

PAPER • OPEN ACCESS

Sustainable Materials Production for Oily Wastewater Treatment

To cite this article: Fatima Mohammed *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **961** 012080

View the [article online](#) for updates and enhancements.

You may also like

- [Natural operation in removing waste compounds within cooking oil using corn cob as adsorbent](#)
B Haryanto, A Pelawi, Octavia et al.
- [Solar irradiated and metallurgical waste catalyzed conversion of waste cooking oil to biodiesel](#)
Abdul Majeed Khan, Sana Manzoor, Shazia Kalam et al.
- [Extraction of Methylene Blue from Aqueous Solutions by Waste Cooking Oil and its Back-Extraction](#)
A K M Sipi and S H Chang



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Sustainable Materials Production for Oily Wastewater Treatment

Fatima mohammed¹, Abbas Khalaf Muhammad Al-Hamidawi b² Mustafa Hasan Azeez AL-buhayder³ Thifaf Jasim mohammed⁴

¹Department of Chemical Engineering, College of Engineering, University of Al-Qadisiyah, AL-Qadisiyah, Iraq

²Department of Chemical Engineering, College of Engineering, University of Al-Qadisiyah, AL-Qadisiyah, Iraq

Abbas.shuaab@qu.edu.iq

Chem.post10@qu.edu.iq

Mustafaalhuseiny657@gmail.com

thifaf.jassim@qu.edu.iq

Abstract. The discharge of water from oil fields It has become one of the most significant environmental concerns associated with the oil sector. Hydrocarbon spills and crude oil fuel spills are a continual hazard to aquatic ecosystems. Inexpensive and sustainable sorbent materials are needed to mitigate the environmental damage of this pollution. To meet this need, this study features a low-density polysulfide polymer prepared by Sulfur and used cooking oils react directly. Since both sulfur and cooking oils are hydrophobic, the polymer is close to hydrocarbons such as crude oil and diesel fuel and can easily remove them from seawater. Oil can be recovered and polymer can be reused in oil spill treatment .Polysulfide is unique in that it is prepared from completely recycled waste. Sulfur is a by-product of the petroleum industry, and used cooking oil can also be used as a raw material. Therefore, waste sulfur from the petroleum industry is used to make effective anti-pollution adsorbents from the same sector According to the study's findings, 98.55 percent of the oil was removed from the north.

Key Words: Polymer, absorption, sustainable materials and oily waste water.

1. Introduction:

Various pollutants are emerging in our environment. One of the pollutants that can cause an environmental problem is the present of oil and grease inside water system[1] and [2]. When petroleum wastewater is introduced into the aquatic environment at high concentrations, it becomes toxic to aquatic organisms and damages other ecosystems in the body of water [3].Oily wastewater discharge into natural water streams has risen as a result of industrial growth and human activities. Crude oil spills, power plants, extraction of crude oil, stations, petrochemical plants, and domestic trash such as spent cooking oil and lubricant from vehicle spills are all sources of oily wastewater. Crude oil transportation is another source of oil spills in surface water [4]. Oil and grease may be removed from wastewater using a variety of procedures, which are chosen based on the characteristics and condition of the effluent. Gravitational techniques, floating, chemical and biological treatment, and dissolved air flotation are some of the most used ways for treating oily wastewater. These solutions, on the other hand, came at a great price and required constant upkeep. Another option is de-emulsification, although it is not frequently utilized due to its low removal efficiency and expensive cost. [3]. Various research has been done in order to determine the best methods for removing oil from water. Adsorption, flotation, coalescences, membrane filtration biological treatment,



electrocoagulation, coagulation, and flocculation are some of the methods used to remove oil. Each approach has its own set of benefits and drawbacks. One of the most popular ways for eliminating pollutants is adsorption, which is one of the methods described above. The advantages of employing adsorption techniques, according to earlier studies, include high oil removal efficiency, cheap cost, and low processing cost [3].

2. Experimental Work

- Materials

All chemicals that were used with in experiment are of high purity and analytical grades, except for the oil that was supplied from Al-Durra refinery

Table 1. Shows the materials were used in the experimental part.

