Detection of Oil Mineral Pollution in Tigris River from Aldora Refined using Absorbance Spectroscopy

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Abstract

Accurately identifying the kind and amount of dissolved metal salts in wastewater used in oil refining processes is an iconic feature of ultraviolet and visible absorption spectroscopy. This method relies on the dissolved metal salts' ability to absorb light at certain wavelengths after reacting with it. The experiments were conducted in a lab setting with a broadband source (200-800 nm) to measure the absorbance of dissolved element salts and precisely identify the lowest concentration up to 2 ppm. A mixture of the mineral salts from oil refining operations was prepared and diluted to different concentrations using a standard solution. This allowed us to study and compare this result with the absorbance behavior of the wastewater from the Al-Dora Refinery. The two results reinforced that we can accurately estimate the detection parameters for the lowest water contamination. These materials are lead nitrate (PbNO3), phenol, calcium carbonate (CaCO3), sodium chloride (NaCl2), sulfide (SO4), and nitrate (NO3). At wavelengths of 340, 404, and 741 nm, the concentrations (10, 20, 30, 40, 50, 60, 70, 80, 90, and 100) ppm were found, and for the concentration of 10ppm, the absorbance (0.15323, 0.15326, and 0.14685) was found, respectively. The process that has been tested with varying concentrations is considered and simulates the variation in river water concentrations caused by the river's water level and flow rate changes by the effect of rain abundance and thawing. It is fast, accurate data analysis, and a lower cost compared with the other chemical analysis and conventional methods.

Keywords: Mineral Oil Detection, Contamination, UV-Vis Absorption Spectroscopy, Wastewater.

الكشف عن التلوث النفطي لمياه نهر دجلة بواسطة اطياف الامتصاص

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الخلاصة:

ان مطيافية الامتصاص المنطقة فوق البنفسجي والمرئية تمتاز بدقة كشف وتحديد المعادن والاملاح الناتجة من تسرب النفط الى مياه نهر دجلة من خلال المياة المستخدمة في التبريد اثناء عمليات التكرير.اساس عمل هّذه التقنيةعندما يمتص المعدن أطوال موجية بعد تفاعله مع الضوء المسلط عليه يعطي مؤشرا على شدة الامتصاص وهي دالة لتركيز العنصر من خلاش شدة الامتصاص هذه التقنية لها اهمية في كشف الأطياف الامتصاص للعينة للحصول على بيانات عالية الدقة حول نوع وتركيز العناصر الذائبة والمسببة لتلوث المياه نتيجة تسرب المياه المستخدمة في تكرير النفط الى الانهار وبدون معالجة. تم اجراء الفحوصات في المختبر باستخدام جهاز الفحص ذو مدى واسع من الاطوال الموجية(٢٠٠-٨٠٠ نانومتر) لتغطية اكبر من العناصر التي تمتازبامتصاصية مختلفة من الاطوال الموجية وبدقة كشف لاقل تركيز (٢ جزء في المليون). تم الإشارة إلى أعلى امتصاص من خلال العناصر التي تم تحديدها عند تعريضها نطاق طيفي واسع ضمن الاشعة المرئية والفوق البنفسجية. بعد تحديد العناصر الملوثة من خلال العينات التي تم جلبها من مياه النهر تم تحضيرخليط من هذه العناصرواملاحها وتخفيفها الى عدة تراكيزمختلفة باستخدام محلول قياسي لملاحظة سلوك الامتصاصية وتحديد دقة الكشف ومحددات الكشف لاقل قيمة للتراكيز ومن هذه المواد هي النترات (NO_3) والكبريتيد (SO_4) وكلوريد الصوديوم ($NaCl_2$) والكالسيوم كربونات ($CaCO_3$) والفينول والكحول الإيثيلي (C_2H_5) ونترات

