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Physico-Chemical Parameter Evaluation of Agra and the nearby Area Industrial Wastewater

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ABSTRACT

Industrial wastewaters entering a water body represent a heavy source of environmental pollution. It affects both the water quality as well as the microbial and aquatic flora. With competing demands on limited water resources, awareness of the issues involved in water pollution, has led to considerable public debate about the environmental effects of industrial effluents discharged into aquatic environments. The main objective of the present work is to provide a clear insight into receiving inland surface water quality in Agra, Uttar Pradesh, India. In this study, effluents from four different industrial units have been analyzed for various physicochemical features. The colour, odor, pH, electrical conductivity (EC), total dissolved solids (TDS), Biochemical oxygen demand (BOD), chemical oxygen demand (COD), were determined using standard analytical procedures. Organic pollution is always evident and the pollution is made worse by land-based sources such as the discharge of industrial effluents. Waste effluents rich in decomposable organic matter, is the primary cause of organic pollution. Wastewaters from Textile dyeing industry, Car wash industry, the world famous Petha industry and Mathura refinery were collected and the cases chosen are believed to give a broad outline of industrial wastes as well as disposal problems.

Graphical Abstract:

Map of Agra.

Keywords: Industrial effluents, Physico-chemical, pH, COD, DO.

INTRODUCTION

Freshwater shortages and declining water quality are now major global issues as freshwater resources are degraded more quickly each day [1]. One of the biggest problems facing emerging and highly populated nations is the pollution of natural water bodies by industrial waste [2]. The principal method for disposing of waste materials, particularly the effluents from nearby enterprises, is through river systems. The industrial effluents have a significant impact on water body pollution because they can change the receiving water body's physical, chemical, and biological characteristics [3].

The primary source of direct and frequently ongoing pollution input into aquatic ecosystems is industrial effluents. These discharges have long-term effects on ecosystem functioning, such as altered food availability and a serious risk to the biosphere's ability to self-regulate. Pesticides, dioxins, petrochemicals, microbes, polychlorinated biphenyls (PCBs), poly-aromatic hydrocarbons (PAHs), and phenolic compounds are some of the industrial wastes and discharges [4].

According to the 2011 census, Agra, the most populated district in Uttar Pradesh. Agra district is the eighth most urbanized district in Uttar Pradesh, out of all the districts. The main contributors to the water contamination include improperly disposed of industrial waste as well as the usage of chemicals.

The quality of the surface water is impacted by the numerous small-scale industries that surround Agra City and nearby areas industries dump their effluents into the Yamuna River [5]. Increased industrial activities have led to pollution stress on surface waters [6]. Central Pollution Control Board (CPCB) reported that 70% pollution in river is from untreated industrial and sewage sources and 30% is from agricultural waste and garbage. Hence placed the quality of Yamuna River water under category "E" (CPCB, 1986) [7].

High levels of pollutants cause an increase in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS) [8, 9]. Polluted water has detrimental effects due to its toxic properties or the various pollutants that diminish the levels of oxygen of the water [10].

Monitoring and evaluating water quality are essential for accurately diagnosing problems withwater pollution and developing successful prevention and mitigation plans. Water quality is a general term used to describe the characteristics (physical, chemical, and biological) of water resources. It plays an important role in determining aquatic ecosystems and public health [11, 12].

In this study, surface water parameters at different industrial sites in Agra and nearby area are measured for their physical and chemical characteristics. This study's goal is to evaluate the current state of the water supply by analyzing a few key water quality indicators, including pH, COD, BOD, and TDS, and comparing the results to global norms.

MATERIALS AND METHODS

Study area: The study area chosen for assessing the industrial wastewater quality is Agra and Mathura. Agra is situated on the bank of Yamuna River. The Agra district is located in western U.P., between 27.11’-degree Latitude North and 78.0' degree to 78.2’-degree Longitude East. Its Altitude is 169 meters above sea level. It is bordered by the districts of Mathura, Dhaulpur, Firozabad, and Bharatpur on its borders to the north, south, east, and west, respectively.

Figure 1. Map of Agra.

Sample Collection: Water Samples from the four selected industries namely Textile dyeing industry (Site 1), Car wash industry (Site 2), the world famous Petha industry (Site 3)and Mathura refinery (Site 4)were collected and Samples were analyzed immediately for parameters, which need to be determined instantly.

Physico-Chemical Analysis: After sampling, the analysis was started immediately in the laboratory. The standard methods recommended by APHA (2005).The collected samples were analysed for major physical and chemical water quality parameter like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO) Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD). pH of the effluent samples was determined by the pH meter. The COD test and BOD were analysed by Winkler's method in 300mL BOD bottles. To determine the correlation between two investigated parameters, a linear correlation analysis was performed.

