Review Paper on Various Techniques used in Effluent Treatment of Textile Industry

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Abstract- Textile industries have their own importance in Indian economy. It consumes large amount of water and as a result huge amount of waste water is generated. Textile effluent comprises of suspended solids, mineral oils, residual oils and is characterized by high BOD (from 700 to 2000 mg/l) and COD loads. It is necessary to treat the waste water so that it does not have any threat to the environment. This review paper discusses about characteristics of textile waste and various methods applied by the researches to treat the effluent discharged from textile industry. Conventional treatment methods like biological treatment methods are not applicable as mostly colors are identified as non-biodegradable. So, modern techniques are to be implemented for effluent treatment. Some of them discussed here are advanced oxidation method, photo catalytic treatment by titanium oxide and membrane analysis.

Key words- BOD, COD, oxidation, photo catalytic, membrane

I. INTRODUCTION

Textile industries are the most polluting industries in terms of volume of effluent generated. The colored waste water released in the nature is harmful not only to the humans but also to aquatic life. Various processes involved in textile industries comprises of slashing/sizing, desizing, scouring, mercerizing, bleaching, printing, dyeing and finishing. Wet-processing textile techniques have increased due to increased awareness of environmental problems. Cotton provides an ecological friendly textile, but more than 50% of its production volume is dyed with reactive dyes. Unfortunately, dyes are unfavorable from an ecological point of view, because the effluents generated are heavily colored, contain high concentrations of salts, suspended solids, acidity, heat and exhibit high biological oxygen demand/chemical oxygen demand (BOD/COD) values. (Babu and Parande, 2007) [1] The major challenge of this industry is to modify treatment methods, so that they become environmental friendly and are applicable at a reasonable price. There are three ways to minimize pollution: (1) by using less polluting contaminants; (2) effective effluent treatment so that it meets the standards of discharge requirement; and (3) recycling waste before discharge (Sule and Bardhan, 1999) [2] The objective of this paper is to discuss characteristics of effluent of textile waste and methodologies adopted for treating textile wastewater by various researches.

II. CHARACTERISTICS OF GENERATED EFFLUENT

Composite textile effluent is characterized by measuring Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS) and Dissolved Solids (DS). Determination of parameters like colour, odour, density, surface tension, viscosity, alkalinity, acidity, chloride, hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), nitrogen, sodium, potassium is done to study its characteristics. Composite textile waste water characteristics are shown in Table 1. The results which are shown in following table show a large variation from plant-to-plant and sample-to-sample. As given in following table, COD values of composite wastewater are very high as compare to other parameters. Mostly, BOD/COD ratio is nearly 0.25 of composite textile wastewater, which means that wastewater contains large amount of non-biodegradable organic matter (Adel Al-Kadasi and Azni Idris). [3]

Table 1: Composite textile industry wastewater characteristics [4]

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.0-9.0</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand(mg/L)</td>
<td>80-6000</td>
</tr>
<tr>
<td>Chemical Oxygen Demand(mg/L)</td>
<td>150-12000</td>
</tr>
<tr>
<td>Total Suspended Solids(mg/L)</td>
<td>15-8000</td>
</tr>
<tr>
<td>Total Dissolved Solids(mg/L)</td>
<td>2900-3100</td>
</tr>
<tr>
<td>Chloride(mg/L)</td>
<td>1000-1600</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen(mg/L)</td>
<td>70-80</td>
</tr>
</tbody>
</table>
Table 2: Components of textile effluent obtained from various processes in textile industry [5]

<table>
<thead>
<tr>
<th>Process</th>
<th>Effluent Composition</th>
<th>Pollutant Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizing</td>
<td>Starch, waxes, Carboxymethyl Cellulose (CMC), Polyalcohol (PVA), wetting agents.</td>
<td>High in BOD, COD</td>
</tr>
<tr>
<td>Dyeing</td>
<td>Sodium Hypochlorite, Cl2, NaOH, H2O2, acids, Surfactants, Na4SiO4, Sodium Phosphate, short cotton fibre</td>
<td>High alkalinity, high SS</td>
</tr>
<tr>
<td>Mercerizing</td>
<td>Sodium Hydroxide, cotton wax</td>
<td>High pH, low BOD, high DS</td>
</tr>
<tr>
<td>Dyeing</td>
<td>Dyesuffs Urea, reducing agents, oxidizing agents, Acetic acid, detergents, wetting agents.</td>
<td>Strongly colored, high BOD, DS, low SS, heavy metals</td>
</tr>
<tr>
<td>Printing</td>
<td>Pastes, urea, starches, gums, oils, binders, acids, Thickeners, cross-linkers, reducing agents, alkali</td>
<td>Highly colored, high BOD Oily, appearance, SS, slightly alkaline</td>
</tr>
</tbody>
</table>

III TREATMENT METHODS

a Membrane Process

If we use membranes then there are possibilities for the separation of hydrolyzed dye-stuffs and dyeing auxiliaries that reduce coloration and BOD/COD of wastewater. The choice of membrane process depends upon the quality of final product to be obtained.

