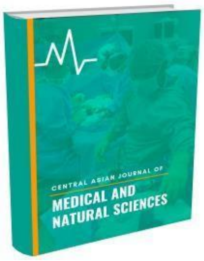

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Article

Assessment of Physical and Chemical Properties in Northern Refineries' Water

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Abstract: This study investigates the physical and chemical characteristics of industrial wastewater from the Northern Refineries Company over a six-month period, aiming to inform the design of appropriate treatment units. Semi-monthly samples were collected from January to July 2023, revealing temperatures ranging from 19 to 38 degrees Celsius, turbidity from 4.1 to 31.2 NTU, and electrical conductivity from 623 to 1517 µS/cm. Total dissolved solids varied between 450 and 980 mg/L, pH ranged from 6.8 to 7.7, and dissolved oxygen levels were notably high, between 1.4 and 7 mg/L. Chloride ion levels 16-19.3 mg/L mostly fell below permissible limits, as did sulfate ions. Phosphate concentrations ranged from 0.01 to 0.14 mg/L, while oil residues fluctuated between 0.54 and 124 mg/L. This research highlights the need for tailored wastewater treatment strategies to address specific contaminants and optimize environmental protection efforts in industrial settings.

Keywords: Water temperature, Turbidity, Total Dissolved Solids (TDS), pH Measurement, Phosphate

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1. Introduction

Due to the growing harm that humans are causing to the environment as a result of technological advancement, the industrial development that goes hand in hand with it, and the changes that these factors have caused in the natural world, humanity is currently going through a difficult period in its history [1]. Large bodies of water and solid pollutants, most of which come from domestic, industrial, and agricultural activities, are a result of the environment—especially the aquatic environment—being irregularly exploited due to a variety of physical, chemical, and biological factors. These eventually cause the natural resources and aquatic life that peacefully coexist in the environment to decline [2, 3]. Crude oil refining wastewater can contaminate aquatic and terrestrial ecosystems, resulting in physical, chemical, and biological changes not seen in unpolluted environments [4]. This is a significant environmental problem. Rivers are contaminated by hydrocarbon compounds, acids, alkalis, dyes, toxic salts, fats, and mining, oil, and chemical industries' discharge of industrial waste [5]. The residuesxand pollutants left by this water are believed to be the cause of manyxenvironmental and healthxproblems due to their effects on plants and animals. They also affect humans by causing a range of water-borne illnesses, such as allergies, cancer, lung diseases, and skin disorders. ailments [6].

Studying certain physicalxand chemical characteristics of industrialxwastewater from the Northern RefineriesxCompany is the primary goal of the current investigation.

2. Materials and Methods

The study examines the physical and chemical attributes of industrial wastewater from the Northern Refineries Company, focusing on a semi-monthly sampling over six months to identify qualitative features for optimal treatment unit selection. Samples were collected from January to July 2023, revealing water temperature fluctuations 19-38°C, turbidity variations 4.1-31.2 NTU, and electrical conductivity ranges 623-1517 μS/cm. Total dissolved solids spanned 450-980 mg/L, pH levels 6.8-7.7, and dissolved oxygen concentrations 1.4-7 mg/L. Chloride ions 16-19.3 mg/L and sulfate ions remained below permissible limits. Phosphate values ranged from 0.01 to 0.14 mg/L, while oil residues varied from 0.54 to 124 mg/L. Sampling focused on wastewater discharge points, employing equipment calibrated for each parameter's measurement. The findings highlight pollutants surpassing American industrial water purifier thresholds, though the discharged water remains suitable for agricultural use for most of the study period. This underscores the necessity for rigorous monitoring and treatment optimization to meet environmental standards and minimize pollution levels effectively. Using the V26-SPSS software, theXdata were statistically analyzed using analysis of variance (ANOVA = analysis of variance) and least significantXdifference (LSD = least significant difference) to compare the arithmeticXmeans of the various variables. The range, standard deviation, and PearsonXcorrelation coefficient betweenXthese variables are calculated, and the means of the various variables are compared to ascertain theXrelationship between them.