RESULTS AND DISCUSSION

The management of the water sources affects how well the resources are being handled. Along with the local environment's natural physicochemical characteristics, this would also contain human-caused discharge [5]. Surface water quality is influenced by a multitude of factors, including various physical and chemical properties, pollutant kinds, sources, and nearby human activities. The primary objective of this research is to evaluate the water quality of surface water bodies of different industries [13]. Table 1and 2 represents the detailed descriptive analysis and correlation matrix of the water quality parameters at each sampling site, respectively.

Table 1. Results of the physicochemical parameters for all the sampling locations

Site	pH	TDS	COD	BOD	DO	Turbidity	Conductivity
Site 1	8.4	2246.3	760.2	321.7	2.4	160	1137
Site 2	9.2	1792.1	810.2	240.8	2.7	100	1105
Site 3	9.8	1756.7	815.1	240.8	3.9	125	1245
Site 4	6.9	2546.5	840.5	305.2	1.7	195	1526

Table 2. Correlation matrix among water quality parameter

Parameter	pH	TDS	COD	BOD	DO	Turbidity	Conductivity
pH	1						
TDS	-0.96954	1					
COD	-0.28448	0.112744	1				
BOD	-0.76274	0.882577	-0.36336	1			
DO	0.925016	-0.86438	-0.10581	-0.72694	1		
Turbidity	-0.89083	0.958518	0.159696	0.839611	-0.68805	1	
Conductivity	-0.74798	0.702716	0.727316	0.334462	-0.47001	0.787102	1

pH: pH is a scale that quantifies the concentration of hydrogen ions in water and indicates how acidic or alkaline it is. [14]. The pH of the collected effluent sample from selected sites was analyzed and found in the range between 6.9 and 9.8, respectively (Figure 2), against the standard of WHO and BIS i.e., 6.5–8.5.

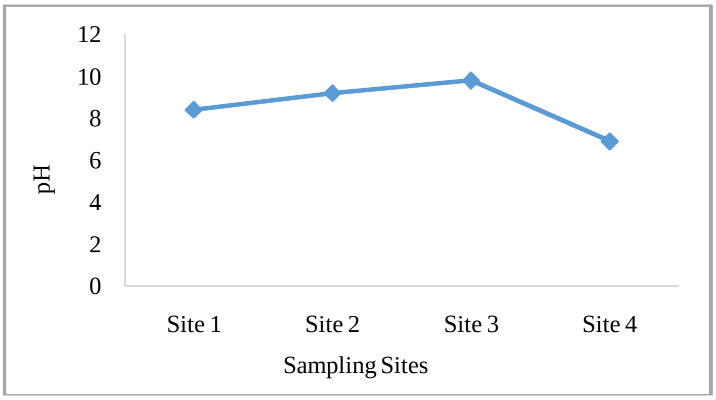

Figure. 2. Graph showing pH levels of the four sampling sites

Total Dissolved Solids: In the present investigation, the value of total dissolved solids (TDS) was recorded in the range between 1756.7 to 2546 mg L^{-1} (Figure 3). Excessive levels of TDS make water unfit for human consumption by affecting its hardness, taste, and corrosion-proneness [15]. Water quality can be effectively determined by monitoring TDS both spatially and temporally, as per a study conducted by [16]. Water discharged with a high TDS level would harm aquatic life, make the receiving water unsafe for human consumption, decrease harvest rates if it were used for irrigation, and worsen water system corrosion [17].

Figure. 3. Graph showing TDS values of the four sampling sites.

Biological Oxygen Demand: BOD indicates the presence of organic impurities in the effluent. The values for BOD of the effluent are more than the permissible limits set by WHO. In the present study, the value for BOD was observed 285.5 mg L^{-1} to 321.7 mg L^{-1} (Figure 4). When organic matter, such food particles or sewage, is broken down by microbes, the amount of dissolved oxygen that is consumed by them is measured as the biochemical oxygen demand [18]. The amount of oxygen required to decompose organic compounds increases with high BOD levels. Water's dissolved oxygen content may drop as a result of the breakdown of organic molecules, potentially leading to oxygen deprivation [19].

Figure. 4. Graph of the BOD values of against sampling location

Chemical Oxygen Demand: High COD values in the current study surpass the allowed limit of Indian Standards (250 mg L^{-1}) for waste waters from sample sites, indicating the presence of both inorganic matter and chemically oxidizable organic matter. [20].The WHO has set the limit of 250 mg/L for COD. Our study reveals, for industrial wastewater COD value is greater than of permissible limit. The value for COD was observed between the range of 760.23 mg L^{-1} to 840.16 mg L^{-1} (Figure 5).One crucial measure of the quality of water is COD. It calculates how much oxygen is required to oxidize organic waste that is soluble and particulate in water. [21].

