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ORIGINAL RESEARCH ARTICLE

Characterization and Treatment of Wastewater from Sapphire Textile Industry, Pakistan

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ABSTRACT

The characterization of textile effluents was carried out with reference to COD, BOD, TSS, Chlorides, pH values and Heavy metals. The pollution in Sapphire textile effluents is due to the chemicals used in processes like dying, finishing, bleaching and washing. Different chemicals like starch, enzymes, caustic soda and dyes are used in these processes. Wastewater samples were taken before and after treatment. The untreated waste water samples were analyzed for BOD, COD, pH, Turbidity, TDS, TSS, Zn, Cu and Iron. The analysis of samples indicates high values of all the parameters; BOD from 219 mg/l to 248 mg/l COD 438 to 496 mg/l, pH 9.25 to 10.5, turbidity 86 to 91, TDS 1955 to 2002 TSS 56 to 65 mg/l Iron 2.01 to 2.9 mg/l Zinc 0.06 to 0.09 mg/l and concentration of Copper from 0.06 to 0.09 mg/l. Untreated wastewater from the mainstream enters into the wastewater treatment plant. The wastewater treatment plant is designed for biological treatment of the effluent. In the treatment plant bacteria are allowed to grow and multiply by using the effluents as nutrients. The treated wastewater is discharged into mainstream Hudyara Drain. The analysis reports of treated wastewater indicate the remarkable change in the parameters; BOD from 6.2 mg/l to 10.2 mg/l COD 64 to 71 mg/l, pH 7.65 to 8.3, turbidity 19 to 22, TDS 2025 mg/l to 2253 mg/l, TSS 17 to 21 mg/l, Iron 0.64 to 1.23 mg/l, Zinc 0.05 to 0.08 mg/l and Copper from below detection limits to 0.08 mg/l. The analysis reports of untreated and treated wastewater indicate that the wastewater treatment plant is useful for the significant reduction of pollutant concentration.

Keywords: Wastewater, Textile Industry, Turbidity, COD, BOD, TSS.

INTRODUCTION

Textile is one of the major industrial sectors of Pakistan. This industry has been established in almost all the major industrial cities. The textile industry is highly water, chemical and energy intensive. There is a widespread reluctance on the part of industries to treat their wastewater. Most of the textile industries are discharging their untreated waste-water either into the existing sewage system or into nearby natural drains and, in some cases, to the adjoining lands. The textile in

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dustries located in Karachi discharge their wastes into Lyari and Malir rivers which ultimately carry these to the sea.[1] Ravi and Chenab Rivers receive the untreated wastewater from the industries located near Lahore and Multan respectively. The textile industries located in Faisalabad and Gujranwala are discharging their wastewaters into a municipal sewerage system which ultimately join the ground water.[2] Textile wastewater is generally characterized on the basis of the process fibers like cotton, wool and synthetic fibers. Cotton textile processing of carding, spinning, sizing, desizing, scouring, rising, bleaching, dyeing, printing and finishing. These processes consume large quantities of water along with several chemicals like starch, enzymes, caustic soda and dyes. The range of water consumption during production is 100 – 200 liter/kg of cotton fiber. The major pollution parameters in textile wastewater are BOD, COD, solids, pH, alkalinity, chlorides, nitrates, toxic chemicals, heavy metals and temperature.[3] (There are a vastly increasing number of available technologies that can be employed for preventing hazardous waste generation and reducing the environmental impact of textile manufacturing. These can be classified as follows: a) Material change strategy b) Process change strategy c) Recovery and reuse strategy.[4] For bleaching process, improved bleaching agent is available which require less amount of water for their reaction. This will result in the reduction in volume of wastewater. Improved dyes have been developed which can reduce the toxicity of dye wastewater. For example, copper free dyes will reduce the metal contents in wastewater. Since a large portion of the biodegradable material in textile wastes is in the soluble form, the effluents are readily susceptible to biological treatment. Thus textile wastewater treatment methods may be of physical, Physio-chemical and biological nature.[5] Air flotation is very useful method for the removal of fibers present in raw wastewater from the textile industry. Compressed or diffused air, released under water surface, brings the fibers to the surface from which they can be removed. In some cases, it is a very useful technique.[6] Porter in 1971, after his studies on treatment of cotton finishing wastewater, has concluded 5 — 15 percent removal of BOD and 15 — 60 percent removal of suspended solids from sedimentation process.[7] Strongly alkaline textile wastes need to be at-least partially neutralized if discharged to sewer. Neutralization is also required for on-site treatment. It can be carried out in the flow-balancing tank or as a separate stage. Sulphuric acid is normally used for alkaline wastes. A continuous pH monitoring system is usually essential and can be used to control the chemical feed. Where wide variations of inflow or pH cannot be avoided, neutralization may need to be carried out in two or more stages. Alkaline wastes may also be neutralized by the addition of carbon dioxide flue gas.[8] Coagulation is an effective means

