etc.), the points of discharge of effluents and wastewater (VOC,BOD and heavy metals), and the solid waste (such as sludge, resin residue, powder dye). This study of layout helps to determine where and how to take the samples of the different emissions.

Cotton dust and cotton fuzz can be noticed visually in the spinning line, and samples of the polluted air can be taken from the opening and cleaning zone where the concentration is expected to be maximum.

In the wet processes air emissions of chemical fumes and vapors can be noticed by odor such as chlorine fumes from the bleaching process, ammonia from the dyeing process, and urea or formaldehyde from the printing process.

Polluted effluents result from the wet processes such as desizing, scouring, bleaching, dyeing, printing, finishing,..etc. These wastewater either to be treated chemically before discharging in the public sewer system, or to be discharged without any pretreatment. The inspector should determine the final disposal points where samples are to be taken. Spills of liquid chemicals or liquors (size) should be noticed visually. In the dye house, powder dye particulates in the dye store should be noticed and sample of the air, in the room where the dye doze is prepared, can be taken to check the concentration in the environment.

Solid waste in the dry processes such as fibers, yarns and fabric scraps can be noticed visually but they do not represent hazardous situation. But solid waste from the wet processes such as grease from wool scouring, sludge from dyeing and printing, and resin residues from finishing, represent hazardous disposals.

The inspector should notice how the solid waste is disposed, and whether there is a regular system for disposal. Also the inspector notices the way of handling the hazardous solid waste such as finishing residues, sludges, dust, resin,..etc., and whether the workers use protective masks when handling powder dye, dust,..etc.

Noise is a very important pollutant in the textile industry especially with modern machines running at high speeds. Noise level is high in the dry processes, and also in some of the wet processes. The noise level is anticipated to be high and perhaps violating the limit allowed by law 4/1994, especially around the ring-spinning machines, winding machines, looms, knitting machines, texturing machines, tufting machines,..etc.

Inspection of the production line should start with the feeding of raw materials and ends with the product packaging and storage.

9.2.1 Inspection of Production Lines of Different Textile Subsectors

a) Cotton spinning line

- Check whether there is a scavenging system for cotton dust and cotton fuzz. Observe if any accumulation of waste fiber on the machines, and flying particulates in the work environment. If the observation expects violation of allowed limits, samples of the suspected polluted air should be taken for analysis
- Check the schedule of evacuating dust filters, method of handling filler waste, and the way for dust disposal
- Check how machine fiber waste is managed, regarding the periodical removal, place of storing, and way of disposal.
- Check the noise level especially at locations expected to exceed the legal limits such as ring-spinning machines, open-end spinning machines, winding machines, ..etc. The instrument for measuring noise level (decibel) is very light to carry, and very simple to operate, so that the inspector should try to evaluate the noise level whenever possible, to discover any excessive noise due to extraordinary vibration of spindles as a result of carelessness in maintenance.

b) Wool spinning line

- Check the presence of a scavenging system, and observe the concentration of particulates in the work environment
- Check the type of volatile organic chemical used as a solvent in the scouring process. If a hazardous chemical is used, samples of air emissions, and effluents should be taken for analysis.(BOD,COD)
- Check the final point of wastewater discharge, and how the grease and sludge are disposed.

- Check the existence of a scavenging system in the area of carbonizing for clearing the fumes of sulpheric acid used in this process. If there is any odor of this acid, the inspector should take a sample of that polluted environment.
- Check for any steam leaks from the drying cylinders.
- Check the noise level around the spinning, and winding machines

c) Weaving line

- Check the type of size used. If PVA is used in the sizing process, check the precautions taken for the resulting methanol which is considered as a hazardous pollutant. The size box should be covered with a suction roof to scavenge the resulting vapor of size
- Check for any spills of size solution, and the size waste from the size cooking process.
- Check the temperature around the sizing machine, and observe the exhaust system of the drying equipment.
- Check the level of noise in the weaving area (using the decibel instrument), where the level is expected to exceed the legal limit. Also, check whether the weavers use ear-plugs as a hearing protection device.
- Check the intensity of particulates in the weaving area, especially if high speed air-jet looms are used and whether there is sufficient ventilation or a scavenging system.