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الرصاص. ($PbNO_3$) تم تشخيص الامتصاصية المحتوية على (١٠، ٢٠، ٣٠، ٤٠، ٥٠، ٦٠، ٧٠، ٨٠، ٩٠، و١٠٠) جزء في المليون عند الأطوال الموجية (٤٠٤،٣٤٠، ٧٤١) نانومتر وبقية امتصاص (٠,١٥٣٢٣، ٠,١٥٣٢٦، و٠,١٤٦٨٥) على التوالي للتركيز ١٠ جزء في المليون، وتجرى نفس خطوات الاختبار للتراكيز الأخرى (٩٠،٨٠،٧٠،٦٠،٥٠،٤٠،٣٠،٢٠ و١٠٠ جزء في المليون) سوف تحصل على امتصاصية وطول موجي بقيمة مختلفة كما هو مبين في الجدول (١) التالي، وهي محاكات لاختلاف التراكيز لمياه الانهارتبعا لتغير الظروف المناخية المسببة لارتفاع منسوب المياة وسرعة التدفق وبعد المقرنة مع الطرق الكيميائية والتقليدية فقد تبين أن هذه التقنية ذات سرعة وقة عالية في تحليل البيانات وباقل كلفة.

1. Introduction

The detection and identifying mineral oil in water is a more important application for a perfect environment [1],[2],[3]. The technique of presented broadband (UV-Vis spectra), and the possibility of measuring different minerals of oil through absorbing wavelength phenomena [4],[2]-[5]. The outlet water from the cooling system of Al-Dora Refining, Baghdad, Iraq is considered in the present work. Diagnosing mineral oil in water includes fast mapping of elements, identifying the mineral's types, and estimating the slick oil leakage. This technique is more efficient in detecting water pollutants by absorbance response. The mineral characterization uses absorbent signals and estimation [3]-[9], the spectra of the minerals oil to detect the type and concentration of elements with more accuracy of data about the dissolved minerals in Tigris River water in Iraq, and the possibility of controlling compared with the other chemical detection methods. This study aims to use spectral absorbance properties of minerals oil concentrations ranging from (10 to 100) ppm in the water under laboratory requirements of analysis and to highlight the problems of optical diagnostics for controlling the leakage of oil waste into river water near oil refineries presented in the laboratory, the element's composition was dissolved in distilled water at different concentrations to study the concentration change behavior that simulates the water flow into the river without treatment as shown in Figure (1). Through the previous study, it was possible to detect mineral oils in water using the fluorescence produced by Laser Light Detection and Ranging (LIDAR) technology, and a pulsed laser was used to raster scan the water to obtain more accurate detection [9]. A charge-integrated device (CCD) camera was chosen to record fluorescent signatures to improve accuracy, fast scanning times, and efficient information extraction, to ensure that the signatures were informative enough to enable wastewater discrimination in the visual inspection of hydrocarbon spills. Ultraviolet, visible, and near-infrared light falls within the broad-spectrum band (350–1000 nm) covered by a hyperspectral camera's spectral and spatial information. It is exceptionally adept at gathering crucial spectral data [10]– [13]. Similar to the pilot plant in the study, the latest collaboration in Iraq intended to achieve high removal efficiency for pollutants like total suspended solids (TSS), Total Dissolved Solids (TDS), and oil and chemical oxygen demand (COD) that are found in wastewater. The outcomes showed that these parameters may be successfully reduced to values below permitted limits, indicating efficient treatment procedures [1],[14], [15]. This technique is well pollutant diagnosed in Iraq, portable devices, tested in the field optically, and low cost compared with other methods of analysis. the field optically, and low cost compared with other methods.

Figure (1): Wastewater Al. Dura Refining, Baghdad, Iraq.

2. Materials and Method

In this study, UV-Vis Absorbance from light interacts with mineral oil samples in the Westwater. A broadband light source, deuterium 25W, tungsten halogen 20W, and 190W maximum power, and wavelength range (215-400) nm for deuterium, and for tungsten-halogen (360-1100) nm.