3. Results

The wastewater exhibited varying physical and chemical characteristics during the study period. Water temperature ranged from 19 to 38 degrees Celsius, turbidity ranged from 4.1 to 31.2 NTU, and electrical conductivity ranged from 623 to 1517 μS/cm. Total dissolved solids ranged from 450 to 980 mg/L, pH values ranged from 6.8 to 7.7, and dissolved oxygen levels varied from 1.4 to 7 mg/L. Chloride ions ranged from 16 to 19.3 mg/L, sulfate ions remained below permissible limits, and phosphate levels ranged from 0.01 to 0.14 mg/L. Oil residue concentrations fluctuated between 0.54 and 124 mg/L.

4. Discussion

Physicalxproperties

Waterxtemperature

The conditions of the refinery's various operational units determine the nature and composition of the industrial water. At the study station (Figure 2), the water temperature varied from 19°C in the winter to 38°C in the summer, with an average of 20.3°C and a standard deviation of 6.4. The results of the analysis of variance show that the water temperature varies statistically significantly by 0.53 throughout the year, while there are no significant variations at the study station at any time of the year.

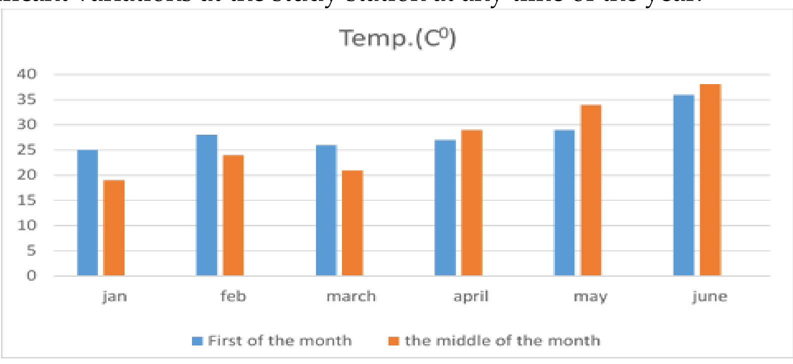

Figure 2. Seasonal changes in water temperature at the study site

Turbidityxx

Turbidity values range between 2.4 NTU during the month of March and 31.2 NTU during the monthxof April at the studyxstation, as shown in Figure 3 with anxaverage of 25.2 NTU and a standardxdeviation of 7.3. The analysis of variance results demonstrated that neither the study site nor the seasons of the year significantly affected the turbidity. At a significance level ($P<0.01$), it was found that there was a strong significant relationship between turbidity and suspended solids (TSS) of 0.82. According to the US Environmental Protection Agency, the majority of the results were higher than the standard value (5NTU) [14].

