

RESEARCH PAPER

REDUCING OIL POLLUTION IN KAWERGOSK OIL REFINERY EFFLUENT

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ABSTRACT:

The present work deals reducing the oil spill pollution by the treatment of oily wastewater in Kawergosk oil refinery. This research evaluates the efficacy of dissolved air flotation in treating manufactured water samples attained from Kawergosk oil refinery. Percent removal into effluent before and after treatment concerning oil content, COD and BOD are determined. Process factors administering the execution of dissolved air flotation in the reducing of oil and grease are initial oil concentration, pH, and flow rate is investigated. In the dissolved air flotation experimentations, highest oil removal is 85%. The optimum pH for maximum percent removal is 9 with flow rate of 88 m³/hr, and 92 m³/hr. Related to COD and BOD maximum percent removal obtained when pH values are 8–9. In addition, the results indicated that the parameters as initial oil concentration, pH and flow rate have a direct effect on the air flotation process in the handling of wastewater.

KEY WORDS: Wastewater; Oil and grease; Separation; Dissolved air flotation.

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1. INTRODUCTION

The risk of oil pollutants will increase thru the evolution of oil survey and manufacturing processes, besides the industrial improvement around the world. The research at the handling of oily wastewater is a crucial problem to ecological safety such as oil brought on troubles to the wastewater treatment offerings (Wahi et al., 2013). Natural toxic waste oil and grease in water results in lower dissolved oxygen levels within the water.

Then made trouble for oxygen particles to be oxidative for bacterial on hydrocarbon particles and cause biology harms to water forms (Ite et al., 2013). The acceptable hydrocarbons and its products that release into water forms in Iraqi protection law are set 20 mg/L (Law, 2011)

1.1 Objective of study

The main objective of this study is to estimate the efficiency of DAF in removing oil and grease from refinery wastewater. Additional purposes involved the following:

1. In Erbil city, external runoff from each aspects of greater-Zab River blends through the river water. Formed effluent from Kawergosk oil refinery can also blend through surface runoff and far ahead input to the river; otherwise it might also blends at once through aquatic assets.

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- Classification of wastewater produced at the Kawergosk refinery.

- To investigate the influences of the processing factors on removal efficiency of oil and grease, COD, BOD and TDS in the Kawergosk waste water treatment site.

1.3 Principles of Air Flotation

In the dissolved air flotation, the pressurized stream is saturated with a gas commonly below 2.7bar-4bar. Upon the discharge of pressure, the air is above of the atmosphere saturation concentration is discharge from solution evolving bubbles almost 30µ to 120µ in diameter. The bubbles produce on the exteriors of the postponed particles otherwise are interested in the particles via surface energies. The most significant electrical property of the colloidal and suspended particles is their surface charge. This charge makes the particles to stay in suspension deprived of collecting for long times. Surface water particle suspensions are thermodynamically unsteady and given sufficient time; they will flocculate and settle. For most particles in water, the sign of the charge is negative (McCave, 1984). Therefore, an aggregate is formed who is a mean density is much less than that of water will rise to the surface, which follows the same laws as sedimentation but in an inverse field of pressure.” The governing equation in air flotation separation, as in all gravity controlled approaches, is Stokes Law, that's used to calculate the rising rate of bubble flocks, agglomerates, and bubble-oil accumulation (Alwared and Faraj, 2015).

1.2 Refinery Overview

Erbil Kawergosk oil refinery is the first most crucial refinery inside the northern of Kurdistan about 30 km far from Erbil City. Kawergosk refinery is the fourth biggest in Iraq, the biggest private part one and native investment in Kurdistan. It obtained its first oil in 2009. Its produced wastewater disposed to characterize through the attendance of massive amounts of crude oil yields, greases, polycyclic and aromatic hydrocarbons, phenol, sulfides, naphthenic acids, and different chemical substances (Aziz, 2017). If manufactured wastewater from oil refiners inclined to the surroundings, it might harm to the water assets (Fakhrey, 2016).

