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Environmental Pollution Management of Textile Industrial Waste Water

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ABSTRACT

Textile industry is one of the most important and rapidly developing industrial sectors in India. It has high importance in terms of its environmental impact, since it consumes considerably high amount of processed water and produces highly polluted discharge water in large amounts. Textile industry is one of the main sources of pollution problem worldwide. Textile effluent is characterized by high BOD (from 700 to 2, 000mg/L) and COD loads, suspended solids, mineral oils and residual dye. Traditionally produced fabric contains chemical residues, used during their manufacturing. For the treatment of textile industry wastewater, biological treatment, chemical treatment and combination of these are used. The main challenge for the textile industry today is to modify production methods, so they are more ecologically friendly at a competitive price, by using safer dyes and chemicals and by reducing cost of effluent treatment/disposal. There are three main ways to reduce pollution: (1) use of new, less polluting technologies; (2) effective treatment of effluent. So that it conforms to specified discharge requirements; and (3) recycling waste several times over before discharge , which is considered the most practical solution. The textile dyeing industry consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and finishing processes. Wastewater from printing and dyeing units is often rich in color, containing residues of reactive dyes and chemicals, and requires proper treatment before being released into the environment. The toxic effects of dyestuffs and other organic compounds, as well as acidic and alkaline contaminants, from industrial establishments on the general public are widely accepted. Dyes are extensively used in the textile industry. The colour which dues impart to water bodies is very undesirable to the water user for aesthetic reasons. Due to high concentration of organics in the effluents and higher stability of modern synthetic dyes, their discharges into rivers are harmful to aquatic life. The objectives of this research are to discuss the various processing stages in the textile industry and methodologies adopted for treating textile wastewater. Water depletion of good quality water and environmental pollution has given tremendous importance to the water management. Our motto is to save living species and its surrounding environment.

Keywords : Adsorption, Dyes, Waste Water, Adsorbent

I. INTRODUCTION

Environmental pollution is constantly threatened our biosphere. Water pollution by domestic, industrial, agriculture, shipping, radio-active, aquaculture wastes; air pollution by industrial pollutants, mobile combustion, burning of fuels, agricultural activities, ionization radiation, cosmic radiation, suspended particulate matter; and land pollution by domestic wastes, industrial waste, agricultural chemicals and fertilizers, acid rain, animal waste have negative influence over biotic and abiotic components on different natural ecosystems.

Some of the recent environmental issues include green house effect, loss in bio-diversity, rising of sea level, abnormal climatic change and ozone layer depletion etc.

Textile Engineering has a direct connection with environmental aspects to be explicitly and abundantly considered.

The textile industry plays an important role in the economy of the country like India and it accounts for around one third of total export. Out of various activities in textile industry, chemical processing contributes about 70% of pollution. It is well known that cotton mills consume large volume of water for various processes such as sizing, desizing, scouring, bleaching, mercerization, dyeing, printing, finishing and ultimately washing. Due to the nature of various chemical processing of textiles, large volumes of waste water with numerous pollutants are discharged. Since these streams of water affect the aquatic eco-system in number of ways such as depleting the dissolved oxygen content or settlement of suspended substances in anaerobic condition, a special attention needs to be paid. Thus a study On different measures which can be adopted to treat the waste water discharged from textile chemical processing industries to protect and safeguard our surroundings from possible pollution problem has been the focus point of many recent investigations.

Water is polluted when its natural qualities are altered by addition of undesirable substances in water that makes it harmful to human, animal and aquatic life.

II. METHODS AND MATERIAL

Textile waste water characterization

The textile dyeing wastewater has a large amount of complex components. All wastes can be broadly classified into 4 main categories;

1. Toxic waste (metals, and organic materials)
2. High volume waste (reduced by process modification)
3. Highly dispersible waste
4. Hard to treat waste (colour, phosphates, dyes).

Characterization of waste water can be classified as:

1. Physical characteristics:- colour , odour, temperature, turbidity, total solids(suspended solids, colloidal solids, dissolved solids).
2. Chemical characteristics:- pH value, chlorides content, sulphates, sulphides and H_2S gas, surfactants, organic matters, inorganic matters, nutrients, pesticides, agricultural chemicals, oil and grese, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand.

Owing to their high BOD/COD, their coloration and their salt load, the wastewater resulting from dyeing cotton with reactive dyes are seriously polluted. As aquatic organisms need light in order to develop, any deficit in this respect caused by colored water leads to an imbalance of the ecosystem. Moreover, the water of rivers that are used for drinking water must not be colored, as otherwise the treatment costs will be increased. In the past several decades, many techniques have been developed to find an economic and efficient way to treat the textile dyeing wastewater, including physicochemical, biochemical, combined treatment processes and other technologies. These technologies are usually highly efficient for the textile dyeing wastewater.

