



Environmental Impact Assessment of Textile Industries: Control Measures, Disposal, Recycling and Future Perspectives: A Review

Suresh Kumar* and Priyanka Sati

Department of Chemistry, Banasthali University, Rajasthan, India

*Corresponding author: Sudesh Kumar, Department of Chemistry, Banasthali University, Rajasthan, India, Tel: 8193989818; E-mail: satipriyanka789@gmail.com

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The export of textile and clothing products including handicrafts from India has increased slightly to US dollar 40.4 billion registering a growth of 3% during 2017-18 from US dollar 39.4 billion during 2018-19 (Table 1) [1].

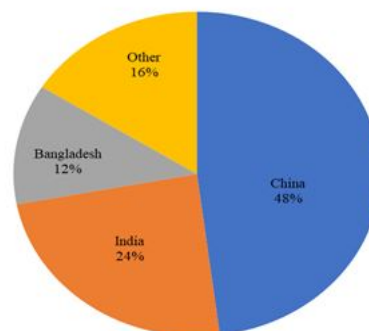


Figure 1: Clothing buyer countries percentage.

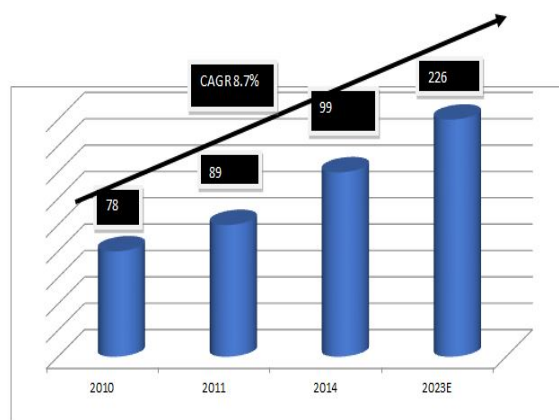


Figure 2: Indian textile industry growth.

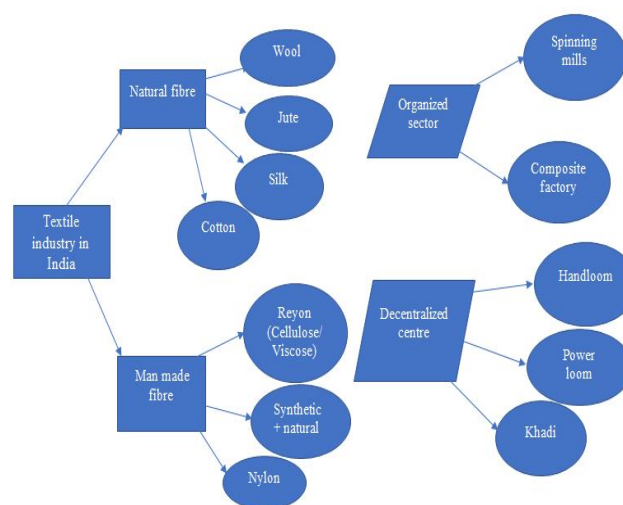


Figure 3: Textile industry in India.

Abstract

Textile industry is a very significant and rapidly growing manufacturing sector and it produces a huge amount of textile effluents becoming the chief cause of water, air, soil and noise pollution. Fabric industrialized sector such as spinning and weaving segment produces ear splitting sound and these are causing audible range trouble to the labour. Textile manufacturing liberates CO and CO₂ gases in air which are significantly contaminating the atmosphere. The fabric production procedure consumes large amount of water, energy and various chemicals. The main difficulty concerning the water utilization is the unprocessed squander sewage which is straight released into the water bodies. Textile industry is answerable for the key ecological contamination trouble all over planet, because they liberate unwanted dye sewage. Some approaches have also been addressed in this article which has the potential to mitigate the environmental hazards originating from textile effluents to some degree. Natural dyeing is mentioned as a replacement to synthetic dyes that is both environmentally compatible and cost efficient.

Keywords: Textile industry; Effluent; Contamination; Manufacturing; Ecological; Technologies; Eco friendly ways

Introduction

India currently holds the position of third largest textile producer worldwide, and the world's second most cotton and yarn producing nation. It has a profound impact on the international cotton and textile markets. After China, India is the world's largest clothing buyer.

