Treatment of Textile Effluent by using Potential Microbes

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Abstract:
This research demonstrated the scope of using high energy gamma radiation for textile wastewater treatment and studied the possibility of recycling the irradiated water for fabric processing and reusing in irrigation purposes. The treatment was carried out in Cobalt-60 gamma radiation source at different irradiation doses (3, 5, 8 and 12 kGy) with a dose rate of 13 kGy/h. The change of pH, decoloration percentage, reduction of total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD5) chemical oxygen demand (COD), variation of electrical conductivity (EC) and heavy metal content of irradiated wastewater were extensively investigated. It was observed that, colored wastewater become almost colorless due to the breakage of the chromophoric groups of the dye molecules by gamma irradiation. Smaller organic compounds (mainly acidic) were formed due to the fragmentation of large dye molecules that results the reduction of pH of the irradiated wastewater. Total suspended solids (TSS), COD and BOD5 were also decreased significantly because of the degradation of the organic solid particles. However, the change of TDS, EC and metal content were found less for treated wastewater after application of gamma irradiation.

Keynotes: COD, BOD, TDS, WASTEWATER, TEXTILE INDUSTRIES EFFUENT.

I. INTRODUCTION:
Textile industry, one of the fastest growing sectors of today’s industrial based life style has an overwhelming presence in the economic life of our country. It contributes about 14 per cent to industrial production, 4 per cent to Gross Domestic Production (GDP), and 17 per cent to country’s export earnings. This sector provides direct employment to over 35 million people and is the second largest provider after agriculture. Undoubtedly, this sector is the major contributor of industrial production and national economy, but at the same time has led to increased anthropogenic effect on the biosphere due to large consumption of water and generation of huge volume of effluent which is colored due to presence of textile colorants (dyes and pigments) used during the dying process. Textile industry utilizes about 10,000 different dyes and pigments. The effluent has strong color, highly fluctuating pH and temperature, large amount of solids, high chemical oxygen demand (COD) and biological oxygen demand (BOD) values. Color is the first contaminant to be recognized in the effluent and has to be removed before discharging into water bodies or on land. Presence of color in the effluent affects the aesthetic merit and gives an indication of water being polluted which will damage the receiving water, when discharged. The discharge of dyes into the environment impedes light penetration and then toxic to food chain organisms and to aquatic life. Because of these characteristics, the effluent poses serious environmental problems. Presently, about 7 x 105 tons of dyes are produced annually worldwide (Wong and Yu, 1999). It is estimated that due to inefficiency of dying process, about 10-15 % of dyes are released in the effluent during dyeing as a waste. Moreover, with increased use of wide variety of dyes, the pollution problem has become alarming.

II. TEXTILE WASTEWATER TREATMENT: Textile wastewater containing varying concentrations of both organic and inorganic compounds (Libra & Sosath, 2003). Treating industrial textile wastewater is complicated due to the high levels of biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS) and no biodegradable nature of the organic dyes present in the wastewater (Badani et al., 2005; Kim et al., 2002). The color of the textile wastewater is not removed efficiently by ordinary treatment technology. Typical techniques for treatment of wastewater include the classical methods such as adsorption (Qada et al., 2008; Hameed et al., 2007; Rauf et al., 2007), coagulation (Ahmad & Puasa, 2007; Shi et al., 2007), filtration (Mo et al., 2008) and sedimentation (Bagyo et al., 1997). All these techniques have some degree of effectiveness but all of them generate secondary waste which needs to be tackled further (Rauf & Ashaf, 2009). On the contrary, biological treatment based on activated sludge can efficiently reduce the COD but complete color removal is not possible with this technique (Bes-Piá et al., 2002).

