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Environmental Assessment of Textile Wastewater of Sanganer Area in Jaipur

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ABSTRACT: Dyeing and printing industry is one the most important and rapidly developing sectors, which consumes high amount of processed water and produces high amount of polluted water. This waste water causes serious environmental pollution creating problems for aquatic flora and fauna and destroying the aesthetic sense of the water. Study here deals with analysis of physio-chemical parameters which are affected by using the huge amount of dyes. The analytical data from different block from the dyeing and printing industry reveals that water is slightly alkaline in nature (7.7- 13.02), rich in total dissolved (3337.25-1494.6 μ S/cm) and suspended solids (22.20-5.8NTU). The cations and anions (Ca⁺²: 427.6-175, Mg⁺²: 174.4-77.8, Cl⁻: 2028-1039, F⁻: 16.8-9.2, SO₄⁻²: 304.6-182.8, CO₃⁻²: 144.2-53.6, HCO₃⁻²: 408.8-180.2) were excess then the desired limit of concentrations.

KEYWORDS : Physio-chemical parameters, dyeing and printing industry

I. INTRODUCTION

Dyeing and textile printing industries of Sanganer houses about 400 small scales and one large scale industry [1]. These industries use a variety of chemicals and azo dyes (direct, reactive, rapid, mordant and premetalised etc.) during processing and finishing of raw materials. The workers in those industries are exposed to such dyes with no control over the length and frequency of exposure. Further, a huge volume of mostly untreated textile dye wastewater (10,000 - 15,000 Kl/day) is released into surface waters of Amani Shah drainage or through the drainage systems, seeps into the groundwater and adjoining water bodies flowing through Sanaganer. The untreated waste water is discharged directly into the drains that connect the industry to the main drainage network through the nullas in the town. The effluents disposed in open drains are directly used for crops cultivation which affects the nearby agricultural land also. The study deals with the collection of effluent from one of the large scale printing and dyeing industry in Sanganer town and physicochemical characterization of these samples in order to find out the physio-chemical load put in by the effluent on the wastewater stream. The study would help in finding the impact of the printing and dyeing effluents on corresponding soil and water bodies.

II. MATERIAL AND METHOD

A large scale industry located in Ramsinghpura, Shikharpura region of the town was selected for the present study. The entire passage of effluent flow, i.e. from the point of its discharge from the dyeing unit passing through the drain adjoining the printing units to the main drainage network was divided into five blocks i.e. Block-I, Block-II, Block-III, Block-IV and Block-V.

Sampling of the Effluent:- Samples were collected in three seasons namely March, December and August from each selected block because the amount of effluent discharged varies in different season. Peak period of production is in March followed by December whereas, August being rainy season results in spreading of the print paste, is the lean period for printing. Samples were collected in polyethylene bottles in morning. Samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30 cm deep, and allowed to over flow before withdrawing

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[2]. Five samples were collected from each block on five consecutive days in each of the months namely March, December and August. The mean of five samples from each block has been taken as the representative value for each parameter. Samples were refrigerated for further use.

Analysis of Sample:- Water samples were analysed in order to ascertain their physiochemical characteristics. Parameters were analysed using standard methods in APHA (1992) [3]. The physical parameters of water samples of dyeing industries include pH, EC and Turbidity whereas chemical parameters are TDS, COD, BOD, Calcium, Magnesium, Chloride, Fluoride, Sulphate, Carbonate, Bicarbonate.

- a. *Physical Analysis:-* pH, Electrical Conductivity and Turbidity was measured by pH meter from Toshniwal INSTS MFG Pvt. Ltd[4], conductivity meter 601 E[5] and deluxe water and soil analysis (Model 191)[6].
- b. *Chemical Analysis:-*
 - Total Dissolved Solids(TDS) was estimated by gravimetric method[7]. A 50 ml of unfiltered sample was evaporated to dryness at 100°C and the final weight was TDS of sample.
 - Biochemical Oxygen Demand (BOD) was estimated titrimetrically[8]. Dissolved oxygen concentration was measured by the difference of the sample before and after incubation for 5 days at 20°C.
 - Chemical Oxygen Demand (COD) was estimated titrimetrically[8] using ferrous ammonium sulphate.
 - Calcium and Magnesium was estimated by EDTA titration [9].
 - Chloride and fluoride was estimated by ion selective method [10].
 - Sulphate was determined by Turbidimetric method[11] precipitating sulphate ions in acetic acid medium.
 - Carbonate and bicarbonate was determined by sulphuric acid titration[12]

