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Research Article

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Physicochemical Characteristics of Surface Water in Vellore District

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Abstract

An investigation was carried out to analyze Physicochemical parameters like colour, odour, pH, electrical Conductivity (EC), Total dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chromium and copper of underground water near the leather Industry. The results of the parameters analysis revealed that the drinking water was black in colour with offensive odour. pH was alkaline with high organic load such as EC, TDS, BOD and COD which were higher than the permissible since the water had high organic load, microbes (bacteria) present within the water was identified. The presence of bacteria indicates the pollution status of the untreated tannery effluent suggesting that it should be treated before its disposal using the biological method particularly native and non-native bacteria for comparing their degrading efficiency. The results of the degradation study shows that native bacteria E. coli was found to be very much successful in reduction of toxic substances at the percentage range of 54-91% whereas non-native Bacillus sp showed reduction percentage range of 56-95% and the bio-treated water can be reused for the agricultural and aqua-cultural purposes.

Keywords: Ground water; Physico-chemical parameters.

1. Introduction

Nature has given gifts like air, water, land, forest, minerals, fossil fuels and several resources to man. These gifts were given to improve his living standards. But unbridled exploitation gradually resulted in the release of pollutants into the environment, Gowd, and Govil (2008). Pollution is a major environmental issue in the world due to its adverse effect on living organism. In the past few decades, uncontrolled urbanization has caused a serious pollution problem due to the disposal of sewage and industrial effluent to water bodies, Cunningham *et al.,* (2004). Majority of industries are water based and a considerable volume of waste water emanates from them which is generally discharged into water courses either untreated or inadequately treated causing water pollution, Isbir *et al.,* (1994).

Tannery is one of the important industries causing water pollution. There are about 2161 tanneries in India excluding cottage industries, which processes 500,000 tonnes of hides and skins annually. A total annual discharge of waste water from these tanneries is 9,420,000 m3, which generates about 100,000 m3 of waste water per day (Mohan *et al.,* 2005) and these industries spread mostly across Tamil Nadu, West Bengal, Uttar Pradesh, Andhra Pradesh, Karnataka, Rajasthan and Punjab. In Tamil Nadu alone there are about 1120 tanneries concentrated in Vellore, Ranipet, Tiruchy, Dindugal, Erode and Pallavaram in Chennai. The effluent generated in the tanneries has high amounts of organic substances as well as high concentration of chloride, chromium, sulphide and ammonium salts used during the process.

2. Impact of Tannery Wastes on the Environment

The tannery industries are considered as polluting due to the inherent manufacturing processes as well as type of technology employed in the manufacture of hides and skin into leather. During the tanning process atleast 30 kg of chemicals are added per ton of hides, Srinivasa Gowd and Pradip Govil, (2008). Tannery effluent when discharged into water bodies alter the physical, chemical and biological characteristics of water and depletes the dissolved oxygen, increases alkalinity, suspended solids and sulphides which are injurious to fish and other aquatic lives

Apart from organic materials which release valuable nutrients for decomposition, tannery effluent contains chromium and pathogens mainly of faecal origin and toxic organic components, all of which pose of serious threat to the environment, Srinivasa Gowd and Pradip Govil, (2008). Heavy metals in the tannery effluent are one of the most hazardous environmental pollutants. Human beings, cattles and plants are affected when these toxic metals like Cr, Cu, Zn, Pb and Cd are incorporated into the food chain, Govil *et al.,* (2005).

3. Aims and Objectives

To analyse the physico-chemical parameters of industrial effluents as a means of monitoring the pollution

4. Materials and Methods

Ground water was collected in polythene containers from an industry located in Chennai, Tamil Nadu of India, were brought to the laboratory, and stored for further analysis. The sample was collected for a period of years (Jan 2012-dec 2014). The physico-chemical parameters of the effluent-pH, Electrical Conductivity (EC), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Hardness, Chloride, Sodium, Calcium and heavy metals were estimated by following the Standard methods, Friberg, (1986).

4.1. Statistical analysis

The data obtained from the experiments were analyzed and expressed as mean and standard deviation.