The change in absorption spectra was studied when the variable concentrations of element compounds dissolved in distilled water, and then wastewater with different concentrations were measured to compare with them by transmittance and absorbance spectra. The distribution patterns of the spectra are shown in Figure (2), the polluted water (wastewater) near the refineries was prepared and analyzed optically using a different concentration and measuring the highest transmittance and absorbance spectra intensity in arbitrary units versus wavelength in nanometers, to identify the type of elements compound in the water. The samples were prepared by standard stock solution and dissolving 100ppm mixing of elements compound such as (Nitrate (NO3), Sulfide (SO4), Sodium Chloride (NaCl2), Calcium Carbonate (CaCO3), Phenol, Ethyle alcohol (C2H5), Lead

Nitrates (PbNO3), in distilled water, removing insoluble materials using a paper filter and diluting the mixture into several concentrations (10, 20, 30, 40, 50, 60, 70, 80, 90, and 100) ppm. The result solution at different concentrations can be considered as polluted water (It can be used as an alternative to polluted water resulting from oil refineries.

3. Result and Discussion

The spectra responses for various concentrations of element compounds dissolved in distilled water were obtained using the absorption spectrum. Figures (2) and (3) display the measured wavelength versus peak transmittance and absorbance. The following table (2) illustrates how the spectra determine the largest absorption peak versus wavelength.

The system is used for measuring the absorbance spectrum, by the consistency of the standard solution of a mineral compound to result in a solution like wastewater, the measurements of the concentration as shown in Figure (2), the peak absorbance obtained has a weak shift compared with the steady state of the spectrogram, the absorbance signal of the mineral compound concentration(10ppm) has the peak wavelength absorption at (340, 404, 741)nm, and peak absorbance (0.15323, 0.15326, 0.14685) respectively, the deviation was little value, it does not affect the concentration of the measurement. Figure (4) shows the absorbance intensity in the arbitrary unit has a linear relation to the limit of detection for concentration is 2ppm, and the fit correlation linearity coefficient (r) is $R^2 = 0.9565$.

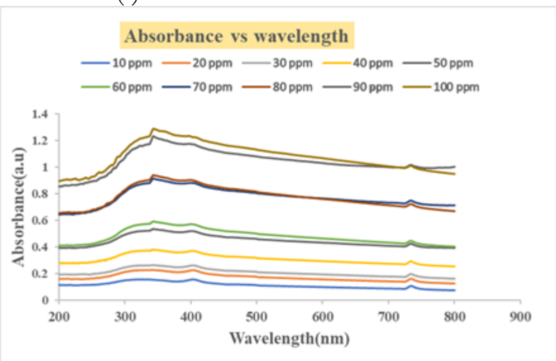

Figure (2): Shows the spectra of the highest absorption peak from the UV-VIS spectra for different oil mineral concentrations dissolved in distilled water.

Table (1): The absorption spectrum of UV-Vis. spectra for many concentrations of element compositions dissolved in water.

Concentration**(ppm)**	Wavelength **(λ max(nm))**	Absorbance **(a.u)**
10	340 404 741	0.15323 0.15326 0.14685
20	340 409 738	0.2592 0.25367 0.18553
30	342 405 738	0.2599 0.2576 0.1855
40	348 408 739	0.3744 0.3646 0.2769
50	347 404 739	0.5860 0.5672 0.4329
60	343 396 736	0.5893 0.5660 0.4407
70	340 403 736	0.9240 0.8987 0.7167
80	344 400 733	0.9363 0.9005 0.7195
90	339 400 736	1,2437 1.2135 1.0059
100	343 400 735	1.2881 1.2388 1.0083

Figure (2) Shows the spectra of the highest absorption peak from the UV-VIS spectra for different oil mineral concentrations dissolved in distilled water.

The peaks of absorbance intensity were different with concentration change, such a method was used to compare the typical characteristics of absorbance spectra of the different states, The shape of the spectra distribution changed when the pure water changed by the effect of mineral compound and slick in the water. Thus, this change results broad homogeneous line to a fairly narrow structured line. This fact is shown in Table (2) and Figure (2) the mechanism of optical interaction of mineral compound molecules in water.

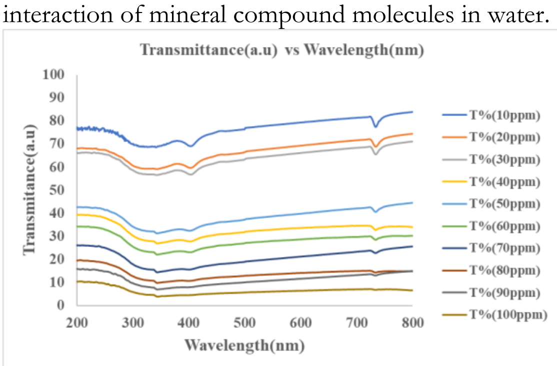

Figure (3): Shows the peaks of transmittance spectra. in arbitrary units versus wavelength in the nanometer for 10 different concentrations dissolved in water.

