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Research Article

Physicochemical characteristics of industrial effluents collected from different industrial sites of India

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ABSTRACT

The need to control toxic materials from the effluents is currently increasing which may cause serious health problems like cancer and diseases. The present study was carried out to find the suitability of industrial effluents of different parts of India for irrigation purpose and to study the physicochemical characteristics. The samples of industrial discharge have been collected from various industries like pulp and paper mills from (Ballarsha, Maharashtra), paint industry (Bangalore), paper industry from (Sarapaka, Bhadrachalam), Diesel engine chemical soils (Warangal), card board (ookal). The collected effluent samples were preserved for further analysis to estimate the Physical Factors– Temperature, Colour, Turbidity, Odour; Chemical Factors – Alkalinity, pH, Total dissolved solids, Acidity; Organic Parameters – BOD, COD; and Inorganic Parameters –, Sulphates, Chlorides. In spite of using adequate treatment system, the industrial effluents were characterized by dark color, high levels of BOD, COD, TDS and significant concentration of phenols indicating significance of biological treatment system..

1. Introduction

Due to the rapid rate of industrialization, the pollution has been increasedremarkably and poses major threat to human and environment. Effluents which arereleased from the industries are proved to be the main source of water pollution.Among all pollutants, phenol is the most frequent pollutant, vast utilization of phenolin industrial activities made it major pollutant in waste water released from effluentsof plastic and fiber glass manufacturing industries, petrochemical dye, coke ovenindustries, herbicide manufacturing, paper and pulp production, and oil refineries.Different types of phenol removal methods such as chemical methods, Fenton'sreaction and hydrogen peroxide & physical methods such as treatment with ozone,ultraviolet rays have been used. These methods are found to be applicable but createcertain hazardous effects in one or other way. Various compounds released by phenoldegradation can change the odour and taste of the water that may pose major threat toanimals and aquatic life.

In recent years development of ecologically sustainable microbial technologyis more prominent research area for treatment of industrial effluents. Microbialdegradation of phenolic compounds is widely acceptable approach to overcome manyproblems. Biological methods are more preferable because it is cost-effective andpossibility to release of low quantity of by products. Selection and screening ofpotential microorganisms is a crucial step in designing of perfect and effectivebioremediation system. In nature few microorganisms can utilize phenol as theirenergy and carbon source, variety of microorganisms have been reported andcharacterized as efficient for degradation of phenol. Industrial effluents can be treatedby microorganisms by certain processes such as biosorption and enzymatic methods.

Several researchers have reported the utilization of microorganisms especiallybacteria, able to degrade the phenolic derivatives in industrial effluent for example*Acinetobacter*species (Jiang *et al.,* 2013) and *Ochrobactrum*species, *Bacillus* species(Hasan and Jabeen, 2015), *Kocuricacamiphilia*(Hamedo*et al.,* 2015),*Pseudomonas* (Ahmad *et al.,* 2014), *Alcaligenesfaecalis*(Nadalian*et al.,* 2016).In particular, different species of Bacillus genus have been identified and isolatedfrom various habitats which are prominent in degradation of phenol at various pH,temperatures by meta and ortho catechol pathways at different concentrations *Bacillusstearothermophilus*(Kim and Oriel, 1995), *Bacillus brevis* (Arutchelvanet.al.,2006, *Bacillus badius*(Sarwadeand Gawai, 2014), *Bacillus thuringiensis*(Ereqat et al., 2018). Several potentialspecies of *Bacillus* has been reported, such as *Bacillus*

cereus, because of itsomnipresent nature and high efficiency to tolerate and degrade phenol by ortho andmeta pathways the Bacillus genus is immensely interesting for the bio prospecting ofphenol degradation, especially strains recovered from phenol contaminated ecologicalsites. The present study, aimed at determination of various parameters of theindustrial effluent collected from different industrial sites. Characterization ofwastewater was performed in terms of temperature, pH, total dissolved solids (TDS),color, odour etc.

2. Materials and Methods

2.1 **Sample collection**

The samples of industrial discharge have been collected from various industries like pulp and paper mills from (Ballarsha, Maharashtra), paint industry (Bangalore), paper industry from (Sarapaka, Bhadrachalam), Diesel engine chemical soils (Warangal), card board (ookal). Water and soil samples were collected from various places in and around industries were stored in sterile bottles at 4°C. All the collected samples have been utilized within 24 hours of collection for microbiological investigation. Prior to their usage, the bottles with samples were shaken mechanically and stabilized for 10 minutes allowing the heavy particles in the mixture to settle down.

