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Physico-chemical and Microbial Characteristics of Textile and Tannery Effluent

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Abstract: *In this paper, waste water obtained from textile and tannery industry in Delhi-NCR and other regions was characterized for basic parameters. The effluent was dark colored with unpleasant odor and acidic in nature (pH 3.2) in case of tannery industry waste and it was basic in textile waste (pH 10.5). The effluent having high organic and inorganic load showing high electrical conductivity 3575 – 7620 µS/cm in textile and 12659 µS/cm in tannery waste water. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total hardness, Phenol, Cr(VI), total Cr , heavy metals like Zn, Cu and Ni were determined . The physico-chemical parameters were calculated as per the standards approved by Bureau of Indian Standards (BIS).*

Keywords*: Textile industry, Tannery industry, BOD, COD, Electrical Conductivity, TDS, BIS*

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I. Introduction

Industrialization and growth of older ones has become the cause of industrial wastes and threat to water quality. While Indian law prohibits the release of improperly treated waste water into the Ganga River and others, disposal of major quantities of such waste water does take place. It becomes the cause of hasty depletion of dissolved O_2 and destruction of water living organisms [1]. In contrast, the unmanaged discharge of industrial waste having different inorganic and organic pollutants are definitely causing severe harmful effects, ultimately making water property unhealthy for domestic utilization [2]. Industrial effluent in river water normally contains elevated amount of BOD (Biochemical oxygen demand) , COD (Chemical oxygen demand), Suspended solids (SS) and changeable inorganic element such as K, P and N_2 [3-5]. The waste water possesses a vast range of chemicals from the different stages of processes which consist of printing, polishing, discoloring and dyeing. The waste matter from these divisions and industries are released in open ground, cultivation land, water bodies, hence causing harmful effect on the phytoplankton's, zooplankton's and general health of people residing around the locations. Because of more water utilization, the recycle of waste water is an efficient approach for water protection. Therefore, the characterization of the effluents is significant to ensure its secure reuse for different function [6-8]. Due to increasing population and the entire development in the Nation, the per capita standard yearly freshwater accessibility has been falling since 1952 from 5180 m^3 to 1870 m^3, in 2002 and 1590 m^3, in 2011. It is predictable to further decrease to 1340 m^3 in 2024 and 1135 m^3 in 2040. So, there is an urgent requirement for proficient water supply management during improved water utilizes competence and waste water reprocesses [9]. Therefore, the management of effluents previous to discharge is essential to decrease pollution and the recommended processes for treatment are the different biological and chemical methods [10].

II. Material and Method

Sample collection: The wastewater of Textile and Tannery industry from various places of Delhi-NCR, India were collected over different and alternate time. These samples were analyzed for different physical and chemical parameters.

Physical, Chemical and Biological Study: Regular methods were used for studying different physical and chemical parameter of the effluent. The physical and chemical parameters analyzed were temperature, pH, color, alkalinity, BOD, COD, total hardness and conductivity, Total suspended solids, Electrical Conductivity, Phenol, Cr(VI), total Cr , heavy metals Zn, Cu, Ni [11-16]. The experiential values and BIS (Bureau of Indian Standards) values are shows in table no 1.

Bacterial analysis of the mud samples

The mud samples were collected from the place of discharge of effluents. Two samples were collected from discharge site of textile (T1) and tannery (T2) industry waste and stored at 4°C. Mud sample and autoclaved distilled water (DW) were mixed in 1:9 (m/V) than stirred properly. 1ml of each sample was pipette out into one sterile test-tube containing 9 ml of peptone water, making 1:10 dilution, second test-tube making 1:100 dilution and third test-tube making 1:1000 dilution respectively. 10 gm of Nutrient Agar was poured in 500 ml flask and the volume was made equal to spot by mixing DDW. pH of medium was changed with the help of conc. NaOH or conc. HCl. The medium was sterilized at 121°C and 15 psi for 15 min and cooled it about 37°C. One ml of the dilution (10-2 and 10-3) was stretch consistently on agar-medium petri dishes to conclude number of populations per gram soil incubation of the petri dishes was completed in a room set at 32±2ºC [17].

