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ORIGINAL CONTRIBUTION

Water Pollution Hazards and Toxicity Caused by Textile Industries Effluent

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***Abstract*— Water pollution is a serious environmental problem that endangers both human health and ecosystems. Due to its heavy use of chemicals and water-intensive processes, the textile industry is one of the biggest contributors to water pollution. Water contamination occurs when effluent from textile manufacturing facilities enters water bodies including rivers, lakes, and groundwater after being improperly or not at all treated. These contaminants may have negative impacts on aquatic life, including reducing their capacity for reproduction, upsetting ecosystems, and even killing aquatic organisms. Furthermore, anyone who uses contaminated water sources for agriculture, pleasure, or drinking can face major health hazards. Heavy metals, volatile organic compounds (VOCs), surfactants, and other harmful substances are some of the pollutants identified in effluent from the textile industry. To reduce water pollution, this abstract emphasizes the critical necessity for sustainable practices in the textile industry for which different investigatory experimental performances were done to highlight and resolve the issue. Chloride content, turbidity and hardness tests were done to evaluate the hazards that are caused by the water pollution. It is possible to lessen the environmental impact of textile production and protect water resources for future generations by implementing efficient pollution prevention measures and adopting cleaner production techniques.**

***Index Terms*— Water pollution, Textile industries, Waste effluent, Water treatment**

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I. INTRODUCTION

Water pollution is the term used to describe the toxicity of a reservoir, such as a lake, river, ocean, etc., brought on by human or environmental pollution. Two examples of things that can cause it are chemicals and germs. A variety of effects can result from water contamination [1]. One in three people worldwide lack access to clean drinking water, and the UN estimates that over 1.5 million people worldwide per year pass away from illnesses associated with drinking water [2]. According to UNICEF and the World Health Organization, the fashion sector generates 20% of the world's wastewater, and textile dyeing is the second-largest global polluter of freshwater [3]. Wastewater can lower the concentration of oxygen in the reservoir if it is not treated before being added, which might be damaging to aquatic life and the aquatic ecosystem as a whole [4].

The extensive use of pesticides and fertilizers during conventional cotton growing might damage nearby water sources [5]. In comparison to other crops, cotton cultivation uses the most insecticides. The impact is significant when cotton is used to make a wide variety of textile items. Due to its reliance on pesticides, herbicides, and fertilizers, cotton cultivation accounts for 2.8% of the world's yearly water usage. Even still, cotton farming accounts for 10% of the 25% global pesticide consumption rate. As a result, those who work in the cotton industry are more likely to be exposed to hazardous substances [6]. In the meantime, the spread of pesticides could put more people in danger of exposure. The textile business can have a disastrous effect on global water supplies, but the good news is that there are solutions to lessen the environment's harm. Many significant corporations are making efforts to lessen the adverse effects of the environment [7].

Cotton fabrics need to be improved to return them to raw materials because it is currently not possible to separate fabrics created from blended fibers, such as polyester and cotton. By avoiding careless use of textile items and reusing water, environmental contamination can be significantly decreased [8, 9]. Water that hasn't been treated is a major pollutant. Fortunately, there are four different ways to purify and reuse contaminated water: biological, physical, chemical, and electrochemical. But to do it, a global consensus must be presented by all organizations. Additionally, there are several techniques to stop water contamination [10].

Textiles made from natural materials, such as plants or animals, may be less damaging to the environment [11]. In addition to basic ingredients, use dyeing objects made from plants, minerals, and insects. A sustainable material can be quickly replicated and lessens environmental pollution.

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Fibers made from hemp, bamboo, organic yarn, alpaca wool, and soy silk are a few examples of sustainable sources. These only make extremely minor use of colors and insecticides. Through recycling, items such as clothing, linen, and towels can be reused [12]. Re-dying and restructuring can lower the overall demand for fabric and textile production, hence lowering the industry's environmental effect [13].