Textile industry is one of India's earliest and widespread industries, as well as the country's second largest employer after agriculture, employing nearly 35 million people. Interestingly, this industry contributes all over 4% of GDP, 14% to industrial output, 9% excise collection, 18% industrial employment, and 16% to the entire export income underscores its significance (Figures 1-4).

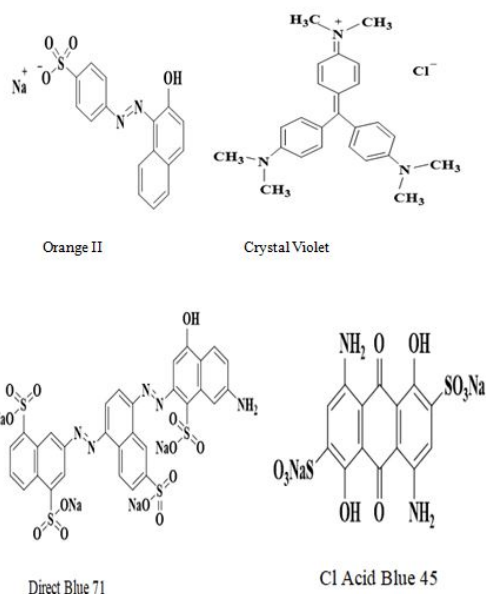


Figure 4: Structure of some textile dyes.

Products	Units	Apr-August	Apr-August
Fabric	Kgs	34572.13	58899.18
	Sqm	662033.4	816516.2
Yarn	Kgs	443083.6	389019.2
Made up	Kgs	146050.8	164959.2
	Nos	39183.66	33242.43
	Sqm	65.59	74.13
Fibre	Kgs	161969	163256.2

Table 1: Synthetic fibre export during April 2019-20.

Textile manufacturing procedure

- Production of fibres
- Processing of yarn
- Fabric development
- Before-hand treatment
- Printing and dyeing
- Treatment for the end result
- Fabrication

The first step in this chain is the production of the fibres and the fibres are divided into two categories:

- Natural fibre
- Man made fibre or synthetic fibre

The natural fibre can be classified on the basis of their source, like cellulose (from plants), Protein (from animal), and cotton (from seed hair), stem fibre such as linen, sisal (from leaf), coir (from coconut), silk (from secretions) (Figure 5). Man made fibre also known as synthetic fibres are generally divided into two types:

- Viscose
- Cellulose based fibre

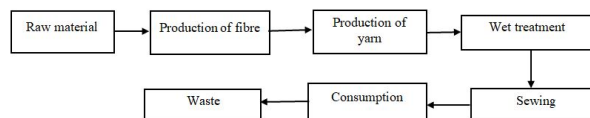


Figure 5: Various processes involved.

Process

- In the first step, seeds and other components such as capsule fragments, leaves, and twigs are separated from the fibre.
- In the second step, fibre is converted into a uniform fibre band with the help of carding machine and this fibre band is known as silver band.
- Various spinning technologies have been established in the industrial sector and by this process formation of yarn takes place.
- Formation of fabrics takes place with the help of weaving or knitting process.
- The final step is the production of textile products [2-4].

Literature Review

Environment impact

The clothes are made from raw materials viz. cotton, flax, and hemp, which consumes ample amount of water. Cotton plant requires a hefty amount of water to survive and to preserve these precious crops; several farmers use plenty of pesticides and herbicides, which are harmful to our climate.

According to a report published in science news in 1991, the amount of nitrous oxide in the atmosphere increased by 0.2 percent each year, with 0.0002 percent coming via nylon along with polyester processing. Nitrous oxide is a potent greenhouse gas with 300 times the ability to deplete the stratospheric ozone layer than carbon dioxide [5]. In textile production chain, the wet process is the important part of toxic emission [6]. The principal garments organisation countries for whole world are China, India, Bangladesh, Indonesia and Cambodia (Figure 6) [7].

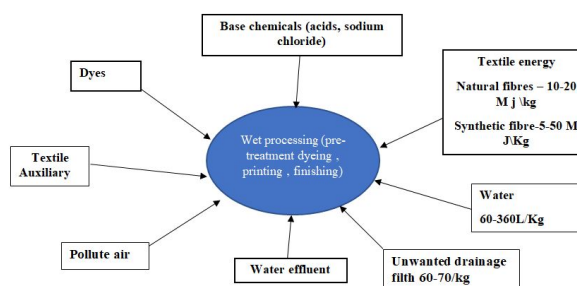


Figure 6: Textile finishing process inputs and outputs are analyzed.