Material	Properties	Source
Sulfur	S Ultrafine MOL. Wt. =32.065	Sharqat
Cooking oil	High quality	cooking oil can be used as
Ethanol	C ₂ H ₅ OH , Mol. W=46.07 g/mol	Germany
Oil	High quality	Iraqi oil refineries
Salt	NaCl Ultra fine Mol. Wt. =58.44 g/mol	India

- Equipment and procedures
- polysulfide preparation apparatus

A photographic image of the apparatus are shown in figures (1) .

Based on the study [5] that was conducted to prepare a polysulfide polymer. A 4.7 L stainless steel cylindrical reaction vessel with a diameter of 20 cm was placed on a variable hot plate. The reaction An upper mechanical drive (LS-50D, KOREA) was mounted on an H-shaped rack and supplied with a stainless steel impeller, and the device was constructed in a fume hood as follows: (15 cm square blade). Temperature probes were installed in the vessel (SH-2, Germany). The reactor Cable ties were used to fasten the grips to the H-frame stand. The temperature of the reaction inside the reaction vessel was digitally recorded by inserting a thermocouple into an electrical recorder (Micromax, Germany) for further monitoring of the reaction's thermal status. The reactor is further secured by attraction to the magnetic hotplate since the reaction vessel is magnetized. The temperature probe and a big glass funnel were fastened so that they would not come into contact with the moving impeller, and the impeller blade was positioned several millimetres from the bottom of the reaction vessel.



Figure (1): Photographic picture of the polysulfide preparation apparatus.

- Adsorption apparatus

Figures (2) show photographic picture of the apparatus used for the adsorption process. Based on the study [3],[6],[7],[8],[9] and [10] A 500 ml three neck conical flask (Goel, Germany) was used as an adsorption chamber. The adsorption temperature was measured and recorded using a glass thermometer submerged within the flask. The flask was equipped with Pyrex glass recycling condenser to ensure retarding of any vapors from adsorption mixture. 1000 ml Pyrex glass beaker (Simax, Germany) covered via a layer of glass wool insulation material was used as a water bath for the adsorption mixture. A thermo couple connected to a digital recorder was put inside the beaker for continuous monitoring of water bath temperature. The whole adsorption equipment was put over a hot plate magnetic stirrer (SH-2, Germany) for supplying necessary heat required for the water bath as well as providing the vigorous mixing of adsorption mixture.

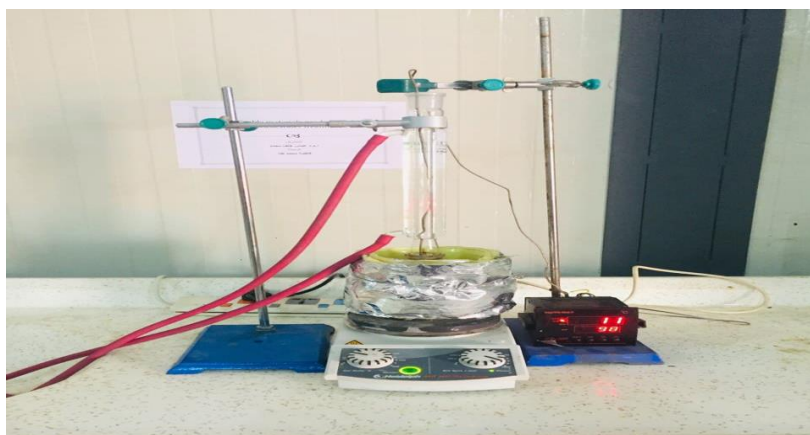


Figure (2): Photograph of the polysulfide adsorption apparatus.

3. The result and discussion .

• Equilibrium of Adsorption

Isothermal information analysis with the application of characteristic isothermal modeling is a major development in determining the appropriate model that can be used for design purposes. As a result, the relationship of equilibrium data that uses either a theoretical or experimental formula to understand and predict the degree of adsorption, in choosing the most extreme adsorption limit for a given adsorbent [11],[12],[13],[14],[15]and [16]

Figures (3 and 4) represent the equilibrium adsorption isotherms curves for the North oil on the surface of the prepared polysulfide adsorbent. These curves were plotted for the range of concentration (3–27) parts per billion at various temperatures (20, 25, 30, 35, and 40 ° C). It could be recognized from these figures that there is a proportional relationship between the concentration of oils in the solution and its concentration in the adsorbed phase. This is clearly shown from the shape curves of isotherms that are of classical adsorption type. This means that any increasing of concentration of oil in the solution increases the concentration of oil on the surface of the adsorbent. But this proportionality becomes less notable at high concentrations of oils in the solution because the adsorbent reaches its maximum capacity. The values of maximum capacities for the prepared polysulfide is shown in table (1).