i. Reverse Osmosis

Reverse osmosis membranes have a retention rate of 90% or more for most types of ionic compounds and produce a high quality permeate. (Ghayeni et al., 1998;[6] Treffry-Goatley et al., 1983;[7] Tinghui et al., 1983)[8]). It allows the removal of all mineral salts, hydrolyzed reactive dyes and chemical auxiliaries. As the concentration of dissolved salts increases, importance of osmotic pressure increases; hence energy required for separation process increases.

ii. Nanofiltration


iii. Ultrafiltration

Ultrafiltration can only be used as a pretreatment for reverse osmosis (Ciardelli and Ranieri, 2001)[15]) or combination with biological reactor (Mignani et al., 1999[16]). It enables removal of macromolecules and particles, but the removal of polluting substances such as dye is not complete (it is only between 31% and 76%) (Wattera et al., 1991[17]).

iv. Microfiltration

Microfiltration is suitable for treating dye baths containing pigment dyes, (Al-Malack and Anderson, 1997[18]) as well as for subsequent rising baths. It can be used as a pretreatment for nanofiltration or reverse osmosis. (Ghayeni et al., 1998[19])

b Photo catalytic Treatment Using Titanium Oxide

In this method photo catalytic decolouration in investigated by using TiO2 photo catalyst for treating textile effluent. Experiment shows that photo catalytic decolouration process can efficiently treat textile effluent and reduce the levels of BOD, COD, turbidity, TDS and alkalinity. In this method firstly physio-chemical parameters of effluents are studied. Dye solutions were prepared by dissolving 10 mg dry powder in 100 ml distilled water. Standard stock solution of TiO2 was made by dissolving 0.399 gm of TiO2 in 250 ml of distilled water. This experiment is done by UV-Visible double beam spectrophotometer. 1ml of TiO2 was separately introduced in 25ml of standard dye sample and was kept for photoreduction at room temperature in visible radiation. Results show that colour intensity was reduced by 88% as observed in 96 hours (Sharmila Pokharna and Rupali Srivastava 2013[20])

c Advanced Oxidation Method
Advance oxidation is the one of the method to decrease the adverse effect of component of wastewater of textile industries on environment. Advance oxidation method is use to generate and use hydroxyl free radicals as strong oxidant to destroy compound that cannot be oxidized by conventional oxidant. The versatility of the advance oxidation is enhanced by the fact that they offer many way for hydroxyl radicals like H2O2/UV/Fe2+ (photo assisted fenton), H2O2/Fe2+ (fenton), O3/H2O2, O3/UV,H2O2/UV etc. from which O3/H2O2,O3/UV and H2O2/UV oxidize textile waste water in great amount.

i. O3/UV

Hung-yee and Ching-rong, 1995[21] O3/UV is the most effective method for decolorizing of dyes comparing with UV oxidation by UV. (Bes-pia et al., 2003[22]), documented that O3/UV treatment of biologically treated textile wastewater reduced COD from 200-400mg/l to 50mg/l.

ii. H2O2/UV


iii. O3/H2O2

(Arslan et al., 1999[28] documented that H2O2/O3 treatment of synthetic dyeO3/H2O2: (Arslan et al., 1999[28] documented that H2O2/O3 treatment of synthetic dye highly depends on the pH 74% ozone absorption at pH 1.15 and 10 mm H2O2 whereas at the same concentration of H2O2 and pH 2.5, ozone absorption was only 11%. This shows that higher pH, the more H2O2 will be dissociated into OH2- ions and as pH increases rate of ozone decomposition also increases.

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Process</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aazbar et al. (2004)</td>
<td>Advanced oxidation by O3/UV</td>
<td>99% COD removal and 96% color removal</td>
</tr>
<tr>
<td>Bes-Pia et al. (2003)</td>
<td>Advanced oxidation by O3/UV</td>
<td>Reduce COD from 200-400mg/l to 50 mg/l in 30 minute</td>
</tr>
<tr>
<td>Babuna et al. (2009), Arslan and Isil(2002)</td>
<td>Advanced oxidation by ozonation</td>
<td>Formation of by products which increased toxicity of the formulation, 99% decolourization of waste water</td>
</tr>
<tr>
<td>Yan et al.(2010)</td>
<td>Advanced oxidation by ozonation</td>
<td>Combined system achieved 3 times higher TOC removal compared to using biological activated carbon process alone</td>
</tr>
<tr>
<td>Gomes de Moraes et al. (2000)</td>
<td>TiO2- assisted photo catalysis ozonation</td>
<td>60% decolourisation and TOC reduction</td>
</tr>
<tr>
<td>Ghayeni et al. (1998)</td>
<td>Membrane filtration by reverse osmosis</td>
<td>removal of all mineral salts, hydrolyzes reactive dyes and chemical auxiliary</td>
</tr>
</tbody>
</table>

IV CONCLUSION

Reduction of waste is very important as it decreases pollution and production costs. This review has shown that various methods can be applied to treat textile effluent and thus minimizing pollution load. Technologies based on membrane systems are the best alternatives methods that can be used for large-scale ecologically friendly treatment process. Advanced oxidation process represents a powerful treatment for refractory or toxic pollutant in textile wastewaters. TiO2 has great potential in photo reduction of dyes in effluents and this method is applied commercially to treat textile effluent. The decline in physiochemical parameter values shows the decolorization ability of TiO2.

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