2.2 Investigation of effluent characteristics

Toanalyzethe physicochemical properties of industrial discharge, the below mentioned parameters were evaluated considerably (Chandra *et al.,* 2009).

1. Physical Factors– Temperature, Colour, Turbidity, Odour.
2. Chemical Factors – Alkalinity, pH, Total dissolved solids, Acidity.
3. Organic Parameters – BOD, COD.
4. Inorganic Parameters –, Sulphates, Chlorides

During the winter season (October-December) all the effluent samples were collected (Figure 1).The average maximum and minimum temperature of study area is about28^{o}C-24^{o}C.Soil from the top of the 5 – 10 cm layer of effluent contaminated site was collectedand the soil samples were transported to lab, air dried and kept at room temperature.The collected effluent samples were preserved for further analysis to estimate theCOD, BOD, TDS and inorganic salts.

3. Results and Discussion

3.1 **Analysis of effluent characteristics**

Some physicochemical characteristics of industrial wastewater were ascertained, where phenol tolerant bacteria were isolated. The collected samples were designated as SF1 (paper industry (Sarapaka, Bhadrachalam,) SF2 (BILT graphics paper industry, Ballarsha), SF3 (textile industry Warangal), SF4 (paint industry from Bangalore) and SF5 (Card board industry Ookal). The physico-chemical propertieswere studied by taking the untreated effluent samples. Such as pH, color, odour,turbidity, temperature and TDS, BOD, COD, sulphates and chlorides were analysed (Table 1).

The color of the effluent sample SF1was blackish brown with pungent smell,SF2 was Pale brownish, SF3 was dark brown, SF4 was appeared in brownish blackand SF5 was appeared in dark brown red with unpleasant smell. The intense darkbrown colored samples have not shown clarity in their color due to presence of ligninand its derivatives. Effluent sample consists of dark color because of presence oflignin, which may have inhibitory compounds, that inhibits growth of lowerorganisms in food chain. Due to high concentration of phenol and its derivatives fromeffluents of paper and pulp industries acquire unpleasant odour and such type ofeffluents are not easily biodegradable, similar observations were also made by Ghaly*et al.,* (2014).

Temperature is one of the crucial ecological factors to assess the effluentcharacter. Temperature plays an important role in determination of rate of metabolicreactions of microorganism, and suitability of aquatic life. An increase in temperaturealso enhances the rate of microbial activity in particular ecological site. In our study,we observed that the temperature of industrial effluents varies between 27 °C - 31°Cfor the effluent SF4 and maximum of 31°C and SF5, it was 30°C The temperaturevalues were observed as 29 ^{o}C for SF1 and SF2. Temperature of industrial effluents iscommonly high because of usage of hot water for industrial activities. Increase intemperature can change the aquatic life. The rate of microbial reactions increased dueto discharge of hot effluents. Due to anaerobic microbial reactions, solubility ofoxygen reduced and amplified odour may be released (Akan *et al.,* 2007).

pH is the negative log of H+ ion concentration. The pH determination is animportant factor in treatment of industrial effluent. Variation in pH values of effluentcan affect survival of various microorganisms and the rate of biological reactions.Either highly acidic or alkaline would kill aquatic life. Aquatic organisms are highlyinfluenced by drastic pH changes. The toxicity of heavy metals also gets enhanced atparticular pH. Thus, pH plays a major role in deciding the quality of effluents. Strongalkali such as and Ca (OH) and NaoH were released pH of effluent water may raise upto 10 and above. The pH of the individual sample was measured immediately after itscollection using pH meter. Higher pH values were recorded in SF3. The pH of SF1and SF2 are in the range of permissible limit of 6.5 to 8.5. The PH of SF1 and SF2were recorded as 7.9 and 8.4 respectively. In the cases of SF3, SF4 and SF5 the pHvalues were 11.9, 10.4 and 9.8 respectively. This is slightly above the permissiblelimit. The pH value of effluents observed indicating the alkaline range. The discharge of waste water into water bodies may cause a drop or increase in their pHvalues due to the size and activities of microbial population. Savin and Butnaru(2008) reported that the pH value of water sample under study fluctuates between 5.4to10.8. This trend of pH value shows towards alkaline. Imran (2005) reported that thepH of industrial effluent is generally towards acidic side. Thora*et al.,* (1999)reported the pH of the effluent sample as 8.4, Rao *et al.,* (1993) observed the pH ofthe textile industry effluent varied from 8.0 to 11.0 Kolhe*et al.,* (2008) recorded thepH of Sugar industry effluent as 6.5. A drastic variation in pH of effluents has beenreported to affect sustainability and survival of aquatic life and alter toxicity of otherpollutant in one or the other form.