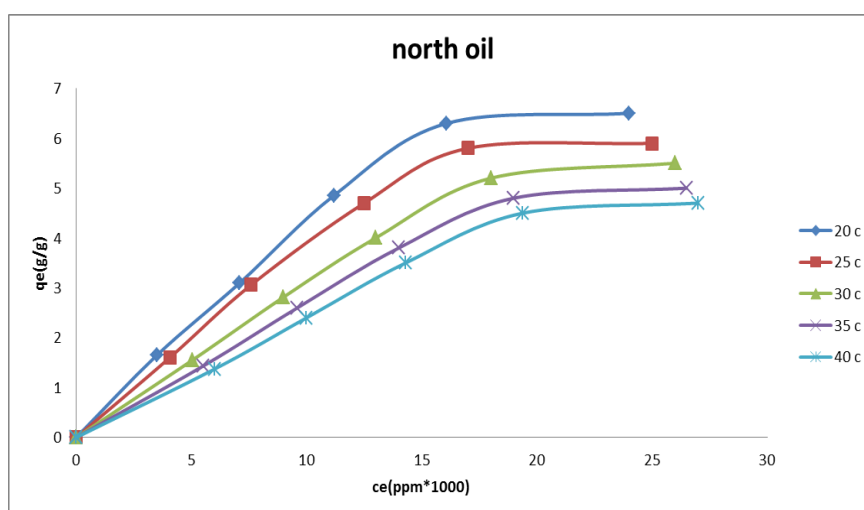


Figure (3): adsorption equilibrium isotherms for north oil adsorbed on the polymer at different temperatures.

Table 2: Polysulfide maximum capacities for strategic line oil and north oils.

Temp.°C	North oil	
	Ce(ppm*1000)	qe(g/g)
20	3.5	1.65
25	4.06	1.6
30	5.04	1.55
35	5.5	1.43
40	6.01	1.373

• polymer adsorption of oils.

The stock solutions were made by weighing (2 percent, 4%, 6%, 8%, and 10% ml) of North oil and dissolving it in 100 ml of distilled water. Then, following the dilution law [17],[18],[19],[20], and [9], solutions with the appropriate concentrations were produced by serial dilution with distilled water:

$$C_1 * V_1 = C_2 * V_2 \quad (1)$$

Where:

C1: The initial concentration of the solution in milligrams per liter (mg/L).

C2: The concentration of the solution after dilution in milligrams per liter (mg/L).

V1 is the volume of the solution before it is diluted (mL).

V2: After dilution, the volume of the solution (mL)

- Effect of temperature.

In the adsorption process, it is very important to know the extent to which the temperature affects the efficiency of the adsorbents [21].

Figures (4.9 and 4.10) show the effect of temperature on the adsorption capacity in aqueous solution of polymer for North oil. The temperature range for the adsorption process was chosen as (20–40) °C in viewing to the expected values for the industrial process. From these graphs, it can be seen that an increase of temperature causes a decrease in the adsorption capacity for the two oil. This result is consistent with a recent research by [22] (4.154.18), which showed the effect of temperature on the percentage of oils removed. These figures indicate that the increasing of temperature leads to a decreasing of the removal percentage of the oils. Where, the removal North oil decreased from 98.55% to 77.99% with increasing the temperature from 20 °C to 40 °C. This behavior is in agreement with the study done by [23]. They explained that the adsorption forces between the dye molecules and the active sites become weak when the temperature increases, which leads to a decrease in the removal percentage of oil.

- Kinetic of adsorption

The quantity of north oil adsorbed on the produced polysulfide as a function of time for the temperature range (20–40) C is shown in **Figures (4)**. The amount of oils adsorbed grows fast in the first sixty minutes, as seen by these data. After that, until the equilibrium state is reached, there is no substantial variation in the quantity adsorbed.

