Experimental Study of Oil Sorbent Performance for Removing Seawater Oil Pollution by PERLIT and ZEOLITE

Danehpash, Shaghayegh, Farshchi, Parvin, Roayaei, Emad, Ghodousi, Jamal, Hassani, Amir Hesam

Department of Environmental Science, Faculty of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran.
Department of Environmental Science, Faculty of Environment and Energy, Science and Research Branch,
Islamic Azad University, Tehran, Iran
Research Institute of petroleum Industry, Tehran, Iran.
Department of Environmental Management, Faculty of Environment and Energy, Science and Research Branch,
Islamic Azad University, Tehran, Iran
Department of Environmental Engineering, Faculty of Environment and Energy, Science and Research Branch,
Islamic Azad University, Tehran, Iran

Abstract
The appearance of COVID-19 virus has affected many aspects of our life. These include and not limited to social, financial and economic changes. One of the most important impacts is the economic effects. Many countries have taken actions to continue the teaching process through online teaching platforms. The students are expected to graduate during the next few semesters with certificates that include some online-completed courses and their graduation certificates are called mixed certificates. This paper considers graduation mixed certificates with some online courses and its impact on graduates seeking jobs. First, we study how well the mixed certificates are accepted by job market. In other words, how different companies, organizations and even governmental entities would accept such certificates when hiring. We study the perception of job market for such certificates for different learning fields. Secondly, we study how well the online courses are accepted by the students keeping in mind that these students are used to traditional face to face teaching. Finally, we paper our results and recommendations according to the collected data from the surveys. Some of the results show that about 60% of companies do not have policies to encourage hiring graduates with mixed certificates. Also, colleges are almost divided evenly between preferring face to face and preferring online teaching.

Keywords:
Oil Sorbent, PERLIT and ZEOLITE, Seawater Oil Pollution, Experimental Study

1. Introduction

The most important source of ocean water pollution is oil materials. The harmful impact of hydrocarbors in river pollution subject has been studied and it's been determined that this type of pollution s especially what originate from oil materials interrupt oxygen demand in water. But their distribution across ocean environment despite the vast expanse influences the life density and usually have destructive effects on plant and animal classes at a large scale [1-3].Economic development and progress of countries and their attempt to provide the required propelling force to move industry, large part of the mental and financial power of the human at every corner of the world have extracted oil resources and mineral oils [4]. Oil waste is estimated at about 900 million barrels in Persian Gulf [5]. It has also been reported that around 39000 barrels of oil has leaked from oil reservoirs [6].

Continental shelf oil extraction on one side and oil transference by large ships has left oceans with critical oil pollution. Such activities provide large amount oil spills into water and by considering the increasing cost of such activities each year the rate of water oil pollution is increasing. These materials because of theirs lightness create a fatty layer on water and prevent light and oxygen entrance into water. since oil spills are not absorbed by the creatures inside the water they become remain on the surface of water and by the expansion of these matrerials ,more and more areas become entangled and finally creat many problems [7].

One of the main ways of removing seawater oil pollution is to make use of oil sorbents. So afar several researches have been carried out about the performance of sorbents in removing seawater oil pollution. High oil sorption capacity, low water sorption and the reusability quality are among the most important reasons of selecting of oil sorbent. So far different materials such as non-organic materials, natural organic sorbents and artificial ones have been analyzed comprehensively [8]. One of the main features of oil sorbents is its hydrophobicity . this mechanism and the structure of adsorbent coud be used to collect crude oil from water surface. These sorbents are used in different forms such as powder, grain, and sheet [9]. In the present work ,two types of adsorbents (expanded perlite and clinoptilolite as a natural zeolite) with different physical properties,were used to adsorbe oil speard on water surface.The experiments were carried out in dynamic method.

Manuscript received July 5, 2026
Manuscript revised July 20, 2026
https://doi.org/10.22937/IJCSNS.2026.26.7.7

2. Experimental Section

2-1-Materials and method

Expanded PERLIT was purchased from tabande toos mashhad company . the natural clinoptilolite obtained from zeolite mine in semnan.oil samples were provided form hengam oil field in south of iran.

2-2-Procedure

In this work we used dynamic method to perform the experiments.in the dynamic method a 100 ml sample of sea water,taken from Persian gulf in south of iran,was placed in abeaker and the desired amount of oil (10-40 g)was added .then,the desired amount of adsorbents (1 g)was added to the oil-water mixture.at this stage the mixture was placed in shaker with the fereqency at range of 75 cycles per minute.these tests were performed at different periods of time from 1-60 min.the each adsorbent was then collected from the mixture surface and wetted adsorbent material was weighted after being drained for 2 min ,the weight of oil and water sorbed on to the adsorbent was measured[10].Also the weight of the absorbed water in each sample was measured using Karl Fischer technique [11].The experiment was performed in replicated 3 times,and the average value was taken for calculating the sorption capacity.The crude oil sorption capacity was calculated as shown in eq1:

$$\text{Oil sorption capacity}=\frac{(S_{st}- S_0)}{S_0} \quad (1)$$

Where $S_0$is the initial dry sorbent weight,S_{st} the weight of sorbent with oil at the end of the sorption test,and the quantity $(S_{st}-S_0)$ the net oil sorbed.(All weighted are measured in grams)

3. Charateristic of Materials

Table 1 and 2 present the chemichal analyses for Expanded perlite and natural zeolite respectively .It is necessary to mention that the composition of the constituents were determined using XRF apparatus. Table 3 gives the bulk density ,porosity and BET surface area of all types of expanded perlite and natural zeolite used in this work.as seen in table 3 expanded perlite with lower density ,higher porosity and surface area.this characteristic makes the adsorbent more applicable in adsorption of oil spill.