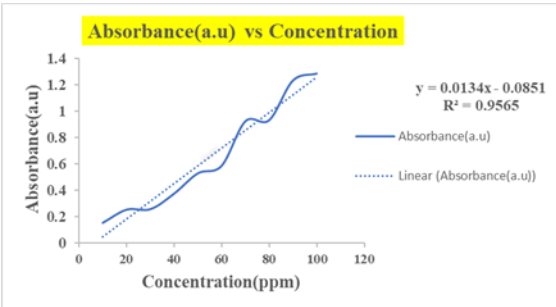

Figure (4): The absorbance intensity in the arbitrary unit has a linear relation to the limit of detection for concentration is 2ppm, the fit. linearity coefficient (r) is $R^2 = 0.9565$.

The linearity coefficient is $R^2 = 0.9565$….(1)
related to absorb. (y) when y= 0.0134X-0. 0851...(2)
The value of X is a function of concentration and y is the absorbance value, R is the linear correlation as a function of the mineral oil concentration in the water, the data demonstrate the appearance of absorbance increase with the increased concentration of oil minerals in the water. The absorbance of the dependent wavelength for the mineral oil represents the linear fit for each concentration. Figures (5)and(6) show the absorbance and transmittance versus wavelength, the high absorbance and transmittance value proportional to peak wavelength (346, 402, and 734) nm, these values more related at different concentrations, Absorption and transmittance spectra value are change with different mineral concentrations in water to evaluate and determine the peak wavelengths absorbed by dissolved substances at various concentrations.

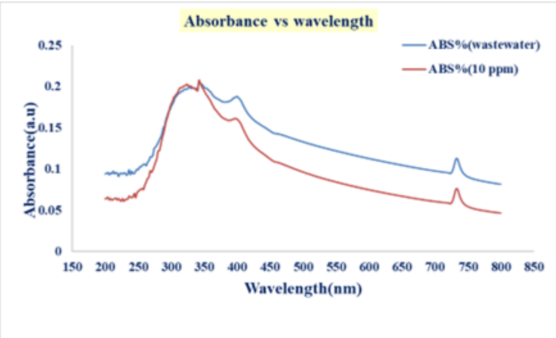

Figure (5): Shows the peaks of absorbance spectra in arbitrary units versus wavelength in the nanometer for wastewater in different concentrations.

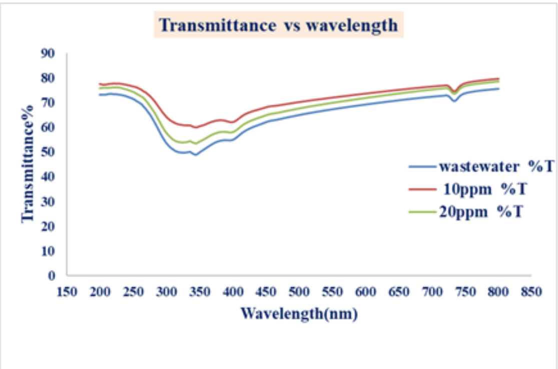

Figure (6): Shows the peaks of transmittance spectra in arbitrary units versus wavelength in the nanometer for wastewater in three different concentrations.

4. Conclusion

The absorption spectra provide a valuable indication of the water pollutants in the Tigris River's aquatic environment they are sensitive and dependable for various mineral compounds produced during refining operations and seeping into the river.

Compared to previous chemical analysis procedures, the contaminated element compound was discovered with high accuracy, faster, and cheaper, with an acceptable detection limit of 2ppm. As a result, this feature may detect oil sources optically by identifying the types and amounts of minerals, hydrocarbon compounds, and oil stains that float in the water. Minerals, hydrocarbon compounds, and oil stains float in the water.

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