The oily effluent in the Kawergosk oil refinery will be separated and removed through these steps shown in figure (1).

$$V_t = \frac{gd^2(\rho\alpha - \rho_0)}{18\mu} \dots\dots\dots (1)$$

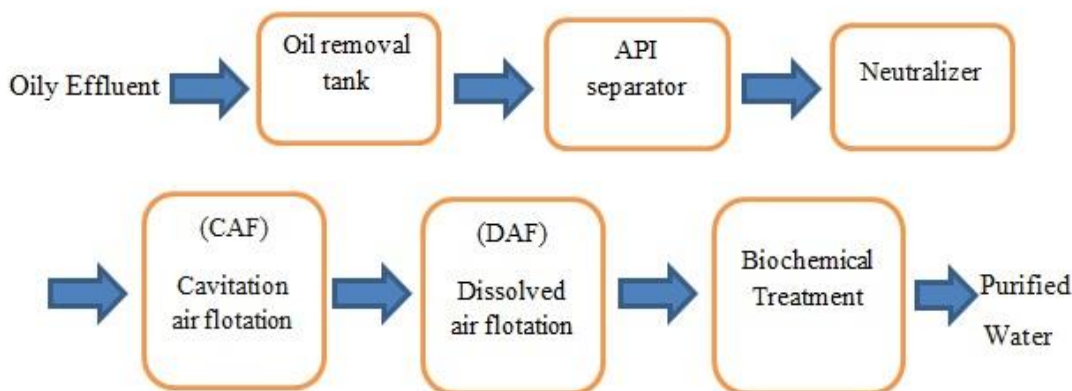


Figure (1) Kawergosk refinery wastewater treatment plant

2. LITERATURE REVIEW

(Painmanakul et al., 2010) the removal of oil mixture in wastewater via the induced air flotation on the research of the consequence of bubble size and chemical coagulant and chemical amount for the handling of greasy wastewater has been developed on this study. The pH value within the range of pH 8-10 is the efficient value for removing oil emulsion using alum as a chemical coagulant.

(Saththasivam, Loganathan, & Sarp, 2016) air flotation is one of the practical devices to remove oil components from oily wastewater. DAF is reducing oil concentration from about 10 ppm to 1000 ppm by prior adding of coagulants-flocculants. Oil bubble attachment by using of full encapsulation gives the greatest percent removal.

(e Silva, e Silva, da Silva, et al., 2018) applying bio surfactants and the dimensionless number of Damköhler (Da) in a prototype of DAF yields the removal efficiency around 90%. It was detected it is probable to estimate the flotation chamber volume based on the desired value of removal efficiency.

(Tetteh and Rathilal, 2018) DAF is less affected by rising saturator pressure and rising rate, as compared with raising the air-water ratio. The accumulation of the oil precipitations is depended only on the poly aluminum sulfate (PAS) amount to weaken the oil drops. The DAF removal efficiency presented above 80% at optimal circumstances of pH of 5, PAS dosage of 10 mg/L, the rising rate of 15 minutes, air saturator pressure of 300-500 kpa, and the air-water ratio of 5-15%. The most significant factor is the PAS dosage.

(Varjani et al., 2019) have reviewed different types of petroleum waste water treatment technologies such as adsorption, coagulation, opposite osmosis, ultrafiltration, chemical destabilization, flocculation, dissolved air flotation (DAF). In this analysis, they similarly offer technical works on information fissures also futurity investigation that orders to estimate the impacts of several treatment technologies existing.

3. MATERIALS AND METHODS

3.1 Oil and Grease

The process applied for the oil and grease test was improved by Standard Methods for the Analysis of Water and Wastewater which is investigation way for oil and grease petroleum hydrocarbons in water (ASTM D3921-96, 2011). During visits to the Kawergosk refinery in December 2018, January and February 2019, effluent water samples were collected from air flotation treatment unit. Input sampling point is shown in figure (2 a) and (2 b) shows the output sampling point. The samples are daily collected during the visiting to the site. Poly Aluminum Chloride (PAC) is used as a coagulant. The process parameters such as oil content, pH and flow rate was different in each sample. The refinery ranges for parameters are shown in table (1) these parameters have been changed to determine the effect of each parameter on the DAF during the treatment of oily waste water. Input oil contents are changed depend on the crude oil that refined in the site so in every two hours the oil content was determined.

