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ASSESSMENT STUDIES ON WASTEWATER POLLUTION BY TEXTILE DYEING AND BLEACHING INDUSTRIES AT KARUR, TAMIL NADU.

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ABSTRACT

The effluent samples from 3 different textile dyeing and bleaching industries E(1), E(2) and E(3), were characterized for their pollution potential. The concentration of total dissolved solids (TDS) were found to be 3785, 4500 and 4210 mg/L for the industries1, 2 and 3 respectively. The BOD's and COD's were 342.8 and 642.4 mg/L for E(1), 223.2 and 424.6 mg/L for E(2) and 456 and 838.4 mg/L for E(3). The pH of the effluents were 7.36, 7.8 and 7.6 for E(1), E(2) and E(3) respectively. This implies that the effluents were not in acidic region. The nitrate, nitrite and phosphate concentrations were 21, 37 and 30 mg/L, 0.5, 0.8 and 0.8 mg/L and 25, 36 and 20 mg/L fir E(1), E(2) and E(3). The levels of copper (Cu), zinc (Zn), iron (Fe), manganese (Mn), lead (Pb) and chromium (Cr) were higher than the World Health Organization (WHO) standards for effluent discharge. This shows that the textile effluents have severe pollution potentials since the parameters measured have values above the tolerable limits compared to the world health organization (WHO) standards even if the industries promise their treatment. The results also showed that the ratio of COD:BOD were 1.87, 1.90 and 1.84 for E(1), E(2) and E(3) respectively, indicating that the effluents may not be able undergo up to 50 % substrate biodegradation, thus biological processes may not be feasible for the treatment of these effluents. The high values obtained for the parameters assessed, especially those of the concentrations of the solid and of the oxygen demands, call for a pretreatment of the effluent before its discharge into water body. Also, the high conductivity observed shows that sufficient ions are present in the effluents, thus suggesting that the chemical method of coagulation and flocculation may be an ideal treatment method.

Keywords: Textile wastewater, pollution, biodegradation, coagulation, flocculation, industry.

INTRODUCTION

The degradation of the environment due to the discharge of polluting wastewater from industrial sources is a real problem in several countries. This situation is even worse in developing countries like India where little or no treatment is carried out before the discharge [1-3]. In spite of the many steps taken to maintain and improve the quality of surface and groundwater, the quantities of wastewater generated by these industries continue to increase and municipalities and industries continue to increase and municipalities and industries are confronted with an urgent need to develop safe and feasible alternative practices for wastewater management.

Some industrial wastewater contains high concentration of nitrogen which may exist in the form of ammonia, nitrate (v), nitrate (iii), nitrite and organic nitrogen[3]. It is widely acknowledged that nitrogen in wastewater has become one of the major pollutants for our water resources. Environmental legislation requires the removal of nitrogen from wastewater before being discharged. Nitrogen can pose serious public health threat when present in drinking water above certain concentrations. Nitrogen is commonly found in oxic water as trioxonitrate (v), that is NO_3^-. The nitrate (v) ion is not dangerous as such. It is reduced to highly toxic dioxonitrate (iii), that is NO_2^- by certain bacteria at suboxic conditions commonly found in the intestinal tract. Nitrate (iii) causes the disease known as methemoglobinemia in infants. Furthermore, nitrates and phosphates derived from wastewaters are main nutrients, which promote growth of plants and algae. The amounts necessary to trigger algae blooms in water bodies are not well established but concentrations as low as 0.01 mg/L for phosphorous and 0.1 mg/L for nitrate may be sufficient for eutrophication when other elements are optimal (Henry and Heinke, 1989). In addition to have a detrimental aesthetic effect on lakes (odour and appearance), some algae are toxic to cattle, spoil the taste of the water, plug filtration units and increase the requirements for chemicals in the water treatment [4-5].

The textile industries use large volumes of water in their operations and therefore discharge large volume of wastewater into the environment, most of which is untreated. The wastewater contains a variety of chemicals from the various stages of process operations which include desizing, scouring, bleaching and dyeing [4-5].

The textile industry is distinguished by the raw material used and this determines the volume of the water required for production as well as the wastewater generated. The production covers raw cotton, raw wool and synthetic materials. The industries studied in the present report are raw cotton based. In this type of production, slashing, bleaching, mercerizing and dyeing are the major sources of the wastewater generated. The main products of the industries are super print, guarantee super print and minibrocade.