Today, the identification and classification of waste water are in accordance with existing municipal regulations. General regulations define the most important substances that are critically controlled by consumers and propose a set of activities that should be applied in order to minimize the amount of released hazardous substances. The characteristics of textile effluents vary and depend on the type of textile manufactured and the chemicals used.

Textile industry can be classified into three categories viz., cotton, woollen, and synthetic fibers depending upon the used raw materials. The cotton textile industry is one of the oldest industries in India. The textile dyeing industry consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and finishing processes. Wastewater from printing and dyeing units is often rich in colour, containing residues of reactive dyes and chemicals, such as complex components, many aerosols, high chroma, high COD and BOD concentration as well as much more hard-degradation materials. The toxic effects of dyestuffs and other organic compounds, as well as acidic and alkaline contaminants, from industrial establishments on the general public are widely accepted. At present, the dyes are mainly aromatic and heterocyclic compounds, with colour-display groups and polar groups. The structure is more complicated and stable, resulting in greater difficulty to degrade the printing and dyeing wastewater.

According to recent statistics, India's annual sewage has already reached 390 million tons, including 51% of industrial sewage, and it has been increasing with the rate of 1% every year. Each year about 70 billion tons of wastewater from textile and dyeing industry are produced and requires proper treatment before being released into the environment.

Therefore, understanding and developing effective printing-dye industrial wastewater treatment technology is environmentally important. The public desires water that is low in hardness and total solids, non-corrosive, and non-scale forming.

Hence safe and effective disposal of waste water containing heavy metals and dyes is always challenging task for industrialists and environmentalists due to the facts that the cost-effetive treatment alternatives are not available.

Waste water treatment processes:-

Waste water treatment consists of a combination of physical , chemical, and biological processes.

The different degrees of treatment, in order of increasing treatment level, are preliminary, primary, secondary, and tertiary or advanced waste water treatment process. The main purpose of primary treatment is to provide BOD removal beyond what is achievable by simple sedimentation. It also removes appreciable amounts of oil and phenol. In secondary treatment, the dissolved and colloidal organic compounds and color present in waste water is removed or reduced and to stabilize the organic matter. Textile processing effluents are amenable for biological treatments. The textile waste also contains significant quantities of non-biodegradable chemical polymers. Since the conventional treatment methods are inadequate, there is the need for efficient tertiary treatment process. The commonly used technologies are: coagulation and / or flocculation, membranes (microfiltration, nanofiltration and reverse osmosis), adsorbents (silica, clays, granular activated carbon, natural and synthetic bio adsorbents), oxidation (Fenton-reagent, photocatalyis, advanced oxidation processes, ozonation) and biological treatments (aerobic and anaerobic). Given the fact that the wastewater from the textile industry is complex and variable, it is unlikely that one treatment technology will be suitable for treatment of all wastewater and water recycling [9]. The application of a certain technology for wastewater treatment is dependent on the type of waste water (not every plant uses the same way of production) and also on the amount of used water. Among all adsorbtion is the most promising and feasible technique.

Waste water analysis Methods and materials

Adsorption is one of the tertiary methods used for waste water treatment. Adsorption by activated carbon is advantageous to remove small of organic and inorganic contaminants from waste water.
Activated carbon prepared from plant material for removal of toxic metals and dyes is low cost and high affinity. Absorbance of the dyes measured on spectrometer. pH measurement on pH meter. Conductance measurement done on conductometer.
The coagulants used are Alum, Ferrous sulphate and Ferric chloride.

The adsorbent used in the study is Aziridicha indica(neem) :- it is found locally . The stem wood of tree was cut into small pieces then it is treated with concentrated sulphuric acid (1:5) and kept in oven at 150^0 C for 24 hours. After this it was filtered and washed with distilled water repeatedly to remove sulphuric acid (confirmation test with Barium chloride solution) and finally dried. The adsorbent is now sieved to 40-60 mesh size and heated at 150^0C for 2 hours. This material was used as adsorbent.
Characterization of adsorbent: - 4 techniques of characterization have been used.

1. Scanning electron microscope analysis (SEM)
2. X- RAY diffraction analysis
3. Attenuated total reflectance (ATR) analysis
4. Physico – chemical analysis

Adsorption

Adsorption is used to treat waste water. Activated carbon is granular and powder form is used for adsorption. Adsorption efficiency is tested by adsorption isotherms. Two isotherms are frequently studied for adsorption isotherm.
Langmuir 's isotherm:- this isotherm governs the monolayer coverage of the surface containing a finite number of identical site. it is represented by the following equation

$$\frac{C_e}{q_e} = \frac{1}{Q_0\, b} + \frac{C_e}{Q_0} \qquad \text{....................(1)}$$

Where C is equilibrium concentration (mg/l), q is the amount adsorbed at equilibrium time per unit adsorbent (mg/g) and Q and b are Langmuir constants related to adsorption capacity and energy of adsorption respectively. This isotherm can be expressed in terms of a dimensionless constant separation factor or equilibrium parameter R_L where R_L is defined by

$$R_L = 1/(1+ bC_0) \text{......................(2)}$$

C_0 is the initial adsorbate concentration (mg/l) and b is the lamgmuir constant. The parameter indicates the shape of the isotherms as follows:

R_L value	Type of isotherm
$R_L > 1$	unfavourable
$R_L = 1$	linear
$0< R_L<1$	favourable
$R_L =0$	irreversible

Freundlich's isotherm:- this equation is used for heterogenous surface energies in which the energy term is Q_0, varies as a function of the surface coverage , q_e strictly due to variations in the heat od adsorption.

$$q_e = k_f C_e^{1/n} \text{ ....(4)}$$

The linear form of the equation or the log form is

$$\text{Log } q_e = \log K_f + 1/n \log C_e$$

Where,

Ce = equilibrium concentration (mg/l)

q_e = the amount adsorbed (mg/g) at equilibrium time,

K_f = the capacity of the adsorbent.

Value of n between 1 and 10 indicates good adsorption.

Adsorption rate constant:-

The overall rate constant for adsorption of an adsorbate is given by Lagergen

$$\text{Loq } (q_e\text{-}q) = \log q_e - k_{ad}/ 2.303 \text{ ....(6)}$$

Where q and q_e are the amounts of adsorbate adsorbed(mg/g) at time t (min.) at equilibrium respectively.

III. RESULTS AND DISCUSSION

PROPOSED OBJECTIVES OF THE STUDY

The purpose of this study was to investigate the removal of metals and dyes from aqueous solution by adsorption. Water depletion of good quality water and environmental pollution has given tremendous importance to the water management. Joints efforts are needed by water technologists and textile industry experts to reduce water consumption in the industry. While the user industries should try to optimize water consumption, water technologists should adopt an integrated approach to treat and recycle water in the industry. Our motto is to save living species and its surrounding environment. Thus we must stop using chemicals and dyes, which produce harmful effect to the biotic and abiotic factors in our eco-systems. Reduction of waste at the source is the preferred strategy instead of the traditional method of "end of pipe waste treatment". Apart from problematic chemicals and dyes, the main pollutant is, of course, water. So, the new technologies, which aim to reduce or eliminate water, are to be conceived.

1. Physicochemical analysis of textile wastewater from different regions.
2. Investigation of contaminants.
3. Use of Treatability methods for organic and inorganic contaminants.
4. Removal of metals and dyes from aqueous solution by adsorption.
5. Preparation and characterization of adsorbants.
6. Determine the optimum removal condition by using different adsorbents.
7. Determine the suitable adsorption isotherms.
8. Improve knowledge of the impacts of effluents and reuse of wastewater after proper treatment.

IV. CONCLUSION

The various methods can be applied to treat cotton textile effluents and to minimize pollution load. Traditional technologies to treat textile wastewater include various combinations of biological, physical, and chemical methods, but these methods require high capital and operating costs. Technologies based on membrane systems are among the best alternative methods that can be adopted for large-scale ecologically friendly treatment processes. A combination methods involving adsorption followed by nanofiltration has also been advocated, although a major drawback in direct nanofiltration is a substantial reduction in pollutants, which causes permeation through flux. It appears that an ideal treatment process for satisfactory recycling and reuse of textile effluent water should involve the following steps. Initially, refractory organic compounds and dyes may be electrochemically oxidized to biodegradable constituents before the wastewater is subjected to biological treatment under aerobic conditions. Colour and odour removal may be accomplished by a second electro oxidation process. Microbial life, if any, may be destroyed by a photochemical treatment. The treated water at this stage may be used for rinsing and washing purposes; however, an ion-exchange step may be introduced if the water is desired to be used for industrial processing. The value of water resources is universally recognized and the quality of life depends on the ability to manage available water in the greater interest of the people. The processes of production of textiles especially wet treatments and finishing processes of textile materials (finishing, dyeing, printing, etc.) are huge consumers of water with high quality. As a result of these various processes, considerable amounts of polluted water are released. Joints efforts are needed by water technologists and textile industry experts to reduce water consumption in the industry. While the user industries should try to optimize water consumption, water technologists should adopt an integrated approach to treat and recycle water in the industry. End-of-pipe technologies are used for wastewater treatment and include sequential application of a set of methods: coagulation / flocculation, flotation, adsorption, evaporation, oxidation, combustion, use of membranes, etc that has been adapted to the particular situation of a textile plant. As a result of the extreme variety of textile processes and products, it is impossible to develop a realistic concept for an effective treatment of wastewater without a detailed analysis of the actual situation in the textile plant. Characterization of textile process effluent streams is very important to develop strategies for water treatment and reuse. To optimize treatment and reuse possibilities, textile industry waste streams should be in principle considered separately. When the characteristics of the separate streams are known, it can be decided which streams may be combined to improve treatability and increase reuse options. It is important to explore all aspects of reducing emissions and waste products from the textile industry because it will result not only in improved environmental performance, but also in substantial savings on individual textile companies.

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