Treatment of Emulsified Oil in Produced Water from Oil wells by Adsorption on to Corn-Cob as Sorbent

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Abstract:

In this work , a fixed –bed system has been used to study the performance of corn-cob as low cost adsorbent for Treatment of dispersed oil droplets in oil-well product water in this system . In effect of initial oil content (600-1500 ppm), volumetric flow rate (2-5L/min), Bed height (25-35cm) and particle size (1.05-1.6mm) were studied. The results show that removal oil efficiency reaches high percent with decreasing of initial oil concentration, volumetric flow rate particle size and increasing of bed height.

Introduction

Produced water is water trapped underground reservoir rocks and is brought to surface along with crude oil and gas. Besides elevated concentration of heavy metals and salts Produced water contains dispersed oil droplets and dissolved organic compounds. The largest volume of waste in the upstream

Petroleum industry is produced water. Sources of this water may be include flow from above or below or within the hydrocarbon zone flow from resulting injected fluids and additives from productionactivities[1] the process of finding and producing of oil and gas generate a variety of wastes which can

full into the general categories of drilling wastes, produced water, and associated wastes.These wastes can be impact the environment and the greatest impact arises from the release of wastes in to environment in concentrations above naturally found.Due to hazards of oil filed effluents on environment, treatment is necessary before disposal. treatment of these effluents may result in improved oil /water separation ,improved water quality ,oil recovery, waterreuse, protection of downstream facilities andenvironment alpermit compliance [2] many techniques are available for the separation of oil-water emulsions including avariety of filters chemical dosing reverse osmosis, gravity separation, ultra-filtrationmicro, filtration, biological processes ,air filtration ,and membrane bioreactor ,chemical coagulation ,electro coagulation and electro flotation [3,4,5,6]. One commonly used technique for removing organics dissolved in water is the process of adsorption, which involves the separation of substances from one phase to the surface of another. the adsorbing phase is the adsorbent, and the material concentrated or adsorbed at the surface of that phase is the adsorbate [7] This process is physical adhesion of the polluting chemicals

onto the surface of a solid . A wide range of materials for water remediation have actually been employed in recent years .These include activated carbon , bentonite, peat,sand,coal,fiberglass, polypropylene and amber lite[8,9]Many investigators [2]examined the removel of oil from oil-water emulsions by adsorption on bentonite ,powdered activated carbon and deposited carbon.the results gave evidence of the ability of the adsorbents to adsorb oil and that the adsorptive property of the three adsorbents has been influenced by different factors ; effect of contact time the weight of adsorbents and the concentration of the adsorbates. They show that oil removal percentage increase with increasing contact time. and the weight of adsorbents ,and decrease with increasing the concentration of adsorbate.

Bnito etal ,[10] improved several techniques to remove the oil phase ,which has high organic matter content (50000-80000ppm).A deep bed filtration has been reported as an efficient process [11,12] The feasibility of fixed beds depends on large extent on the costs of the filter media and therefore, research has been focused on the use of solid waste materials or cheap and abundant natural products . The objective of this research is to assess the performance of corn-cob as filter media for the treatment of oil in water emulsions, and study the influence of many operating conditions.

Theory:

The adsorption of a substance from a liquid phase to the surface of a solid phase (corn-cob) in a system , leads to a defined distribution of that substance between the two phases when the system reachs equilibrium that is when the rate of solute onto the surface of the adsorbent is the same as the rate of its adsorption from the surface of the adsorbent .threrfore ,there is no further net adsorption occurs.

Materials and Experimental method:

The adsorbent:-

In this study corn-cob was chosen because of its low cost and available in Iraq.

Usually, corn-cob defined by the size of particle.

The corn-cob has three parts:

- Chaff
- Pith
- Woody-ring

The first part, chaff, which also is called beeswing is on the outside of the cob.

The second part, pith is the soft/spongy center portion.