III. RESULT AND DISCUSSION

Dyeing and printing industry wastewater includes a large variety of dyes and chemicals additions that make the environmental challenge for dyeing and printing industry not only as liquid waste but also in its chemical composition. The result achieved in the present investigation of the dye effluents from the study area reveals that the physiochemical parameters of the dye effluents exceed the permissible limit as per standards [13].

pH: pH is an important index of acidity, alkalinity and resulting values of acidic- basic interactions of number of minerals and organic components thereby its high levels are dangerous[14]. The determination of pH is important since adsorbance of dyes from their water sample is dependent on pH values. It was observed that pH value for different samples lies between 7.45 - 13.85 showing that the water is alkaline in nature. Month wise highest mean value 13.02 (Block -I) is observed in the month of March while in August, lowest mean value 7.70(Block- V) is observed. pH values in wastewater sample are higher than the ISI standard (5.5-9.0) as shown in Figure1.

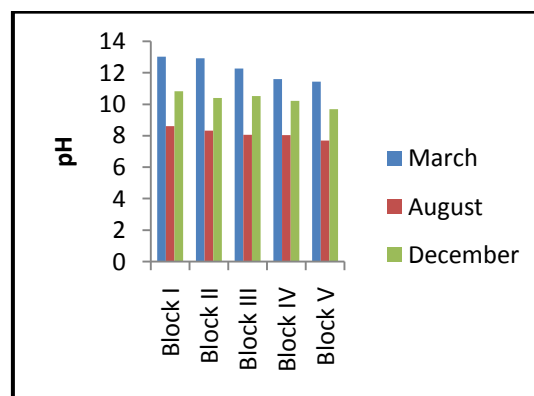


Figure1. Seasonal variation of pH of dye effluent

Electrical Conductivity: Water with high EC affects the soil structure, permeability and irrigation. The range of EC observed for different samples lies between 2.80 – 9.02 S/cm. Within a month wise highest mean value are 8.81 (Block-I) in March, 7.87 (Block-I) in December and 3.69 (Block -I) in August was observed as shown in Figure2. The conductivity of distilled water ranges between 1-3 S/cm and for domestic water USPH standard is 300 S/cm. suitable

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limits for irrigation water is less than 2250 S/cm. This data reveals that the water is saline and such a water is unsuitable for vegetation.

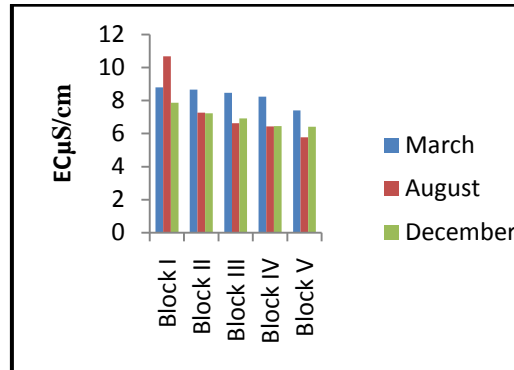


Figure2. Seasonal variation of EC of dye effluent

Total Dissolved Solids(TDS): TDS are the important parameters for evaluating the suitability of effluent for irrigation purpose, since these solids might clog both the soil pores and components of water distribution system. Month wise variation shows highest TDS load in August in Block –I where dyeing is carried out (3337.25 mg/L) whereas lowest is 1494 in Block-V (Figure3). High content of dissolved solids affects the density of water, influences osmoregulation of freshwater organisms, reduces solubility of gases and utility of water for drinking, irrigation purpose [15]. Sediments rate is drastically increased because of high value of TDS which reduces the light penetration into water and ultimately decreases the photosynthesis. The decrease in photosynthetic rate reduces the DO level of wastewater which results in decreased purification of wastewater by microorganisms [16].

