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This document is part of the e-learning tool.

Process analysis of textile manufacturing

Environmental impacts of textile industries

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CONTENTS

2.4. ENVIRONMENTAL IMPACTS OF TEXTILE INDUSTRIES

Textile processing industry is characterized not only by the large volume of water required for various unit operations but also by the variety of chemicals used for various processes. There is a long sequence of wet processing stages requiring inputs of water, chemical & energy and generating wastes at each stage. The other feature of this industry, which is a backbone of fashion garments is large variation in demand of type, pattern and color combination of fabric resulting into significant fluctuation in waste generation volume and load. Textile processing generates many waste streams, including liquid, gaseous and solid wastes, some of which may be hazardous. The nature of the waste generated depends on the type of textile facility, the processes and technologies being operated, and the types of fibers and chemicals used. The overview on the amounts of waste generated within the textile processes are summarized on table 2.3 **(2)**.

Table 3.3Summary of the wastes generated during textiles manufacturing (3).

Process	Emission	Wastewater	Solid wastes
Fiber preparation	Little or none	Little or none	Fiber waste and packaging waste.
Yarn spinning	Little or none	Little or none	Packaging wastes; sized yarn; fiber waste; cleaning and processing waste.
Slashing/sizing	VOCs	BOD; COD; metals; cleaning waste, size	Fiber lint; yarn waste; packaging waste; unused starch-based sizes
Weaving	Little or none	Little or none	Packaging waste; yarn and fabric scraps; off- spec fabric; used oil.
Knitting	Little or none	Little or none	Packaging waste yarn and fabric scraps; off-spec fabric.
Tufting	Little or none	Little or none	Packaging waste; yarn, fabric scraps; off-spec fabric
Desizing	VOCs from glycol ethers	BOD from sizes lubricants; biocides; anti-static compounds	Packaging waste; fiber lint; yarn waste; cleaning and maintenance materials

Process	Emission	Wastewater	Solid wastes
Scouring	VOCs from glycol ethers and scouring solvents	Disinfectants, insecticide residues; NaOH; detergents, oils; knitting lubricants; spin finishes; spent solvents	Little or none
Bleaching	Little or none	H_20_2, stabilizers; high pH	Little or none, even if little, the impact could be considerable
Singeing	Small amounts of exhaust gases from the burners exhaustic which components.	Little or none	Little or none
Mercerising	Little or none	High pH; NaOH	Little or none
Heatsetting	Volatilisation of spin finish agents-synthetic fiber manufacture	Little or none	Little or none
Dyeing	VOCs	Metals; salt; surfactants; organic processing assistants; cationic materials; color; BOD; COD; sulphide; acidity/ alkalinity; spent solvents	Little or none
Printing	Solvents, acetic acid - drying and curing oven emissions combustion; gases	Suspended solids; urea; solvents; color; metals; heat; BOD; foam	Little or none
Finishing	VOCs; contaminants in purchased chemicals; formaldehyde vapors; combustion gases	COD; suspended solids; toxic materials; spent solvents	Fabric scraps and trimmings; packaging waste

2.4.1 AIR POLLUTION

Most processes performed in textile mills produce atmospheric emissions. Gaseous emissions have been identified as the second greatest pollution problem (after effluent quality) for the textile industry. Speculation concerning the amounts and types of air pollutants emitted from textile operations has been widespread but, generally, air emission data for textile manufacturing operations are not readily available. Air pollution is the most difficult type of pollution to sample, test, and quantify in an audit.

Air emissions can be classified according to the nature of their sources:

Point sources:

- Boilers
- Ovens
- Storage tanks

Diffusive:

- Solvent-based
- Wastewater treatment
- Warehouses
- Spills

Textile mills usually generate nitrogen and sulphur oxides from boilers Other significant sources of air emissions in textile operations include resin finishing and drying operations, printing, dyeing, fabric preparation, and wastewater treatment plants. Hydrocarbons are emitted from drying ovens and from mineral oils in high-temperature drying/curing. These processes can emit formaldehyde, acids, softeners, and other volatile compounds. Residues from fiber preparation sometimes emit pollutants during heat setting processes.

Carriers and solvents may be emitted during dyeing operations (depending on the types of dyeing processes used and from wastewater treatment plant operations. Carriers used in batch dyeing of disperse dyes may lead to volatilization of aqueous chemical emulsions during heat setting, drying, or curing stages. Acetic acid and formaldehyde are two major emissions of concern in textiles. The major sources of air pollution in the textile industry are summarized on Table 2.4.