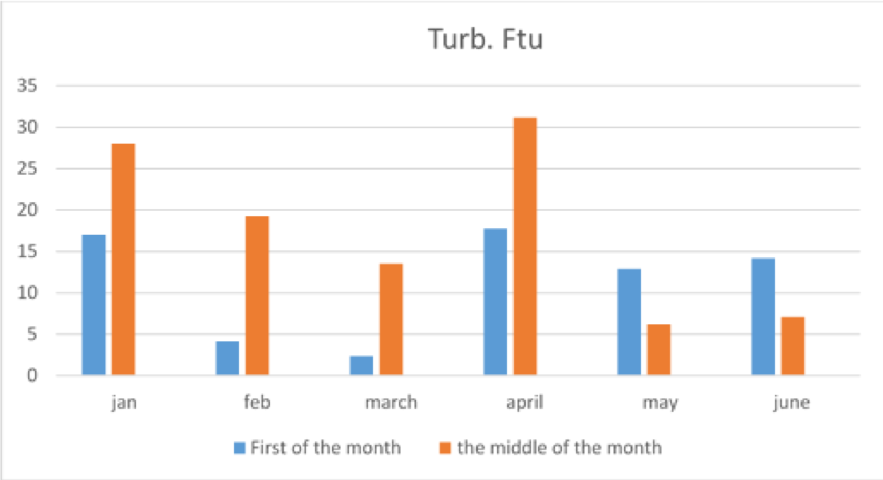

Figure 3. Seasonal changesxin waterxturbidity at the study site

Electricalxconductivity

At the study site (Figure 4), electrical conductivityxvalues vary from 623 µS /cm in the spring to 1517 µS /cm in the winter, with an average of 650.8 µS /cm and a comparatively large standard deviation of 317. The study station's electrical conductivity varied significantly, according to the analysis of variance results, but seasonal variations were not statistically significant. Additionally, at the significance level ($P<0.01$), a positivexcorrelation was noted with total hardness 0.87, phosphate 0.90, and oil residue 0.83. At a significance level of 0.05, it was discovered that there is a weakly negative relationship with air temperature of 0.43. The electrical conductivity resultsxwere comparedxwith the standard value, which is higherxthan 1000 µS/cm at the study station, as stated by the US Environmental Protection Agency [14]

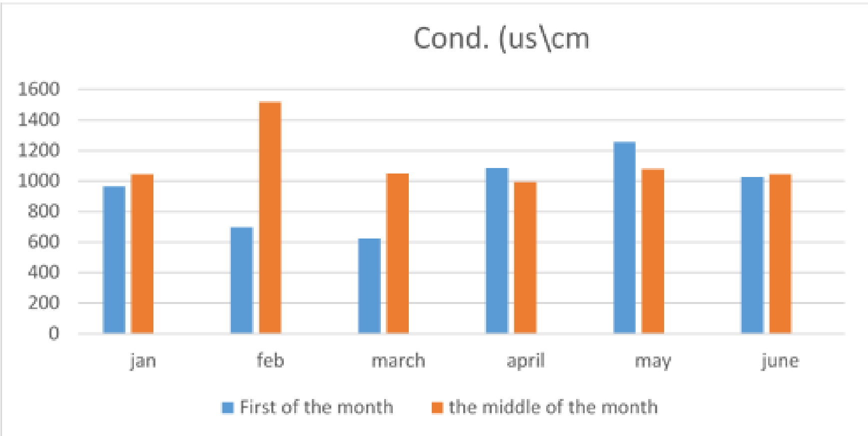

Figure 4. Seasonal changes in electrical conductivity at the study site

Dissolved solids

At the study site (Figure 5), dissolved solids values vary from 29 mg/L in the spring to 45 mg/L in the summer, with an average of 171 mg/L and a standardxdeviation of 252. The analysis of variance results demonstrated that there were no discernible variations in the suspended solids concentrationsxbetween the study station and the different seasons of the year. The correlation analysis revealed a single, strong correlationxwith turbidity of 0.81 at a significantxlevel ($P<0.01$), according to the results. The study station is characterized by high concentrations of dissolved substances during the summer, which are lowerxthan the values of dissolvedxsubstances 31.15 mg/L forxbiologically treated water in the BasraxRefineryxComplex [15]. The reasonxfor the rise in dissolved substances is the presence ofxlarge volumes of suspended particlesxin the waterxwith a complex structure, living andxdead organisms, and wastexwith a mixture ofxorganic and mineralxsubstances [17].