The third part, woody-ring, which forms between the chaff and pith as shown in Fig[1]. Those portions have a bulk density of approximately 8lb/ ft^3 [13] Products made from the woody-ring portion are referred to as "grit" products and products made from pith and chaff are referred to as "pc" products. Both Grit products and pc products are: all-natural, bio-degradable and renewable. The water absorbency for pc products was tested and found that the absorbency of water can
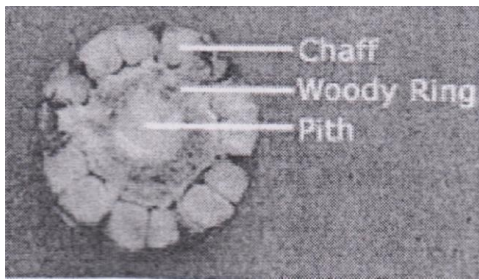
Fig (1): parts of corn-cob

Approach 300% on a eight-to-weight basis and weight compares to grit products at about 100% [13].

Experimental products:-

Preparation of corn-cob:

Particles of corn-cob was obtained by crushing of dry corn cob and separated from its pith/chaff and sieved to produce a particle size (1.05, 1.4, 1.6 mm) which was used in this study.

The corn cob thus treated was washed with distilled water to reduce the residues content, then dried at 110-115ºc for 10hr and store in desiccators at room temperature.

Preparation of samples:

Oil-in water emulsions were prepared by mixing a commercial cutting oil obtained from East Baghdad field in distilled water. The experiments was carried out with emulsions containing initial oil concentration ranged from 600ppm to 1500ppm.

Experimental apparatus

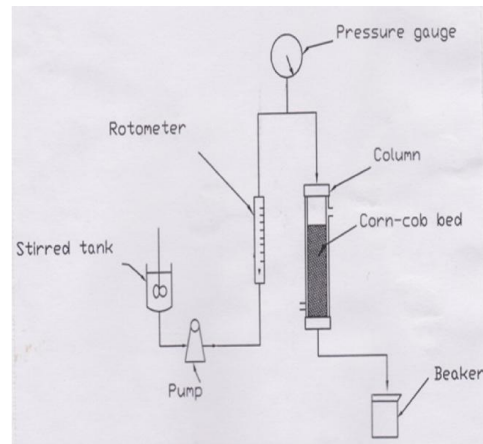A schematic diagram of the experimental apparatus is shown in Fig (2).

Fig (2) schematic diagram of Experimental Apparatus

Fig (3) shows the photo of the system

Procedure:-

For all experimental the mass of corn cob was placed in a column with diameter 10cm and height 45cm.

Filter bed heights (from 25 to 30cm). The pressure drop across the column was measured by pressure or meter gaugeExperiments were carried out by flowing the oil/water emulsion from acontainer through the column by flow meter that allowed monitoring the flow rates.

The oil concentration was measured by spectrophotometer model UV-160A.Experiments were ended when effluent breakthrough took place, due to oil saturation of the bed, or when the pressure at the inlet rose up to 6 bar.

Result and Discussion:

Tables (1-4) shows the results of the ratio of residual oil concentration in the effluent and initial oil concentration in feed solution as a function of major design parameters, which include bed height volumetric flow rates also varying of initial oil concentration and particle size of corn-cob.

The results show how oil removal efficiency affected by these variables.

The effect of variation of initial oil concentration was investigated at constant flow rate (2L/min), constant bed height (35cm) and constant particle size (1.4mm), the curves are presented in Fig (4).
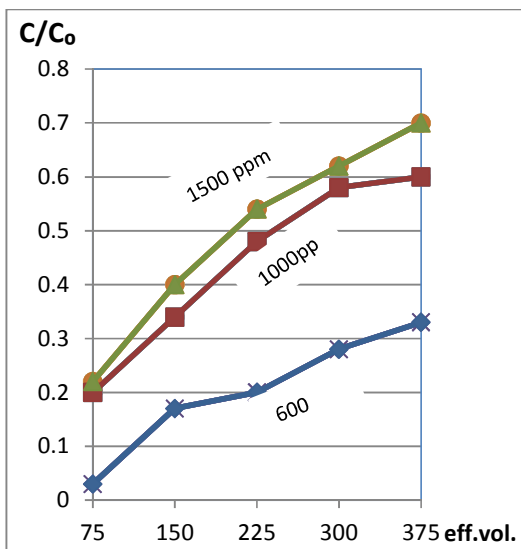

Fig (4) The effect of variation C_o with C/C_o (flow rate = 2L/min , height = 35Cm, particle size = 1.4mm)

It is obvious that increasing initial oil concentration increases the residual oil concentration and hence decreases removal oil efficiency, this attributed to the decrease in surface area of corn-cob because of increasing the amount of oil adsorbed per unit weight of corn-cob.