d) Knitting line

- Check the intensity of particulates in the working area, and whether there is sufficient ventilation in the facility, or a scavenging system is used
- Check the level of noise near the machines, to make sure that it is below 90 decibel.(according to law 4)

e) Nonwoven fabric line

- Observe the intensity of particulates around the fiber web framing machine. If the environment is cloudy by fiber fuzz, the inspector should take sample for analysis.
- Check whether spray adhesive is used, and whether the type of adhesive resin causes emission of formaldehyde. If so, samples should be taken for analysis to make sure that ppm of formaldehyde is below the allowed limit.

f) Tufted carpet line

- check the intensity of particulates around the tufting machine, and the shearing
- machine.
- Check the type of latex used for the back coating of carpets. If the type of resin used causes emission of formaldehyde, sample may be taken for analysis.
- Check the level of noise around the tufting machine.
- Check the temperature around the drying machine.

g) Wet processing line

g-1) Desizing process

- Check the concentration of volatile organic chemicals resulting from glycol ethers used in this process. Make sure that acid id not used but hydrogen peroxide and enzymes are used as a substitute.
- Check wastewater from the process, by taking samples to examine high BOD or COD.
- Check the temperature of the effluents from the process (70-80c˚)

g-2) Scouring process

- Check the concentration of VOCs in the area of process.
- Check oily fats, BOD, pH, temperature (70-80c˚), and the color of the
- wastewater, and samples may be taken for analysis
- Make sure that fatty alkyl sulphates polyglycolether is used instead of alkyl benzene sulphonates, and zeolites (sodium aluminum silicate) is used instead of NTA, EDTA

g-3) Bleaching process

- Check the concentration of toxic chlorine gases, and make sure that it is below the legal limit.
- Make sure that peroxide bleaches are used instead of reductive sulphur
- bleaches, or chlorine compounds
- Check the wastewater from the process, regarding high pH, H2O2,
- residual bleaching agents, surfactants,..etc.

g-4) Mercerization process

- Little or no air pollution from this process.
- Check high pH, NaOH in the wastewater, by taking samples for analysis

g-5) Dyeing process

- The inspector should give great care to the dyeing process as it deals with a number of different chemical compounds containing heavy metals (e.g. Cu, Cr), carcinogenic amines, toxic compounds, irritants, ..etc.
- Concentration of the volatile organic chemicals is worthy to be checked due to its seriousness
- The effluents from the dyeing process represent an important source of pollution as they contain BOD and COD, which are considered hazardous for aquatic life. So, the inspector should make sure whether there is treatment for wastewater

before the discharge to the public sewer or nearby canal or lake. Samples of wastewater before and after treatment should be taken to check the safety of effluents.

- Check that hazardous types of dyes are substituted by another more safe dyes, such as mineral/pigment dyes instead of benzidine based dyestuffs or amine releasing dyes, formic acid instead of acetic acid in the dyeing bath, polymeric compounds instead of copper sulphate used to treat direct dyes, liquid dyes instead of powder dye in automatic injection, high molecular weight polymeric auxiliaries instead of aldehyde and toxic metallic salts used as auxiliaries, ..etc.
- Check the dye bath ratio (weight of dye liquor in bath to weight of fabric) which should be as low as possible to minimize the pollutant wastewater load.
- Check whether dye bath chemicals are reused or not, to minimize the wastewater load.
- Check the way of preparation of dye dose from powder dye container. Make sure that small containers are use rather than big containers where the worker has to insert his face deeply inside the container for taking the required amount of powder dye. This scenario is very hazardous for the respiratory system of the worker. Also the inspector should check for the presence of a scavenging system to draw the air polluted by dye dust away from the worker face, avoiding smelling dye dust.
- Check the way of sludge and residues disposal. Make sure of the existence of a schedule for disposal, and whether there is any accumulation of any hazardous sludges or residues around the facility. Check whether workers, dealing with sludges and chemical residues, wear special masks to safeguard them from hazardous emissions.
- Check the odor of ammonia in the dyeing process. If necessary samples of the surrounding air should be taken for analysis.
- Check for each discharge of dye bath, whether the necessary treatment has been carried out for the wastewater polluted to an extent violating the limits of law 4/1994
- Check the noise level around the dyeing machines, and the drying machine.

