Textile Waste Water Treatment

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"Conserve water even if you are on the bank of a running stream." Holy Quran , Sunan Ibn Majah 425

Water is one of the many blessings which mankind, unfortunately, takes for granted. We will never truly understand the real importance of water until the well has run dry.

The textile industry is a major contributor to the economy in many nations and generates substantial employment opportunities. Alongside many other inputs, water is perhaps one of the most essential inputs in textile processing. Indeed, one of the biggest challenges we face today has to do with a growing water scarcity and a potential water crisis unfolding in the future.

Textile wet processing is one of the largest segments within the textile chain and the sheer volumes of water consumed within this segment alone far exceed all other processes.

These fast approaching challenges are not limited to sustainably, managing existing water resources or reducing water consumption alone. Certainly, a growing concern is effluent discharged from untreated wastewater given its high chemical load, which contaminates not only rivers and surface water but also underground aquifers and disturbs the delicate balance of the natural ecosystem.

A colored river which contains high amounts of hazardous chemicals results in a loss of biodiversity in fish and marine life as well as various species of plants and corals. It has further negative effects downstream when that water is used for human or animal consumption as well as for agriculture since it contains large amounts of COD and BOD hence it clogs the pores of the soil in fields and results in loss of soil fertility.

Since the global textile industry itself has now fully shifted from the Western to the Eastern part of the world, we should pay attention to the experience of developed nations that had experienced this industrial phase decades ago and have now estimated the 'true cost' to the environment, to their citizens, and to their future generations.

The textile industry is a heavy consumer of water and it ranks highly among the top ten water consuming industries that exist around the world today.

Pakistan is considered one of the major cotton producing countries in the world and caters not only to its huge local demand for cotton fabric but also to the international markets for various brands and big names in fashion. As a result, a wide number of dyeing and printing units have propped up throughout the country.

Pakistan has historically held surplus amounts of water but in more recent times, due to rising population pressures, effects of global warming, and various other human and technological changes happening around the globe, our natural resources are depleting at a very rapid rate.

While agricultural usage still accounts for the most amount of water consumed among other industries, next in line in terms of water consumption certainly is the textile industry. The failure is on part of the state, that needs to take regulatory environment measures, issue proper guidelines and enforce strict standards. Additionally, each and every industry should relate to and feel responsible for nature as well as for consuming the water and throwing the contaminated water.

In current times, the major concerns and challenges that exist within the textile industry revolve around bringing further improvements and production efficiencies to consume less water in terms of cost efficiency. Equally important, however, is to reduce hazardous chemicals since the textile industry takes a heavy toll on the environment and the dyeing process is well known to be a major source of water pollution.

Table 1: Usage of water according to various fibres

Substrate	Water Consumption (Kg/Kg of Fabrics
Cotton	250-350
Wool	200-300
Nylon	125-150
Rayon	125-150
Polyester	100-200
Acrylic	100-200

Table 2: Water consumption in the processing unit

Process	Water Consumption (% of Total)
Bleaching, Finishing	38
Dyeing	20
Printing	8-9
Boiler House	13
Humidification spinning	5
Humidification weaving	5
Sanitary usage	7

Table 3: Per capita water availability in selected countries (m^3)

Country	1955	1990	2025
China	4597	2427	1818
Mexico	11396	4226	2597
Philippine	13507	5173	3072
Iraq	18441	3029	2356
USA	14934	9913	7695
Pakistan	2496	1672	837

Source: Population Acton International, 1993

According to the United Nations Environmental Program (UNEP-2010), every year 400-500 million tons of deadly chemicals like cyanide, sulphur and other harmful substances are discharged in water. Source: (European Scientific journal Sept 2014 special edition, volume 2)

Since the industry has undergone a profound shift in developed countries, the prevailing laws, regulatory controls, and other such measures are designed to be stricter and less permissible about untreated wastewater discharge compared to developing nations where laws are often weak, unenforced, and in some cases even non-existent due to lack of knowledge and awareness surrounding public health and environmental issues.

Most textile effluent is discharged into the surface water such as river and lakes, either directly or through municipal sewers. The main issue has to do with the wide variety of chemicals that it contains.

To ensure social responsibility, organizations should look into the concerns of their staff and carefully assess health risks to not only improve the safety level of their employees but also to uphold moral standards and be contributive to the wider textile community. More than 3600 dyes exist today with the addition of more than 8000 chemicals being used in various manufacturing processes. Many of these chemicals are poisonous and damaging to human health directly or indirectly.

