Oil removal technique using spinal cobalt nanoparticles with barley-husk: as additives to increase adsorption efficiency

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Abstract

Oil spills in sea water is the most dangerous type to the marine life in the sea water, for this reason study of the ways to extract spilled oil from sea water ismore important, therefore, this study was about the way that used magnetic nanoparticles to remove oil from sea water. In this study done used the synthesis of magnetic nanoparticle $CoFe_2O_4$ via sol gel mixture with barley- bran to remove and adsorption of oil from sea water.

Two scenarios were being done in this study that is, the first scenario magnetic nanoparticles in mixture with barley-bran in total weight of 0.3 & 0.1in three sections of percentage (50% to 50%), (70% to 30%) and (30% to 70%) of barley-bran and nanoparticles respectively and the second scenario was barley-bran with percentage of 100% of the total weight 0.3 & 0.1 to known the adsorption of it. The gravimetric oil removal capability tests were also performed to investigate the oil absorption properties, the oil removal capabilities of the prepared absorbent were found to be 2.32g/g, 1.75g/g and2.18g/g. and 1.71g/g, 1.27g/g and 1.56g/g. and 1.9g/g and 1.8g/g for 0.3g and 0.1g for mixture & bure barley-bran for two scenarios and three sectionsexplained above respectively.

Keywords: Oil removal, barley husk, nanoparticles, adsorption efficiency.

1. INTRODUCTION

Oil spills from accidents that spread petroleum from transported chips into the surrounding water, mostly seawater. For example, al-Kuwait oil fire in 1991 that are spilled most of oil in sea water [1,2]. Another oil spill accident occurred in 2010 in the Deep-water of Gulf of Mexico and released approximately 206 million gallons of petroleum products into the sea [3, 4]. Globally, the huge amount of oil spill that reach to

400,000 tons the best reason for improve and increase efficient the cleaning technique for

removing oil spilled in the water [5].

Oil spills can have dangerous effects on water and oceans. Because the oil is hydrocarbons (PAHs) that are toxic for both human, marine and bird's life, figure (1) shows chemical structures of some crude oil components. Environmental pollution is the pollution of air, land and water in many ways. There are severalreasons for environmental pollution such as from agriculture and industry (6),Water pollution is the introduction into fresh or ocean waters of chemical, physical, or biological material that degrades the quality of the water and affects the organisms living in it, this process ranges from simple addition ofdissolved or suspended solids to discharge of the most insidious and persistent toxic pollutants (such as pesticides, heavy metals, and non-degradable, bio accumulative, chemical compounds) Petroleum and its products play an important role in our daily life. However, there is a great concern regarding oil spills or leakages accidents into water (e.g., sea, ocean,etc.,) that occur during the extraction, transportation, manipulation and storage of the crude oil (7-8).
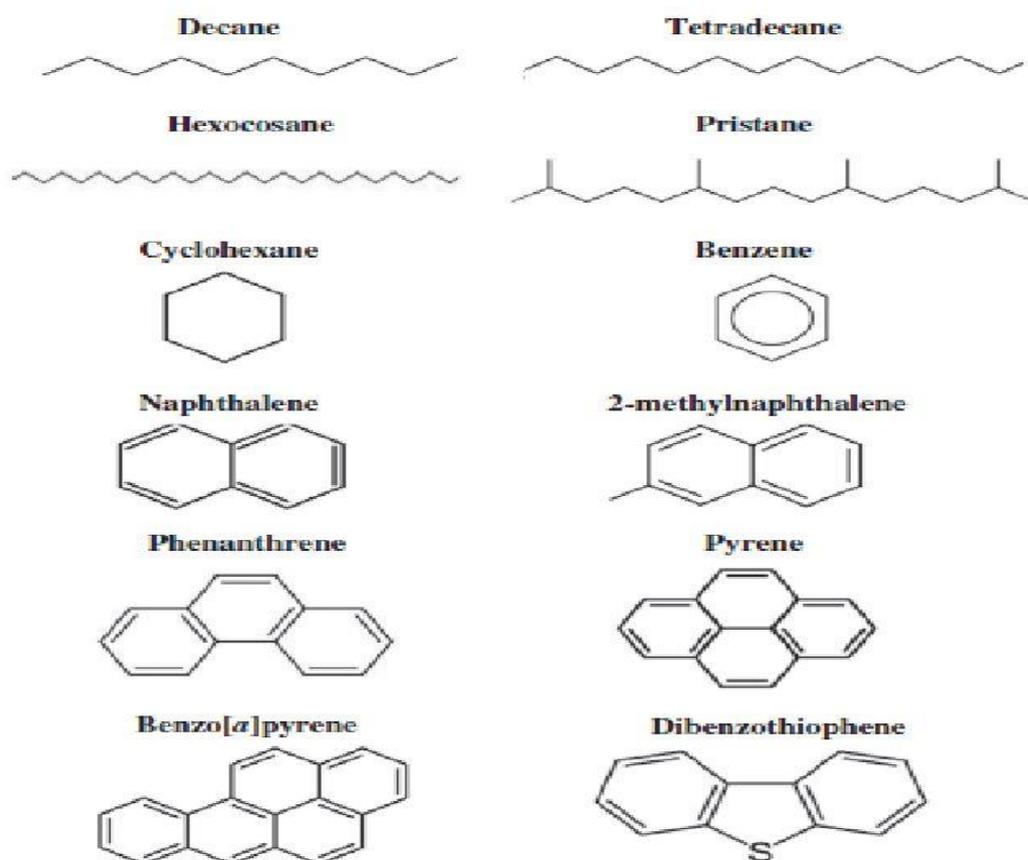