g-6) Printing process

- Check the air emissions of used solvents, acetic acid, drying and curing, oven emissions, and combustion gases. These emissions have hazardous impacts (carcinogenic, fire- hazardous, irritant).
- Check the emissions of urea, kerosene, formaldehyde, and ammonia, and samples should be taken for analysis in these cases, as they represent hazardous pollution in the working area.
- Check the wastewater from printing process as it contains toxic chemicals, COD, BOD, pH, dissolved solids which are hazardous pollutants and should be kept below the limit allowed by the law. So, the inspector should make sure that treatment is used for wastewater before discharge to the public sewer. If no treatment is used, samples should be taken from the final discharge point of the

printing process to be analyzed to make sure that the discharged wastewater is not violating the environmental laws.

- The inspector should check that water based systems are used for printing instead of kerosene or white spirit.
- Check noise level near the printing machine.

g-7) Finishing process

- Note that the types of chemicals used in fabric finishing depend on the type of finishing (water – proofing, antistatic ,..etc), but most of these chemicals are hazardous (toxic, carcinogenic, irritant, skin allergies ,..etc.).So, inspection is mostly recommended to make sure that the environment is safe for workers.
- Check in case of processing and storing resin finished fabrics, that formaldehyde scavengers are used. Samples of polluted air may be taken and examined to insure the compliance of the environment with the laws.
- The inspector should make sure that polycarboxylic acid is used instead of formaldehyde, and fatty alcoholethyoxylate instead of alkylphenol.
- Check the concentration of volatile organic chemicals, formaldehyde vapors, and combustion gases.
- Check the BOD,COD, suspended solids, toxic materials, and spent solvents in the final point of wastewater. If there is treatment before discharge, the inspector should take a sample before and after treatment to make sure of the quality of discharged effluents.
- Check the locations of solid waste accumulation, namely, sludge, and resin residues. Check the method of disposal for such waste, and the schedule for cleaning up the working area.
- If softening finishing is used make sure that cellulose enzymes are used instead of MAC complexing agents.

h) Garment Production Line

- If the facility deals with resin-coated fabrics, the inspector should make sure that the fabric rolls in the store of raw materials should be packaged to avoid emission of formaldehyde. Also the finished garments made of resin-coated fabrics should be packaged before storing for the same reason.
- Observe the particulates (fiber fuzz) in the environment of cutting, and sewing. If excessive intensity of particulates is noticed, samples of the air are taken for analysis.
- Check for any odor of chemical vapor around the heat –fuzing of the interlining to the fabric.
- Check the way of disposal for fabric scraps resulting from the cutting process. Observe the surrounding of the facility to make sure that proper disposal management is used.
- Check the noise level in the sewing area.
- Check for any steam leakages in the ironing process.

i) Man-made fiber production lines

i-1) Viscose rayon line

- Check the intensity of caustic soda vapor around the soaking tank. Check whether there is any spills of soda or any lumps of soaked pulp around the
- presses.
- Check whether a scavenging system is used to drive away the hydrogen sulphide resulting from the process of mixing carbon disulphide with soda cellulose. If not, samples of polluted air should be taken for analysis to check the compliance of the facility with the regulations.
- Check the exactness of the spinning bath cover, and whether there is any leakage of sulphuric acid vapors that can be sensed by odor.
- Check the noise level near the spinning pots, and the winding machines.
- Check the final discharge point of the wastewater. If there is no treatment for the effluents, samples should be taken for analysis from the location just before the discharge to the public sewer.
- Check the safety precautions for the storage tanks of both caustic soda, and sulphuric acid, and notice if any spills exist around the place.

i-2) Nylon production line

- Check for any steam leaks or polymer spills in the polymerization zone
- Check the temperature in the spinning zone.
- Check for any spills of nylon chips.
- Check for any residues of finishing oils.
- Check the noise level in the twisting, texturing, and winding machines.
- Check the final point for the discharge of wastewater, and make sure whether it needs treatment before discharge to public sewer or not. Check the concentration of anti-static lubricants, soap, soda, and fatty esters.
- Check whether the solid waste, sludge, yarn scraps, and nylon chips are regularly disposed or not.

i-3) Polyester production line

- Check steam leakages in polymerization, and heat stretching zones.
- Check spills of DMT.
- Check the registered level of radiation for both Cesium and Cobalt, which are used in the control systems in the polymerization.