Table1: characteristics of refinery wastewater

Parameter	Range
Wastewater Temperature (°C)	25 – 32
pH	6- 10
Input oil content (C _{in}) mg/l	10 -100
Flow rate m ³ /hr	75 - 120
Pressure (bar)	1.5-2.5



(a)



(b)

Figure (2) wastewater sample (a) DAF input wastewater. (b) DAF output wastewater

3.1.1 Experimental procedure

1. Five hundred milliliter of sample composed in a clean 1000 ml separator funnel.
2. A distillation flask of 125ml dried and cleaned. The weight of the flask was recorded.
3. Adding 4 milliliters of 1:1 HCL to the separatory funnel for pH adjustment via a pipette also pipette filler.
4. Fifty milliliters of CCL₄ added to the separator funnel to achieve the extraction between the water and oil.
5. The funnel was closed then reversed to discharge the vapors thru the stopcock. So, the funnel was intensely shaken for 2 minutes. To discharge vapors from the separatory funnel, reverse and wobble it formerly very hard and point the delivery tube in as safe way beneath a hood and gradually open the stopcock to discharge all vapor.
6. Leaving the funnel for at least 10 minutes to approve the separation. This procedure was repeated two more times on the produce water solution that remained.

7. The solvent was drip exhausted into the distilling flask which is pre-weighted thru a funnel.
8. The distilling flask including the solvent was placed in the hot water bath on the top of the heater to 85 °C interior the hood. The flask was detached from the water bath after finishing evaporation of solvent.
9. The flask was located in the desiccator for 30 minutes.
10. The flask was weighted by an analytical balance.

In all the tests oil content was determined before and after treatment. The procedure was repeated for samples having different oil contents at the same conditions, so as to investigate the influence of oil content on the flotation manner.

3.1.2 Oil and Grease %Removal

The amount of oil and grease removed from refinery waste water is calculated by using the following equation:

$$\text{mg oil and grease/l} = (B1 - B2) \times 1000/\text{ml sample} \dots \dots \dots (2)$$

$$\% \text{ oil and grease removal} = \frac{\text{initial concentration} \left(\frac{\text{mg}}{\text{l}} \right) - \text{final concentration} \left(\frac{\text{mg}}{\text{l}} \right)}{\text{initial concentration} \left(\frac{\text{mg}}{\text{l}} \right)} \dots \dots \dots (3)$$

3.2 Chemical Oxygen Demand (COD)

COD of wastewater was evaluated thru usage of COD photometer device. The suitable dosage of wastewater (2ml) was presented into absorption solution (MR-Rang: 150-1500mg/l) including potassium hydroxide, sulfuric acid, and mercuric sulfate. Then the combination moved to COD reactor (model RD-125), for 120 min at 150°C., The COD concentration was displayed on the screen after completing oxidation.

3.3 Biochemical Oxygen Demand (BOD)

BOD was measured via usage of the respirometric system. Each incubation bottle is associated to a pressure sensor in a locked process which called air incubator. Microorganisms devour oxygen in the wastewater, the pressure in the bottle headspace drops. This varying in the pressure relates straight to BOD. Through determining pressure variations alternatively of dissolved oxygen levels, the necessity for inquiries and titrations is removed. One Nutrient buffer pillows and 5tabs of potassium hydroxide absorber added to the bottle. The measured BOD value is displayed as (mg O₂/l) on screen.

4. RESULTS AND DISCUSSION

4.1 Effect of pH on Oil and Grease Removal, COD and BOD

The influence of pH shows a significant character in the eliminating of oil and grease through

flotation process. Values of pH changed daily with produced water also in the rainy days pH value was low. To know the influence of pH on the DAF dissimilar values of pH have been tested.

Figure (3) represents the effect of pH on the removal of oil and grease at a constant flow rate (78m³/hr) and different oil content. The graph displays that the amount of oil deletion increased with increasing pH until achieved its highest percent removal value at pH (7.5) which recommends that the revulsion among bubbles and oil particles are lost and the adhesion between them is motivated. The figure also shows pH (6.5 and 9.3) are giving the same oil removal at this flow rate. The highest oil and grease removal at flow tare (92m³/hr) and at pH (9.2) is approximately 90%; it can be seen in figure (4).

Figure (5) explain the influence of pH on the oil and grease removal at constant initial oil concentration (14mg/l) and (32 mg/l) with different flow rate. It shows that the oil removal decreases at first, then it is beginning to rise gradually through increasing pH.