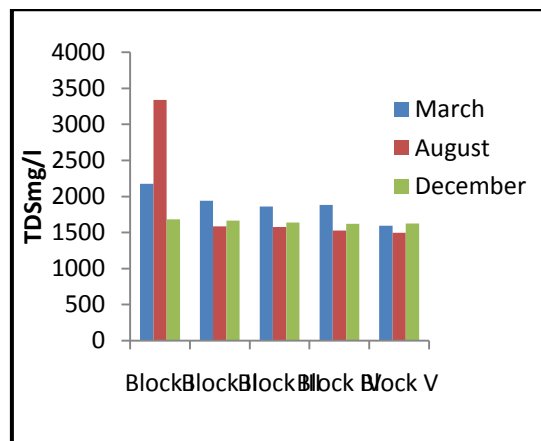


Figure3. Seasonal variation of TDS of dye effluent

BOD and COD: The high levels of BOD indicate that there could be low oxygen available for living organisms in the wastewater when utilizing the organic matter present. BOD of effluent determined was 130-427 mg/L. This BOD of the studied water sample is higher than WHO (50 mg/L) standard which is an indication of the contamination. Month wise variation shows highest BOD load in March is 384.5 mg/L (Block-I), December is 267.25 mg/L (BlockI) and August is 273 mg/L (Block-I) and lowest in August is 185 mg/L, December 200.5 mg/L (Block-II) and March is 241.50 mg/L (Block-V) as shown in Figure 5. COD values are between 790 -1528 mg/L which is very high as compared to ISI standard (250 mg/L) as shown in Figure 4. The higher value of COD is due to the dyes and different chemicals used in the textile industries during the process of printing [17]]. High COD levels imply toxic condition and the presence of biologically resistant organic substances.

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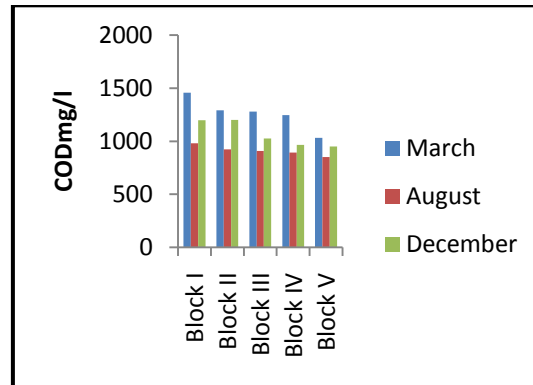


Figure4. Seasonal variation of COD of dye effluent

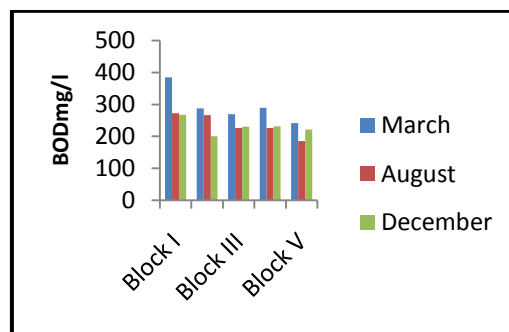


Figure5. Seasonal variation of BOD of dye effluent

Turbidity: Turbidity is a good parameter for the measurement degree of pollution of water. Variation range lies between 4-27 NTU. Highest and lowest Block wise mean is exhibited in the month of March viz. Block-I 22.20 NTU and Block – V 5.8. Similarly, in December and August 16.6 NTU, 13 NTU and 10 NTU, 6.4 NTU are highest (Block-I) and lowest (Block-V) respectively (Figure6). Turbidity limit as per WHO and IS standard is 5 NTU and wastewater sample values are close to it signifies a low degree of turbidity [18].

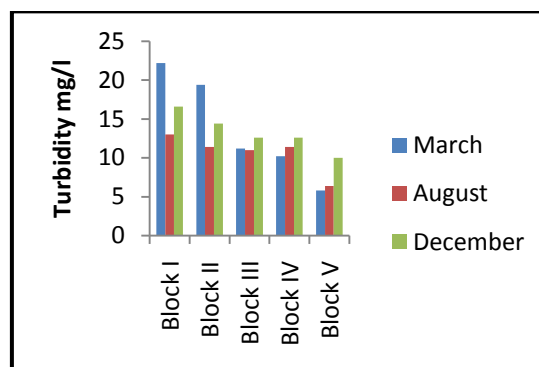


Figure6. Seasonal variation of Turbidity of dye effluent

Calcium and Magnesium: Calcium and Magnesium ions are the hardness causing ions in the water. Month wise highest mean value of calcium ion 427.6 mg/L is observed in the month of March and lowest mean value 175 mg/L in the month of December. Similarly for magnesium ion the highest and lowest mean value are 174.4 mg/L and 77.8 mg/L

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in the month of August (Block – I) and March (Block – V) respectively. The values of calcium and magnesium ions are in the range 132-451 mg/L and 60-197 mg/L respectively which exceeds the WHO limit of 75 mg/L for calcium ion and 50 mg/L magnesium ion (Figure 7 and 8). Higher concentration of calcium and magnesium effect the growth of plant by rendering the soil porous, allowing easy penetration of water and causes easy breakdown of chlorophyll molecules [19].