III. MATERIALS:
The wastewater samples of this study were collected directly from the equalization tank (mixture of chemical singeing, scouring, bleaching, and dyeing, washing, rinsing, finishing and printing wastewater) of Effluent Treatment Plant (ETP) of Delta plus India private Ltd, Falta, India. 500 ml plastic bottle was brought together from the local market to collect wastewater samples. The test of chemical oxygen demand (COD) of wastewater was performed by using higher range COD (HR COD) vials having range 0-1500 mgL⁻¹ was supplied from HACH, USA. The reagents used for the digestion of wastewater for the determination of heavy metals were collected from Merck, India and standard stock solutions of known concentrations of different heavy metals were supplied from Scharlau Chemie, Spain. For the recycling of irradiated...
wastewater 100% cotton knit fabric of 120 GSM (grams per square meter) was used to perform the pretreatment and dyeing operation. The fabric was knitted in single jersey structure and 26Scombed yarn was used to manufacture the fabric. The enzyme treatment of fabric was carried out by using the neutral enzyme (Cellzyme from Dysin, Bangladesh). The scouring and bleaching treatment of fabric was performed by adding a mix of the chemical agents: wetting agent (Imeron PCLF) and peroxide stabilizer (Stabilizer SOF liquid) from nainan, India. Hydrogen Peroxide(H2O2), acetic acid (CH3COOH), and caustic soda (NaOH) from Merck, India.

IV. METHODS:

Study Area:
The wastewater samples of this study were collected from the Delta plus industries Ltd, lima, India. This factory is located 30 kilometer away from the alta city at kolkata. It is a knit composite factory having dyeing and printing capacity 14 tons per day. The source of wastewater of this industry is the dyeing and printing unit, where mainly cotton, polyester, viscose and blended fabrics are dyed and printed. The present study was carried out exclusively on the effluent of this factory.

Sample Collection:
The wastewater samples of this study were obtained directly from the equalization tank of Effluent Treatment Plant (ETP) of the factory. Wastewater samples were collected in 500 ml plastic bottles. Before collecting the wastewater sample, the plastic bottles were washed thoroughly using distilled water. The bottles were almost completely filled with sample water and for the ease of identification each bottle was marked by the permanent marker.

V. CHARACTERIZATION OF IRRADIATED WASTEWATER:

Measurement of pH:
The pH of the raw wastewater and irradiated samples was measured directly by digital pH meter (Ecoscen, 1161795) from Eutech Instruments, Singapore.

Measurement of Color Reduction:
The color absorbance of raw and irradiated wastewater was measured by UV-Vis spectrophotometer (T60, PG Instrument from UK). The degree of decoloration was then calculated from the decrease of absorbance at maximum absorption wavelength after irradiation as follows (Rauf et al. 2009).

Determination of Chemical Oxygen Demand (COD):
The chemical oxygen demand (COD) is commonly used to indirectly measure the amount of organic compounds in water. The test was carried out by dichromate digestion method (Dedkov et al., 2000). 2 ml of wastewater sample was added to the COD vials containing a solution of a strong oxidizing agent, potassium dichromate (K2Cr2O7) in a strongly acidic medium (H2SO4) including a silver sulfate (Ag2SO4) catalyst. The sample was refluxed at 150°C for 2-3 hours for the digestion. The COD values were measured directly by HACH spectrophotometer (Model no-DR 2800, USA) and the test results are expressed as milligrams of oxygen consumed per liter of sample (mg/L COD).

Determination of Biological Oxygen Demand (BOD5):
Biological oxygen demand (BOD5) was measured by dilution method. The method consists of filling with sample to an airtight bottle of 300 ml size and incubating it at 20°C for 5 days. Dissolved oxygen (DO) of wastewater was measured by DO meter (HQ40d portable DO meter, HACH, USA) initially and after incubation, and the BOD5 was computed from the difference between initial and final DO.

Measurement of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS):
The term total suspended solids can be referred to materials which are not dissolved in water and are non filterable in nature. It is defined as residue upon evaporation of non filterable sample on a filter paper. The test TSS was performed by filtering the wastewater through a fiber pad filter and then measuring the dry weight (obtained by drying the filter and its content at 103-105°C for 1 hour) of the material. After drying the filter paper was cooled for 30 minutes in an oven at room temperature. The increase in weight of the filter represents the total suspended solids in wastewater. The term total dissolved solids referred to the materials that are completely dissolved in water. These solids are filterable in nature. It is defined as residue upon of non filterable sample on a filter paper.