of reducing BOD, COD and Colour. Control of pH is critical in order to achieve the best results. Coagulant dose rates can range up to several hundred mg/l of alum or iron salt. Since these salts consume alkalinity, coagulant dosage needs to be considered for pH control. Alum coagulates best near to or just below neutrality. If the waste is strongly alkaline it is usually more economical and effective to use sulphuric acid to adjust pH. Coagulation sedimentation is usually operated continuously. The tank designs are usually of upward rather than horizontal flow.[8] Leatherland (1969) has concluded that stabilization ponds produce wide variations in BOD removal of textile wastewater. The BOD removal depends on a number of factors. Atmospheric temperature and cooling effect of the large water surface area are particularly significant. It has also been recommended that the pond size should be determined by the rate of discharge of BOD rather than the volumetric flow rate of the wastewater. Reasonable pond loading is 25 – 100 lb BOD/day/acre of surface area depending on the climate. Higher loading can be used if unpleasant odours can be tolerated.[9] Activated sludge process is a dominant system for combined municipal and industrial wastewater treatment. A bench scale study was conducted for the treatment of textile wastewater alone (Alternative I) and combined textile and municipal wastewaters (Alternative II). Four continuous flows, bench-scale, completely

mixed activated sludge units were operated simultaneously for the study. Each unit consisted of two compartments, 0.2385 liter capacity aeration chamber and 0.615 liter capacity settling chamber. Dissolved oxygen was maintained up to 5 mg/l in the reaction chamber. 80% BOD removal was reported with extended aeration. The BOD removal by alternative II was considerably higher than the alternative I. The oxygen requirement per pound of BOD removal was less in case of joint treatment.[10] An aerated lagoon is a basin in which bacteria and other organisms have opportunity to grow and proliferate under anaerobic environment. Oxygen is supplied to the basin by mechanical or diffused systems and the turbulence level are maintained to ensure the distribution of oxygen through the basin and to keep solids in suspension. The aerated lagoon is strictly a flow through aeration basin, where the micro-organisms concentration is a function of the wastewater characteristics and detention time. It has been noted that algal growths are absent or greatly reduced due to violent agitation. The oxygen concentration in the pond may be quite high (up to 6 mg/l). Therefore, the oxygen transfer rate which is proportional to the difference between the actual and saturated oxygen concentration per unit energy input is greatly reduced. The input energy is therefore inefficiently utilized for this purpose. Reducing the energy input reduces the oxygen concentration but increased the transfer rate per unit energy input. However, the

agitation may now be insufficient to keep all the settleable solids in suspension and a sludge layer is formed on the bottom of the pond.[11]

MATERIAL AND METHODS

Spectrophotometer

For the determination of metals like Iron, Zinc and Copper we have used spectrophotometer method, because their concentration in the effluents were very small and cannot be measured accurately by the titration method. The spectrophotometer that we used for the determination of metals was HACH USA DR/2010.

Volumetric Analysis or Titrimetric Analysis

The term volumetric analysis refers to quantitative chemical analysis carried out by determining the volume of a solution of accurately known concentration which is required to react quantitatively with the solution of the substance to be determined. The solution of accurately known strength is called the standard solution. The weight of the substance is to be determined is calculated from the volume of the standard solution used and the known laws of stoichiometry.

The standard solution is usually added from a burette. The process of adding the standard solution until the reaction is just complete is termed as a titration and the substance to be determined is titrated. The point at which this occurs is called equivalence point or the theoretical end point.

The completion of the titration should, as a rule, be detected by some change produced by the standard solution itself or more usually by the addition of an auxiliary reagent, known as an indicator.

The effluent samples for analysis were collected from Sapphire Textile which is located in Rai Wind road Lahore. In this industry, wastewater is produced during bleaching, dyeing, washing and finishing operations. All the operations are on a batch basis. The wastewater generated from individual operation, vary in strength and quality. For example, the wastewater from finishing is less polluted as compared to that of from bleaching operations. Since treatment is required for the combined effluent from industry, therefore the effluent samples were collected from combined homogeneous effluent. During the investigation, the samples were collected between 11:00 A.M to 1:00 P.M, after confirming that all processes are in operation, to keep the characteristics of the sample as close as possible to that was actually being discharged.

For wastewater sampling integrated sampling technique was used. About 8 samples were collected, for both untreated and treated wastewater; volume of each sample was 1.5 liter. After sampling the samples were stored in ice

container and immediately delivered to the laboratory.