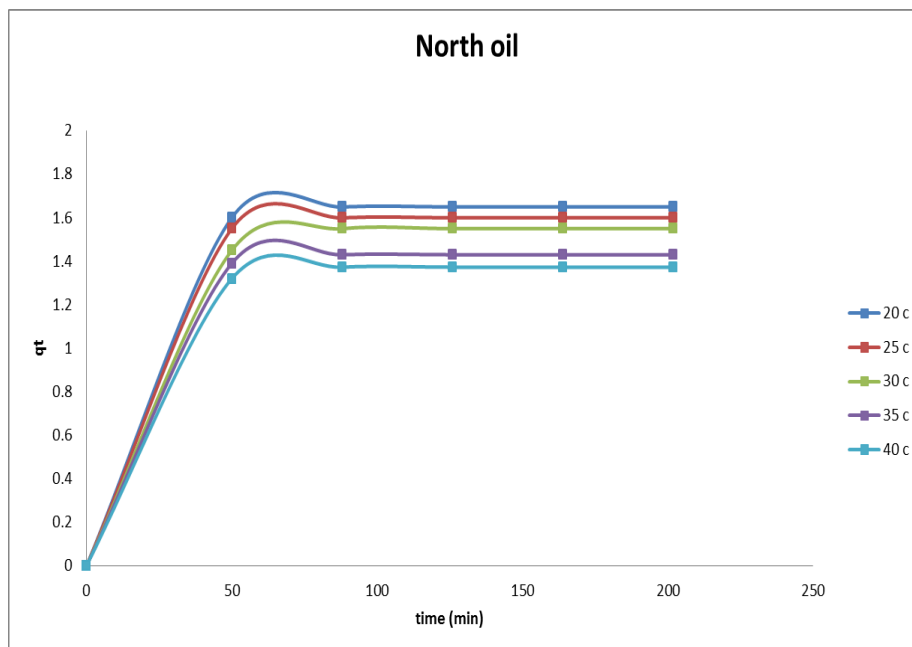


Figure (4): Adsorption rate of north oil on polysulfide at various temperatures.

4. conclusion.

The present study shows that the polymer material gives a high ability to remove North Oil from the aqueous solution, and as a conclusion from this research study, both physical and chemical characteristics show the polymer's ability to act as an absorbent material for removing oil. The initial crude oil concentration in water ranged from 20 to 90 parts per million (ppm * 1000) and the change in oil concentration after adsorption was determined using a UV-VIS spectrophotometer. The experimental data were fitted to the adsorption kinetics of spurious first order models and spurious second order models, with better results obtained for the latter. The results of the study showed that 98.55% of The oil was removed out of the north.