Figure (6) and (7) show the relation between pH and COD and BOD. The graph clearly specifies the highest BOD and COD were observed between the pH values of 8–9. That because the adhesion between bubble and oil droplets promoted at this range.

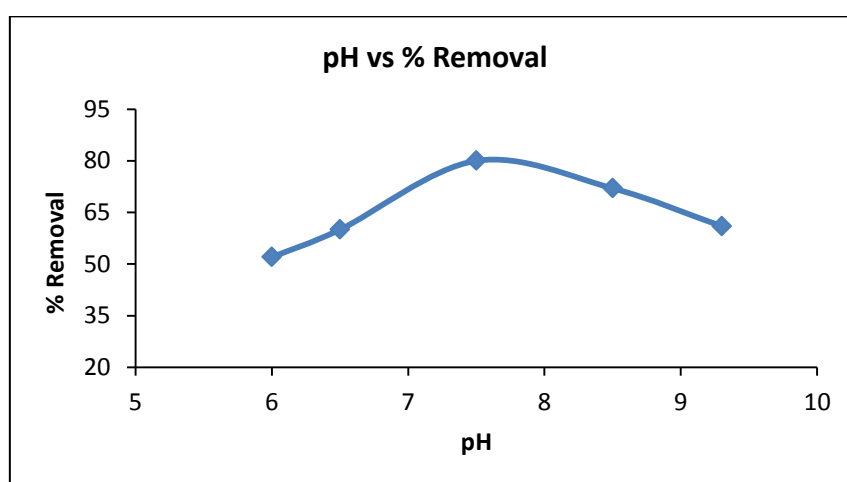


Figure (3) Effect of pH on the oil and grease removal at flow rate= 78m³/hr

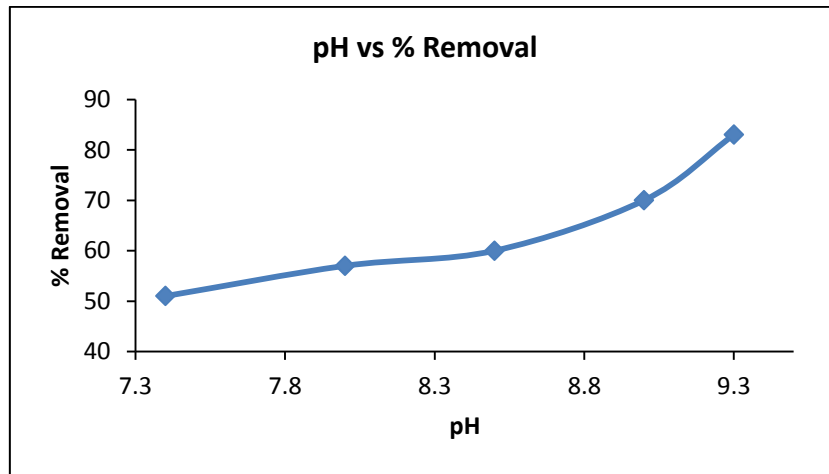


Figure (4) Effect of pH on the oil and grease removal at flow rate= 92m³/hr

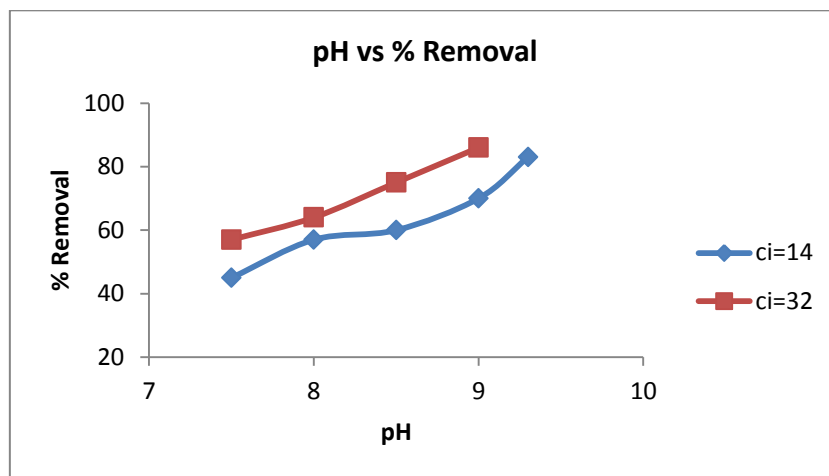


Figure (5) Effect of pH on the oil and grease removal at Different oil content

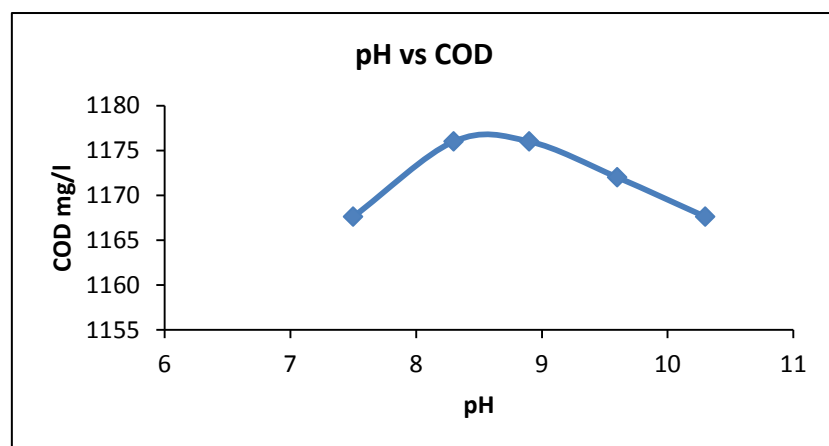


Figure (6) Effect of pH on the COD at oil content= 64.2 mg/l, flow rate=88 m³/hr

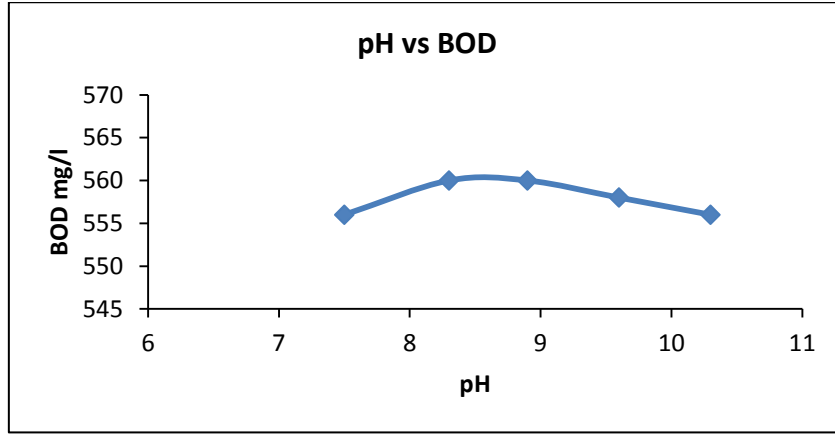


Figure (7) Effect of pH on the BOD at oil content= 64.2 mg/l, flow rate=88 m³/hr

4. 2 Effect of Initial Oil Concentration on Oil and Grease Removal, COD and BOD