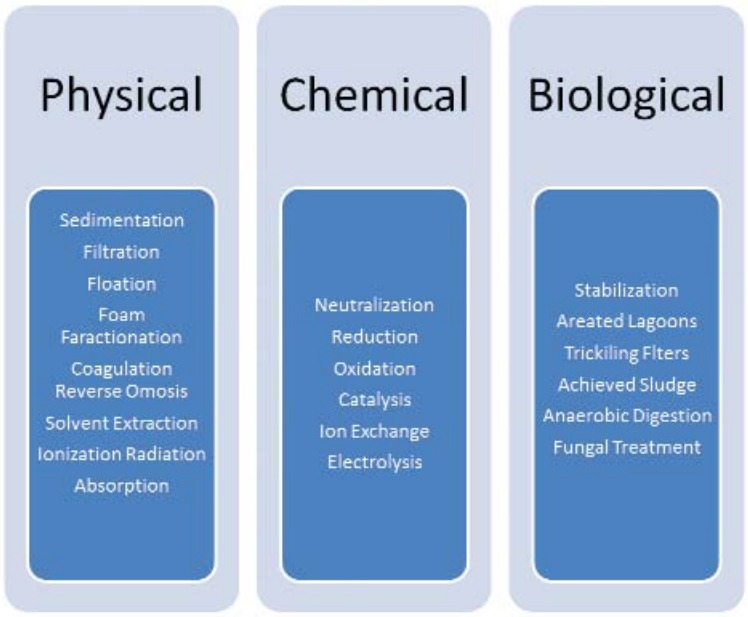
The daily water consumption of an average size textile unit while producing about 8T/day of fabric, may be up to 1.6 Million litres. Specific water consumption for dyeing varies from 30-70 litres per kg of cloth depending on the type of the dye. Dyeing section only contributes to about 25% of the total wastewater.

The World Bank estimates that 20-30% industrial water pollution comes from textile dyeing and finishing plants. Mills discharge millions of gallons of this effluent as hazardous toxic waste consisting of various dyes, acids, soaps, heavy metal like copper, arsenic, lead cadmium, mercury, nickel, cobalt and certain auxiliaries which all collectively make the effluent highly toxic.

Moreover, the high pH and temperature are also damaging for the streams and rivers. The colloidal matter present along with colours and oily scum increases the turbidity and gives the bad appearance that prevents photosynthesis and depletes the oxygen transfer mechanism at the air-water interface.

Table 4: List of Textile Pollutants from Textile Waste Water

S. No.	Process	Chemical Discharge	Pollutants	Health Effect
1	Sizing	Benzene	Resin, fats, waxes, starch and glucose	Carcinogenic/Mutagenic effects on nervous system
2	Bleaching	Cyanide	Wax, grease, soda ash, sodium silicate	Prolonged exposure may affect kidney and liver
3	Dyeing	Sulphate	Sulphides, NaCl mordant	Eye and respiratory problem
4	Printing	Nitrate, Phosphate	Starch, gum, acids, solvents	Harmful health hazards
5	Finishing	Lead	Starch, salt, finishing agent	Effect hematological system



Classification of waste water Treatment Process.

Prevailing situation of water pollution is a major cause of human illness these days. About 40% of the synthetic organic colours contain bound chlorine known as "Carcinogen Compounds". Chlorine is commonly known as a disinfectant. These carcinogen chemicals in the effluent disturb the bacterial growth or once they are evaporated in the air which human breathe or absorb through the skin and show up as allergic reactions causing harm to the immune system of living species.

To define the term BOD and COD and its impact on aquatic life, it is important to first understand the concept.

The depletion of Oxygen in water has a negative impact on water life. BOD is Biological Oxygen Demand and measured as mg/l or ppm, it is the measure of the number of organic Carbons present that bacteria can oxidize. COD or Chemical Oxygen Demand is the total measurement of all chemicals in the water that can be oxidized.

In general, the textile water discharge has a higher level of COD than BOD. The COD is less affected by the usual effluent treatment process.Another term which is been used as "TOC" Total Organic Carbon and it serves as an alternative to BOD and COD.All these can be measured through pre-defined format of analytical techniques.

In order to reduce water pollution, some measures have been taken for the betterment of life.

There are many techniques and processes to treat textile effluent with primary importance of reducing water pollution by optimizing processes so that fewer contaminants are discharged.