III. Results and Discussion

The parameters analyzed for the textile and tannery industry effluents are higher than the BIS values for pH, BOD, COD, TDS, TSS, and others shows table no 1.

Table no 1: Standard and observed values of different physical and chemical parameters of textile and tannery industry effluent.

Parameters	**BIS Value**	**Observed Value** (Textile industry)	**Observed Value** (Tannery industry)
pH	5.5 – 9.0	8 -10.5	3.2
BOD (mg/l)	100 -150	580 - 750	895
COD (mg/l)	250 -300	1220 - 2200	2381
Total dissolved solids (mg/l)	2000	3580-4670	3060-4000
Total suspended solids (mg/l)	100	280-430	120
Temperature (^{0}C)	Not exceed 40	>48	>42
Basicity (mg/l)	200	16.40 - 19.30	170
Hardness (mg/l)	500	322-870	1460
Electrical Conductivity (µS/cm)	1400	3575 - 7620	12659
Phenol (mg/l)	0.05-0.1	250	0
Cr(VI) (mg/l)	0.05-0.1	5	0.25
Zn (mg/l)	5	10	2.4
Cu (mg/l)	3	8	0.8
Ni (mg/l)	3	7	0.5

pH: The pH meter was used to calculate pH. The standard range of pH value for waste water is 5.5 – 9.0. Observed pH value varied from 8 to 12.5 in textile industry waste water samples which indicates alkaline tendency. Heavy metal toxicity also increased at this pH. In case of tannery industry waste water samples pH was found 3.2 which showed acidic nature. Low value of pH is due to the metabolism of microorganism [9-10].

Biochemical Oxygen Demand: BOD of the waste matter was examined by incubating sample at 20^0 C for 4-5 days prior and later the waste treatment. Elevated value of BOD showed the amount of biodegradable matter present in waste. Higher the decomposable substance, greater BOD values because more O_2 is required. Less value of BOD is an indicator of high-quality water, while high value of BOD point to polluted water. BOD value of textile samples ranged from 580 - 750 mg/l and 895 mg/l in tannery industry waste. This is much higher than the BIS limit of 100 mg/l.

Chemical Oxygen Demand: It was calculated by using closed reflux method. During COD calculation, O_2 demand value is helpful in identifying toxic situation and existence of biologically resistant matter. It is significant, quickly measured parameter for waste water studies and control of waste water treatments. COD analysis is used to calculate the load of organic pollutants in the industrial waste. The specified limit of COD concentration by BIS, for waste water is 250 mg/L. The concentration of COD in textile industry samples was observed as 1220 - 4500 mg/l and 2381 mg/l in tannery industry waste.

Total Dissolved Solids: TDS content shows total salts in water. Total dissolved solids, is the quantity of total inorganic substances and other salts that are soluble in water. Many salts are generally present in natural waters; these are bicarbonates, carbonates, sulphates, chlorides, nitrates and phosphates of Ca, Mg, Na, K, Fe and Mn. A high amount of soluble solid elements affects water density, manipulate osmoregulation of freshwater in protozoans, reduces solubility of oxygen and efficacy of drinking water, industrial and irrigational purposes. Water is classified on the basis of concentration of TDS as- fit for drinking (500 mg/L), acceptable for drinking (1,000 mg/L), valuable for irrigation (2,000 mg/L), not practical for drinking and irrigation (more than 3,000

mg/L). In our study, the average value of TDS was noticed in the range of 3580-4670 mg/L in textile industry waste and 3060-4000 mg/L in tannery industry waste.

Total Suspended Solids: In this work, the total suspended solids were found in range of 280-430 mg/l in textile industry waste and 120 mg/l in tannery industry waste. This is high compare to the BIS value (100 mg/l).

Temperature: Along with BIS, the temperature of wastewater should not go above 40^0C.Temperature was noted at the site prior to its collection and all the samples show temperatures more than 42^0C and 48^0C.