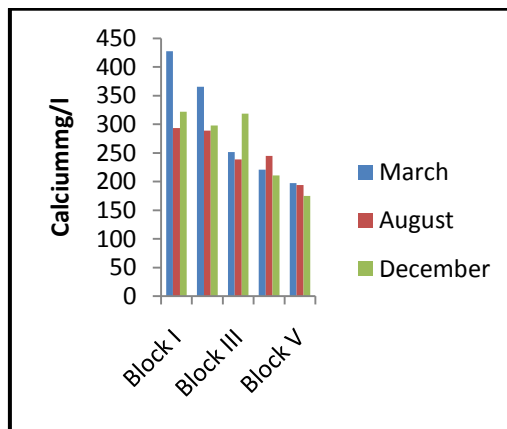


Figure7. Seasonal variation of Calcium of dye effluent

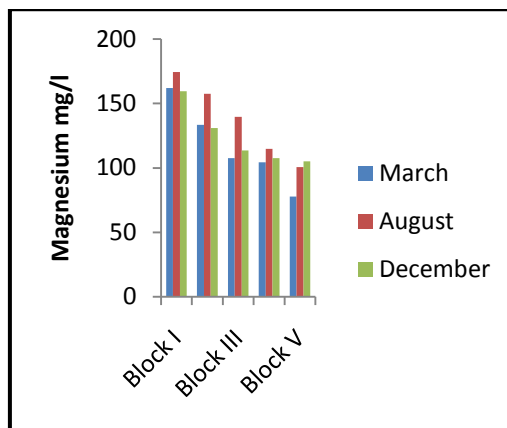


Figure8. Seasonal variation of Magnesium of dye effluent

Chloride and Fluoride: The presence of chloride in natural water can be attributed to the salt deposits, discharge of effluents from chemical industries; sewage discharges etc. Block wise highest mean value 2028 mg/L, 1665.8 mg/L and 1328 mg/L and lowest mean value 1039 mg/L, 1515 mg/L and 1200 mg/L was observed in March, December and August (Figure 10). Chloride content in these waste water samples (>950 mg/L) are far more than the ISI standard (600mg/L). High chloride contents are harmful for metallic pipes and are also harmful for agricultural crops if such wastes containing high chlorides are used for irrigation purposes. In these wastewater samples the value of fluoride was found to be in range of 6-20 mg/L which is slightly more than the ISI standard of 2 mg/L. Month wise highest mean value 16.80 mg/L is observed in the month of March and lowest mean value 9.2 mg/L in the month of August(Figure 9). Presence of excess fluoride in water is harmful for health causing floursis and mottling of bones.

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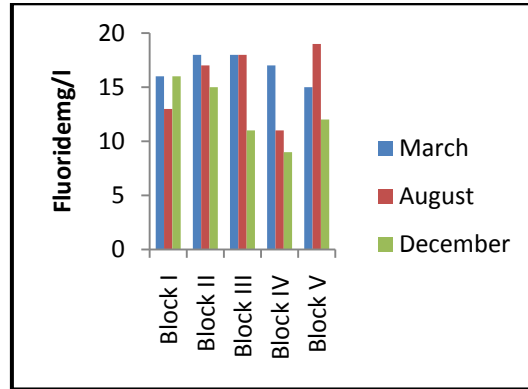


Figure9. Seasonal variation of Fluoride of dye effluent

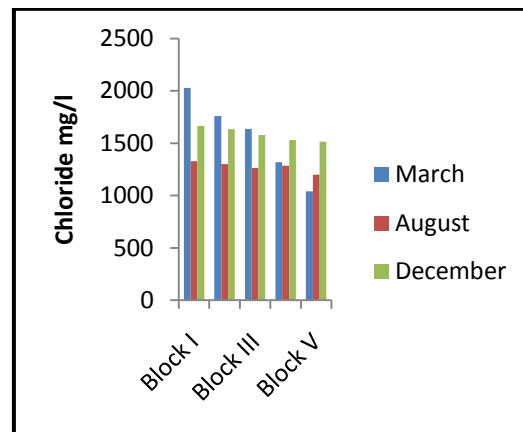


Figure10. Seasonal variation of Chloride of dye effluent

Sulphate: Sulphate usually occurs in natural water. Month wise highest mean value is 304.6 mg/L (Block-I) and lowest mean value is 257.2 mg/L (Block-V) in the month of August. In March highest and lowest value is 253.8 mg/L and 182.8 mg/L (Figure 11). Presence of sulphate beyond limit is harmful as it directly effects the concentration of Ca and Mg ion and quality of water. Its average concentration in sample just exceeds the WHO and IS permissible limits which is 200 mg/L but is far more than the ISI Limit 60 mg/L. The presence of Na_2SO_4 and MgSO_4 in drinking water beyond the prescribed limit may cause cathartic action.