There are four main types of contamination

- Water contamination
- Air contamination
- Soil contamination
- Noise contamination.

Water pollution

Textile industry wastewater shows toxic effects on aquatic macrophytes and algae [8]. Quality of water is usually determined by the rate at which a product in an aqueous solution degrades [9]. Millions of gallons of water per day used in industries. The problem is not the excessive use of water, but the problem is that contaminated water is released into the environment without treatment. According to a report, the textile industry is responsible for 20% of all freshwater emissions (Table 2) [10,11].

Table 2: Effect of pollutants on health.

Number	Process	Discharge of Chemicals	Contaminants	Health effect
1	Singe	Benzene, starch	Resin, wax, glucose and starch	Carcinogenic, mutagenic and effects central nervous system
2	Achromatizing	Hydrogen, NAOH, Detergent	Crude wax, caustic, sodium silicate	Effect kidney and liver
3	Dyeing	Sulphate, Urea	Dyes, sulphate, urea	Eye and respiratory problems
4	Printing	Nitrate, phosphate, dyes	Starch, gum, pva pigment, colour	Harmful health hazard's
5	Finishing	Fats, silicone	Starch, finishing agent	Suppression of haematological system.

Two processes are involved in the production of fibre (Figure 7) (Tables 3-5).

- Dye process [12].
- Wet process.

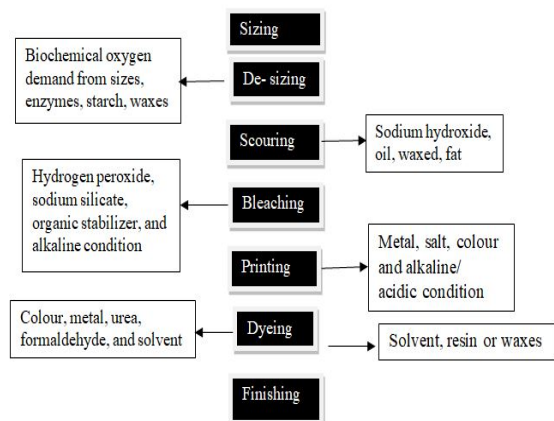


Figure 7: Pollutants discharge from each step of wet processing.

Types of industry	Production, tones/day	Water waste m ³ /day
Composite industry cotton, synthesis	10.63	840
Synthesis	2.6	180
Refining	1.61	150
Whisking	16.66	1500
Woollen industry	8.5	2700
Woollen	3.3	700

Table 3: Quantity of waste water generated by textile industry in India.

S. NO.	Result	Amount
1	Jean	30-35 L/ meter
2	Shirt part	11 L/meter
3	Slacks	80 L/meter
4	Weaving textile	90 L/Kg

Table 4: Amount of H₂O required.

S. No.	Boundary	Degree
1	pH	6.9 ppm
2	BOD	30 ppm
3	COD	250 ppm
4	TDS	2000 ppm
5	Sulphide	2 ppm
6	Chloride	500 ppm
7	Calcium	75 ppm
8	Magnesium	50 ppm

Table 5: Textile manufacturing boundary for water contamination.

Ways to treat water effluent from textiles

To reduce the textile water pollution these techniques are proving to be useful.

- Biological approaches
- Chemical procedure
- Physical methods

Biological approach: The biological method can only discard the soluble impurities, the biological systems is categorised in two different categories on the basis of oxygen needfulness.

- Aerobic
- Anaerobic
- Facultative

Chemical procedure: Organic compounds are usually removed using chemical methods such as flocculation and coagulation. [13,14]

Physical method: The physical procedure are soil purification or carbon adsorption, the method of carbon adsorption gives a result to reduce additional than 50% from COD, also to exclude surface active and manufacturing from staining.