5. Results and Discussion

5.1. Analysis of physicochemical parameters of ground water

Results of the analysis of the physicochemical parameters of surface water collected for a period of 3years (Jan2012 - Dec2014) are depicted in Table 1. Statistical analysis was also carried out. "The results of the study revealed that colour of the surface water were blackish with unpleasant odour. This colour and odour could be due to decomposition of organic and inorganic matter, Shaban El-Taweel, (2002). A large number of pollutants can impart colour, taste and odour to the receiving water, thereby making them unaesthetic and unfit for domestic consumption, Cunningham *et al.,* (2004): WHO/UNEP, (1989).

Table-1: Analysis of physicochemical parameters of ground water

Physico – chemical examinations	BIS (IS 10500: 1991)	Unit	Concentration	Values as (Mean±SD)
pH	6.5 - 8.5	-	6.85 to 8.55	7.725±0.588
EC	1500-3000	µmho/cm	2850[1] to 4850	3618.67±556.839
TDS	500 - 2000	mg/l	3950 to 8750	6198.47±1411.59
TH	300 - 600	mg/l	1750 to 3270	2518.6±499.484
BOD	250	mg/l	180 to 305	208.47±45.39
COD	250	mg/l	240 to 350	292±45.18
Cl	250 - 1000	mg/l	620 to 992	857.6±108.98
Cr	0.05	mg/l	0.40 to 1.250	0.915±0.251
Zn	15-May	mg/l	6.15 to 12.58	9.626±1.835
cu	0.05 - 1.5	mg/l	3.35to 7.94	5.415±1.187

5.2. Hydrogen Ion Concentration (pH)

The pH value of the water indicates whether the water is acidic or alkaline. The permissible limit of pH in drinking water should be within 6.5-8.5 according to Bureau of Indian Standard (BIS). We observed that the pH value of water samples in the study area was within the safe limit ranging from 6.85 to 8.55 characterized by slightly acidic to slightly alkaline nature

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The pH was also expressed as mean± SD (7.725±0.588) during the period (Jan2012 - Dec2014) of study, According to Shaban El-Taweel, (2002) highly alkaline water if consumed would affect the mucous membrane and may cause metabolic alkalosis. In addition, the toxicity of certain substances present in water may be enhanced due to their interaction with high or low levels of pH prevailing which may further be detrimental to aquatic organisms, Aggett, (1985) ; Swapnil, *et al.,* (2006)

5.3. Electrical Conductivity (EC)

Electrical conductivity is a measure of water capacity to conduct electric current. It is used to estimate the amount of dissolved solids. It increases as the amount of dissolved mineral (ions) increases. The most desirable limit of EC in drinking water was predicated as 1500µScm^{-1} and permissible limit 3000µScm^{-1}.

We observed that the EC value of water samples in the study area exceeds the safe limit ranging from 2850µScm^{-1} to 4850µScm^{-1} Higher EC value found in the sample collected from the trunk road indicates the enrichment of salts in the groundwater. Electrical conductivity of the water was 3618.67µmhos/cm ± 556.839. Surface water showed higher level of Electrical conductivity which could reflect the presence of organic and inorganic substances and salts that would have increased the conductivity, Yu *et al.,* (2004); Srinivasa Gowd and Pradip Govil, (2008).

5.4 Total Dissolved Solids (TDS)

Total dissolved solids (TDS) generally reflect the amount of the mineral content that dissolved in the water and this controls it's suitability for use. Higher concentration of total dissolved solids may cause adverse taste effects. The most desirable limit of TDS in drinking water is predicated as 500 mg/L and permissible limit 1500 mg/L.

In the study area we observed that the TDS value of water samples in the study area exceeds the safe limit ranging from 3950mg/L to 8750mg/L Generally, higher TDS decrease palatability and cause gastrointestinal irritation in the human beings. It has also laxative effect, especially upon transit. High concentration of TDS in groundwater sample is due to leaching of salts from tannery waste disposal may percolate into the groundwater, which may cause a huge increase in dissolved solids

The composition of solids present in a natural body of water depends on the nature of the area and the presence of industries nearby. High levels of TDS may be due to high salt content and also renders it unsuitable for irrigation; hence further treatment or dilution would be required Shaban El-Taweel, (2002); Aggett, (1985) cautioned that if the TDS level of water exceeded 500 mg/l, it becomes unsuitable for bathing and drinking purposes for animals as it could cause distress in cattle and livestock.