To study the effect of volumetric flow rate on adsorption ability of corn-cob. Many experiments conductedto show this effect at constant bed height (35cm), initial oil concentration (600ppm), and particle size 1.4mm) Fig(5).
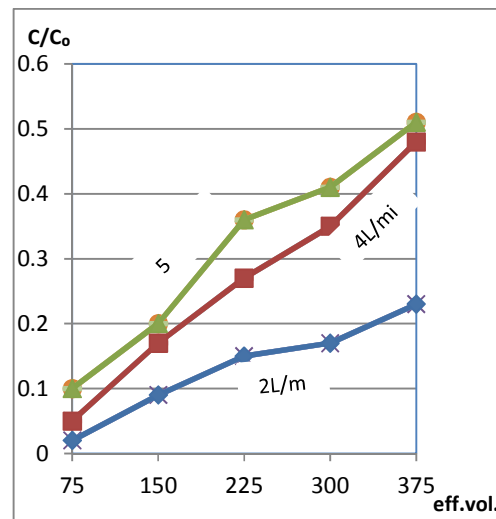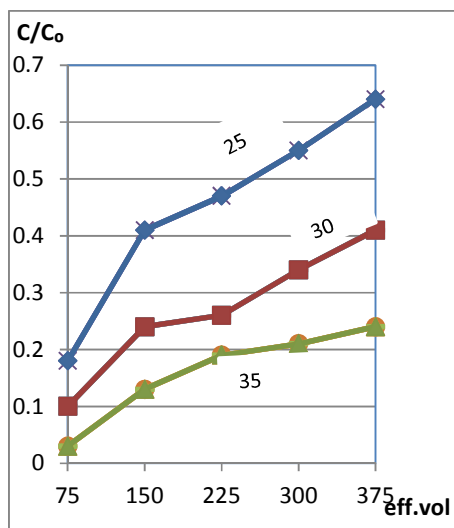

Fig (5) The effect of variation flow rate with C/C_O (H =35 cm,Particle size =1.4 mm,C_O=600 ppm

It is obvious increasing of flow rate decreases the ability of corn-cob to subtract oil droplets, then decreasing oil removal efficiency, the explanation is due to generation of large size oil droplets which trapped in the void space and residence in these spaces which cause increase in velocity of a liquid phase and decrease in the resistance to mass transfer and increases the mass transfer rate

(weakening the driving forces of disperse phase).

Fig (6) show the curves obtained for different bed height by increasing the amount of corn-cob, keeping constant initial oil concentration (600ppm), volumetric flow rate (2L/min), and constant particle size (1.4mm).

it is obvious that increase in bed height increases the ability of corn-cob to treat a larger volume of contaminate solution, this is due to increasing of residence time of emulsion in the column due to increasing of bed porosity and increasing of surface area

Fig(6) The effect of variation bed height with C/C_O (C_O = 600 ppm , flow rate = 2L/min , P.S=1.4 mm)

Varying the particle size is another important effect which investigated, the experimental curves are presented in Fig(7) for different particle sizes (1.6, 1.4, and 1.05 mm) at constant initial oil concentration (600ppm), constant flow rate (2L/min) and constant bed height (35cm). it is obvious that the

