Introduction
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In this new millennium, we are faced with the challenge of cleaning our natural water and air resources. While we enjoy the comforts and benefits that chemistry has provided us, from composites to computer chips, from drugs to dyes, with the task of treating wastes generated during manufacturing processes and the proper disposal of various products and by products.

The textile industry occupies a unique place in the industrial map of India. Textiles dyeing industries are a part of textile industry, which involves the dyeing process for making coloured garment by means of large consumption of dyestuff. During the dyeing process, a large quantity of water (100-200 L/kg of fabric) is being used and the wastewater is highly coloured due to the presence of unfixed dye. In first commercial synthetic dyestuff in 1856 and that led to the birth of dyestuff industry. Synthetic dyes are used extensively for textile dyeing. Approximately 10,000 different dyes and pigments are used industrially worldwide. It is estimated that 10-15% of the dye is last in the effluent during the process. In the textile industry, various types of dyes are used viz., direct dyes, reactive dyes, vat dyes, sulphur dyes, disperse dyes and naphthal dyes, which are both soluble and insoluble in water and involves a variety of organic chemicals.

Environmental problems of the textile industry are mainly caused by discharges of wastewater. Depending upon the nature of the raw material and their production a variety of chemicals has been used for textile processing. Some of
these chemicals are different enzymes, detergents, dyes, acids and salts. Industrial processes generate wastewater containing heavy metal contaminants. Since most of heavy metals are non-degradable lead to non-toxic products, their concentrations should be reduced to acceptable levels before discharging them into environment. Otherwise these could pose threats to public health and/or affects the aesthetic quality of potable water. According to World Health Organization (WHO), the metals of most immediate concern are chromium, zinc, iron, mercury and lead etc.

The fate of these chemicals varies, ranging from 100% retention on the fabric to 100% discharge with the effluent. Generally, there are a number of wet processes involved with high requirements for resource inputs, generating several types of wastewater. Textile industry uses large amount of water, mainly because of washing operations.

Textile industry released wastewater contains substantial pollution loads in terms of COD, BOD, TSS, TDS and heavy metals. The values of these parameters are very high as compared to the values in National Environment Quality Standards (NEQS) set by the government of India. Very little work has been done on the characterization of textile wastewater. Characteristics of textile wastewater are requirement for the investigation of treatment options. In addition, increase in literacy and world trade organization (WTO) implication has made environment an important issue in all the industrial sectors. The textile sector is major exporter
of India has definitely to comply with ISO 14000. In India, there is a lack of effluent treatment facilities due to ignorance of implementation, shortage of resources, deficient of technical facilities and personals.

The current practice is that effluent is being discharged into streams or canals after retention period of some hours in stabilization pond without any secondary or tertiary treatment. This wastewater has serious negative impact not only on underground and surface water bodies, but also has an adverse effect on the aquatic ecological system. Effluents from textile mills contain various pollutants, which has a cumulative effect and higher possibilities for entering into the food chain. Due to usage of dyes and chemicals, effluents are dark in colour, which increases the turbidity of water body. This in turn hampers the photosynthesis process, causing alteration in the habitat.

For the treatment of effluent oxidants, especially hydrogen peroxide has been used to reduce the COD and BOD for many years. Hydrogen peroxide (H₂O₂) due to its redox properties finds application in bleaching paper pulp, sugar and textile. The main objective of this study was characterization of textile wastewater for finding treatment option. This baseline information is inevitable for proper treatment and management of waste being generated from textile sector and other industries.

Dyes are an abundant class of organic compound. During their production and textile manufacturing, process a large amount of wastewater, containing
dyestuff with intensive colour toxicity to aquatic systems\textsuperscript{11}. Dyes are hazardous causing serious diseases such as cancer, hormone deficiency and bronchitis. Varying small amounts of dyes i.e. below 1-ppm could cause a clear visible colour in wastewater\textsuperscript{12}.

Azo dyes are the largest and most versatile class of compounds. Due to the outstanding coloring properties, “Brilliance of shades very good leveling power with excellent light and wash fastness”. They are used in dyeing and printing wool, polyamides, silk and other fabric materials\textsuperscript{13}.

Azo dyes are characterized by presence in the molecule of one or more azo group, \(-\text{N=N-}\) which form bridges between organic residues of which at least one is usually an aromatic molecule.

The depth of colour is related to the molecular structure of the dyes, which is related to the structure (-\(\text{N=N-}\) or > C = 0) involved within the structure\textsuperscript{14}.

In addition, visible and the UV irradiation electron transfer effects at varying wavelengths on the dye structure have been observed, supporting tautomeric capabilities of the dye molecules\textsuperscript{15}. As oscillation between the double and single bonds occurs along the conjugated molecular chain; therefore as the chain becomes longer, the vibration rate becomes slower resulting in a slower kinetic degradation rate\textsuperscript{16}.

Photocatalyst is one of the most important methods, which widely used in the photodegradation process of textile industrial waste-water. TiO\textsubscript{2}, ZnO have
been widely used as a heterogeneous photocatalyst for the treatment of colour industrial wastewater in textile industries\textsuperscript{13}. This method is based on the activation of a semiconductor especially TiO\textsubscript{2}, and ZnO, which widely used in the existence of solar or artificial light. When the two type catalysts of charge carriers absorb the sunlight viz, electrons (e\textsuperscript{−}) and holes (h\textsuperscript{+}) are generated\textsuperscript{1}. The two main factors involved in photocatalysis are the UV light radiation & a semiconductor that can be activated by light energy.

The mechanism of photodegradation in aquatic media is based on the excitation of one electron from the valence bond, leaving a positive hole, which oxidizes the OH\textsuperscript{−} of adsorbed water on the surface of the catalyst, whereas a reduction of oxygen to form O\textsubscript{2} on conduction band take place. The formation of OH\textsuperscript{−} and O\textsubscript{2} leads to the formation of different types of free radicals leading to complete mineralization of the dye to CO\textsubscript{2} and H\textsubscript{2}O\textsuperscript{16}.

The participation of semiconductor nanoparticles in a photocatalytic process can be either direct or indirect as illustrated charge separation in semiconductor particles occurs when they are subjected to band gap excitation. The photo generated electrons and holes are capable of oxidizing or reducing the absorbed substance. Alternatively, the semi conductor nanoclustor also promote a photo catalytic reaction by acting as mediators for the charge transfer between two absorbed molecules. This process, which is commonly referred as photosensitization.
In the first case, the charge transfer at the semiconductor (electrolytic interface) follows the band gap excitation of a semiconductor particle.

In the second case, the semiconductor nanoparticle quenches the exited state by accepting an electron and then transfers the charge to another substrate or generates photocurrent.

Degradation does not occur on the absence of oxygen. The dependence of the dye degradation rate on the surface coverage shows the participation of excited dye and TiO$_2$ semiconductor in the surface photochemical process$^{17}$. Hence, the present study aimed at the use of photocatalytic degradation of azo dyes and coloured effluent collected from textile industries. The results obtained during our research programmes are conveniently categorized into four chapters are as follows.

I. Introduction

II. Photocatalytic degradation of Azo dyes

III. Physico chemical Characterization of textile industrial effluent

IV. Photocatalytic degradation of textile industrial effluent
References


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