CHEMICAL ANALYSIS OF WASTE WATER

Determination of Turbidity

Turbidity measurements are based on the depth of suspension required /-in the image of the flame of a candle to disappear when observed the suspension.

Determination of pH Value

For the determination of pH we used WTW pH330 pH meter. In the first the pH meter was calibrated. Then the pH value of the sample solution was determined by dipping the electrode of pH meter in the sample solution.

Conductivity Determination

The conductivity meter WTW Inolab-720 was used for the determination of conductivity of the samples. The conductivity of the samples was determined with the help of conductivity meter by dipping the electrode of the conductivity meter inside the sample solution.

Total Solid Determination

About 50 ml sample was taken in a pre weighed 100mI beaker and heated in the electric oven at 110 °C. After heating, the beaker was allowed to cool down and then weighed the beaker. Then the difference of the two readings was noted and find out the T.S in ppm by using the following formula.

$$TS = \frac{(W2-W1) * 1000 * 1000}{V} = ppm$$

Where

W_1 = weight of empty beaker in grams.

W_2 = Weight of beaker + dried residue in grams.

V = Volume of the sample used

Chemical Oxygen Demand (COD)

COD is a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. This test allows measurement of a waste in terms of the total quantity of oxygen required for complete oxidation to carbon dioxide and water.

Methodology

The sample is relaxed with excess potassium dichromate in concentrated sulphuric acid for 2 hours. This oxidizes most of the organic matter in the sample. Silver sulphate is included as a catalyst to speed up the oxidation process. After digestion, the un-reacted dichromate remaining in solution is titrated with ferrous ammonium sulphate.

$$Cr_2O_7 + 6Fe^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

Apparatus

Reflux apparatus consisting of a round bottom 250m1 to 500m1. Capacity flask with ground glass joint and a condenser with 24/40 joint and hot plate.

Reagents

Standard potassium dichromate 0.25 N solution, sulphuric acid reagent, Standard ferrous ammonium sulphate 0.1 N solution, ferroin indicator and mercuric sulphate.

Preparation of Reagents

Standard Potassium Dichromate (0.25 N)

Dissolve 12.35 gm $K_2Cr_2O_7$ at 103°C for 24 hour in distilled water and dilute to 1000ml, add about 120 mg of sulphuric acid.

Sulphuric Acid Reagent

Add 1 gm silver sulphate to 100ml concentrated H2SO4 and keep over night for dissolution.

Standard (FAS) (0.1 N)

Dissolve 39 gm ferrous ammonium sulphate in about 400 ml distilled water add 20 ml of concentrated H2SO4 and dilute to 1000 ml.

Standaralization of FAS

Take 10 ml standard potassium dichromate add 90 ml distilled water, approximately acidify by adding 30 ml concentrated sulphuric acid and titrate with F.A.S using ferrooin indicator.

Procedure

Place 0.4 grams of HgSO4 in a reflux flask. Add 2 ml sample diluted to 20ml with a distilled water mix well. Add glass beads followed by 10ml standard $K_2 Cr_2O_7$. Add slowly 30 ml sulphuric acid reagent and mix well.

Reflux for minimum of two hours. Cool and then wash the condenser with distilled water. Dilute to 150 ml, cool and titrated excess K2Cr2O7 with 0.1 F.A.S solution using ferroin indicators.

End Point

Sharp colour change from blue green to wine red is the end point.

Calculation

Chemical Oxygen Demand (mg/L) = (B-S *N*8*1000) /ml of sample

B = ml of F.A.S consumed for blank

S = ml of F.A.S consumed for sample

N = Normality of F.A.S

Biological Oxygen Demand (BOD)

Microorganisms can utilize carbohydrates, proteins, oils and fats and oxidize them to maintain their life processes. Some bacteria can also utilize to reduce inorganic materials like H2S and NH3 as resources of energy.

The biological oxygen demand is an empirical determination of the amount of O2 required to oxidize the organic material in the sample. BOD is determined by incubating the water sample with aerobic microorganisms under specific conditions of time and temperature. The most widely used tests; BOD5 is based on a five day incubation period at 20°C. The dissolved oxygen measured at the beginning and the end of the incubation period, and the BOD represents the difference between the initial and final BOD.

BOD = (initial DO – Final DO)

The BOD value does not represent the total BOD, since the biological oxygen of organic matter takes

more time than 5 days to run to completion. About 95 – 99% of reaction is completed after 20 days, but as this is too long to wait for results, a 5-day incubation period is usually used. For most domestic and industrial wastewater the BOD value represents between 60% and 80% of the total BOD.

Methodology

The water sample is diluted with suitable volume of oxygen saturated water containing nutrients and incubated in the dark for 5 days at 20°C. The dissolved oxygen concentration is determined before and after incubation and BOD5 is calculated by difference. The BOD is represented as mg O2 L-1 consumed by one litter of undiluted sample. No more than 70% of oxygen should be consumed during incubation.

