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Physico-Chemical characteristics of Wastewater from Dye industries of Surat, Gujarat, India

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Abstract

Alterations in the physical, chemical, biological characteristics of air, water and soil that are undesirable present a significant risk to human safety on a global scale. Owing to growing human population, industrialization and human activity, water is heavily contaminated with various dangerous substances. Dye manufacturing industries represent a significant environmental pollution challenge globally due to their discharge of undesirable dye effluents. This study examines the physico- chemical properties of various industrial effluents gathered from different facilities in and around Surat. The report emphasizes the necessity of proper treatment of industrial estate influents to mitigate land and water pollution. The pharmaceutical, chemical, dye and textile industries are significant contributors to the pollution of the surrounding aquatic environment. Analysis of effluent samples obtained from dye industries revealed elevated levels of Total Dissolve solid (TDS), Chemical Oxygen Demand (COD), Biochemical oxygen Demand (BOD), Chloride concentrations. In addition, various other parameters were assessed for wastewater samples, including pH, Temperature, Total Suspended Solids (TSS). The results of the present analysis underscore the importance of adopting innovative and enhanced wastewater treatment methods along with a range of supportive policies and objectives.

Keywords: Physico-Chemical, Parameter, Wastewater, Treatment, Zone, Pollution, Dye Industry Effluent.

Introduction

Water is one of the most essential and ubiquitous components of the environment. Water is vital for the survival and development of all forms of life on the planet. Currently, only Earth is a planet with almost 70% water. However, because of human activity, industrialization, an increase in the human population, the environment is severely contaminated with various dangerous substances. Large volumes of industrial wastewater were dumped into rivers, lakes and coastal areas over the past century[1]. The nation's fast industrialization has resulted in a massive rise in the amount of industrial waste polluting the environment[2]. The human population is vulnerable to numerous water-borne diseases due to the consumption of contaminated drinking water; therefore, it is essential to conduct regular assessments of water quality[3]. Water pollution has become one of the most pressing environment issues globally[4].

In the modern world, effluent from the dyeing industry has become a difficult problem. Since dyes have numerous uses, it was anticipated that manufacturing would increase yearly. Due to the many uses for dyes, annual growth in output was anticipated[5]. China and India are currently the top and second-largest producers and exporters, respectively. Researchers indicate that over 100,00 commercially available dyes are identified annually[6]. The resulting dyes employed in the manufacturing of carpet, textile, food, paper, pharmaceuticals, and leather. Factory wastewater is responsible for human mutation, allergic dermatitis, skin irritation and environment pollution[7]. Various types of dyes can be classified, including direct dyes, reactive dyes, vat dyes, disperse dyes and azo dyes[8]. Most of the industry that dispersal of dyes, because these dyes are present in water bodies, aquatic life will soon be in risk as well[9].

Many researchers have stated various strategies are now being used to extract dye from wastewater. The advancement of new treatment techniques and environmental management strategies has also benefited from this development[10]. Ion exchange[11], oxidation, biodegradation[12], solvent extraction[13] and membrane processes are a few examples[11]. Ion exchange has a cost disadvantage, whereas the membrane method has a low flow rate. A Significant quantity of untreated dye wastewater is discharged into surface waters via drainage systems, which subsequently infiltrates ground water and nearby water bodies. Industrial effluents include heavy metal ions, aniline, caustic soda, bleaching powder, and colors. Although the majority of heavy metals are necessary for organism growth, they are only needed in small amounts[14].

Untreated or inadequately treated dye textile effluent poses significant risks to both aquatic and terrestrial organisms, negatively impacting the nature ecosystem and potentially leading to long-term health consequences. This study aimed to investigate the Physico-Chemical parameters of wastewater in Surat, Gujarat.

Materials and Methods

Study Area: Surat is the southernmost district located in the state of Gujarat. Due to town's advantageous location, GIDC founded numerous industries there. The Sachin industrial area ranks as the second-largest industrial colony in Asia by land area.

Sample Collection and Analysis: Samples are gathered in high quality poly lab bottles. Three times before sampling, the bottle is cleansed with a water sample, and then it is filled to the brim and securely sealed. To avoid contamination, samples are collected directly from rinsed bottles and transported to the laboratory without the inclusion of any preservatives. To prepare solutions for analysis, only double distilled water and purity chemicals were utilized. Every sample bottle has an appropriately labelled date of origin on it. Water samples must be shielded against degradation and compositional changes brought on by diverse interactions. The amount of time between sample collection and analysis should be shortened. Within a day, various parameters are studied after the temperature is recorded in the field.

Wastewater effluents were gathered from five representative dyeing units located in the Sachin Industrial Estate of Surat, designated Zone-1, Zone -2, Zone -3, Zone -4, Zone -5.