The industries consist of various World Health Organisation (WHO), each of which carried out different operations and produces one type of specific wastewater[6]. The wastewater contains acid used in desizing, dyeing bases like caustic soda used in scouring and mercerization[7]. It also contains inorganic chlorine compounds and oxidants, eg., hypochlorite of sodium, hydrogen peroxide and peracetic acid for bleaching and other oxidative applications. Organic compounds are also present, eg., dyestuff, optical bleachers, finishing chemicals, starch and related synthetic polymers for sizing and thickening, surface active chemicals are used as wetting and dispersing agents and enzymes for desizing and degumming. Salts of heavy metals are also present, eg., of copper and zinc, and iron (iii) chloride used as printing ingredients. All these wastes are passed into an effluent tank and then drained into a drainage system.

EXPERIMENTAL

Textile wastewater was collected from 3 textile industries located in Karur, Tamil Nadu. Karur lies at 10°57′N 78°05′E / 10.95°N 78.08°E. It has an average elevation of 122 m (400 ft). It is about 371 km south west of Chennai (Madras), the capital of Tamil Nadu. Concerning industrial location, it is one of the developing city in Tamil Nadu and textile industries are its dominating industries. Amaravathi River, a major river in the state receives the effluents from these industries, adding to the pollution load already present in the environment and a good reason for the importance of this research. This work is aimed at characterizing the wastewater obtained from 3 textile industries in Karur to assess their pollution potentials and to recommend appropriate treatment processes for the wastewater. The wastewater flowchart of these industries in shown in Fig. 1.

Sampling of wastewater

Composite samples of the wastewater were obtained from primary sedimentation tanks of the industry. Plastic container of 1 L capacity each were used to take samples manually over 12 h sampling period with 2 h interval starting at 7.00 am and ending at 7.00 pm. This coincided with the working period in the industry and sampling was most convenient during this period. Composite samples were collected from each industry once a week for 7 weeks and analyzed. To avoid biodegradation the sample is preserved in a refrigerator at 4^0C.

Each week the weekday for the sample collection was changed to account for cyclic and intermittent variations occurring at the worksite.

Sampling Location

The located sampling area at Karur is in the following Fig. 2

Methods of sample analysis

All samples were analyzed as described in the standard methods for the examination of water and wastewater (APHA, 1995) and standard methods for water and effluents analysis[8]. The pH was determined with a pH meter, temperature was measured with a thermometer, conductivity and TDS were measured using a TDS/conductivity/salinity meter. TS and TSS were determined by a gravimetric method. DO was determined by the sodium azide modification of Winkler method, as well as the BOD after appropriate dilutions. The COD was determined by the dichromate digestion method, nitrate nitrogen by using the indophenol colorimetric method. Phosphate was determined by the use of a spectrophotometer, calcium and magnesium were determined by EDTA method and potassium by a flame photometric method, heavy metals, Cu, Zn, Fe, Mn, Pb and Cr were determined using an atomic absorption spectrophotometer (AAS). All the reagents used for the analysis were of analytical grade and obtained from BDH chemicals limited.

RESULTS AND DISCUSSION

Table 1 shows results of the detailed analyses carried out on the effluents obtained from the 3 textile processing industries E(1), E(2) and E(3). The pH values were slightly alkaline.

The effluents have high levels of solids. The total solids (TS), total suspended solids (TSS) and total dissolved solids (TDS) were 3925, 140 and 3785 for E(1), 4760, 260 and 4500 for E(2) and 4540, 330 and 4210 mg/L for E(3), respectively. The high values of solids in E(2) may be cause of other domestic activities going on at that point.

The concentration of dissolved oxygen in the effluents of E(1), E(2) and E(3) were 6.52, 4.28 and 5.10 mg/L respectively. The BOD and COD were 342.8 and 642.4 mg/L for E(1), 223.2 and 424.6 mg/L for E(2) and 456 and 838.4 mg/L for E(3). . From these results a ratio of COD:BOD was calculated, resulting in 1.87, 1.90 and 1.84 for E(1), E(2) and E(3) respectively. This indicates that these effluents are high in recalcitrant and hardly degradable compounds and may not undergo more than 50 % substrate biodegradation, as it is known that organic matter with 50-90% substrate biodegradation has a COD: BOD ratio between 2 and 3.5 (Quanto et al., 1978).

The concentrations of solids and the oxygen demand were quite high when compared to the effluent discharge standard set by Environmental Protection Agency. The water of all 3 effluents also shows a high conductivity, indicating that sufficient ions are present in the effluent. The high conductivity suggests that the effluent could be treated by physicochemical method of coagulation and flocculation (Asia and Ademoroti, 2002).

The levels of nitrogen 21, 37 and 30 for E(1), E(2) and E(3) respectively and phosphate, 25, 36 and 20 mg/L for E(1), E(2) and E(3) respectively were also higher than WHO standard.