The primary causes of pollution are the improper disposal of chemicals from domestic, commercial, and medical waste, the disorganized use of agricultural fertilizers, and unintentional oil spills that significantly contaminate water [14]. Examples of significant water contaminants that harm people's health include the numerous infectious agents (bacteria, viruses, and parasites) that contaminate the water through sewage, human waste, and animal excreta radioactive waste that contains highly toxic materials such as uranium, thorium, and radon [15]. This waste is a major water pollutant resulting from mining activities, power plants, or natural sources. The chemical substances that contaminate the water. These chemicals can be either organic - pesticides, plastic, oil, detergents, etc. - coming from domestic, industrial, or agricultural waste, or inorganic - acids, metals, salts - domestic and industrial effluents [16]. Examples of major water pollutants that affect the ecosystem only are the following:

Plant nutrients like phosphates and nitrates form various chemical fertilizers, sewage, and manure oxygen-demanding manures and agricultural waste resulting from sewage and agricultural run-offs. Sediments in the soil (silt) following soil erosion and heated waters used in several industries and power plants cause water pollution [17]. Microplastics can enter the body through contaminated seafood or drinking water. Research has connected microplastics to oxidative stress, inflammatory responses, and metabolic problems in people [18]. When pregnant women are exposed to chemicals, contaminated water has serious negative consequences for them. It raises the rate of low birth weight, which has an impact on the well-being of the fetus. Metal-tainted water can lead to hair loss, liver cirrhosis, renal failure, and brain disorders [19].

The issue of poisonous, damaging chemicals being used in the textile industry is not new. Due to the vast volumes of water and chemicals used in manufacturing, it has been the second largest industrial pollutant behind the agricultural industry. Of the more than 80,000 chemicals used in the production of textiles, many of which are carcinogenic, little is currently known about them. Since these wastewaters are dumped in rivers and creeks, causing severe chemical contamination to the environment and aquatic ecology, they have become a major problem for everyone. Let's utilize jeans, the most common type of trousers in the world. The average American owns 8 to 9 pairs out of the 450 million pairs that are sold in America each year. Denim is just one sort of cotton by-product, and cotton is grown using 54% of the worst chemicals. 15% of the city's water supply is used by the Levi's factory outside of El Paso, Texas [20].

You might be surprised to learn that 1,500 gallons of water are required to cultivate one pair of jeans' worth of cotton. The UN advises that individuals require a minimum of 50 liters of water per day for the most fundamental needs, such as drinking, cooking, and sanitation, to comprehend the enormity. Many people are even without that. Every nation in the globe faces a problem with water conservation, and as climate change progresses, this problem will only grow worse. The process of turning cotton into denim is exceedingly laborious and difficult. Caustic soda is used to give denim a frayed appearance, but when these chemicals are discharged into waterways, the oxygen needed for aquatic life to exist is depleted. One of the most hazardous processes in the production of jeans is the dying phase of denim. It is extremely hazardous to both the workers and, eventually, the consumers. The Environmental Protection Agency (EPA) in the United States has created a manual that directs the reduction of significant environmental contaminants since the textile sector uses a lot of chemicals and water [21]. It is not an industry to be disregarded for its environmental problems with a $100 billion business that employs almost 500,000 textile workers and a million clothing workers. As the public's knowledge of environmental issues grew, steps were taken to increase the textile industry in the USA's ability to compete internationally. According to the U.S. Energy Information Administration, the textile industry is the second largest water polluter after agriculture because it uses a lot of pesticides, fertilizers, and toxic chemicals. It is also the fifth largest contributor to CO2 emissions in the United States, behind primary metals, nonmetallic mineral products, petroleum, and chemicals. Following are the objectives of this research work.

- To highlight the health damages caused by intake of contaminated drinking water.
- To avoid the industrial effluent to be the part of different water bodies used by the humans.
- To spread awareness of water borne diseases causing by the consumption of contaminated water.
- Textile industrial effluent must be treated before the disposal.

II. MATERIALS AND METHOD

Research work was done on water pollution due to the textile industries' waste causing hazardous diseases. Materials in this investigation are the different samples of the water being tested in the laboratory for different properties to be calculated and compared for the disasters it can bring into the lives of the people and aquatic life.

Water pollution is the term used to describe when a reservoir, such as a lake, river, ocean, etc., becomes poisonous as a result of pollution caused by humans or the environment. It may be brought on by elements like chemicals or microbes. The consequences of water pollution are extensive. One-third of people globally lack access to clean drinking water, and the World Health Organisation and UNICEF estimate that over 1.5 million people worldwide die each year as a result of tainted water.

Following is the step-by-step method practiced in this research.

