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PHYSICO-CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF TEXTILE PROCESSING EFFLUENTS FROM KARNATAKA PROCESSORS LTD., KARNATAKA

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ABSTRACT

Physico-chemical and microbiological characteristics of textile processing effluent from Karnataka Processors Ltd. have been investigated. It has been observed that some of the waste streams are highly alkaline in nature (pH 8.7 to 10.9). Such waste streams also exhibit higher COD levels; 1300 mg/L from mercerization section and 1680 mg/L from desizing section. All the waste water streams possess higher TDS concentration ranging from 2000 to 6000 mg/L. BOD values were in the range of 135 to 900 mg/L, and alkalinity from 200 to 8000 mg/L. Highest possibilities of microbial counts on nutrient agar (NA) and potato dextrose agar (PDA) were observed in the water samples collected from general utilities. Combined waste and wastes from dyeing and desizing sections also indicate the presence of microflora on growth media. However, no microbes were observed in the waste samples from mercerizing and bleaching sections. When the study conducted on quantitative basis, it was observed that microbial count was maximum (2110×10^4 CFU/mL) in the sample plate of general utilities, which was reduced to minimum in the samples from other streams.

INTRODUCTION

The textile industry is one of the oldest and second largest industry next to agriculture providing occupation to over 20 million people. About 700 textile mills are located mainly at Ahmedabad, Mumbai, Coimbatore, Delhi, Kanpur, Ludhiana and Ichalkaranji in India.

Textile industry can be broadly classified into spinning, weaving, processing and garmenting. The spinning, weaving and garmenting are the dry processes and do not contribute to water pollution. However, it is the wet processing which contributes significantly to water pollution. The pollutants are generated mainly from processing of cloth, which consists of desizing, scouring, bleaching, mercerising, dyeing, printing and finishing operations. Such processing operation involves use of a large number of chemicals including acids, alkalies, oil, detergents, dyes, SO_2 and H_2O_2 etc. This generates pollutants, which ultimately meet the receiving water bodies reflecting in terms of pH, colour, dissolved solids, suspended solids, acidity or alkalinity, BOD, COD, phenolics, chlorides, oil and grease, sulphate, and sodium etc. Some chemicals such as dyes and detergents need extra care for proper treatment and disposal of the textile process effluent. On an average, textile mill producing 60,000 meter of fabrics per day is likely to discharge approximately 1.5 million litres per day of effluent. Out of the total water consumed in textile mills, around 38 % is used for bleaching, 16 % for dyeing, 8 % for printing, 14 % for boilers and 24 % for miscellaneous uses. This present paper describes important physico-chemical and microbial characteristics of a textile mill situated in Karnataka.

MATERIALS AND METHODS

Sample Collection

Samples were collected in grab, composite mode, preserved and transported to laboratory for various experiments as well as for analysis.

Methodology

Characterization of Textile Waste water

Physico-chemical characterisation: Grab samples collected from desizing, scouring, bleaching, mercerizing, dyeing and combined and general utilities were analysed for pH, TDS, SS, COD, BOD, alkalinity and heavy metals as per standard methods of APHA (1998).

Microbiological characteristics: Qualitative analysis of microbiological analysis of grab samples, collected under sterile conditions, was made by streaking them on nutrient agar (NA) and potato dextrose agar (PDA) to get first hand idea about the presence of microflora in the samples of various effluent streams. To quantify the microbes in the samples, serial dilution method was adopted for various samples.

RESULTS AND DISCUSSION

Table 1 describes the results of the physico-chemical analysis of various waste streams. In Table 2, results of heavy metal analysis are listed.

The physico-chemical analysis of waste effluents from different units shows distinctly different characteristics. The pH was comparatively higher in the wastes from scouring, mercerising and dyeing where it was more than 10. TDS were highest in scouring waste (8900 mg/L) with the minimum value (750 mg/L) found in utilities waste. Suspended solids were much higher in desizing and scouring wastes as compared to others. Similarly, the values of COD and BOD were also quite higher in desizing and scouring wastes. However, the values of alkalinity were comparatively more in scouring, bleaching, dyeing and combined waste streams. In general, the waste from utilities showed lower values of the parameters than others.

The wastes were also analysed for heavy metals especially cadmium, chromium, copper, iron, nickel, lead and zinc. The metals showed only minor variations in quantities in the wastes from different units, but zinc and lead were absent in desizing and scouring wastes. Iron was much more higher than other heavy metals.