The amount of calcium(62, 68 and 70 mg/L for E(1), E(2) and E(3) respectively) and magnesium (30, 48 and 45 mg/L for E(1), E(2) and E(3) respectively) in the effluent within the world health organization (WHO) standards of 75 and 50 mg/L for calcium and magnesium respectively.

The levels of heavy metals present in the effluent were quite high. The amount of copper (Cu), Zinc (Zn), iron (Fe), manganese (Mn), lead (Pb) and chromium (Cr) obtained for E(1) were 2.2, 8.7, 27.21, 3.80, 19 and 0.70 mg/L as against the effluent discharge standard of 1.0, 5.0, 0.3, 0.05, 0.05 and 0.05 mg/L respectively for these parameters set by WHO. The values obtained for E(2) were 4.5, 7.3, 37.0, 13.20, 1.7 and 0.5 mg/L and for E(3) the values were 3.6, 6.1, 28.0, 0.9, 1.12 and 0.24 mg/L for Cu, Zn, Fe, Mn, Pb and Cr respectively. These values are higher than the WHO standards (WHO, 1971).

Heavy metals if present even in low concentrations are toxic to living organisms, including humans as well as the microbial population present in the effluent treatment processes[9]. Furthermore, heavy metals may limit the use of the effluent for irrigation in agriculture due to its toxicity.

CONCLUSION

The results obtained from this study showed that the effluents from the textile processing industries was alkaline and had a high salt concentration[8].

The amount of nitrogen, phosphorous and heavy metals present in the effluent were significantly higher than the standards given by the world health organization (WHO)[6]. The results also showed that the values of the concentrations of solids of the oxygen demands were quite high. The results of this study indicate that biological treatment may not be feasible for these effluents and that physicochemical method may be a better alternative[9].

Based on the study, we call for treatment of all effluents generated by the textile industries in Karur before its discharge into a natural water body. These effluents can be treated by chemical methods of coagulation and flocculation.

Table-1

S. No.	Parameters	E(1)	E(2)	E(3)	WHO/CPHEEO
1.	pH	7.36	7.8	7.6	6.5 to 8.5
2.	Temp., ºC	32	28	31	NA
3.	Conductivity, (µS/cm)	7128	8975	8930	NA
4.	TS, mg/L	3925	4760	4540	2030
5.	TDS, mg/L	3785	4500	4210	2000
6.	TSS, mg/L	140	260	330	30
7.	Total Hardness, mg/L	1200	1415	1630	600
8.	Total Alkalinity, mg/L	488	560	236	600
9.	DO, mg/L	6.52	4.28	5.10	NA
10.	BOD5, mg/L	342.8	223.2	456	50
11.	COD, mg/L	642.4	424.6	838.4	NA
12.	Nitrate nitrogen, mg/L	21	37	30	10
13.	Nitrite nitrogen, mg/L	0. 5	0. 8	0.8	NA
13.	PO4, mg/L	25	36	20	5.0
14.	Ca, mg/L	62	68	70	75
15..	Mg, mg/L	30	48	45	50
16.	Na, mg/L	480	615	910	NA
17.	K, mg/L	158	15	258	NA
18.	Cu, mg/L	2.2	4.5	3.6	1.0
19.	Zn, mg/L	8.7	7.3	6.1	5.0
20.	Fe, mg/L	27.21	37.0	28.0	0.3
21.	Mn, mg/L	3.80	13.20	0.9	0.05
22.	Pb, mg/L	19	1.7	1.12	0.05
23.	Cr, mg/L	0.70	0.5	0.24	0.05