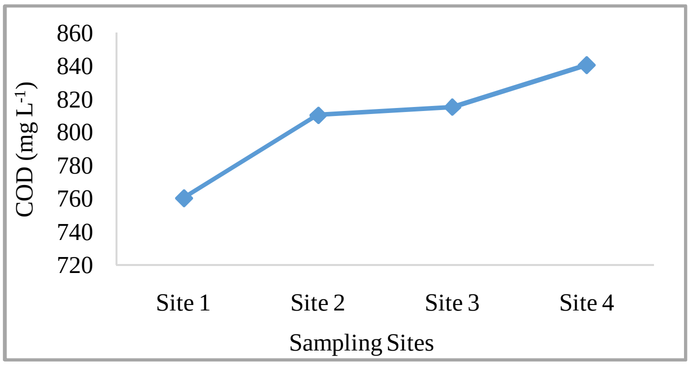

Figure 5. Graph showing COD values of the four sampling sites.

Dissolved Oxygen: Industrial site average DO is 1.7 to 3.9 mg L^{-1} (Figure 6). Dissolved oxygen levels are found to be very low and hence a lot of oxygen has been used up. It reveals how the amount of biological matter has increased. A sign that water can sustain biological life is the existence of free oxygen in the water. A raised water temperature and increased microbial activity, which uses a lot of oxygen for metabolic processes and the breakdown of organic matter, could be the cause of a low DO value. [22].

Figure. 6. Graph showing DO levels against sampling sites.

Turbidity: The turbidity in water is mainly caused by sand, silt, clay, phytoplankton, microorganism or organic material suspended or dissolver in it [23]. The turbidity content of water samples varied from 145 NTU to 200 NTU (Figure 7).

Figure. 7. Graph showing Turbidity values.

Electrical conductivity: The existence of ions, their total concentration, mobility, and temperature all affect a solution's ability to conduct an electric current, which is measured by the electrical conductivity of water. This practical indicator measures the overall salt content or salinity of waste water. [24]. Present study, the value for EC was observed 1105 to 1526 µS cm^{-1} (Figure 8). All industrial wastewater very higher value of EC compares to limit set by Indian Standards.

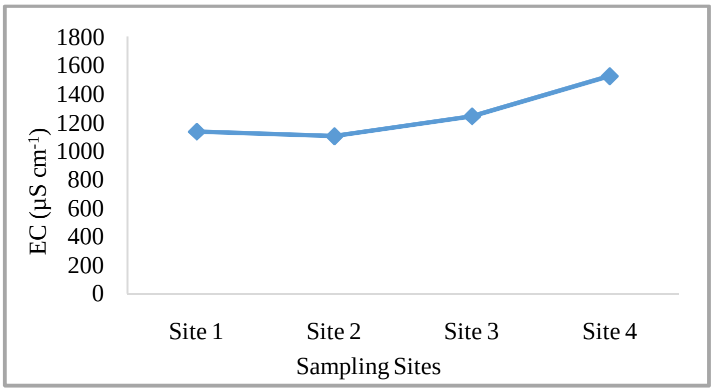

Figure. 8. Graph showing EC concentration for sampling sites.

APPLICATION

The research on the impact of industrial effluent pollution on surface waters presented above shows how important it is to regulate this kind of pollution in developing nations, and the best way to do so is by preventing or reducing it at its source. Recovering raw materials, reducing wastewater emissions, and lowering treatment costs are all achieved by such actions. To lessen or completely eradicate the negative impacts of industrial effluents in receiving waters, additional administrative and technical measures are required. Authorities can regulate this by imposing norms.

CONCLUSION

In order to ascertain the impact of the industries on water pollution, the effluents from four distinct industries in Agra and Mathura, U.P., India, were gathered and analyzed. Industrial effluent's water quality metrics, such as BOD, COD, and DO were discovered to be significantly higher than the

WHO-mandated maximum allowable limit. The findings of this study unequivocally demonstrate that the local surface water bodies in Agra, India are being contaminated by the industrial water. Therefore, it is crucial to adequately treat industrial effluent that enters rivers and stop other waste sources from lowering the quality of the water. Because of their operational practices that contaminate water resources, this report suggests that certain industries in Agra and nearby area be managed. This study might offer helpful references for safeguarding water bodies. Since enough water quality variables are included in the study to accurately reflect the quality of incoming surface water, the technique adopted in this work ensures that the research is completely objective. In order to increase the accuracy of the results, future research may take into account all other factors that contribute to pollution that the industries provide to the water bodies.

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