Following are some textile wet processing innovations that are on rise and has significant environmental and other benefits:

- Dyeing using supercritical CO₂
- Textile wet process with plasma technology
- Bleaching cotton fabrics with ozone

Some other Techniques for wastewater treatments

Primary

- Showing
- Alleviation
- Homogenisation
- Nullification
- Motorised flocculation organic flocculation

Secondary

- Aerobic and anaerobic treatment
- Fizzy inlet
- Started mud
- Dripping purification
- Corrosion channel and pond

Tertiary:

- Film machineries microfiltration nano filtration and reverse osmosis.
- Adsorption silica granulated stimulated carbon natural and synthetic bio adsorbents.
- Oxidation method, fenton reaction, photo catalysis, enhanced oxidation procedures, ozonation.
- Electrolytic capacitor precipitation and bubble fractional process.
- Electro chemical methods [15].

Air pollution

Air discharges involve dirt, lubricant fogs, acidic fumes, terrible smells and reservoir tires. Air release could be categorized on the basis of their origin:

Viewpoint origin:

- Burner
- Stoves
- Storage capacity

Diffusive:

- Cleaner focused
- Sewer water therapy
- Store Houses
- Overflows

The international weight of infection evaluations projected 0.74 million and 1.1 million early losses in between 1990-2016 because of outside PM_{2.5} and ozone contamination while, 0.99 million and 0.78 million early mortalities in between 1990-2016 because of internal PM_{2.5} contamination (Tables 6 and 7) [16].

Contaminants	Influence on person	Resources
SO ₂	Annoys breathing procedure, triggers bronchitis	Container chimney vapour, rayon factory etc.
-CHO group	Bothers each component of respiration structure	Polyester factory
-Cl	Produces lung inflammation coupled with additional inflammation in senses	Handling home
CO	Remove corpse unit of O ₂ then triggers coma by way of CO mixing along with Hb	Container home

Table 6: Impact of contaminants upon people.

Process	Limit (mg/m ³)
Spinning	0.2.2
Twisting	0.2.1
Sizing	0.76
Weaving	0.77
Non-woven	0.6

Table 7: Limitation of dust in the air steam.

Technical textiles can be used to improve safety and protect the environment such as air and water filtration systems, erosion protection, oil spill control, and floor protection sealing and waste disposal (Table 8) [17].

S. NO	Procedure	Resources	Contaminant
1	Sizing	Radiation from utilizing sizing complex	NO ₂ , SO ₂ , CO
2	Blanching	Radiation from utilizing complex	Cl, ClO ₂ ,
3	Painting	S dyeing, C ₆ H ₅ NH ₂ dyeing	Hydrogen sulphide, C ₆ H ₅ NH ₂ spray
4	Closing	Mastic completing	NH ₃ , polymer, greasing fats
5	Sewer water therapy	Radiation from therapy containers and ships	Volatile organic compound, noxious secretion

Table 8: Air discharge after various fabric procedures.

Soil pollution/Solid waste pollution

Poisonous toxic waste might penetrate downward into the soil and arrive into earth water, which eventually generate health problems in humans [18]. Actually, soils of countries are primarily priceless inheritance (Table 9) [19].

Resource	Hard squander
Yarn production	Fibres and thread
Knitting	Fibres and thread
Weaving	Fabric fragment
Sizing, de sizing	Textile piece
Dyeing, printing	Colour vessel

Table 9: Resources and category of hard squander in fabric industry.

Textile waste recycling options

Composting: Natural fibers degrade easily when sliced into smaller fragments and then discarded. Microbes are used to treat toxic clothing effluents, which are then turned into a composition for safe disposal.

Regeneration: Recycled fiber can be used to make wipes, yarn twisted and reworked into modern yarn forms, mattresses and wadding.

Paper making alternatives: In handmade paper, matrix is made from biomass, agricultural waste, and old cotton textiles which relieves burden on tree cutting [20,21].

Noise pollution

The maximum noise level of a number of fabric machinery should be 95 dB, and placing a large number of machines in a single space would increase the total sound volume (Table 10) [22].

Procedure	Sound intensity (dB)
Texturizing	96-100
Rotating	
1. Sphere edge	81
2. Armature	85
3. Tropical storm	101-110
4. Weaving	100-119

Table 10: Sound intensity in fabric manufacturing.