Table 1 Chemical analyses obtained for the expanded PERLIT used in this study

Tio2	0.2%
MgO	0.4%
SiO2	68-72%
Al2O3	12-14%
Fe2O3	1%
CaO	1%
Na2O	2-5%
K2O	1-4%
pH	6.7-7.5
Grain Size	1-4mm
Bulk density	<0.12 g/cm^3

Table 2 Chemical analyses obtained for the natural zeolite(clinoptilolite)used in this study

Tio2	0.3 %
MgO	0.8 %
SiO2	68-72%
Al2O3	11.8%
Fe2O3	1.3%
CaO	3.1%
Na2O	2%
K2O	2.1%
L.O.L	12%
Grain Size	60-80µm
Bulk density	1gr/cm^3

Table 3 The Results of BET analyses for two type of different adsorbent

Adsorbent Type	Bulk density(gcm^{-3})	Porosity %	BET surface area(m^{2}g^{-1})
Expanded perlite	<0.12	>90	139.5
Natural clinoptilolite	1	<65	32.46

4. Results and Discussion

The effect of the contact time ,expressed in minutes, the adsorption of oil spill was studied by placing 10 g crude oil on a100 ml sea water at 25˚c with 1 g of each adsorbent for different contact times.Figure 1 shows that sorption capacity of the expanded perlite and natural zeolite increased as contact time increased till they reached maximum values at 10,15 min for each respectively.

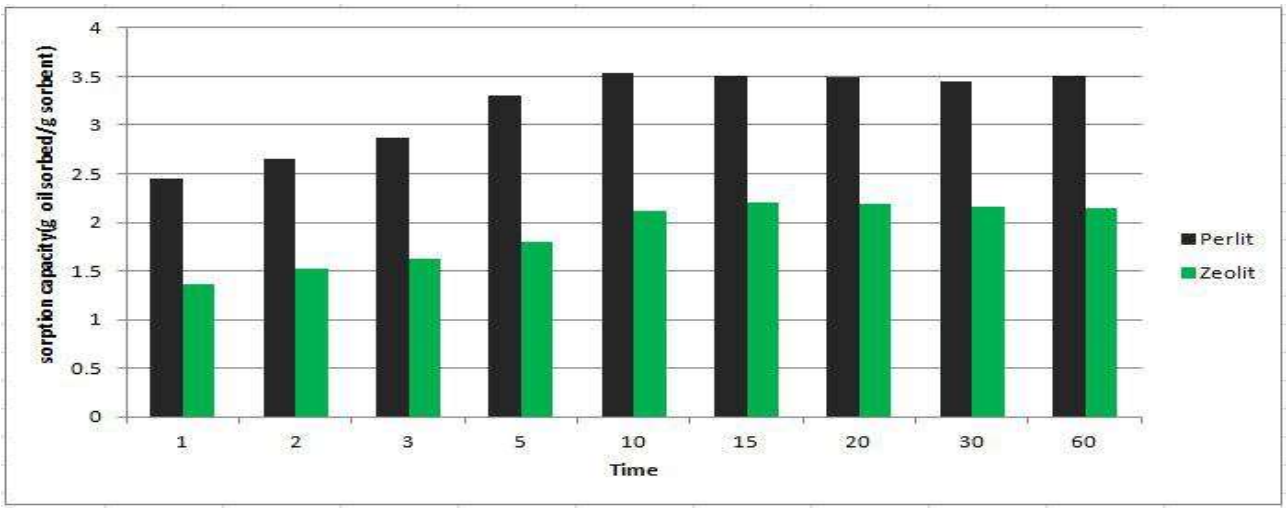

Figure 1: Effect of contact time on sorption capacity of Exapanded perlite and Natural clinoptilolite at 10 g crude oil,25°c and 1g of each adsorbent

The initial concentration of crude oil is an important factor in sorpion capacity.in this stage the effect of amount of crude oil on adsorption obtained with placing 1g of each adsorbent and desired amount of oil from 10 g to 40 g in 100 ml sea water at 25˚c. The results of figure 2 shows that when the intial concentration of oil increase the sorption capacity increases till they reach maximum values at 4.13 and 2.69 for expanded perlite and natural zeolite respectively.in fact there is a direct relation- ship between initial oil concentration and adsorption capacity for both of expanded perlite and natural zeolite.