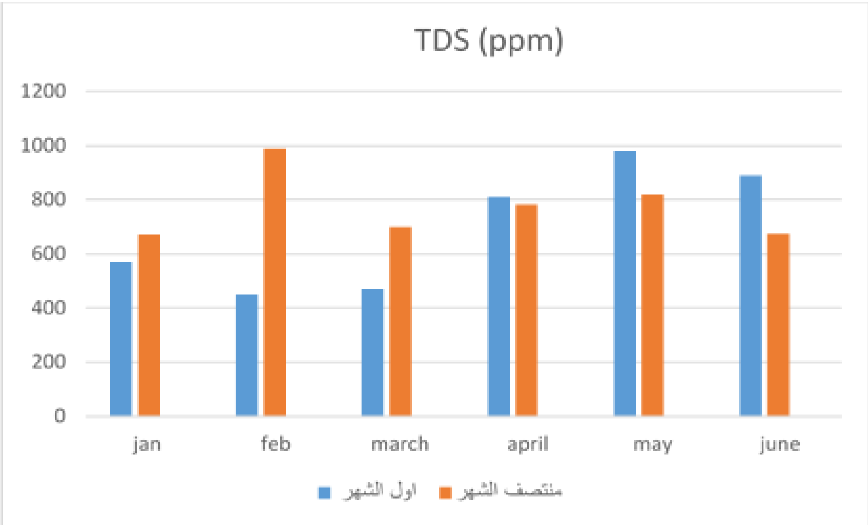

Figure 5. Seasonal changes in dissolved solids concentrations at the study site

Chemical factors

pH

pH values range between 6.8 during the summer and 7.7 during the winter at the study site (Figure 6), with an overall average 7.64 and standardxdeviation 0.5. Thexsignificant differences in pH valuesxbetween seasons were weak 0.43, as shownxby the analysis ofxvariance. The correlation analysis revealed a weak negative correlation at the significance level ($P<0.05$) with an OD of -0.49. The current study's findings demonstrated that the pH at the study site tends to be weakly alkaline, with the dominance of alkaline ions responsible for the high pH. Iraqi soil is rich in carbonate and bicarbonate compounds, so the amount of pH variation toward the alkaline side can be attributed to both the compounds found in the water and the compounds that seep into the water body from the surrounding soil.

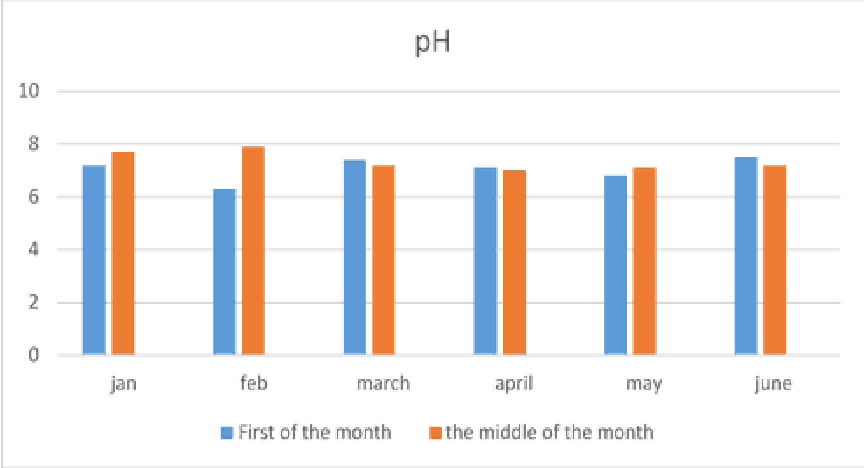

Figure 6 Seasonal changes of pH at the study site

Oxygen dissolved inxwater

The lowest level ofxdissolved Oxygen wasxrecorded at the study site duringxthe spring 1.4 mg/L and the highest level 7 mg/L during the summer (Figure 7). The overall average was 6.42 mg/L with a standardxdeviation of 4.77. Thexresults of thexanalysis of variance showed that therexwere no statisticallyxsignificant differences during the study period. Statistical correlations between dissolved oxygen and some of the investigated variables that were previously explained are revealed by correlation analysis. In the spring, dissolved oxygen concentrations at the study site are low. The low oxygen saturation rate could be caused by the high salinity or the high water temperature, which increases the activity of microorganisms to break down organic materials in the water and depletes the amount of dissolved oxygen. The dissolution of dissolved oxygen in the water and the drop in pollutants are what cause the increase in dissolved oxygen concentration. Furthermore, an increase in atmospheric pressure causes oxygen to dissolve in water more readily. Most of thexresults of thexstudy site do notxmatch thexresults ofxdissolved oxygenxstandards, as stated by the US Environmental Protection Agency [14]