5.5. BOD

The value of BOD was 208.47±45.39 which was beyond the permissible limit (30 mg/l) of CPCB, APHA, (2002). Increase in BOD which is a reflection of microbial oxygen demand leads to depletion of DO which may cause hypoxia conditions with consequent adverse effects on aquatic biota. Oxygen depletion could be followed by anaerobic conditions which would result in reduced diversity and distribution of aquatic fauna. Further the presence of organic matter will promote anaerobic action leading to the accumulation of toxic compounds in water bodies. Oxygen depletion could be followed by anaerobic conditions which would result in reduced diversity and distribution of aquatic fauna.

5.6. COD

COD was 292±45.18 which has exceeded the permissible limit (250 mg/l) of CPCB, APHA, (2002). COD test is the best method for organic matter estimation and rapid test for the determination of total oxygen demand by organic matter present in the sample. The present investigation revealed high levels of COD. This indicates that the effluent is unsuitable for the existence of aquatic organisms due to the reduction in DO content Aggett, (1985).

5.7. Total Hardness (TH)

Hardness is an important criterion in determining the suitability of the water samples for domestic and industrials purpose as it is involved in making the water hard. The most desirable limit of TH in drinking water is predicated as 300mg/L and permissible limit as 600mg/L.

In the study area we observed that TH values in ground water ranged from 1750mg/L to 3270mg/L respectively. The sample collected at Conamedu village shows the highest TH values which shows that water is not safe for drinking purpose. The hardness of the water is due to the presence of alkaline earths such as calcium and magnesium. The classification of the groundwater samples based on hardness revealed that most of the sample belongs to hard to very hard category. High levels of hardness may affect water supply system, excessive soap consumption and calcification of arteries and cause urinary concentrations, disease of kidney of bladder and stomach disorders. Total Hardness has a value of 2518.6±499.484 which was beyond the CPCB, APHA, (2002) permissible limit of 1000 mg/l.

5.8. Chloride (Cl)

The origin of Cl in groundwater may be from anthropogenic sources such are industrial waste discharges, municipal effluents, domestic waste discharges, weathering, leaching of soil and rocks, etc. The most desirable limit of Chloride in drinking water is predicated as 250mg/L and permissible limit 1000mg/L. In the study area we observed that concentration of chloride in ground water ranged from 620mg/L to 992mg/L**.** We observed that, all the samples in the study area are below the maximum permissible limits. Chloride ranged at1857.6±108.98which surpassed the permissible limit (1000 mg/l) of CPCB, APHA, (2002) With regard to the heavy metals evaluation.

5.9. Chromium

We observed that the chromium concentration in that study area ranged from 0.40mg/L to 1.250mg/L. The permissible limit of chromium in drinking water is 0.05mg/L according to bureau of Indian Standard (BIS). But the chromium concentration in ground water varied greatly in different sampling sites of study areas. We found that chromium ion concentration was higher in Conamedu village**.** In the groundwater, chromium concentration varies with the type of rock that the water flows through but do not usually exceed 3mg/L, presence of large amounts of chromium is associated with skin allergy and skin related problems, Chromium ranged 0.915±0.251.

5.10. Copper

We observed that the copper concentration in the study area ranges from 3.35mg/L to 7.94mg/L. The permissible limit of copper is 1.5mg/l. Copper generally occurs in trace quantities in surface water but may attain high levels in some ground waters. We found that copper ion concentration was higher in Kachiarpet village. It can be toxic to certain aquatic organism even at concentration of 4mg/l**.** Copper has a value of 5.415±1.187

5.11. Zinc

We observed that the Zinc concentration in the study area ranged from 6.15mg/L to 12.58mg/L, The permissible limit of zinc in drinking water is 5 -15mg/L according to bureau of Indian Standard (BIS). Zinc generally occurs in trace quantities in water but may attain high levels in some ground waters. It was observed that, all the samples in the study area were below the maximum permissible limits**.** Whereas zinc ranged 9.626±1.835

6. Conclusion

The presence of heavy metals in the surface water produces several adverse effects on living organisms physicochemical parameters analysis of surface water for a period of 3years (Jan2012-Dec2014) confirms that the parameters surpassed the permissible limits of CPCB, APHA, (2002) for its disposal, indicating high pollution potential of the effluent.

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