Figure (8) demonstrates the consequence of increasing percent removal of oil and grease within constant pH (8.9) and flow rate (88m³/hr). The graph shows increasing of initial oil concentration will result in increasing oil and grease removal because the interaction between an air bubble and oil precipitations will increase while the initial concentration of oil increased. Wherein the oil content is more significant than (25mg/l) with pH (7.5) there is no apparent

increase in the oil removal, so at this region. Hence there is an average oil and grease removal (75%).

Figure (9) and (10) demonstrate the influence of increasing initial oil concentration on COD and BOD. The graph indicate increasing of initial oil concentration results rising in COD and BOD because while the input oil content augmented the requirement for air bubble for oxidation reaction is increased.

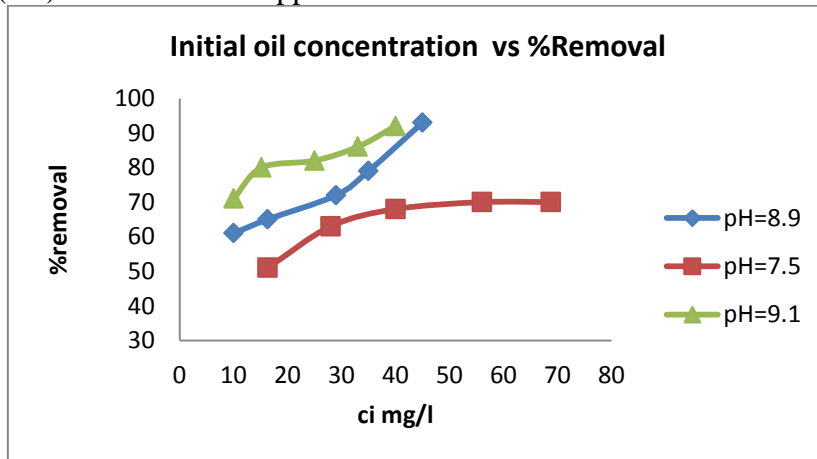


Figure (8) Effect of initial oil concentration on the removal of oil and grease at different pH