- Literature was thoroughly studied based on the water pollution due to the textile industries.
- The random vocal survey was done in a particular nearby location to the textile industries in Faisalabad, Pakistan where the water bodies are getting contaminated with the industrial effluent.
- Different types of samples treated, untreated, and drinking water were taken and transferred to the laboratories for the necessary evaluation.
- Following are the testing performed on the different water samples e.g. Hardness of water, PH of water, chloride content of water, and turbidity test
- Results data was numerically and graphically compiled and compared ultimately the conclusions were drawn based on this investigation.

III. RESULTS AND DISCUSSION

Following are the experimental performances done in this investigation.

A. Hardness of water

The purpose of this test is the determination of hardness of the water sample by the standard EDTA method.

TABLE I
TO DETERMINE THE HARDNESS OF A SAMPLE

S. No	Sample	pH	Temperature, °C
1	Treated	7.29	22
2	Untreated water	7.93	22
3	Drinking water	6.95	22

The table shows the hardness values of the water samples like treated, untreated and drinking of the same site which was under observation. The guideline value of hardness is 500 mg/liter as $CaCO_3$ EU guidelines = 250 mg/liter as $CaCo_3$

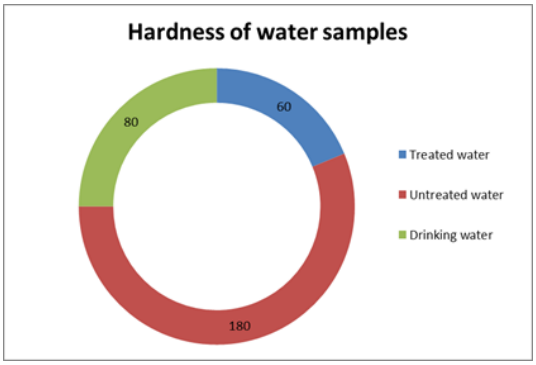

Fig. 1. Hardness of different water samples

B. PH of water by electrometric method

The purpose of this test is the determination of the pH of the water sample by electrometric method.

TABLE II
TO DETERMINE THE PH OF WATER BY ELECTROMETRIC METHOD

S. No	Sample	pH	Temperature, °C
1	Treated	7.29	22
2	Untreated water	7.93	22
3	Drinking water	6.95	22

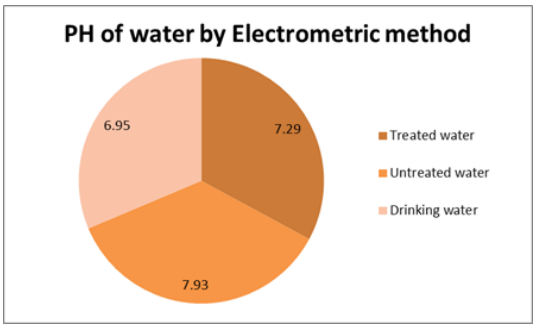

Fig. 2. PH of water by electrometric method

TABLE III
PH VALUES AT VARIOUS TEMPERATURES

S. No.	Temperature ºC	pH values		
		Treated water	Untreated water	Drinking water
1	0	4.01	7.13	10.32
2	5	4	7.1	10.24
3	10	4	7.07	10.18
4	15	4	7.04	10.12
5	20	4	7.03	10.06
6	25	4.01	7.01	10.01
7	30	4.02	7	9.96
8	35	4.03	6.99	9.92
9	40	4.04	6.98	9.88
10	45	4.05	6.98	9.85

The table shows the ph values of the water samples (Treated, Untreated and Drinking water) under observation after the experiments were done. Following suggested a guideline value of (6.5 to 8.5) pH of water.

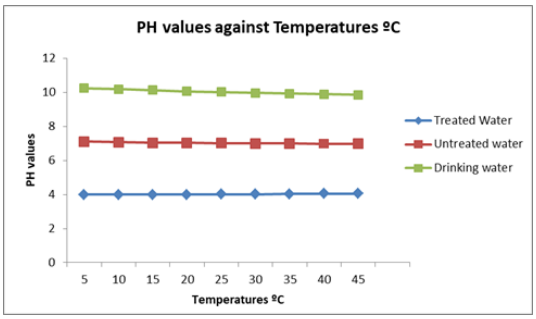

Fig. 3. PH values against temperatures in ºC

C. Chloride content

The purpose of this test is the determination of Chloride content of the water sample.