- Check the precautions of handling methanol as a by-product (fire protection).
- Check the noise level around the twisting, texturing, and winding machines
- Check the wastewater contents, (oil residues and finishing agents) and
- concentration, and make sure of the pretreatment effects if it exists.
- Check for the way of managing the fiber waste and yarn scraps, and whether accumulation of solid waste exists around the machines.

9.2.2 Inspection of Service Units

a-1) 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.

a-2) 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.
- Check noise level.

a-3) Cooling towers

- The amount of blowdown from the cooling towers is about 10-15% of the make-up water and is low in BOD and high in TDS.

a-4) Storage facilities

- Check storage of hazardous chemicals, and dye containers.
- Check spill prevention and containment measures for storage of liquids.
- Check storage of finished fabrics in case of resin-coated fabrics.

a-5) Scavenging systems

- Check the filters in the scavenging system in spinning and weaving production lines. Check the way of dust and fiber waste disposal. Observe the cleanness of the work environment.

9.2.3 Effluent Analysis

a-1) Receiving body

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

a-2) 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, three sample are taken, one is sealed and kept untouched, the second is analyzed and the third is kept in the industrial facility.

9.3 Ending the Field Visit

When violations are detected a legal report is prepared, stating information defining sample location and time. Violations of work environment regulations should also state location and time of measurements. Other visual violation such as cotton dust, fiber fuzz waste accumulation, waste handling, material spills, powder dust, ..etc. should be photographed and documented. The facility management should sign the legal report. A closing meeting with the facility management can be held to discuss findings and violations.

10. Conclusion of the Field Inspection

The work performed during the inspection of the facility is essential for the following targets:

- Preparation of the inspection report.
- Assessing the seriousness of the violations.
- Pursuing a criminal or civil suit against in court without being contesed.
- 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 Environmental Inspection Manual (EPAP,GIM 2002). The inspection report presents the findings (pollutants which violate the recommendations, and supporting information in an organized from. It provides the inspectorate management with the basis for proposing enforcement measures and follow-up activities.

10.2 Supporting the Enforcement Case

In some enforcement actions many issues may be and disputed. In this case the 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 (such as photograph, laboratory analysis, and site measurements).
- Establish that the procedures were fairly followed.
- Demonstrate the environmental and health impact of the violating polluting parameter.

Notes to Inspectorate management:

- ***Although the inspector is not required to suggest pollution abatement solutions, the inspectorate management should be able to demonstrate that a remedy for the violation is available.***
- ***Enforcement should not cause financial collapse of the facility and inspectorate management should select the reasonable means within the ability of the violator.***

10.3 Following-up Compliance Status of Violating Facility

As a result of performing the comprehensive inspection and detecting the sources of violation, the inspectorate management should make the following actions:

- Decide on the sanctions and send the legal report to the judicial authority.
- Make a plan for routine follow-up inspection. 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).
- Notes: protecting basic rights
- Routine inspections should be spaced to give sufficient time for the remedial solutions to be implemented.
- The inspectorate management should make sure that the inspectors do not abuse their power.
- Inspectors should not become too familiar with facility managers and they should make compromise between objectivity and integrity.

Annexes

Annex (1)

Annex 1

ASSESSMENT OF DYES

(in ppm of the commercial product or preparation)

Element	Concentration	
Chromium (Cr)	100	ppm
Manganese (Mn)	1000	ppm
Iron (Fe)	2500	ppm
Cobalt (Co)	500	ppm
Nickel (Ni)	200	ppm
Copper (Cu)	250	ppm
Zinc (Zn)	1500	ppm
Arsenic (As)	50	ppm
Selenium (Se)	20	ppm
Silver (Ag)	100	ppm
Cadmium (Cd)	20	ppm
Tin (Sn)	250	ppm
Antimony (Sb)	50	ppm
Barium (Ba)	100	ppm
Mercury (Hg)	4	ppm
Lead (Pb)	100	ppm

These limits do not reflect actual levels which are often much lower.
These limits do not apply to dyes containing a listed metal as an inherent part of it's molecular structure, e.g. metal-complex dyes or double salts of certain cationic dyes.