Apparatus

OD bottles capacity 300ml and incubator to be controlled at 20°C + 1°C

Reagents

Phosphate buffer solution, Magnesium sulphate solution, calcium chloride solution, ferric chloride solution, Manganese sulphate solution, alkali Iodide acid solution, standard sodium thiophosphate solution, starch indicator and sulphuric acid.

Preparation of Reagents

Phosphate Buffer Solution

Dissolve 8.5 gm K2PO4, 21.75 gm K2HPO4, 33.4 gm Na2HPO4.7H2O and 1.7 gm NH4Cl 1N 500ml distilled water and dilute to 1000 ml.

Magnesium Sulphate Solution

Dissolve 22.5 gm MgSO4.7H2O and dilute to 1000ml.

Calcium Chloride Solution

Dissolved 27.5 g of CaCl2 in distilled water and dilute to 1000ml.

Ferric Chloride Solution

Dissolve 0.5mg FeCl3.6H2O and dilute to 1000ml.

Manganese Sulphate Solution

Dissolve 480 gm of MnSO4.4H2O or 400gm MnSO4.2H2O or 364gm MnSO4.H2O 1N, distilled water, filter and dilute to 1000ml. This solution should not give colour with starch when added to an acidified solution of KI.

Alkali Iodide Azide Reagent

Dissolve 500 gm NaOH and 150 gm KI or 135 gm NaCl, dilute to 1000ml, add to 10 gm of NaN3 and dissolve in 40 ml distilled water. This solution should not give colour with starch solution when diluted and acidified.

Stock Sodium Thiosulphate Solution (0.1N)

Dissolve 24.82 gm, sodium thiosuiphate in boiled distilled water and dilute to 1000 ml preserve by adding 0.4 gm NaOH pellets per litter.

Standard Sodium Thiosulphate (0.025N)

Dilute 250 ml, stock Na2S203 solution to 1000m1, with freshly boiled and cooled distilled water, preserve by adding 0.4 gm NaOH pallets per litter.

Standardization of sodium Thiosulphate

Take 5ml K2Cr2O7 and 2.5 ml HCI and 10% KI, (Freshly prepared) solution and keep it in dark place for 5 minutes, and titrated against Thiosulphate solution using starch as an indicator and calculate normality.

Starch Indicator

Prepare paste or solution of 2 gm L.R Grade solution starch powder and 0.2 gm salicylic acid as preservative in distilled water. Pour this solution in 100 ml boiling water, allow boiling for few minutes cool and then use.

Procedure

Preparation of dilution water

Aerate the required volume of distilled water in a container by bubbling compressed air to attain dissolved oxygen saturation. Add 1 ml each of phosphate buffer, Magnesium sulphate, calcium chloride and ferric chloride solution for each liter of dilution water mix well.

Dilution of Sample

Fill half of the BOD bottle with dilution water carefully. Add a suitable volume of sample in the BOD bottle. Now, the full capacity of the BOD bottle to be filled with dilution water and stopper immediately. Prepare blank using plain dilution water.

Set of dilution to be done, keep one bottle for determination of the initial dissolved oxygen and incubate the other bottle at 20°C or in ambient temperature for five days see that the bottles have a water seal.

Determination of Dissolve Oxygen

Add 2 ml $MnSO_4$ followed by 2ml alkaline Iodide acid mix well and keep for five minutes for setting then add 2ml of concentrated sulphuric acid and mix well.

Take 203 ml of sample and titrate against sodium thiophosphate solution using starch as an indicator, the end point is the disappearance of blue color. This 203 ml taken for titration will correspond to 200 ml of the original.

1 ml of 0.025 N thiosulphate = 0.2 mg of O_2

DO in mg/L = (0.2 * 1000) ml of Thiosulphate ÷ 200

BOD mg/l = (D — B) * dilution factor (300/s Vol)

D = Dissolve oxygen of 0 days - dissolve oxygen of 5 days

B = Dissolve oxygen of blank of 0 days - dissolve oxygen of blank samples after 5 days.

Reagents Required

1. Standard sodium thiosulphate solution (N/40)

2. Potassium permanganate solution (N/10)

3. Potassium oxalate solution (2%)

4. Manganous sulphate solution (48%)

5. Alkaline potassium iodide solution

6. Concentrated sulphuric acid.

Determination of Total Dissolved Solids (TDS)

About 100 ml of the sample solution was filtered through a Whitman filter paper. Evaporated the filtrate and dried the residue in the electric oven at 110 °C. Allowed to cool in a desiccator and weighted to get the amount of total dissolved solids in the sample.