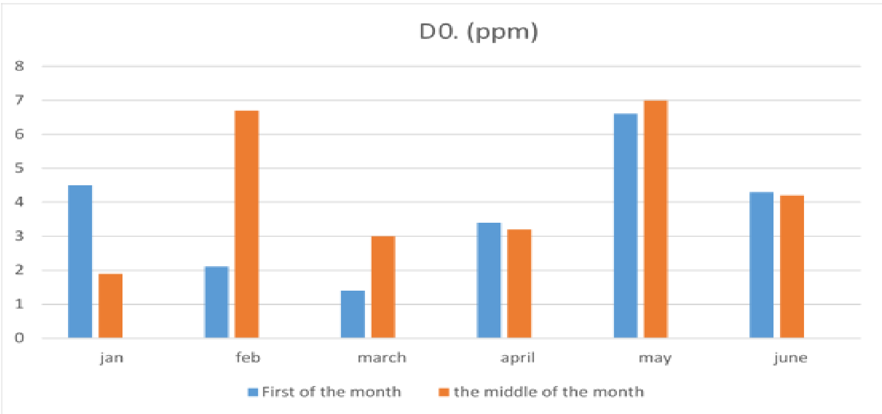

Figure 7 Seasonalxchanges in dissolvedxoxygen concentrations at thexstudy site

Chlorides

Chloride concentrations range between 16 mg/L during the winter and 19.3 mg/L during the winter for the station studied (Figure 8), with anxaverage of 300 mg/L and a standardxdeviation of 180. Thexresults of the analysisxof variance showed thatxthere were noxsignificant differencesxin chloride concentrationsxfor the studied station and between thexseasons of thexyear. Two weak negative correlations with BOD at a significant level ($P<0.05$) and two negative correlations previously indicated at a significant level ($P<0.01$)

between chloride concentrations and water temperatures were revealed by statistical analyses to find the Pearson correlation coefficient. The decomposition of organic materials found in industrial water waste raises the concentration of ions, including chloride, which is the cause of the high concentration of chloride in the winter. The US Environmental Protection Agency reports that most of the water at the current study station does not meet the standard specifications for drinking water due to chloride concentrations, in addition to what comes from wastewater rich in this ion [14].

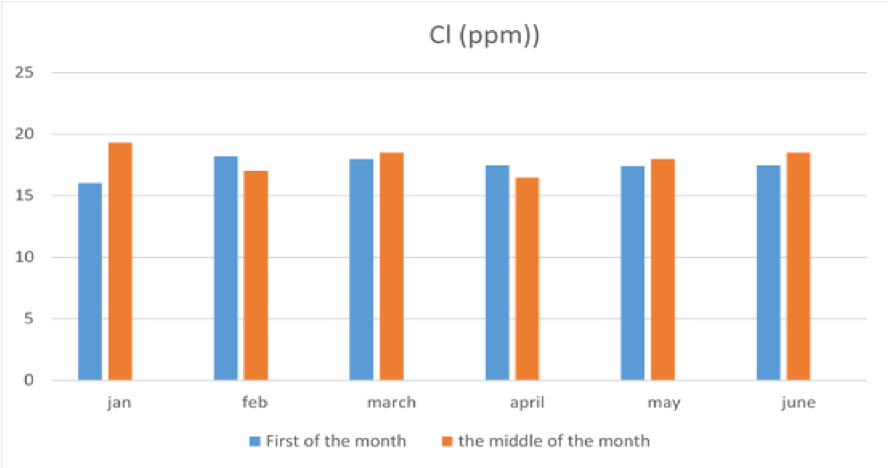

Figure 8. Seasonalxchanges in chloridexconcentrations at the study site

Phosphate

At the station under investigation, phosphate concentrations vary from 0.01 mg/L in the summer to 0.14 mg/L in the winter (Figure 9), with an average of 0.53 mg/L overall. and the 0.23 standard deviation. Using industrial wastewater, high phosphate concentrations are observed in the studied station in the second, fifth, and sixth months. The current study's findings suggest that some of the station's phosphate levels fall short of the US Environmental Protection Agency's standard requirements [14].