Annex (2)

Annex (2)

Inspection Checklist for
Textile Manufacturing 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 ❑

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

Power Consumption

Electricity ❑ Fuel ❑

Electric power: ……………...kWh/(day-month-year)

Type of fuel	Fuel consumption	
Mazot	……………………….	Ton/(day-month-year)
Solar	……………………….	Ton/(day-month-year)
Natural gas	……………………….	Ton/(day-month-year)
Butagas	……………………….	Ton/(day-month-year)
Other ….	……………………….	Ton/(day-month-year)

The GPS (Global Positioning System) reading for Gaseous Emissions

1- LAT(Latitude):..……. LONG(Longitude):…….
2- LAT(Latitude):……… LONG(Longitude):…….
3- LAT(Latitude):……… LONG(Longitude):…….

Production

Product	Quantity/ (day-month-year)
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………

Water Supply

Artesian well ❑ Municipal water ❑ Treated water ❑ Nile water ❑

Canal water ❑ Other………….. ❑

Water Consumption

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

Process ……..m^3/ Boilers…………………..m^3/

Domestic usage………....m^3/ Cooling………………....m^3/

Other…….. …………….m^3 /

Total amount of water consumed (day-month-year)……… …………..m^3/

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^3 /
Amount of waste water/(day-month-year)……………………….m^3 /

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 ❑

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:

Team member	**Position**

Date: Inspector signature:

Inspection Checklist for Yarn Production Line

1. General	
1.1 Housekeeping - Floor - Penetrative odour - Solid wastes accumulation	 ---------------------------- ---------------------------- ----------------------------
1.2 Check that the unit is in operation	----------------------------
2. Status of Ambient Air	
2.1 Check the measurements of the total particulates from the cyclones of raw cotton opening and cleaning section. - Are they included in the environmental section?	----------------------------
***Note**: If suspicious, take your own measurements*	
3. Status of Work Environment	
3.1 Identify the ventilation system in the unit	----------------------------
3.2 Check the ground suction system in the unit. Does it work efficiently?	❑ Yes No ❑
3.3 Notice the particulates in the opening, cleaning and carding sections. - Are there any measurements for the particulates? - Are they included in the environmental register?	---------------------------- ❑ Yes No ❑ ❑ Yes No ❑
3.4 Do you notice high noise beside the winding and spinning equipment? - Are there any measurements for the noise? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
3.5 Identify the exposure period for noise	----------------------------
3.6 Do you notice odours of VOCs or acids in wool spinning operation? - Are there any measurements for these emissions? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
3.7 Are the personal protective equipment provided in the unit?	❑ Yes No ❑
***Note**: In case of suspecting the existing measurements, take your own measurements.*	
4. Status of Liquid Wastes	
4.1 Identify the disposal methods for the used oils generating from wool spinning.	----------------------------
4.2 Check the disposal method for the chemicals residuals from wool cleaning. Check the indicative documents.	----------------------------
4.3 Identify the disposal outlet for wool spinning unit.	----------------------------
4.4 Identify the time in which cleaning the wet processes tanks is applied.	----------------------------
5. Status of Solid Wastes	
5.1 What are the disposal methods for machines wastes?	----------------------------
5.2 What is the disposal method for filters wastes in the spinning section.	----------------------------
5.3 Check the presence of the indicative documents in the environmental register.	----------------------------