The samples were gathered and examined for the parameters listed in Table-1. The procedures and methodologies employed for collection, preservation, analysis and interpretation adhere to the guidelines established by APHA[16].

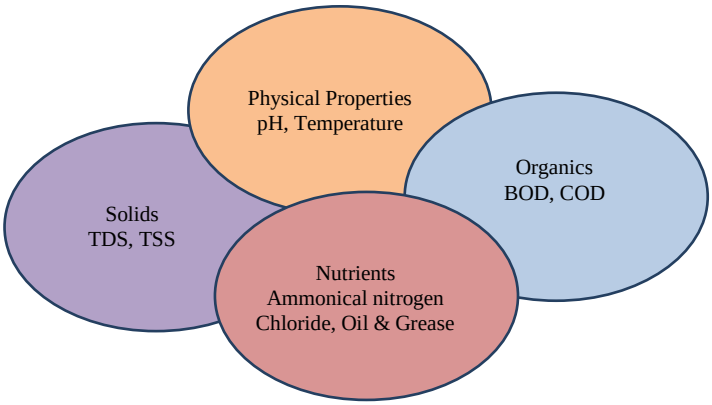

Figure-1: List of Parameter.

Results and Discussion

The data obtained through experimental measurements regarding the Physico-Chemical properties of industrial wastewater effluents discharged from dyeing industries in the Surat region.

pH: The pH values were observed to range from 6.0 to 8.50, reflecting a transition from slightly acidic to slightly basic conditions. This variation suggests the presence of both acidic and basic dyes. Furthermore, the pH of the effluents was determined to be within the permissible limit (5.5 – 9.0).

Temperature: The temperature of the water significantly influences the physiological functions and life processes of the majority of aquatic organisms. The temperature range in the current investigation was between 28 and 38^{0}C.

Table-1: Dye industries result.

Parameter	Unit	Zone-1	Zone-2	Zone-3	Zone-4	Zone-5
pH	-	8.41	7.94	7.56	6.23	8.30
Temperature	°C	34	30	32	32	38
Total Suspended Solids (TSS)	mg/L	286	521	328	407	293
Total Dissolved Solids (TDS)	mg/L	2860	4590	2267	3674	1512
Biochemical Oxygen Demand (BOD)	mg/L	243	226	362	297	418
Chemical Oxygen Demand (COD)	mg/L	2860	3580	920	2120	1560
Chloride	mg/L	862	791	648	636	742
Ammoniacal Nitrogen	mg/L	72	40	61	52	67
Oil & Grease	mg/L	2.4	4.0	2.6	1.3	3.2

Total Suspended Solids (TSS) and Total Dissolved Solids (TDS): In the current investigation, the TSS were observed to range from 250 to 550mg/L, while the TDS values varied between 2200- 4600mg/L, both of which significantly exceed the limits established by the World Health Organization (WHO).

Biochemical Oxygen Demand (BOD): Biochemical Oxygen Demand (BOD) refers to the quantity of oxygen consumed by microorganisms in the decomposition of dissolved organism substances in water over a five-day aerobic process. An increase in BOD levels may result from significant discharges of industrial wastewater, which often contains high concentration of organic materials. The allowable BOD levels are typically set between 100 to 300mg/L, while the analysis of wastewater from the dye industry indicates a BOD of 200-420(mg/L).

Chemical Oxygen Demand (COD): Chemical Oxygen Demand (COD) quantifies the oxygen necessary for the chemical oxidation of organic substances. The recorded COD value was 900-3600 (mg/L). Typically, the organic strength of effluent is assessed through COD measurements. Elevated COD levels may result from significant contributions of industrial waste, including detergents, softeners, non-biodegradable dyeing agents and formaldehyde- based dye fixing substances.

Chloride: Chloride typically exists in low concentrations. Elevated levels of Chloride can result in an unpleasant taste in drinking water. The concentration of Chloride in the effluents was measured at 630- 870 mg/l.

Ammoniacal Nitrogen: Ammoniacal Nitrogen was measured from 40-72mg/l respectively.

Oil & Grease: Oil & Grease was measured from 1 - 4mg/l respectively.

Conclusion

The wastewater parameters of the regions in Surat that are in close proximity to the industries have been examined. This study has shown that Dye industries in Sachin GIDC, (Surat) discharges effluent with high Total dissolve solid, high COD, BOD, Chloride, values which are not in compliance with standards. It can be concluded from this analysis that an effective environmental management plan should be implemented to regulate the discharge of effluent. It is essential to implement all necessary precautions prior to utilizing the water for irrigation and consumption. Failing to do so could result in severe health consequences.

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