Fig.1 structure of common components of petroleum [5]

Currently, there are different methods for spilled oil cleanup, such as physical (e.g., skimmers and sorption) [9-11], chemical (e.g., dispersion and in-situ burning) [12, 13], and bioremediation [14]. Among these, the oil sorption technique is preferred due to its unique properties, such as environmental-friendliness, availability of various sorbents, cost-effectiveness, low energy consumption, high efficiency, etc. [15, 16].

Skimmers and booms may be controlled from shore or operated from vessels and may be self-propelled [17].

Spinel ferrites are also named as cubic ferrites; they are generally applied at microwave frequencies due to high electrical resistivity and low eddy current losses. The chemical formula of spinel ferrites is MFe_2O_4. In the early 21st century, the spinel ferrite nanoparticles (MFe_2O_4, in which M represents one ormore bivalent transition metals such as Mn, Fe, Co, Ni, Cu, and Zn) have become an important and efficient tool in modern catalytic organic synthesisdue to their unique electronic and magnetic properties (easily separate by external magnet), which are quite different from the conventional bulk materials [18,19,20,21,22].

2. EXPPERIMENTAL PART

The oil removal tests were performed as described previously in the literature[23,24,25]. In this test, 20 mL of Sea water was poured into a 25 ml beaker anda certain amount of the crude oil, was split on the top of water surface. Afterwards, a known mass (0.1 and 0.3 g) of the BHS.CFO NPS, was added onto the tested oil spot. After that, the beaker was left for 15 min before the BH.CFO NPs., and the oil spill being removed magnetically with the help of a permanent magnet. The crude oil removal tests were conducted at room temperature. Finally, the gravimetric oil removal was estimated using the following equation:

GOR= weight of baker with sample (Oil +Powder +Water)- weight of bakerafter

construction / total weight of Powder + Oil

Where: GOR: Gravimetric Oil Removal

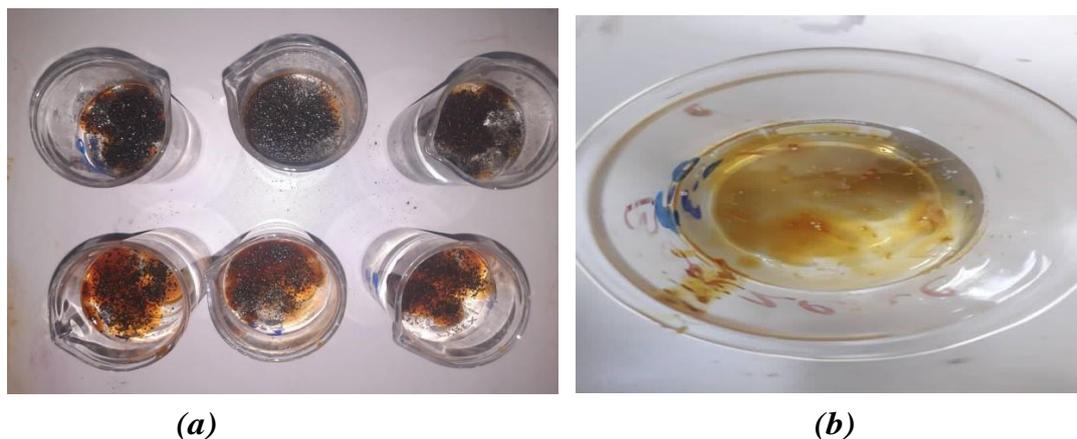*(a)*   *(b)*

Fig.2. Process of crude oil removal from sea water using Nano magnetite (a)mixture of crude oil with BH.CFO in seawater, (b) attraction of crude oil with BH.CFO in sea water by magnetite.

3. Results and Discussion

3.1.Characterization studies

The structure and phase purity of $CoFe_2O_4$ was confirmed by (XRD) analysis, synthesized via sol-gel auto combustion method is shown in Fig. (2)Accordingly, The diffraction peaks are indexed based on the JCPDS (#22 1086). These reflections belong to cubic structure of f.c.c type. The analysis of XRD pattern shows the strong reflections namely (220), (311), (222), (400), (422), (511) and (440) planes of spinel $CoFe_2O_4$ respectively, [26]. the single phase cubic spinel structure of the prepared samples. The most intense peak (311) of the XRD pattern was considered to estimate the crystallite size.

By an increase in temperature the size of the particles is increase, the lattice defects and strains decrease, this may cause coalescence of crystallites that results in increasing the average of the nanoparticles size [26]. at 600ºC or at higher temperatures, magnetization increases with temperature.
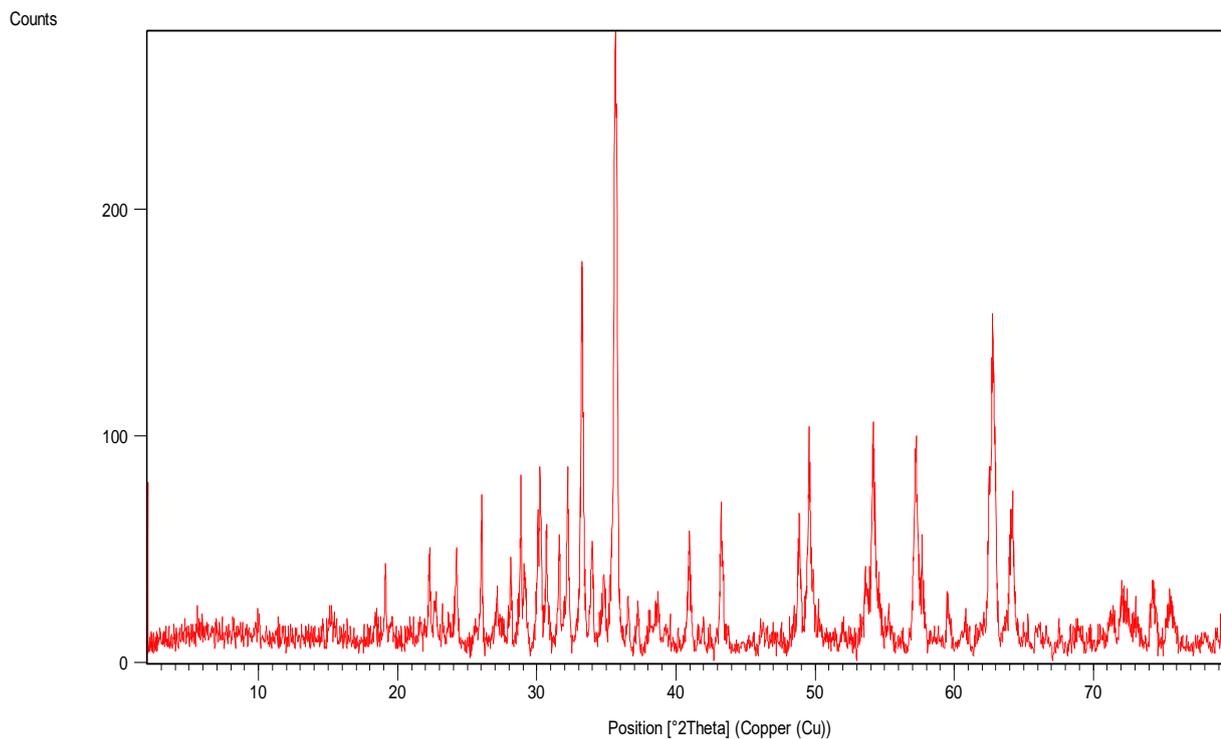
Counts