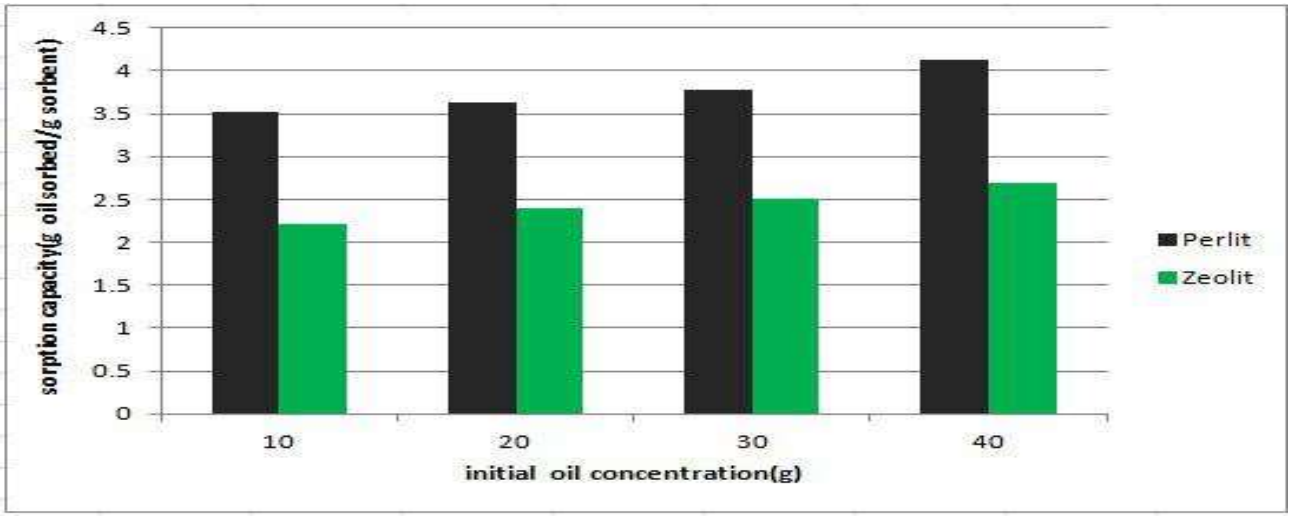

Figure 2 :The effect of initial oil concentration on sorption capacity of Expanded perlite and Natural zeolite.

5. Conclusion

Expanded perlite,which is mainly compsed of aluminum silicate and natural zeolite which is clinoptilolite kind that usually applies for remediation and purification was used to remove oil spills from the surface of sea water .Results obtained under condition ,100 ml sea water,10 g crude oil,25˚c,10,15 min 1g of each adsorbent,respectively,showed that the adsorption capacities of the expanded perlite and natural zeolite are 3.53 g/g and 2.21 g/g respectively.since expanded perlite with high surface area and high porosity shows good results when compared with natural zeolite, so they are recommended to be use in oil spill removal.

References

[1] Abdullah, M.A., Rahmah, A.U., Man, Z., 2010. Physicochemical and sorption characteristics of Malaysian Ceibapentandra (L.)Gaertn as a natural oil sorbent. J. Hazard. Mater. 177, 683–691.
[2] Gurav, J.L., Rao, A.V., Nadargi, D.Y., Park, H.H., 2010. Ambient pressure dried TEOSbased silica aerogels: good absorbents of organic liquids. J. Mater. Sci. 45, 503–510.
[3] J. Ghazi, S. Sultan, Al. Lihaibi, Hydrocarbon distributions in sediments of the open area of the Arabian Gulf following the 1991 Gulf war oil, Mar. Pollut. Bull. 34 (1997) 941–948.
[4] M.R. Riazi, M. Edalat, Prediction of the rate of oil removal from seawater by evaporation and dissolution, J. Petrol. Sci. Eng. 16 (1996) 291–300.
[5] M. Ingaki, M. Toyoda, N. Iwashita,Y. Nishi, H.Konno, Exfoliated graphite for spilled heavy oil recovery, Carbon Sci. 2 (2001) 1–8.
[6] C.A. Page, J.S. Bonner, T.J. McDonald, R.L. Autenrieth, Behavior of a chemically dispersed oil weland environment, Water Res. 36 (2002) 3821–3833.
[7] HooshangAbbasi, oil pollution impacts on Persain Gulf, environment magazine, 1998
[8] Adebajo, M.O., Frost, R.L., Kloprogge, J.T., Carmody, O., Kokot, S., 2003. Porous materials for oil spill cleanup: a review of synthesis and absorbing properties. J. Porous Mater. 10, 159–170.
[9] H. Choi, J.P. Moreau, Oil sorption behavior of various sorbents studied by sorption capacity measurement and environmental scanning, Microsc. Res. Tech. 25 (1993) 447–455.
[10] A.Alihosseini,D.Bastani,A,A.Safekordi,Emulsion and sorption oil spills by expanded perlite,J.Environ.Sci.23(2005)55-68
[11]]ASTM,D1533-00,Annual Book of ASTM Standards,vol.10.3,American Society of Testing and Materials,Philadelphia,2005.