Table 2.4 Summary of the wastes generated during textiles manufacturing

Process	Source	Pollutants
Energy Production	Emissions from boiler	Particulates, nitrous oxides (Nox) sulphur dioxide (SO_2)
Coating, drying and curing	Emission from high temperature ovens	Volatile organic components (VOCs)
Cotton handling activities	Emissions from preparation, carding, combing, and fabrics manufacturing	Particulates
Sizing	Emission from using sizing compound (gums, PVA)	Nitrogen oxides, sulphur oxide, carbon monoxide.
Bleaching	Emission from using chlorine compound	Chlorine, chlorine dioxide
Dyeing	Disperse dyeing using carriers Sulphur dyeing Aniline dyeing	Carriers H_2S Aniline vapors
Printing	Emission	Hydrocarbons, ammonia
Finishing	Resin finishing Heat setting of synthetic fabrics	Formaldehyde Carriers - low molecular weight Polymers - lubricating oils
Chemical storage	Emissions from storage tanks for commodity and chemicals	Volatile organic components (VOCs)
Waste water treatment	Emissions from treatment tanks and vessels	Volatile organic components, toxic emissions

2.4.2 WATER POLLUTION

The textile industry uses high volumes of water throughout its operations, from the washing of fibers to bleaching, dyeing and washing of finished products. On average, approximately 200 L of water are required to produce l kg of textiles (Table 2.5). The large volumes of wastewater generated also contain a wide variety of chemicals, used throughout processing. These can cause damage if not properly treated before discharge to the environment. Of all the steps involved in textiles processing, wet processing creates the highest volume of wastewater.

Table 2.5 Average water consumption for various types of fabric (2).

Processing subcategory	Water consumption (m^3 /ton fibre material)		
	Minmumum	Median	Maximum
Wool	111	285	659
Woven	5	114	508
Knit	20	84	377
Carpet	8.3	47	163
Stock/yarn	3.3	100	558
Nonwoven	2.5	40	83
Felted fabric finishing	33	213	933

The aquatic toxicity of textile industry wastewater varies considerably among production facilities. The sources of aquatic toxicity can include salt, surfactants, ionic metals and their metal complexes, toxic organic chemicals, biocides and toxic anions. Most textile dyes have low aquatic toxicity. On the other hand, surfactants and related compounds, such as detergents, emulsifiers and dispersants are used in almost each textile process and can be an important contributor to effluent aquatic toxicity, BOD and foaming.

Detailed information on the sources of wastewater for the wet processing of different fibers (cotton, wool and blendes, synthetic fiber) includes, main pollutants, volumes, wastewater characteristics and pollution impact is summarized in appendix 2.

2.4.3 SOLID WASTE POLLUTION

The primary residual wastes generated from the textile industry are non-hazardous. These include scraps of fabric and yarn, off-specification yarn and fabric and packaging waste. There are also wastes associated with the storage and production of yarns and textiles, such as chemical storage drums, cardboard reels for storing fabric and cones used to hold yarns for dyeing and knitting. Cutting room waste generates a high volume of fabric scraps, which can often be reduced by increasing fabric utilization efficiency in cutting and sewing.

The following table (Table 2.6) summarizes solid wastes associated with various textile-manufacturing processes.

Table 2.6 Sources and types of solid waste in textile manufacturing (3).

Source	**Type of Solid Waste**
Mechanical Operations of Cotton and Synthetics:	
• Yarn preparation.	Fibers and yarns.
• Knitting.	Fibers and yarns.
• Weaving.	Fibers, yarns and cloth scraps.
Dyeing and Finishing of Woven Fabrics:	
• Sizing, desizing, mercerizing, beaching, washing and chemical finishing.	Cloth scraps
• Mechanical finishing.	Flock
• Dyeing and/or printing.	Dye containers
• Dyeing and/or printing (applied finish).	Chemical containers.
Dyeing and Finishing of Knitted Fabrics.	Clothe scraps, dye and chemical containers.
Dyeing and Finishing of Carpets:	
• Tufting	Yarns and sweepings.
• Selvage trim.	Selvage.
• Fluff and shear.	Flock.
• Dyeing, printing and finishing.	Dye and chemical containers.

Source	Type of Solid Waste
Dyeing and Finishing of Yarn and Stock.	Yarns, dye and chemical containers
Wool fabrication	
• Wool scouring.	Dirt, wool, vegetable matter, waxes.
• Wool fabric dyeing and finishing.	Flocks, seams, fabric, fibers, dye and chemical containers.
Packaging.	Paper, cartons, plastic sheets, rope.
Workshops.	Scrap metal, oily rags.
Domestic.	Paper, sheets, general domestic wastes
Wastewater treatment.	Fiber, wasted sludge and retained sludge.