TABLE IV
TO DETERMINE THE CHLORIDE CONTENT OF A SAMPLE

S. No.	Vol. of sample (ml)	Burette readings (ml)		Vol. of $AgNO_3$ Soln. (ml)	Chloride content (mg/l)
		Initial reading	Final reading		
Treated water	50	36	41.5	1.5	54.98
Untreated water	50	44.2	50	4.6	57.98
Drinking Water	50	36	41.3	4	52.98

This table of results shows the content of chloride in a water sample that was being collected from the site and reviewed by performing different experiments. According to WHO Guidelines (1970) Higher Desirable Limits = 200mg/liter as $CaCo_3$ Higher Desirable value = 250mg/liter (1984) as$CaCo_3$

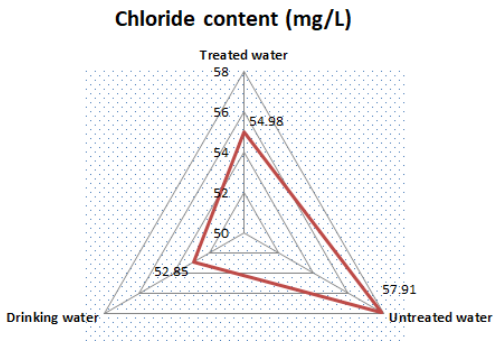

Fig. 4. Chloride content of multiple water samples

D. Turbidity test

The purpose of this test is the determination of turbidity of the water sample by euphotometric method.

- Sample#1 Treated water Turbidity = 1.71 NTU
- Sample #2 Untreated water Turbidity = 7.54 NTU
- Sample #3 Drinking water Turbidity = 0.67 NTU

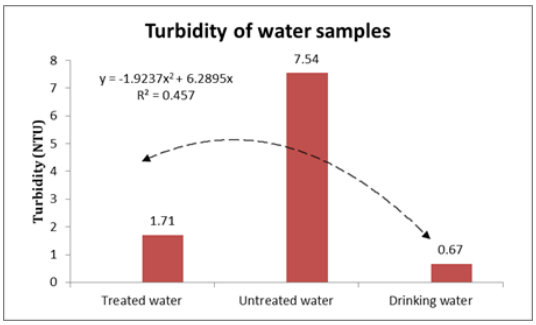

Fig. 5. Turbidity of multiple water samples

TABLE V
TURBIDITY RANGES OF DIFFERENT WATER SAMPLES

S. No	Turbidity (NTU)	Remarks
1	0-5	Good (Perfect for Drinking)
2	5-100	Drinkable (Normal Turbidity)
3	100-300	High Turbidity
4	Above 300	Very High Turbidity (Non-Drinkable)

This table shows the turbidity of the water ranges along with the remarks indicating the quality related to its drinking criteria. World Health Organization (WHO) suggests a guideline value of 5 NTU.

1) Description

An important environmental problem is the textile industry's contribution to water pollution. One of the major industrial contributors to water pollution worldwide is the textile sector. Here is a description of some typical textile industry-related water pollution sources and their consequences.

2) Chemical discharge

Chemicals including dyes, solvents, bleaching agents, and finishing agents are used in the making of textiles. Frequently, effluent from companies contains these compounds that are released into bodies of water. Water supplies can get contaminated by contaminants like chlorine, poisonous dyes, heavy metals, and formaldehyde.

3) Waste water volume

For procedures like dyeing, printing, and washing, textile production needs a lot of water. Large amounts of wastewater are discharged, exceeding the capacity of treatment facilities, resulting in the release of untreated or insufficiently treated effluents into rivers, lakes, and seas.

4) Color and organic matter

Water bodies' visual appeal may be impacted by wastewater that has brilliant colors due to dyes used in the textile industry. Aquatic life is negatively impacted by the loss of oxygen in water, which is caused by organic material from textile waste like unused cloth.

5) Toxicity and bioaccumulation

The potential to penetrate the food chain, build up over time in creatures, and affect aquatic life as well as people who eat contaminated seafood Toxic chemicals released by the textile industry can harm aquatic life. These contaminants have.

6) Eutrophication

Eutrophication in water bodies can be facilitated by the release of nutrients from textile wastewater, such as nitrogen and phosphorus. Excessive nutrient levels encourage the development of algae, which lowers water oxygen levels and harms aquatic ecosystems.