The solids present in the effluent that passes through fine filter with a normal pore size of 2 micrometer or less are classified as dissolved solids. Waste water contains high fraction of dissolved solids. Presence of total dissolved solids in water is a measure for salinity. A large number of salts are found dissolved in industrial effluents, among those most common salts are bicarbonates, carbonates, sulphates, chlorides, nitrates of calcium, phosphates, magnesium, sodium, manganese, iron and potassium etc. Density of water generally

Figure-1. Different sites of industrial effluents from where the wastewater samples were collected.
A: card board industry (Ookal); **B**: Textile industry (Warangal); **C**: BILT graphics paper industry (Ballarsha); **D**: Paper industry (Sarapaka, Bhadrachalam,)

enhances with dissolved salts that affects, osmo regulation of organisms, reduces solubility of dissolved oxygen and affects quality of water for drinking, irrigation, and industrial applications. In the present investigation. The chemical parameters such as TDS, BOD and COD of the effluent samples were analysed. The values for these parameters are shown in (Table 1.).

These parameters are the best indicators of the toxic nature of the effluents.The TDS value was about 1403 mg/L, 2912 mg/L, 1120 mg/L, 1081 mg/L and 1302mg/L for the samples SF1, SF2 and SF3, SF4, and SF5 respectively. Hosetti and Frost (1994) reported that total dissolved solids in range 488 ppm in the waste water. Rao,*et al.,* (1993) studied textile industrial effluent and recorded the amount of dissolvedsolids value ranges from 8500 mg/L to 10,000 mg/L. BOD and COD levels werefound to be much higher than the permissible limits. BOD levels were found to benearly 8 times higher than the prescribed CPCB limits. The BOD of the sample SF1was 895 mg/L while it was observed to be 820 mg/L 564 mg/L, 788mg/L and, 652mg/L for samples SF2, SF3, SF4, and SF5 respectively. COD levels showed a 4 to 5fold increase than the permissible levels. The concentration of COD for the samplesSF1, SF2 and SF3, SF4, and SF5 was recorded as 1045 mg/L, 1206 mg/L 960 mg/L605 mg/L and 825 mg/L respectively. The maximum permissible limits for TDS,BOD and COD according to Central Pollution Control Board (CPCB) India(www.cpcb.nic.in), guidelines standards are 500, 100 and 200 mg/L respectively.

The different Inorganic salts like Chlorides, Sulphates have been observedfrom effluents of paper pulp and textile industries.

Table-1. Physico-chemical properties of untreated effluent samples

Parameters	SF1	SF2	SF3	SF4	SF5	Permissible limit(CPCB)
Colour	Blackish brown	Pale brown	Dark brown	Brownish black	Dark brownish red	----
Turbidity	Turbid	Turbid	Turbid	Turbid	Turbid	----
Odour	Unpleasant odour	-	-	-	Unpleasant odour	----
Temperature	29 ℃	29 ℃	27 ℃	31 ℃	30℃	----
pH	7.9	8.4	11.9	10.4	9.8	6.5-8.5
TDS Units(mg/L)	1403	2912	1120	1081	1302	500
BOD (mg/L)	895	820	564	788	652	100
COD(mg/L)	1045	1206	960	605	825	200
sulphate(mg/L)	1120	1205	1040	980	800	1000
chloride(mg/L)	1000	1300	600	800	900	1000

The results of the analysis of themajor inorganic constituents of the paper mill wastewater and their respectivepermissible limits are mentioned in the (Table 1) the level of chloride in the effluentshas been found to be higher than the permissible limit in SF2. The sites SF1 and SF2had higher chloride content while the site SF3, SF4, and SF5 had chloride content ofabout 600,800,900 mg/L respectively. Which is well below the permissible limit.Sulphate concentration was found to be more than the permissible levels in thesamples of SF1, SF2, SF3, while SF5 showed low sulphate concentration.

4. Conclusion

The effluents collected from these industries are in mostly in dark-colored, with alkaline pH up to 11.9, as well as high biochemical oxygen demand (BOD) ranges from 650-890 mg/L for different industrial effluents, chemical oxygen demand around 600-1200 mg/L, TDS 1100-2912 mg/L, sulphates ranges from 800-1200 mg/L, chlorides 600-900 mg/L. In spite of using adequate treatment system, the industrial effluents were characterized by dark color, high levels of BOD, COD, TDS and significant concentration of phenols indicating significance of biological treatment system.

Conflicting Interests

The authors have declared that no conflicting interests exist.

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