Calculation

$$TDS \ (mg/L) = \frac{(A - B) * 1000 * 1000}{Sample \ volume, \ ml}$$

Where

A = Weight of Dried residue + dish, g

B = Weight of dish, g

Determination of Total Suspended Solids (TSS)

Wet a filter paper with a small volume of distilled water, placed it in the oven and dry for 1 hour at 103°C. Then cooled and stored in Desiccator until needed. Weighted immediately before use for initial weight. Filtered a measured volume of well-mixed sample through the filter paper by sucking with vacuum pump. Washed with three successive 10 ml volumes of distilled water, allowed complete drainage between washings. Carefully removed the filter paper from filtration apparatus and transferred to the oven for drying. Dried for 1 hour at 103°C in the oven. Cooled in a desiccator to balance temperature and weight.

Calculation

$$TSS\ (mg/L) = \frac{(A - B) * 1000 * 1000}{Sample\ volume,\ ml}$$

Where

A = Weight of Dried residue + filter, g

B = Weight of filter, g

Determination of Chloride

A known amount of sample solution was taken in the titration flask and added 1 ml of hydrogen peroxide and stirred for one minute to avoid the interference of sulphide, sulphite or thiosulphate. The pH of the solution was adjusted to 7 — 10 with H_2SO_4 or NaOH, added about 1 ml of K2CrO4 solvent as an indicator. Then the contents were titrated with a standard AgNO3 solution to get the end point which was pink yellow.

Calculation

$$Chloride,\ mg/I = \frac{(A - B) * N * 35.5}{Sample\ volume,\ ml}$$

A = Volume of titrant used for sampling, ml

B = Volume of titrant used for blank, ml

N = Normality of silver nitrate

Reagents Required

1. Potassium chromate indicator solution

2. Standard silver nitrate titrant, 0.0141 N

3. Standard sodium chloride, 0.0141 N

4. Hydrogen peroxide, 30%

Determination of Copper

Treated 100 ml of water with 1 ml of citric acid solution, 2 ml of 10% ammonia solution and 0.5 ml of ammonium chloride solution, with a shaking fuel. Then add 10 ml of carbon tetrachloride, and shake the mixture for 5 minutes. Separated off the carbon tetrachloride layer and discarded.

Treated the aqueous phase with 1 ml of the sodium diethyldithiocarbamte solution, and shake with 30 ml of carbon tetrachloride for 5 — 30 minutes. After separation of the layers filtered the lower layer through a small dry filter into a flask having a glass stopper.

Measured in an ELKO II against distilled water treated in the same manner. The light source used was a mercury lamp with filter Hg 436, and the cells have a layer thickness of 0.5 cm and were covered. The mercury lamp switched on at least 15 minutes before beginning the measurements.

The calibration curve was prepared with the aid of a copper sulphate reference solution.

Regents

Ammonia solution 10%: 400 ml of ammonia solution minimum 25% made up to 1 liter with distilled water.

Ammonium chloride solution: 200 g of ammonium chloride dissolved in distilled water to make 1 liter.

Citric acid solution: 200 g of citric acid dissolved in distilled water to make 1 liter.

Copper Sulphate Reference Solution: It prepared by dissolving 0.393 g of copper (II) sulphate in freshly boiled and cooled distilled water to make 1 liter. This solution contains 0.1 mg of Cu^{2+}/ml.

Sodium Diethyldithiocarbamte Solution: 1g of sodium diethyldithiocarbamte dissolved in 100 ml of distilled water.

Determination of Iron

Add 0.3 ml of 3% perhydrol and 3 ml of hydrochloric acid to 100 ml of the water to be investigated, and evaporate to half the volume. After cooling to room temperature, add 2 ml of potassium thiocyanate solution, and mark up to 100 ml with distilled water.

For the comparison solution mix 50 ml of distilled water with 0.3 ml of 3% perhydrol, 3 ml of hydrochloric acid and 2 ml of potassium thiocyanate solution, and make up to 100 ml with distilled water. Measure in an ELKO II with filter S49

E, in 5 cm cells when the content is between 0.01 and 1.5 mg of Fe^{3+}/l and in 0.5 cm cells when the content is between 1 and 10 mg of Fe^{3+}/l. Calibration curve prepared with the aid of iron (III) reference solution of known content, and diluted thereof with distilled water, which have been treated as described above.

Reagents

Iron (llI) Reference Solution: 0.8634 g of ammonium iron (III) sulphate and 10 ml of hydrochloric acid dissolved in distilled water to make 1 liter. 1 ml is equivalent to 0.1 mg of iron (III) ion.

Potassium Thiocyanate Solution: 10 g of potassium thiocyanate dissolved in 100 ml of distilled water.