7) Long-term environmental impact

Ecosystems may be negatively impacted by the textile industry's water contamination for a long time. It throws off the aquatic ecosystems' natural equilibrium, which causes habitat degradation and biodiversity loss.

Better wastewater treatment technology, cleaner production methods, and the promotion of sustainable practices within the textile sector are all being used to address these problems. Reducing water pollution brought on by the textile industry requires both regulatory actions and more consumer and manufacturer knowledge.

IV. CONCLUSION AND FUTURE RECOMMENDATION

Following are the conclusions and recommendations of the investigation.

A. Conclusion

In conclusion, the textile industry's contribution to water contamination is a serious environmental problem that requires immediate attention. Several techniques used in the manufacture of textiles discharge hazardous chemicals and trash into water sources, causing serious pollution and ecological destruction.

- Wastewater from textile manufacturing facilities that are discharged untreated or improperly treated is one of the leading causes of water contamination. This effluent contains harmful pollutants that can contaminate rivers, lakes, and groundwater, including dyes, solvents, heavy metals, and other pollutants. These contaminants destroy biodiversity and have negative effects on aquatic life, upsetting ecosystems.
- Additionally, the issue is made worse by the excessive water use in textile manufacture. For the procedures of dyeing, printing, washing, and finishing, the industry needs enormous amounts of water. The depletion of freshwater supplies and the buildup of pollutants in water bodies are frequent results of this water's improper treatment or recycling.

- The effects of water contamination brought on by the textile industry go beyond harm to the environment. The risk to human health is likewise very high. Communities that are close to textile manufacturing facilities frequently experience contaminated water sources, which can lead to a variety of health issues, including cancer, skin illnesses, and respiratory problems.
- Governments, textile producers, and consumers must work together to address the water contamination the textile sector causes. Strict laws for wastewater treatment and discharge must be implemented and upheld. Sustainable business practices should be used by textile enterprises, such as purchasing water recycling equipment, utilizing eco-friendly dyes and chemicals, and streamlining production to use less water.
- Additionally, consumers are a key force behind change. People can help the textile business have less of an adverse effect on the environment by choosing textiles that have been produced responsibly, supporting eco-friendly brands, and caring for their clothing properly.

In general, reducing water pollution caused by the textile industry necessitates a multifaceted strategy comprising legislative changes, technological breakthroughs, and alterations in consumer behavior. We can secure the health of ecosystems, human populations, and the environment by acting quickly to protect our water resources.

B. Recommendation

Several ideas can be put into practice to reduce water contamination brought on by the textile industry.

- The treatment and disposal of wastewater in the textile sector should be subject to strict rules and standards set by the government. Effective enforcement of these laws is necessary to guarantee that textile producers follow environmentally responsible procedures.
- Advanced wastewater treatment and recycling technologies should be funded by textile firms. The impact on the environment can be considerably reduced by implementing effective treatment systems that reduce the release of pollutants into water bodies.
- Cleaner production techniques that use less water and produce less chemical waste should be used by textile makers. This entails streamlining dyeing and finishing procedures, utilizing eco-friendly chemicals and dyes, and investigating cutting-edge printing methods like digital printing that use less water and generate fewer pollutants.
- The amount of water used in the production of textiles can be greatly decreased by putting in place water conservation measures, such as installing water-efficient machinery and systems. The usage of water recycling systems can also assist in the reuse and treatment of water, reducing the industry's total impact on freshwater resources.
- Collaboration between government agencies, environmental organizations, and industry partners is essential. Sharing best practices, expertise, and research results can help the textile sector innovate and promote the adoption of sustainable practices.
- Consumers can be empowered to make ethical decisions by being informed about how the textile business affects the environment. Demand for more ecologically friendly products may be increased by urging customers to choose textiles made with sustainable practices, to purchase eco-friendly brands, and to take care of their clothing properly.
- Transparency in the supply chains and manufacturing processes should be a priority for textile companies. Consumers can recognize and support firms that uphold strict environmental and social standards by using certifications and labeling programs like the Global Organic Textile Standard (GOTS) or the Blue Sign system.
- More study and development are needed to find innovative strategies to reduce water pollution in the textile industry. This includes investigating alternative textile materials, creating more eco-friendly dyeing and finishing techniques, and figuring out ways to utilize dangerous chemicals less.

By implementing these suggestions, players in the textile industry may contribute to lowering water pollution, protecting ecosystems, and ensuring the sector's long-term survival.

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