Fig.3. X-ray diffraction (XRD) pattern of the spinel cobalt ferrite oxide nanoparticles synthesized via sol-gel auto combustion method

2. Effect of Nano (CoFe$_2$O$_4$) with barley husk on crude oil removal:

Figures (4) and (5) indicate that the percentage reduction oil removal of crude oil from seawater is very good of the mixture especially by using total weight of 0.1g on 1ml of oil drop in sea water. this result can show that small amount of the mixture can remove more oil without diving into the water or 1ml of oil drop can remove by only 0.1g of the mixture.

Conversely, by using barley-husk straw with 100% percentage show that the best result is obtained with total weight of 0.3g.
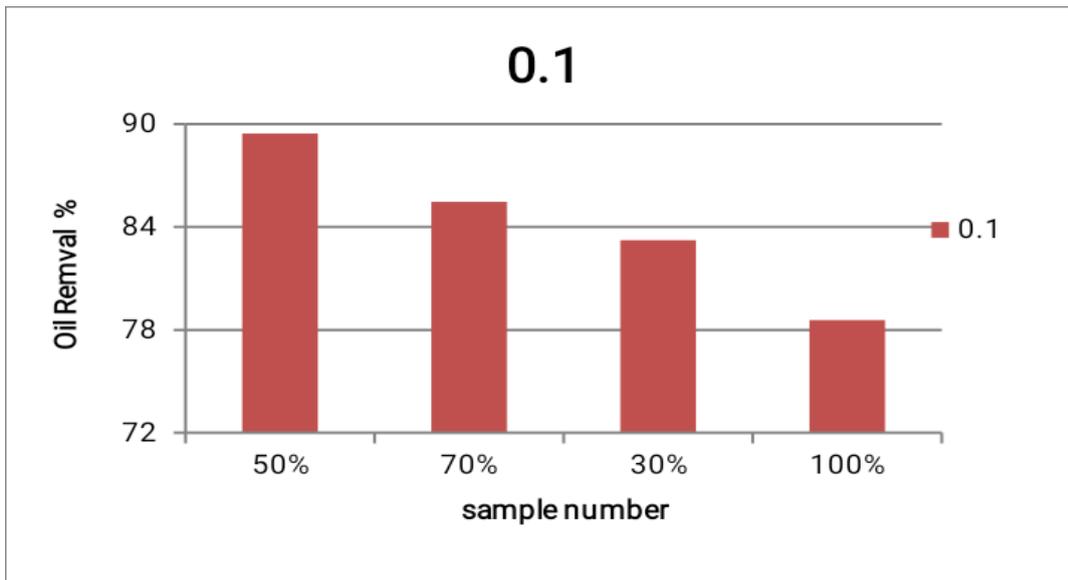
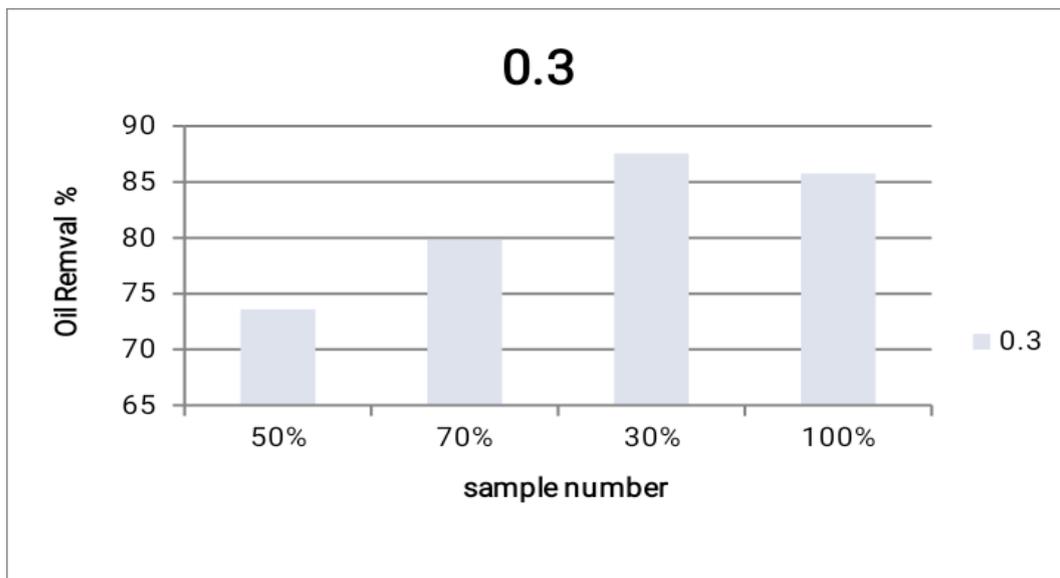**Fig. 4** Removal efficiency percentage of Nano ($CoFe_2O_4$) with barley huskat 0.1

Fig. 5

Removal efficiency percentage of Nano ($CoFe_2O_4$) with barley huskat 0.3

3. Chemical composition of Cobalt Ferrit Oxide (CFO) and barley husk (BH):

Table (2) indicates the chemical constituents of CFA and BH, as determined by x-ray flourecence technique (XRF). The table indicates that the three investigated samples composed mainly of Iron (Fe) 43.6% and 0.988%, respectively. They possess variable contents of Cobalt (Co) 15.6% and 0.203%,in addition to little contents of silica (SiO_2);

0.522% and 45.2%, Some other constituents are also present in variable amounts e.g. Mn, S, Ca, Ni, P, Zn

Table (1): Shows the Chemical Composition of CFA and BH.

Compound formula	Concentration(%)	
	CFO	**BH**
Si	0.522	45.2
Al	0.300	6.82
Fe	43.6	0.988
Ca	0.123	10.8
Co	15.6	0.203
S	16.1	4.81
K	-	12.7
Cl	-	5.70
Ni	0.102	0.912
P	0.785	3.97
Cu	0.0229	0.393
Zn	0.114	0.377
Br	0.0224	0.0411
Rb	0.0228	0.0184
Ta	00.173	0.0857