Perhydrol 3%: 100 ml of Perhydrol diluted with 900 ml of distilled water, as required.

Determination of Zinc:

Evaporated the amount of water corresponding to the probable content of zinc to dryness, and ignited the residue to decompose organic substances. Take up the residue in 2 - 3 ml of approximate 2 N hydrochloric acid. With warming, make the solution up to 100 ml with distilled water, boiled for a short time, and then adjust the pH 5 with sodium acetate solution. Then added the mixture quantitatively to a separating funnel, added 20 ml of masking solution and 50 ml of the dithizone working solution, and shake for 5 minutes. After separation of the layers, transferred the lower layer to second separating funnel, added 10 ml of sodium phosphate solution and 15 ml of distilled water, and shake well for ' minute. Dried the stem of the separating funnel with a small roll of filter paper, and run out a little of the lower layer to clear the stem, filled a 0.5 cm cell with the remainder of the lower layer, and measured, e.g., in an ELKO II, against a similarly treated blank of distilled water.

Reagents

Dithizone Stock Solution: 25mg of dithizone (diphenylthicarbazone) dissolved in 200 ml of Carbon tetrachloride.

Dithizone Working Solution: 50 ml of dithizone stock solution diluted with 250 ml of carbon tetrachloride.

Stock Solution: 4.399 g of Zinc sulphate dissolved in distilled water to make 1 liter. 1 ml of stock solution contains 1 mg of Zn2+.

Sodium Phosphate- Sulphide Solution: 10 g of Sodium acetate crystal GR indifferent to potassium permanganate dissolved in 90 ml distilled water.

Solution a: prepared by dissolving 60 g of di-sodium hydrogen phosphate 12-hydrate in 1000 ml of distilled water and adjusting to a pH of 11.0 with sodium hydroxide solution.

Solution b: Prepared by mixing 25 ml of 1 N sodium hydroxide solution with 75 ml of distilled water and passing in hydrogen sulphide with a pH of 8.0 is attained.

RESULTS

Characteristics of Composite Textile Wastewater under Investigation

The results of the laboratory testing of 8 wastewater samples, collected from Sapphire textile, Rai Wind road Lahore to determine various characteristics BOD, COD TSS, TDS, DO, pH, TS and heavy metals like iron, copper and zinc, are presented in tables 1 to table 8.

Table 1: Results of Sample No. 1

S. No.	Parameters	N.E.Q.S	Results	
			Before Treatment	**After Treatment**
1	Temperature	40 °C	39.32 °C	27.6 °C
2	pH value	6—10	10.04	8.12
3	BOD	80 mg/l	232 mg/l	6.2 mg/l
4	COD	150 mg/l	462 mg/l	64 mg/l
5	TDS	3500 mg/l	1980 mg/l	1702 mg/l
6	TSS	150 mg/l	62 mg/l	17 mg/l
7	Total solids	3650 mg/l	2042 mg/l	1719 mg/l
8	Chloride (CI)	1000 mg/l	735 mg/l	650 mg/l
9	Turbidity	FTU	89	20
10	Iron	2.0 mg/l	2.14 mg/l	0.64 mg/l
11	Zinc	5.0 mg/l	0.08 mg/l	0.05 mg/l
12	Copper	1.0 mg/l	0.08 mg/l	BDL
13	Dissolved Oxygen		10.5	11.6

Table 2: Results of Sample No. 2

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	After Treatment
1	Temperature	40 °C	40.10 °C	28.1 °C
2	pH value	6-10	9.33	7.65
3	BOD	80 mg/l	204 mg/l	7.1 mg/l
4	COD	150 mg/l	413 mg/l	67 mg/l
5	TDS	3500 mg/l	1870 mg/l	1622 mg/l
6	TSS	150 mg/l	55 mg/l	19 mg/l
7	Total solids	3650 mg/l	1925 mg/l	1641 mg/l
8	Chloride (CI)	1000 mg/l	736 mg/l	603 mg/l
9	Turbidity	FTU	83	20
10	Iron	2.0 mg/l	2.01 mg/l	0.65 mg/l
11	Zinc	5.0 mg/l	0.06 mg/l	0.06 mg/l
12	Copper	1.0 mg/l	0.06 mg/l	BDL
13	Dissolved Oxygen		10.9	11.7