Some of the terms that should be understood here which are being used in the treatment process of water include:

- **ETP:** Effluent treatment plant used to treat the industrial wastewater.
- **INFLUENT:** Untreated industrial wastewater.
- **EFFLUENT:** Treated industrial waste products.
- **SLUDGE:** Solid part separated from wastewater by ETP.

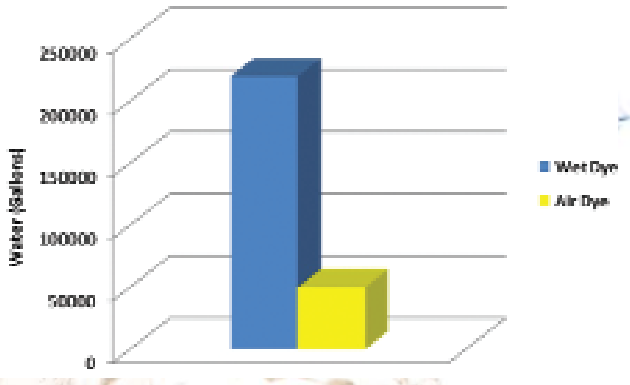
Awareness to go green

Eco-friendly clothing concepts are emerging in line with consumer preferences with several apparel manufacturers opting to use organic cotton (pesticides free) along with using GOTS (Global Organic Textiles Standard) approved dyes and chemicals. At the same time, a seemingly contradictory preference has been for richer variety and versatile textile colour palettes driven by fast fashion. It seems a near impossibility to produce fabrics that have no colour.

Dyeing

The preventive measures are already in consideration about the ongoing awareness of environment on part of the dyes and chemical manufactures even up to the extent of designing future machines, including 'air dyeing technology' which is already in use now produced by a Dutch company Dyecoo.

This company has introduced a machine in collaboration with Nike for a commercial setup in Taiwan. The process, which Nike has dubbed ColorDry, reduces dyeing time by 40%, energy use by about 60%. Lowering the impact of the carbon footprint for the manufacturing of textile goods.



Nike expects Dyecoo's supercritical fluid Carbon dioxide or "SCF" CO2 dyeing technology to have a particularly positive impact in Asia, where much of the worlds textile dyeing occurs. This technology is so far limited to disperse dyeing of polyester, where 95% water is being conserved.

Bleaching

Chlorine was known to be the most known bleaching element at one time in the textile industry for the bleaching process. Since it has been realized that chlorine adversely affects the environment, the industry has shifted to the alternate of Oxidation bleaching i.e Hydrogen per Oxide. It is a relatively safer option compared to the older approach. Ozone Bleaching is also in consideration but its economic viability is questionable and therefore, it has not been widely adopted for the process.

Finishes

Today, more focus is being given for more natural finishes made of bees' wax, Aloe Vera and Vitamin A, but many finishes have yet to be identified with safer alternatives particularly the application of fluorocarbons for flame retardants and other finishes of oil and water repellency.

Sizing

The PVA (Polyvinyl Alcohol) is still been used for sizing but alternative can be potato starch or CMC (Carboxy Methyl Cellulose) as both are used in food and are chemically inert and nontoxic.

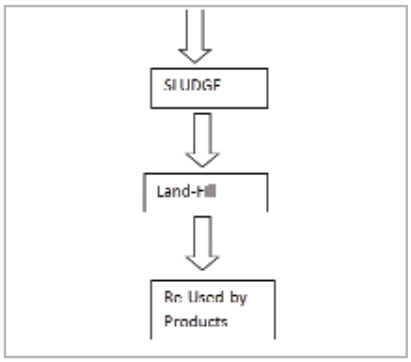
Dyes

The studies are being conducted for developing dyes that ensure highest safety standards from manufacturing to the point of application. The German Consumer goods ordinance in 1997, identified certain aromatic amines which were being used for the synthesis of certain dyestuff that was either completely banned or with very strict prescribed limits to be detected in the final article. These aromatic amines have potentially adverse effects on mankind with certain acute and chronic toxicities.

Sulphur dyes have the limitation of using sodium sulphite, notoriously harmful for the environment, hence companies have looked into safer options of producing liquid Sulphur ready to use.

The vat dyes are generally safer in terms of reconverting back into their water-insoluble form in the fibre. They are less likely to wash out without any harmful effect, but manufacturing of these dyes and as well in application usage of Sodium hydrosulfate is of a big question mark.

The reactive dyes are by far the surest and safest option for cotton clothing but research is supportive of producing new products with Vinyl Sulphone chemistry than to counterpart of reactive dyes based on reactive groups consisting of Chlorine and Florine, AOX compounds. Sodium chloride is widely being used during reactive dyes, which increases the salinity of the water been discharged from dye houses effluent hence issues of corrosion of concrete and pipes.