5.Reference

- [1] O. Bridges, "Double trouble: Health risks of accidental sewage release," *Chemosphere*, vol. 52, no. 9, pp. 1373–1379, 2003, doi: 10.1016/S0045-6535(03)00472-7.
- [2] M. Fingas, *The basics of oil spill cleanup*. CRC press, 2012.
- [3] N. S. Abdul Hamid, N. A. Che Malek, H. Mokhtar, W. S. Mazlan, and R. Mohd Tajuddin, "Removal of oil and grease from wastewater using natural adsorbents," *J. Teknol.*, vol. 78, no. 5–3, pp. 97–102, 2016, doi: 10.11113/jt.v78.8519.
- [4] M. Ramutsindela and D. Mickler, *Africa and the Sustainable Development Goals*. 2020.
- [5] M. J. H. Worthington *et al.*, "Sustainable Polysulfides for Oil Spill Remediation: Repurposing Industrial Waste for Environmental Benefit," *Adv. Sustain. Syst.*, vol. 2, no. 6, 2018, doi: 10.1002/adsu.201800024.
- [6] H. Singh, A. Jain, J. Kaur, S. K. Arya, and M. Khatri, "Adsorptive removal of oil from water using SPIONs–chitosan nanocomposite: kinetics and process optimization," *Appl. Nanosci.*, vol. 10, no. 4, pp. 1281–1295, 2020, doi: 10.1007/s13204-019-01195-y.
- [7] E. Worch, *Adsorption Technology in Water Treatment*. 2012.
- [8] C.-I. Lin and L.-H. Wang, "Rate equations and isotherms for two adsorption models," *J. Chinese Inst. Chem. Eng.*, vol. 39, no. 6, pp. 579–585, 2008.
- [9] M. Ungarish and C. Aharoni, "Kinetics of chemisorption. Deducing kinetic laws from experimental data," *J. Chem. Soc. Faraday Trans. 1 Phys. Chem. Condens. Phases*, vol. 77, no. 5, pp. 975–985, 1981.
- [10] S. W. Nam, D. J. Choi, S. K. Kim, N. Her, and K. D. Zoh, "Adsorption characteristics of selected hydrophilic and hydrophobic micropollutants in water using activated carbon," *J. Hazard. Mater.*, vol. 270, pp. 144–152, 2014, doi: 10.1016/j.jhazmat.2014.01.037.
- [11] S. J. Kulkarni, "Role of Adsorption in Petroleum Industries and Refineries," *Int. J. Pet. Petrochemical Eng.*, vol. 2, no. 1, pp. 16–19, 2016, doi: 10.20431/2454-7980.0201004.
- [12] C. Franco, M. Martínez, P. Benjumea, E. Patiño, and F. Cortés, "Water remediation based on oil adsorption using nanosilicates functionalized with a petroleum vacuum residue," *Adsorpt. Sci. Technol.*, vol. 32, no. 2–3, pp. 197–207, 2014, doi: 10.1260/0263-6174.32.2-3.197.
- [13] W. Rudzinski and W. Plazinski, "Kinetics of solute adsorption at solid/solution interfaces: A theoretical development of the empirical pseudo-first and pseudo-second order kinetic rate equations, based on applying the statistical rate theory of interfacial transport," *J. Phys. Chem. B*, vol. 110, no. 33, pp. 16514–16525, 2006, doi: 10.1021/jp061779n.
- [14] P. Wisner, K. Heimlich, and L. Gervais, "Survey of Oil Water Separators and Drainage Design Aspects at Transformer Stations," in *Global Solutions for Urban Drainage*, 2002, pp. 1–13.
- [15] J. Idris, U. Teknologi, and J. Idris, "Oil Spills and Sustainable Cleanup Approach," *Aust. J. Basic Appl. Sci.*, no. March, pp. 272–280, 2013.
- [16] S. Sen Gupta and K. G. Bhattacharyya, "Kinetics of adsorption of metal ions on inorganic materials: A review," *Adv. Colloid Interface Sci.*, vol. 162, no. 1–2, pp. 39–58, 2011, doi: 10.1016/j.cis.2010.12.004.
- [17] B. Lacher, *Pharmacy Technician Certification Review and Practice Exam*. ASHP, 2016.
- [18] F. Mansour, M. Al-Hindi, R. Yahfoufi, G. M. Ayoub, and M. N. Ahmad, "The use of activated

- carbon for the removal of pharmaceuticals from aqueous solutions: a review,” *Rev. Environ. Sci. Biotechnol.*, vol. 17, no. 1, pp. 109–145, 2018, doi: 10.1007/s11157-017-9456-8.
- [19] M. O. Adebajo, R. L. Frost, J. T. Klopogge, O. Carmody, and S. Kokot, “Porous Materials for Oil Spill Cleanup: A Review of Synthesis and Absorbing Properties,” *J. Porous Mater.*, vol. 10, no. 3, pp. 159–170, 2003, doi: 10.1023/A:1027484117065.
- [20] S. Development, P. Chemistry, S. Branch, R. Academy, and P. Akademicheskii, “Materials for Adsorption Purification of Water from Petroleum and Oil Products,” *Chem. Sustain. Dev.*, vol. 13, pp. 359–375, 2005, [Online]. Available: <http://sibran.ru/upload/iblock/7f1/7f1bf8c1d3689a4ea21cb7cb5e2865d2.pdf>.
- [21] N. C. Corda and M. S. Kini, “A review on adsorption of cationic dyes using activated carbon,” in *MATEC Web of Conferences*, 2018, vol. 144, p. 2022.
- [22] M. T. Yagub, T. K. Sen, S. Afroze, and H. M. Ang, “Dye and its removal from aqueous solution by adsorption: A review,” *Adv. Colloid Interface Sci.*, vol. 209, pp. 172–184, 2014, doi: 10.1016/j.cis.2014.04.002.
- [23] P. Kundu and I. M. Mishra, “Treatment and reclamation of hydrocarbon-bearing oily wastewater as a hazardous pollutant by different processes and technologies: A state-of-the-art review,” *Rev. Chem. Eng.*, vol. 35, no. 1, pp. 73–108, 2019, doi: 10.1515/revce-2017-0025.