Consequence of sound contamination on human

- Audible consequence
- Audible range defeat
- Cardio problems
- Non acoustic consequence
- Communicate intrusion
- Slumber intrusion
- Attentiveness intrusion
- Irritations
- Defeat of operational organization

Instructions for reducing noise in the textile manufacturing process:

- Apply earshot safeguard
- Not function clamorous equipment
- Determine din
- Separate sound [23]

Noise and vibration can be reduced by taking proactive steps:

The following are a few of the proactive noise and vibration control steps taken by textile machine manufacturers, especially in the weaving industry:

Reducing inertia forces

Noise and vibration are caused by inertia forces created by machines. These forces may be reduced by lowering the mass or lowering the acceleration. Another way to reduce mass is to use a certain element, such as carbon. Mass balance is another tool for reducing noise.

Active noise control

Active Noise Reduction (ANC) is electro acoustic modulation of sound fields, specifically sound field cancellation. A speaker is driven by a control system to generate a sound field that is a perfect replica of the obnoxious sound in its most basic form which cancels out the noise, and there is no echo at all [24].

Passive measures:

The following three simple solutions should be considered when considering these measures:

- Echo absorption in the air.
- Vibration absorption in atmosphere.
- Vibration dampening

Echo absorption in the air: Individual ear plugs are the most reliable and cost effective way of reducing noise emission in the air. Important reduction can be achieved when the absorber is combined with a barrier [25].

Vibration absorption in atmosphere: When the enclosure is lined with a properly chosen absorption product, the energy of reflected sound waves does not improve the energy of incident waves, resulting in a sound reduction of 90 decibels.

Vibration dampening: The resonance of a panel or enclosure can be minimized by damping it. If the panel's resonance is large enough to generate airborne sound, this could reduce the sound frequency [26].

Discussion

Natural dyes: a more comprehensive approach

The majorities of synthetic dyes are harmful to people's health and pose a risk to the environment. As a result, natural colours derived from plants and microbes are becoming increasingly popular around the world. Natural dyes are becoming more widely used in textile production due to improved dyestuff efficiency, environmental compatibility, and lower costs. Because a large number of natural colours have inherent antibacterial qualities, they may have a significant therapeutic efficacy.

Natural dyestuffs are derived from plant components that include colouring components including pigments viz. tannin, flavonoids and quinonoid, such as leaves, seeds, bark, roots, fruits and flowers. Microbes like algae, fungi and bacteria can also make natural colours.

Extraction by aqueous, using alum as a chelator and acid as a precipitant, extraction with the aid of enzymes, extraction of organic solvents with appropriate equipment's namely soxhlet extractor, utilizing alcohol, extraction using ultrasound waves are some

techniques for extracting these elements from the natural sources mentioned above (Figure 8) [27].

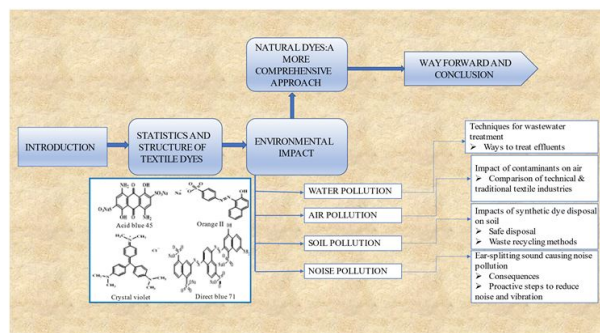


Figure 8: Natural dyes: A more comprehensive approach.

Highlights

- Environmental management one of the most pressing concerns facing the globe today.
- Textile industry's globalization needs review of manufacturing practices and operations.
- Future research on disposal, recycling, control measures for eco friendly fibre discussed.
- Natural dyes employed due to improved dyestuff efficiency, ecological, and cost-effective.
- Controlling deafening noise, safe disposal, recycling and replacing toxic dyes is non-polluting.

Conclusion

The textile industry in India is the country's oldest and largest division, as well as the most widely used manufacturing zone. Improvements and mechanization in Indian fabric manufacturing helps it get recognition globally, except they have negative consequences for the environment and people who live there. Fabric sewage can be grave and important foundation of environmental contamination like water, air, soil and noise contamination. Fabric mechanized operations placed employees in poor physical condition. In every part, well-being and security play a significant role. Manufacturing waste should not be used as inundation water for minor purposes because it can lead to a significant increase in dust pollution over time. The release of fabric sewage into the atmosphere has the potential to cause major health and environmental issues. Substituting natural colours for hazardous dyes in the future will prove to be a more extensive approach, as it offers huge health and environmental benefits.

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