Table 3: Results of Sample No. 3

12	Parameters	N.E.Q.S	Results	
			Before Treatment	After Treatment
1	Temperature	40 °C	38.7 °C	26.5 °C
2	pH value	6-10	9.25	7.71
3	BOD	80 mg/l	248 mg/l	10.2 mg/l
4	COD	150 mg /I	496 mg/l	10.2 mg/l
5	TDS	3500 mg/l	1955 mg/l	1684 mg/l
6	TSS	150 mg/l	66 mg/l	21 mg/l
7	Total solids	3650 mg/l	2021 mg/l	1706 mg/l
8	Chloride (CI)	1000 mg/l	697 mg/l	653 mg/l
9	Turbidity	FTU	89	22
10	Iron	2.0 mg/l	2.07 mg/l	0.71 mg/l
11	Zinc	5.0 mg/l	0.08 mg/l	0.07 mg/l
12	Copper	1.0 mg/l	0.09 mg/l	0.08 mg/l
13	Dissolved Oxygen		10.6	11.3

Table 4: Results of Sample No. 4

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	After Treatment
1	Temperature	40 °C	39.8 °C	27.4 °C
2	pH value	6-10	10.53	8.15
3	BOD	80 mg/l	219 mg/l	8.09 mg/l
4	COD	150 mg/l	438 mg/l	66.2 mg/l
5	TDS	3500 mg/l	1962 mg/l	1691 mg/l
6	TSS	150 mg/l	65 mg/l	18 mg/l
7	Total solids	3650 mg/l	2027 mg/l	1709 mg/l
8	Chloride (CI)	1000 mg/l	721 mg/l	649 mg/l
9	Turbidity	FTU	88	22
10	Iron	2.0 mg/l	2.9 mg/l	0.73 mg/l
11	Zinc	5.0 mg/l	0.08 mg/l	0.08 mg/l
12	Copper	1.0 mg/l	0.09 mg/l	0.08 mg/l
13	Dissolved Oxygen		10.2	11.1

Table 5: Results of Sample No. 5

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	**After Treatment**
1	Temperature	40 °C	41.3 °C	28.2 °C
2	pH value	6-10	9.7	7.9
3	BOD	80 mg/l	234 mg/l	7.2 mg/l
4	COD	150 mg/l	468 mg/l	68.3 mg/l
5	TDS	3500 mg/l	1976 mg/l	1680 mg/l
6	TSS	150 mg/l	60 mg/l	17 mg/l
7	Total solids	3650 mg/l	2036 mg/l	1697 mg/l
8	Chloride (CI)	1000 mg/l	730 mg/l	651 mg/l
9	Turbidity	FTU	88	21
10	Iron	2.0 mg/l	2.75 mg/l	1.23 mg/l
11	Zinc	5.0 mg/l	0.09 mg/l	0.07 mg/l
12	Copper	1.0 mg/l	0.07 mg/l	BDL
13	Dissolved Oxygen		9.8	10.4

Table 6: Results of Sample No. 6

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	**After Treatment**
1	Temperature	40°C	39.4 °C	27.1 °C
2	pH value	6-10	9.2	8.3
3	BOD	80 mg/l	239 mg/l	7.6 mg/l
4	COD	150 mg/l	478 mg/l	71.3 mg/l
5	TDS	3500 mg/l	1972 mg/l	1668 mg/l
6	TSS	150 mg/l	63 mg/l	19 mg/l
7	Total solids	3650 mg/l	2035 mg/l	1687 mg/l
8	Chloride (CI)	1000 mg/l	738 mg/l	655 mg/l
9	Turbidity	FTU	90	21
10	Iron	2.0 mg/l	2.05 mg/l	0.70 mg/l
11	Zinc	5.0 mg/l	0.08 mg/l	0.06 mg/l
12	Copper	1.0 mg/l	0.07 mg/l	BDL
13	Dissolved Oxygen		10.8	11.5

Table 7: Results of Sample No. 7

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	**After Treatment**
1	Temperature	40 °C	40.3 °C	27.8 °C
2	pH value	6-10	10.5	7.86
3	BOD	80 mg/l	227 mg/l	9.6 mg/l
4	COD	150 mg/l	451 mg/l	68.16 mg/l
5	TDS	3500 mg/l	2002 mg/l	1769 mg/l
6	TSS	150 mg/l	63 mg/l	18 mg/l
7	Total solids	3650 mg/l	2018 mg/l	1787 mg/l
8	Chloride (CI)	1000 mg/l	741 mg/l	657 mg/l
9	Turbidity	FTU	86	19
10	Iron	2.0 mg/l	2.2 mg/l	0.9 mg/l
11	Zinc	5.0 mg/l	0.09 mg/l	0.08 mg/l
12	Copper	1.0 mg/l	0.08 mg/l	BDL
13	Dissolved Oxygen		11.0	11.9