Inspection Checklist for Textile Production Line

1. General	
1.1 Internal Cleaning and maintenance - Floor - Penetrative odour - Solid wastes accumulation - Noise level outside the unit	 ---------------------------- ---------------------------- ---------------------------- ----------------------------
1.2 Check that the unit is in operation	----------------------------
2. Status of Gaseous Emissions	
2.1 Specify the ventilation system in the unit	----------------------------
2.2 Check the ground suction system in the unit. Does it work efficiently?	❑ Yes No ❑
2.3 Do you notice high noise beside the weaving equipment? - Are there any measurements for the noise? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
2.4 Identify the exposure period for the noise	
2.5 Are there personal protective equipment in the unit?	❑ Yes No ❑
2.6 Do you notice emissions of penetrative odours beside the sizing basins (e.g. methanol odour)? - Are there measurements for these emissions? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
2.7 Do you notice heat stress beside the sizing basins? - Are there measurements for noise? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
Note*: In case of suspecting the existing measurements, take your own measurements.*	
3. Status of Liquid Wastes	
3.1 Specify the disposal time for the sizing solution to the factory' sewage.	----------------------------
3.2 Identify the disposal outlet for the unit.	----------------------------
3.3 Identify the time and rate of floor washing.	----------------------------
4. Status of Solid Wastes	
4.1 Specify the disposal methods for the yarns packaging wastes.	----------------------------
4.2 Specify the disposal method for the sizing materials wastes	----------------------------
4.3 Check the presence of the indicative documents in the environmental register.	----------------------------
5. Status of Hazardous materials	
5.1 Check the type of hazardous materials used in sizing.	----------------------------
5.2 Check the compliance of handling and storage of the hazardous materials with the law 4/ 1994	----------------------------
5.3 Check the emergency measures for these materials.	----------------------------

Inspection Checklist for Finishing and Dyeing Line

1. General	
1.1 Internal Cleaning and maintenance - Floor - Penetrative odour - Solid wastes accumulation	 ---------------------------- ---------------------------- ----------------------------
1.2 Check that the unit is in operation	----------------------------
2. Status of Work Environment	
2.1 Specify the ventilation system in the unit	----------------------------
2.2 Do you notice the following odours: - Gases from cotton singeing - VOCs (glycol ether) from desizing operation - VOCs from textile rinsing after desizing - Vapours of bleaching chemicals (chlorine and acetic acid) - Vapours of dyeing chemicals - Vapours of organic chemicals from printing (ethylene glycol, urea, kerosene, ammonia, formaldehyde). Are there measurements for these emissions? Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
2.3 Do you notice high noise beside the printing, brushing and napping, shearing and polishing equipments? - Are there measurements for the noise? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
2.4 Identify the exposure period for noise.	----------------------------
2.5 Are there personal protective equipment in the unit?	❑ Yes No ❑
2.6 Do you notice heat stress at the rinsing, drying, dyeing and heat stabilization? - Are there measurements for noise? - Are they included in the environmental register?	❑ Yes No ❑ ❑ Yes No ❑ ❑ Yes No ❑
***Note**: In case of suspecting the existing measurements, take your own measurements.*	
3. Status of Liquid Wastes	
3.1 Specify the disposal time for the bleaching and dyeing solutions to the factory' sewage?	----------------------------
3.2 Specify the disposal outlet for this unit.	----------------------------
3.3 What are the floor washing rates and times?	----------------------------
4. Status of Hazardous Wastes	
4.1 Check the hazardous materials used in bleaching, desizing, dyeing and finishing operations.	----------------------------
4.2 Check the compliance of handling and storage of the hazardous materials with the law 4/ 1994	----------------------------
4.3 Check the emergency measures for these materials.	----------------------------