4.Characterizations FTIR of CoFe$_2$O$_4$

Figure (4) shows the FTIR results for Nanoparticles, it is clearly seen that there are bundles of the terminals at 3410 cm-1 and 1072 cm-1; thesepackets can be attributed to the Co-O and Fe-O bonds, respectively. These specialty packs are characteristic of all spinel oxides Functional groups on the surface of the spinel oxide prepared by the sol-gel method and

then identified using the infrared absorption spectrum (FTIR). The (CFO) after burning the ash compounds in preparation in air at 600∘C fortwo hours.
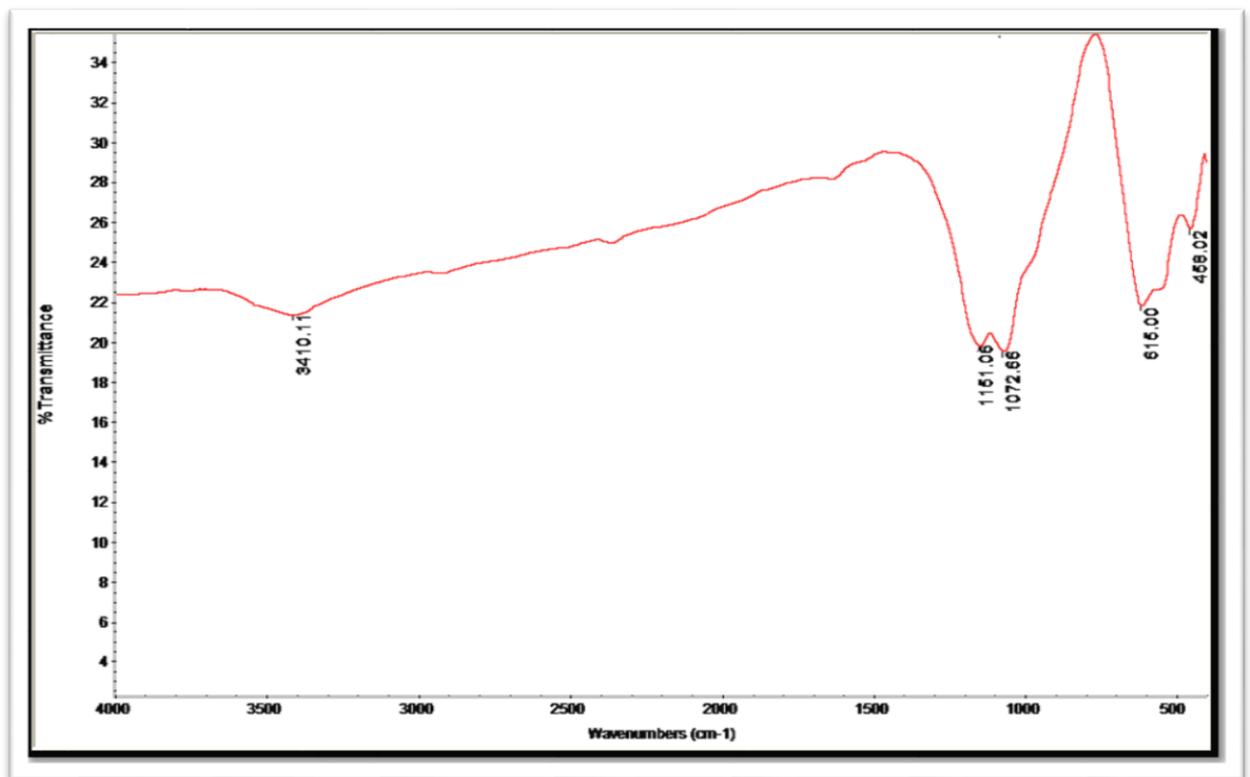

Fig. 4 FTIR spectrum of CoFe2O 4 magnetic nanoparticles

CONCLUSION

- By using a mixture of spinal nanoparticles and barley husk the results were obtained very good reach to 89.45 by using the total weight of 0.1g.
- Observed that by using equal ratios of the mixture 50% the oil cleanup or removal from seawater is high

➕ By using barley husk with 100% percent the result was very good reach to 85% when increasing total weight from 0.1g to 0.3g which concludes barley husk has good adsorbed efficiency for oil.

➕ Finally, we observe that the result obtained by the mixture is very good by using a total weight of 0.1g

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