Table 8: Results of Sample No. 8

S.No.	Parameters	N.E.Q.S	Results	
			Before Treatment	**After Treatment**
1	Temperature	40 °C	39.5 °C	26.2 °C
2	pH value	6—10	9.6	8.24
3	BOD	80 mg/l	236 mg/l	9.5 mg/l
4	COD	150 mg/l	472 mg/l	69 mg/l
5	TDS	3500 mg/l	1989 mg/l	1732 mg/l
6	TSS	150 mg/l	68 mg/l	19 mg/l
7	Total solids	3650 mg/l	2057 mg/l	1751 mg/l
8	Chloride (CI)	1000 mg/l	742 mg/l	658 mg/l
9	Turbidity	FTU	91	20
10	Iron	2.0 mg/l	2.1 mg/l	0.74 mg/l
11	Zinc	5.0 mg/l	0.07 mg/l	0.05 mg/l
12	Copper	1.0 mg/l	0.08 mg/l	BDL
13	Dissolved Oxygen		10.1	11.7

DISCUSSION

Temperature of untreated effluents varied from 39.32 to 41.30 °C, the water used for processes like bleaching and dyeing is of very high temperature but during the process temperature falls. The temperature of the effluents also dropped when it moves in the long main stream towards the wastewater treatment plant. The temperature of the effluents further dropped when mixed up, stayed during the equalization process up to 26.2 to 28.2°C. This temperature range is favorable for the mesophelic bacteria.

The pH of raw wastewater varied from 9.2 to 10.53 with an average value of 9.8. These results clearly indicate that wastewater is alkaline in nature. This alkaline nature of effluents is good for the biological oxidation of wastewater, if this untreated effluent is discharged into natural streams and seeps into ground water it will serious pollution. Treated wastewater has a pH range from 7.65 to 8.3. It is evident that there is a reasonable change in pH after the treatment. The range of pH of treated wastewater is not toxic as it is before treatment.

The values of BOD5 of untreated effluent range from 204 to 248, and the COD of untreated effluent range from 413 to 496. The values of BOD and COD are very high the values decrease significantly when the effluent passes from the biological oxidation during the treatment.

The values of dissolved solids and total solids are very high both in treated and untreated wastewater, so there must be an additional method for the significant reduction of both values.

The concentration of Iron, zinc and copper in the effluent is small because of the chemical composition of the raw material used for different textile processes. It is evident from the results that

biological treatment has very little effect on the concentration of these metals. Other methods like coagulation and sedimentation can be used successfully for their removal from the effluent.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The idea of chemical studies of wastewater from textile industry helps a researcher in the evaluation of wastewater. After studying physical and chemical quality of wastewater, it can be concluded that textile wastewater containing a large number of pollutants that alter the natural environment.

The BOD5 and COD of untreated wastewater collected from Sapphire textile Lahore varied from 219 to 248 mg/l and 438 to 496 mg/l respectively. The concentration of total suspended solids, total dissolved solids and total solids are also very high. The range of pH varies from 9.20 to 10.05 indicates the alkaline nature of the effluent. The average values of above-mentioned factors in the present study are comparable with the results of research conducted on textile wastewater from the industries having similar manufacturing process. The analysis reports of treated wastewater indicate the reasonable change in the parameters like BOD from 6.2 mg/l to 10.2 mg/l, COD 64 to 71 mg/l, pH 7.65 to 8.3, turbidity 19 to 22, TDS 2025 mg/l to 2253 mg/l, TSS 17 to 21 mg/l, Iron 0.64 to 1.23 mg/l, Zinc 0.05 to 0.08 mg/I and Copper from BDL to 0.08 mg/l from 9.20 to 10.05. The present study indicates that wastewater treatment plant is useful to enhance dissolve oxygen and reduction of BOD, COD, pH, turbidity and total suspended solid but there is no reasonable change in heavy metals after treatment.

RECOMMENDATIONS

It is suggested that in order to develop cost effective pollution control strategy, industrial waste surveys, possibilities of reuse and useable byproducts, reduction in waste value, process modifications and segregation of various waste streams must be conducted.

The pollution strength of wastewater from textile industry can be reduced by material change strategy. This can be achieved by substituting the conventional chemicals like starch, enzymes with carboxy methyl cellulose, hydrogen peroxide.

Employing low liquor ratio, foam technology for dyeing and spraying technology for finishing, can reduce the use of water and chemicals in the textile manufacturing process. This will result in the reduction of wastewater quantity and strength.

The literature survey reveals that extended aeration activated sludge process, trickling filter, stabilization ponds and aerated lagoons can carry out biological treatment of textile wastewater successfully.

The aerated lagoon system is a competitive option for biological treatment with advantages of the relatively lesser extent of required operational control, lesser sludge volumes, higher shock absorption potential and production of relatively more stabilized sludge.

There must be the additional process of coagulation and sedimentation for the removal of the materials like heavy metals which cannot be removed successfully by simple biological treatment.

The reverse osmosis process can be used successfully for the significant removal of dissolved solids.

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