Basicity: It is the ability of water to absorb hydrogen ions. In industrial wastewater many aspects contribute to basicity with the type of dissolved inorganic and organic compounds found in water. Basicity concentrations in various types of industrial waste waters used in this work were in the range 16.40 to 19.30 mg/l in textile industry samples as $CaCO_3$ and 170 mg/l in tannery industry samples.

Hardness: It was studied by titrimetric method by EDTA. It assessment ranged from 322-870 mg/l in textile industry waste and 1460 mg/l in tannery industry waste. Specified limit of this parameter by BIS is 500 mg/l.

Electrical conductivity: It was measured by conductivity meter. The EC ranged between 3575 - 7620 µS/cm in textile industry waste and 12659 µS/cm in tannery industry waste. This is very high compare to the BIS value (1400 µS/cm).

Heavy metals: The physico-chemical properties and heavy metals of the effluent varies depending on the method used in different industries [18]. The textile waste water is contaminated with higher levels of metals as nickel, chromium, zinc and copper which contaminate agricultural soil. The crops and vegetables, which when absorbed these metals cause severe health risk to the consumer [19]. Higher value of Cr (VI) (5.0 mg/L), copper (8.0 mg/L), zinc (10 mg/L) and nickel (7 mg/L) was observed in textile effluent. Chromium content (0.25 mg/L) was found in soil contaminated with tannery effluent [20]. Nonstop discharge of chromium in low % has been noticed to be toxic to aquatic life and has been exposed to disturb aquatic food chain [21]. Copper is essential element in mammalian nourishment as a constituent of metallic-enzymes in which it performs as an electron acceptor or donor. 0.8 mg/L of Cu content was found in tannery effluent and high levels of copper can affect health [22]. In tannery effluent the amount of Zn was noticed 2.4 mg/L, acute toxicity of zinc may result in sweet taste, throat dryness, cough, weakness and vomiting [23]. 0.5 mg/l of Nickel was found in tannery effluent which is less then BIS value.

Microbial Study: Industrial effluents result indicates decrease in bacterial mud micro-flora as contrast to control. The tannery effluent pollutes the mud to a greater level than the textile industry effluent (Table 2). It could be due to higher BOD and COD values of effluents [24].

Table no 2: Bacterial CFU x 10^3 in mud samples

Samples	Bacterial CFU × 10^3 Dil. (10^{-2})	Colour of Agar	Bacterial CFU × 10^3 Dil. (10^{-3})	Colour of Agar
Control	360	Yellow	360	Yellow
T1	170	Brown	120	Light brown
T2	252	Dark Brown	202	Brown

The brightness of colour change is noticed when dilutions of mud samples are compared. The results explain that the bacterial counts have reduced because of the contamination of the mud samples by effluent waste from textile and tannery industry.

IV. Conclusion

Our country is a developing country where small industrial units mainly in textile industry and tannery industries form a major part and wastewater management are not done properly. From the analysis of effluent samples collected from textile and tannery industries, it is concluded that wastewaters demonstrate harsh variations from the BIS standards in terms of pH, hardness, electrical conductivity, Biochemical oxygen demand, Chemical oxygen demand and Heavy metals. The highly polluted effluents affects the water quality which in turn leads to significant environmental problems and health risks for the rural and urban communities which depend freely on water presented in the nearby water bodies for farming of different kinds of vegetables and domestic purposes without its treatment in Delhi-NCR region. This heavy metals intake has become the cause of many severe problems. Thus, it is compulsory that the waste water of such industries should be treated fine before their release into the neighboring water bodies. The use of eco-friendly natural dyes for dyeing and hand block printing is suggested. The wastes may be treated by different physico-chemical & biological treatment techniques together with adsorption by activated carbon, treatment by mixed culture of bacteria & highly developed oxidation procedures. The more levels of TSS and TDS are of main reason of alarm due to the enlarged rate of cancer.

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