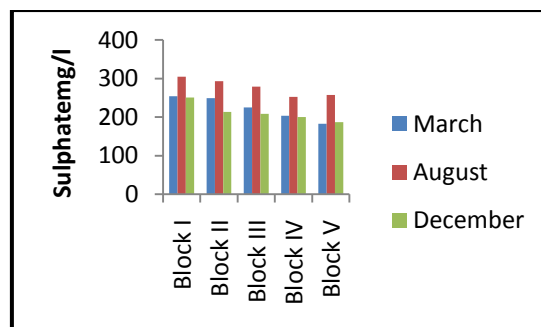


Figure 11. Seasonal variation of Sulphate of dye effluent

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Carbonate and Bicarbonate: In the effluent, the concentration of bicarbonate is found in the range of 121 – 445 mg/L, whereas the concentration of carbonate is found in the range of 36 – 196 mg/L. Month wise highest mean value for bicarbonate is 408.8 mg/L in August (Block-I), 245.2 mg/L in December and 367.8 mg/L in March and for carbonate highest mean value in March (144.2 mg/L), December 121.8 mg/L and August 133.8 mg/L was observed (Figure 12 and 13). Carbonate and bicarbonate may have an indirect effect on the quality of water as they result in precipitation of calcium and magnesium, thereby, increasing the sodium percentage [20].

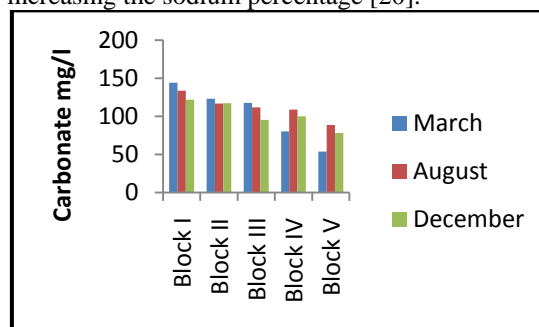


Figure12. Seasonal variation of Carbonate of dye effluent

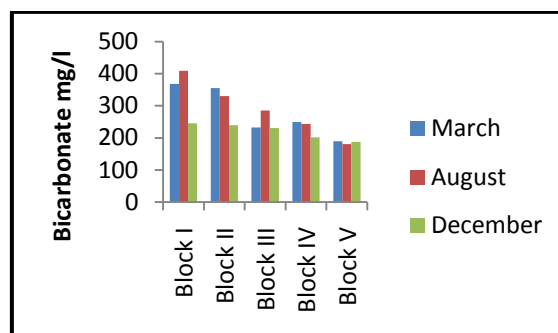


Figure13. Seasonal variation of Bicarbonate of dye effluent

IV. CONCLUSION

Dye effluents studied from Sanganer dyeing and Printing industry are highly polluted with high degree of alkalinity, dissolved solids, cations and anions which are not in compliance with standard. Such waters are not only unfit for secondary human use such as swimming or irrigation but also a serious threat to ground and surface water resources. Pollutants showed a downwards trend from discharge point (Block-I) to drain point (Block-V) as the effluent at Block-I is rich in pollutant discharged by the dyeing and printing industry. The gradual decrease in the pollutant can be attributed to the self purification property of water. The present investigation has led us to conclude that the quality of water samples subjected to study needs to be treated as per the physico-chemical parameters before using it for irrigation and domestic applications

As a consequence of it requires an urgent and cost effective method for the adequate treatment of the dye effluent. Various methods of dye removal, including aerobic and anaerobic microbial degradation, coagulation, chemical oxidation, membrane separation, electrochemical treatment, filtration, flotation, hydrogen peroxide catalysis, and reverse osmosis, have been proposed from time to time. There are two major technologies available for dye removal, i.e., oxidation and adsorption. There are many adsorbents available in market but their use is often limited due to high cost, making them unfavourable for the needs of developing countries like India. Therefore, fly ash, a by-product of thermal power plants, is used as adsorbents for removal of dyes.

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