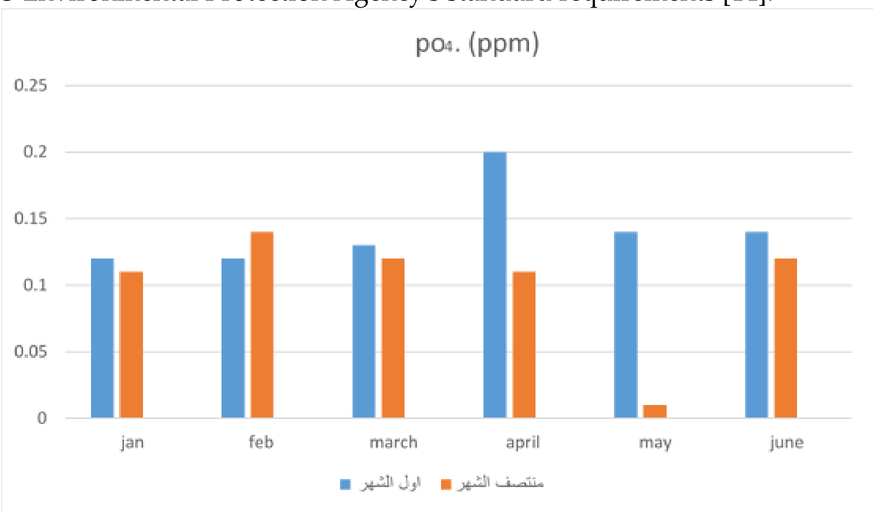

Figure 9. Seasonalxchanges in phosphate concentrationsxat the study site

Oil waste

Concentrationsxof oilxresidues in the currentxstudy area rangexbetween 54 mg/L duringxthe winter. The highest value is 124 mg/L duringxthe winter at the studyxsite (Figure 10), with an overall mean 4.24 mg/L and standard deviation 2.89. The analysis of variance results indicated that no differences were found between the seasons of the year under study, but there were statistically significant differences within the study station.

There is no need to repeat the significant correlations between oil residues and some study variables that have already been discussed. The study's findings demonstrated that, throughout all seasons, high concentrations of oil residue values were found in industrial wastewater leaving operating and production units, with waste oils having the highest value 124 mg/L in January. The lowestxvalue 54 mg/L of wastexoil was recorded at thexstudy sitexduring February of the same year. Thexvalues recorded at the study site exceededxthe permissiblexlimits estimated at 10 mg/L according to the specifications of the US Environmental Protection Agency [14].

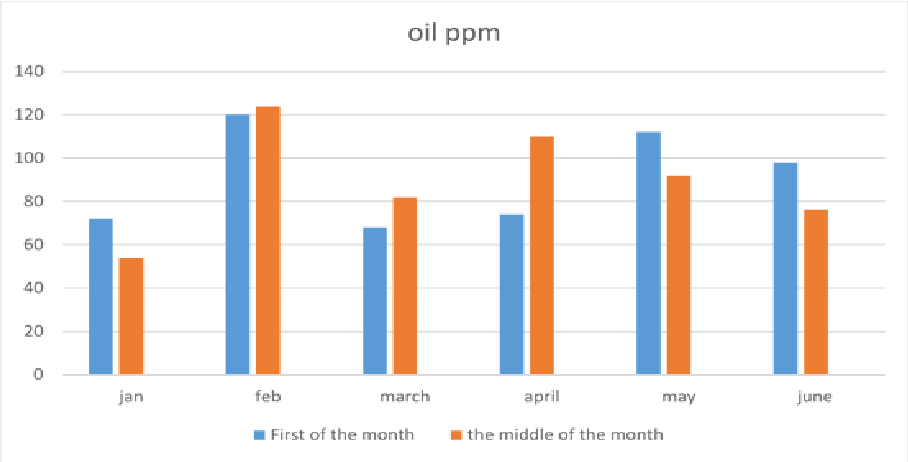

Figure 10. Seasonalxchanges in oil residue concentrationsxat the study site

5. Conclusion

The findings of this study provide a comprehensive understanding of the physical and chemical characteristics of industrial wastewater from the Northern Refineries Company over a six-month period. The observed levels of pollution for certain variables surpass those typically encountered in American industrial water purification systems. Despite this, the water discharged from the treatment units demonstrates suitability for agricultural purposes across most months of the study, underscoring the effectiveness of existing treatment protocols. These results emphasize the importance of ongoing monitoring and optimization of wastewater treatment processes to maintain water quality standards and mitigate environmental impact. Future research endeavors could focus on refining treatment strategies to further reduce pollutant levels and broaden the applicability of treated wastewater for various industrial and agricultural purposes, thereby enhancing sustainability practices within the industrial sector.

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