smaller size of particles showed a higher oil removal efficiency than the other sizes, this is due to elimination of inter particle mass transfer resistance andlarge surface area of smaller size particles.
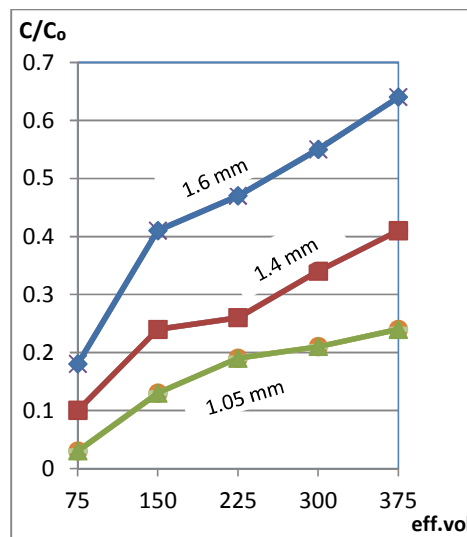
Fig(7) The effect of variation of particle size with C/ C_O (C_O=600 ppm, flow rate = 2 L/min, Height of bed H =35 cm)

Conclusion:

Experiments on oil removal by affixed – bed system under varying condition of initial oil content, flow rate, bed height and particle show that:

1_ corn – cob has great absorbent for oil droplets in water.

2_ removal efficiency reaches high percent with deceasing of initial oil concentration, volumetric flow rate and particle size.

3_ removal efficiency reaches high percent with increasing of bed height .

Table (1) Variation of CoWith C/CO Height of bed H= 35cmflow rate = 2 L/min Particle size = 1.4 mm

$c_0 = 600ppm$		$c_0 = 1000 ppm$		$c_0 = 1500ppm$	
eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$
75	0.03	75	0.2	75	0.22
150	0.17	150	0.34	150	0.4
225	0.2	225	0.48	225	0.54
300	0.28	300	0.58	300	0.62
375	0.33	375	0.6	375	0.7

Table(3) Variation of Hwith C/COCO= 600 ppmflow rate = 2 L/min Particle size = 1.4 mm

V.F.= 2 L/m		V.F.= 4 L/m		V.F.= 5 L/m	
eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$
75	0.03	75	0.05	75	0.1
150	0.09	150	0.17	150	0.2
225	0.15	225	0.27	225	0.36
300	0.17	300	0.35	300	0.41
375	0.23	375	0.48	375	0.51

Table(2)) Variation of F.RWith C/C Height of bed H= 35cmCO = 600 ppm P.S = 1.4 mm

	p_s:1.6 mm		p_s:1.4 mm		p_s:1.05 mm	
eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$
75	0.18	75	0.1	75	0.03
150	0.41	150	0.24	150	0.13
225	0.47	225	0.26	225	0.19
300	0.55	300	0.34	300	0.21
375	0.64	375	0.41	375	0.24

Table(4)) Variation of P.Swith C/COCO= 600 ppmflow rate = 2 L/minHeight of bed H= 35cm

H= 25cm		H= 30cm		H= 35cm	
eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$	eff. vol.	$\frac{c}{c_0}$
75	0.12	75	0.05	75	0.01
150	0.2	150	0.07	150	0.02
225	0.33	225	0.2	225	0.1
300	0.4	300	0.26	300	0.19
375	0.54	375	0.36	375	0.23

Nomenclature :

C: residual oil concentration effluent ppm

C_0:initial oil concentration in feed solution ppm

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معالجة النفط المستحلب للنفط في المياه المنتجة في الآبار النفطية بإستخدام عرانيص الذرة كممدص

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الخلاصة:

يتضمن البحث استخدام منظومة الطبقة الثابتة في دراسة ادائية عرانيص الذرة كعامل ممدص حيث يمتاز برخصة وتوفرة محليا وسهولة تحضيره في معالجة قطرات النفط المشتتة في المياه المصاحبة المنتجة في آبار النفط. تم دراسة مجموعة من الظروف او المتغيرات التشغيلية التي تؤثر على كفاءة ادائية هذه العملية في ازالة النفط والتي شملت التركيز الاولي للنفط المتشتت في المحلول ومعدل الجريان الحجمي وارتفاع طبينة عرانيص الذرة في العمود وحجم حبيبات عرانيص الذرة اوضحت النتائج ارتفاع كفاءة ازالة النفط المشتت في المستحلب مع نقصان التركيز الاولي للنفط ومعدل الجريان وحجم الحبيبات وازدياد ارتفاع طبقةعرانيص الذرة.