ZDHC

The issue of pollution is of serious concern, the companies are feeling responsible and working towards sustainability with the emergence of the concept of ZDHC (Zero Discharge of Hazardous Chemicals).

A step towards sustainability many fashion retailers have joining hands for a safer environment in textile chain moreover due diligence of awareness and regulations are pushing for the step up of ETP plant for all processing houses. This shift in the textile trades paradigm means that in future it is likely that the operation of an ETP will be integral to sustain business in the competitive world market.

ZDHC is concept and approach towards a measure of sustainability for manufacturing the goods with a high level of safety at all stages. Certain chemicals are being strictly prohibited for use during the manufacturing process so it does not have any impact in the chain from the beginning till it reaches the final consumer.

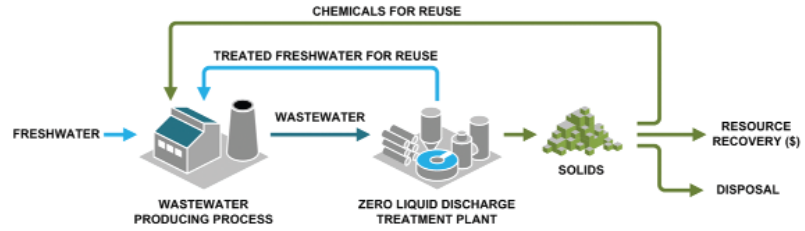
This roadmap of ZDHC defines the safest way of achieving the new standard of environmental performance for the Global apparel and footwear industry.

The fashion retail like H&M, Levi-Strauss, M&S, Adidas, Nike etc. is part a greater effort towards eco-friendly clothing that does not harm the environment.

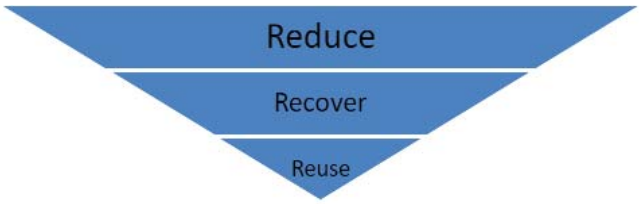
A further effort from the industrial side, responsible companies are moving towards the concept of ZLD (Zero Liquid Discharge) where during the production of either any industrial chemicals or dyes or even final textile effluent from dyeing mills are treated and reused so that it cannot pollute the natural environment and also conserve water.

This treatment of water developed to completely eliminate all liquid discharge from a system. The goal is to reduce the volumes of wastewater that requires additional treatments to make it clean enough to be reused.

Since past several years sustainability has been adopted by many companies in the textile chain, as well as in other industries as a target in order to improve existing process and products with the aim to guarantee environmental care solutions. Sustainability is one of the main drivers for innovation. And accepting this challenge,



The concept of 3R is now been readily looked into as a step towards sustainability and efficiencies



companies will receive and give a lot of benefits.

JAY Chemical Industries Limited. aims to practice right, behave ethically, act with integrity, live and breathe the values. Their philosophy supports the approach to sustainability management. To secure a sustainable future they have taken into consideration the Economic, Environmental and Social impact as to contribute towards nature and society.

One of the main production facility of JAY Chemical Industries is operating on ZLD – "zero liquid discharge" since the mid of 2016.

Over 1 Million litres per day of wastewater is recycled or reused into the process. Several by-products are recovered from the waste and are either used in-house or commercially offered to other industries. This project has already attracted an initial investment of over US$ 10 million.

A step forward has been towards the generation of "renewable energy" to reduce the carbon footprints. Where the company has invested about USD 9 million for Solar and Wind projects and generating about 17 Million Units of Power per Annum.

Conclusion

The importance of water as a precious resource is globally recognized and the quality of life depends on the ability to manage available water resources in the greatest interests of the people.

The collaborators are required to work on an objective to optimize and implementation of the concept of 3R in the whole chain of textile i.e. from dyestuff chemical manufacturer till the final end of the chain.

According to an article in business week Issue of June 2005, the population that is allergic to chemicals will grow to 60% by the year 2020. The R&D efforts to be stepped up "Value Product" in a "Value Environment" we all need to join in a race to go green.

This aspect should also be considered by national and local governments to create and promote safer environments, in addition to regulatory checks and measures that are enforced since we all owe our planet and want to leave it intact for future generations.

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