Ramana & Reddy (1986) found chemical characteristics of combined wastewater, which showed pH ranging from 7 - 12, TDS 800 - 15,000 mg/L and COD 700 - 2000 mg/L. In the present investigation, it has been observed that some of the waste streams are highly alkaline (pH 8.7 to 10.9) with higher COD (1100-1700 mg/L). All the waste water streams exhibit higher TDS concentrations ranging from 2000 to 6000 mg/L, BOD values are in the range of 135 to 900 mg/L and alkalinity varies from 200 to 8000 mg/L. In a review paper, Dutta (1994) described similar ranges of pollutants from cotton textile mill effluent. Rao & Dutta (1987) have also reported similar range of these physico-chemical parameters in textile mill wastes. Correia et al. (1994) observed that the chemical pollutants, which are present in the wastewater, arise both from the raw material itself and a broad range of additives used to produce the finished clothes. They also observed that chemical composition of textile wastewater is subject to considerable change due to the diversity in the textile

Table 1: Chemical analysis results of grab samples, collected from various waste streams from Karnataka Processors Ltd.

Unit	pH	TDS mg/L	SS mg/L	COD mg/L	BOD mg/L	Alkalinity mg/L
Desizing	8.7	5590	2410	1680	900	760
Scouring	10.9	8900	2220	1200	830	7500
Bleaching	8.7	2790	210	950	226	3330
Mercerizing	10.2	2360	350	1300	425	910
Dyeing	10.1	3330	366	900	210	2100
Combined	9.8	4010	900	950	335	8021
Utilities	7.4	750	220	650	135	210

Table 2: Heavy metals analysis results (mg/L) of grab samples, collected from various waste streams from Karnataka Processors Ltd.

Unit	Cd	Cr	Cu	Fe	Ni	Pb	Zn
Desizing	0.12	0.12	0.12	4.50	0.50	-	-
Scouring	0.10	0.05	0.20	1.62	0.16	-	-
Bleaching	-	-	0.50	4.12	0.28	0.36	-
Mercerizing	0.19	0.50	0.30	3.18	0.56	0.31	0.23
Dyeing	0.18	0.20	0.49	2.60	0.40	0.21	0.42
Combined	0.10	0.41	0.48	4.20	0.42	0.32	0.31

Table 3: Qualitative estimation of microbes on various growth media.

Growth media	Samples from various units						
	Desizing	Scouring	Bleaching	Mercerizing	Dyeing	Combined	Utilities
NA	Moderate growth	Light growth	No growth	No growth	Considerable growth	Moderate growth	Heavy growth
PDA	Moderate growth	Light growth	No growth	No growth	Light	Moderate	Heavy

NA – Nturient Agar: PDA – Potato Dextrose Agar

Table 4: Quantitative estimation of microbes at various growth media, average of two sets ($\times 10^4$ CFU/mL).

Growth media	Samples from various units						
	Desizing	Scouring	Bleaching	Mercerizing	Dyeing	Combined	Utilities
NA	1100	360	-	-	91	510	2110
PDA	900	201	-	-	95	401	1500

NA–Nturient Agar; PDA–Potato Dextrose Agar

processes employed and the chemicals used within each industrial category. Parvez & Pandey (1994) found metallic ions like Cr (III and VI), Hg (II), Mn^{2+} and Ca^{2+} etc. in the textile wastewater. Heavy metals like Sb, As, Be, Cr (VI), Co, Cu, Pb, Ni, Se, Ag, Sn, V and Zn etc. were also observed by various investigators in textile mills (Dutta 1994, Correia et al. 1999). In the present investigation presence of various heavy metals in various waste streams was observed in the higher range.

Highest possibilities of microbial counts on NA and PDA were observed in the waste water samples collected from general utilities. Combined waste, and wastes from dyeing and desizing sections also indicate the presence of microflora (Table 3). However, no microbes were observed in the waste samples from mercerizing and bleaching units. When the study was conducted on quantitative basis (Table 4), it was observed that microbial count was maximum (2110×10^4 CFU/mL) in the sample plate of general utilities.

Microbiological examination of various waste streams indicates the presence of native microflora in them. Fungal count was also observed comparatively in higher range in the wastewater samples of dyeing. Microorganisms like *Pseudomonas* and *Bacillus* have shown their ability to degrade dye molecules. However, such type of degradation was microorganism-specific or dye specific, because the mechanism was directly dependent not only on the presence of azo-reductase in the microorganisms, but on the permeation of dye molecules into the cells (Yatome et al. 1991). Presence of microbial population in various waste streams indicates that the waste streams are biodegradable, and should be separated from toxic waste streams. Buitron & Capdeville (1995) found that native microflora can be acclimatized for degradation of specific types of wastewaters. The mechanism of acclimatization includes factors such as enzymatic, multiplication of specialized microorganisms, genetic exchanges, inorganic nutrient limitation and toxicity etc. In general, mixed microflora gets acclimatized with a given set of environmental conditions, which can be observed in the form of native microflora. Based on their morphological similarity, 8 different groups of microbes were found. It has further been seen that some of the microbial cultures were common in all the waste streams. It can be concluded that some of the waste streams are easily biodegradable while some others like bleaching and mercerizing can not be treated by conventional methods. Hence, these waste streams have to be separated and special treatments are to be given.

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