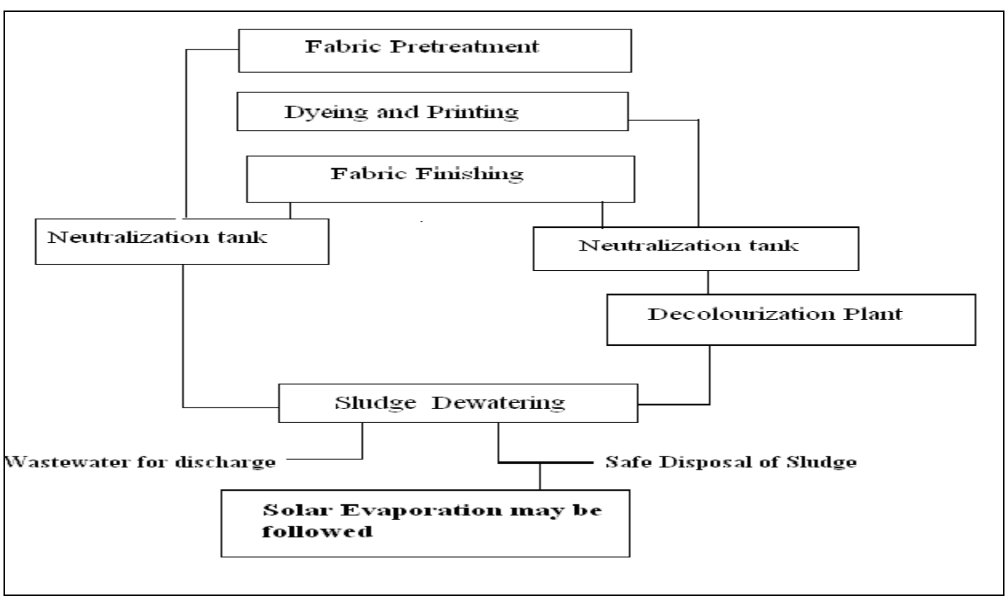

Fig.- 1: Water treatment plant at textile industries

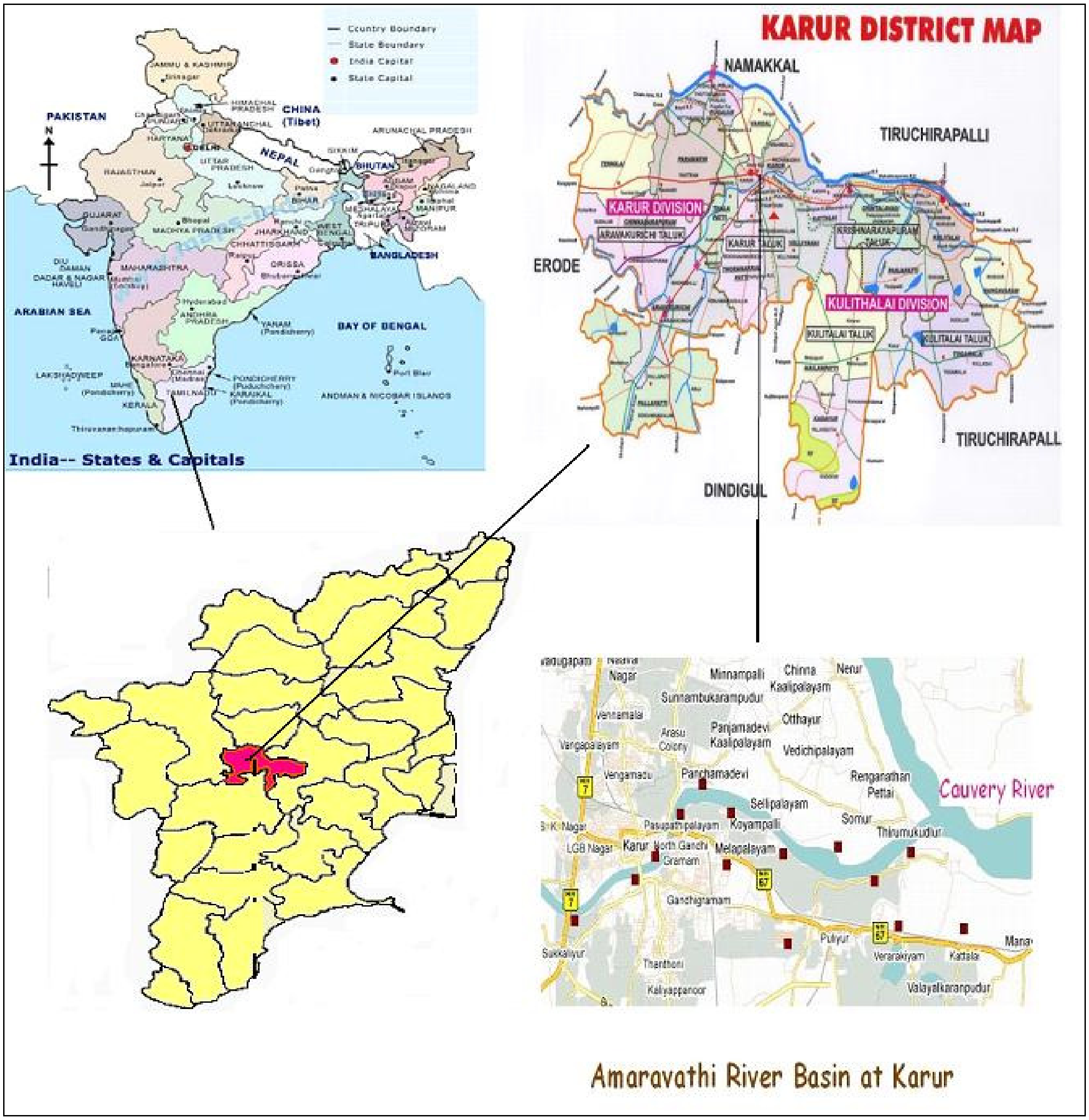

Fig.-2: Study area

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