Checklist for Boilers and Water Treatment Units

1. General	
1.1 Number of boilers and capacity	--- ---
1.2 What is the method used for water treatment?	❑ Lime ❑ Ion exchange ❑ Reverse osmosis
2. Status of Air Pollution	
2.1 What is the height of the stack of each boiler	Boiler (--)-------------------------- Boiler (--)-------------------------- Boiler (--)--------------------------
Note: the height of the stack must be 2.5 times the height of adjacent buildings.	
2.2 Type of fuel used for boilers	❑ Mazout ❑ Solar ❑ Natural gas ❑ Other…….
2.3 In case of using mazot for boilers, is the surrounding area residential?	❑ Yes ❑ No
Note: The use of mazot as fuel in the residential area is Prohibited by law.	
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	❑ Yes ❑ No
2.5 If Yes Check the compliance of the analysis readings in the register with your observations	--- --- ---
Note : Whatever the fuel used ,if you notice any smoke, take a sample for analysis	
3. Status of Work Environment	
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?	❑ Yes ❑ No
Note : In case of suspicious perform your own measurements	
4. Status of Effluent	
4.1 What is the blow down rate from the boilers?	-- m^3/d
4.2 What are the blow down and back wash rates for the treatment units?	-- m^3/d -- m^3/d
4.3 Steam condensate is	❑ Recycled to the boilers ❑ Discharged to sewer
5. Status of solid waste	
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?	---
6. Status of Hazardous Material	
6.1 Check the storage method of chemicals used in the treatment process. Is it in compliance with law 4?	-- -- ❑ Yes ❑ No
6.2 Is there any fuel leaks from fuel tanks	❑ Yes ❑ No
6.3 Is there any fire extinguishing devices and fire fighting measures?	❑ Yes ❑ No
6.4 Is there a spill prevention plan?	❑ Yes ❑ 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)	❑ Yes ❑ No Comment --- ---

Checklist for Cooling Towers

1.General	
1.1 Number and capacity of cooling towers	--- --- ---
1.2 Cooling tower make-up rate Note : Blow-down = 10-15% of make-up	Rate --- Blow-down --
2. Status of Effluent	
2.1 Cooling water for the compressors is performed in	□ Open Cycle □ Closed Cycle
Note : If performed in open cycle it will dilute the final effluent	
2.2 Record the amount of open cycle cooling	---

Checklist for Mechanical Workshops (Maintenance)

1. Status for the Effluent			
1.1 What is the amount of wastewater produced?	-----------------------------------		
1.2 What is your visual observation for the inspection? Manhole of the workshop?	------------------------------------		
2. Status of Solid Waste			
2.1 What is the amount of solid waste generated?	---		
2.2 How does the facility dispose the solid waste produced?	--		
3. Status of the work Environment			
3.1 Are there any noise in work place	Yes ❑	No ❑	
<u>If yes</u>			
Are there any measurements for noise	Yes ❑	No ❑	
<u>If not</u>			
Perform measurements			

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	☐ Found ☐ Not found
Equalization tank	☐ Found ☐ Not found
Neutralization	☐ Found ☐ Not found
Sedimentation tank	☐ Found ☐ Not found
Sludge thickening tank	☐ Found ☐ Not found
Sludge drying	☐ Found ☐ Not found
Others	--
1.3 List any chemical and their quantity used for wastewater treatment (coagulants,…..)	-- -- --
2. Status of Effluent	
2.1 Are there analyses for the effluent If not Make your own	☐ Yes ☐ No
2.2 Are the results of the analysis included in the environmental register	☐ Yes ☐ No
3. Status of Solid Wastes	
3.1 Determine the sludge disposal	--
Note : It can be use in liquid or dry form, in agriculture	
If a third party is involved in disposal, get documents for proof	☐ Found ☐ Not found Comment -- --

Checklist for Garage

1. General	
1.2 Is there any detergent or solvent used for washing equipment parts, trucks, floor,… etc.?	Yes ❑ No ❑
1.3 What are the amounts of oil and grease used per day?	---------------------------------
1.4 What is the amount of spent lube oil produced per day?	---------------------------------
1.5 How dos the facility dispose the spent oil?	---------------------------------
2. Status of the Effluent	
2.1 What is the amount of wastewater generated?	---------------------------------
2.2 Do you observe any oil/ foams/ solid matter in the inspection manhole?	Yes ❑ No ❑

Check list for Laboratories

1. General	
1.1 What is the amount of wastewater produced per day	-----------------------------------
1.2 List the chemicals and materials used in the laboratories	---------------------------------
2. Status of the Work Environment	
2.1 Are there any odor/ in the work environment?	Yes ❑ No ❑
3. Handling of Hazardous Material	
3.1 Inspect the methods of handling and storage of hazardous material. Are they in compliance with the requirements of law 4?	Yes ❑ No ❑
3.2 Are there any first aid measures in place ?	Yes ❑ No ❑