Measurement of Electrical Conductivity (EC):
Electrical conductivity is defined as a measure of the ability of a water sample to convey an electric current and it is a useful parameter for assessing the concentration of solid substances present in any sample of waste water. The determination of electrical conductivity of raw and irradiated wastewater was carried out directly by electrical conductivity tester EC 150, from HACH, USA.

Determination of Heavy Metals in Wastewater:
The determination of heavy metals such as chromium (Cr), copper (Cu) and cadmium (Cd), lead (Pb) and nickel (Ni) in raw and irradiated wastewater was analyzed by Atomic Absorption Spectrophotometer (Model AA-7000, from Shimadzu Corporation, Japan). The test was carried out after digestion of wastewater with a mixture of concentrated acids HNO3 and HCL solution. The solution of wastewater was carefully heated in sand bath nearly to dryness in fumehood. After cooling the crucible at room temperature, deionized water was added to the sample and was filtered through a filter paper. The filtrate was collected in the measuring flask and was preserved for the determination of Pb, Cd, Cu, Cr and Ni. The Atomic Absorption Spectrophotometer was calibrated for all the metals by running different concentrations of standard solutions.

VI. RECYCLING OF IRRADIATED WASTEWATER:

Pretreatment of Cotton Fabrics:
Pretreatment is the process of preparing the textile materials for dyeing, printing and finishing operation. The pretreatment of cotton includes chemical singeing, scouring and bleaching of fabric. The chemical singeing also known as enzyme treatment or biopolishing is the process of removing the loose hairy fibers protruding from the surface of the cloth, thereby giving it a smooth, even and clean look appearance. The treatment was carried out by using a neutral enzyme applied to the fabric in neutral medium (pH 6.5-7.0) at a temperature 70°C for 50
minutes maintaining material liquor ratio 1:10. The scouring of cotton is carried out to improve absorbency by removing the impurities like fat and wax and the bleaching action destroy the natural pigments present in cotton to impart a permanent whiteness.

**Dyeing performance Test:**
The performance of dyed fabric regarding the depth of color and small color difference for acceptability was analyzed by using color measurement spectrophotometer (Data Color 650 from USA). The depth of color of the dyed fabric was determined by the K/S value (Broadbent, 2001) and color differences for acceptability i.e. CMC ΔE color difference value was evaluated according to AATCC test method 173-2006. The color of the fabric was measured on Data Color with the setting: illuminant D65, large area view and CIE 10° standard observer. Each sample was folded twice to give an opaque view and color reflectance was measured four times at different parts of fabric surface.

**VII. RESULTS AND DISCUSSIONS:**

**Analysis of Raw Wastewater:**
The wastewater collected from the equalization tank of ETP was the combination of water, discharged from different processing steps of dyeing and printing operation. As a result, the parameters of wastewater samples were not fixed. The parameters were varied depending on the step of fabric processing. For instance, the wastewater from scouring and bleaching includes high alkalinity and BOD where as dyeing wastewater comprises high salinity, pH, color and COD (Broadbent, 2001; Cooper 1995). Again the wastewater from washing and rinsing is almost neutral and contains low amount of contaminants. As a result, the physicochemical parameters of wastewater were changed after combination of water of different processing steps. The resultant parameters of wastewater after mixing are tabulated in Table 1.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>pH</th>
<th>Color</th>
<th>COD</th>
<th>BOD5</th>
<th>TSS</th>
<th>TDS</th>
<th>EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount:</td>
<td></td>
<td></td>
<td></td>
<td>mg/l</td>
<td>mg/l</td>
<td>mg/l</td>
<td>mg/l</td>
</tr>
<tr>
<td>8.2-9.0</td>
<td>Puepe/</td>
<td>Orange</td>
<td>272-295</td>
<td>180-197</td>
<td>m-1</td>
<td>900-1055</td>
<td>1980mg/l</td>
</tr>
</tbody>
</table>

**IX. REFERENCES:**