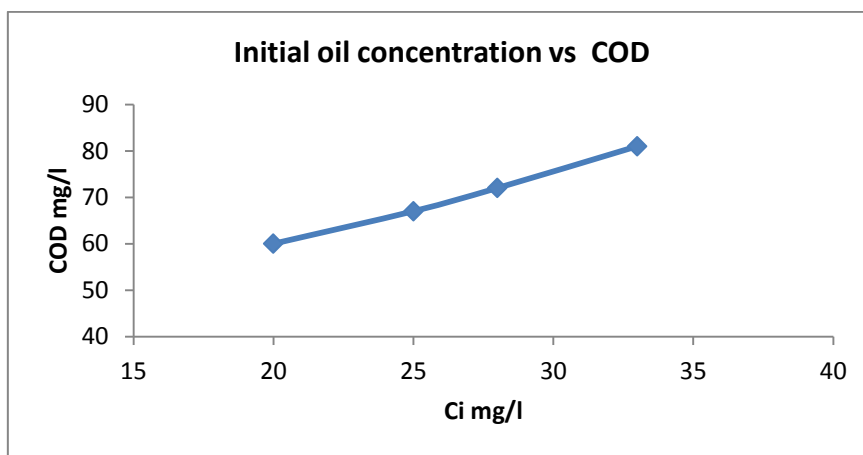


Figure (9) Effect of initial oil concentration on the COD removal

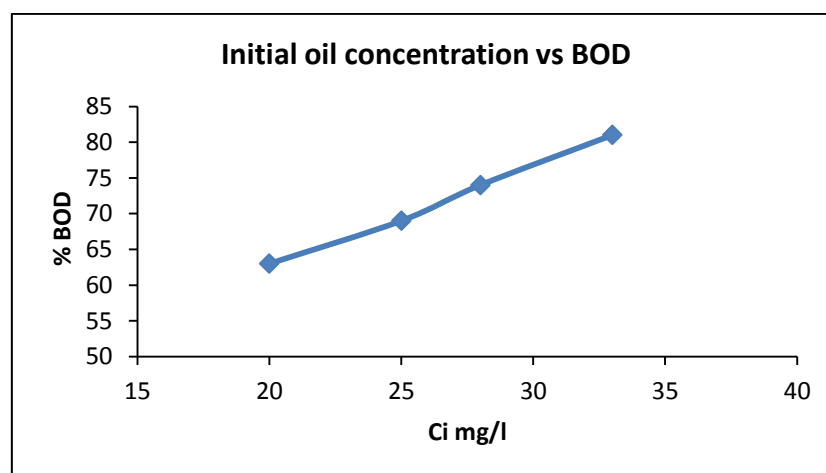


Figure (10) Effect of initial oil concentration on the BOD

4.3 Effect of Flow Rate on Oil and Grease Removal

Figure (11) presents the relationship between flow rate and oil removal. The figure indicates the percent removal of oil decreases as flow rate increases for constant pH (6), the lowest oil removal is achieved at a flow rate of (120m³/hr). The maximum oil removal at constant pH (8) is obtained at lowest flow rate (78m³/hr) figure (12).

Figure (13) illustrate the influence of flow rate on the oil removal. The graph demonstrates the increasing of flow rate which is significant at (88m³/hr) and the optimum flow rate

for removing oil and grease at pH (9), where the minimal removal yielded at flow rate (75m³/hr) because at this flow rate the probability of impact between bubbles and oil droplets results to reduction in the separation efficiency.

Figure (14) shows the relation between flow rate and percent oil removal at constant oil content (33mg/l) there is no apparent increase in the oil removal, so at this oil content, the amount of oil removal does not much affected by flow rate.

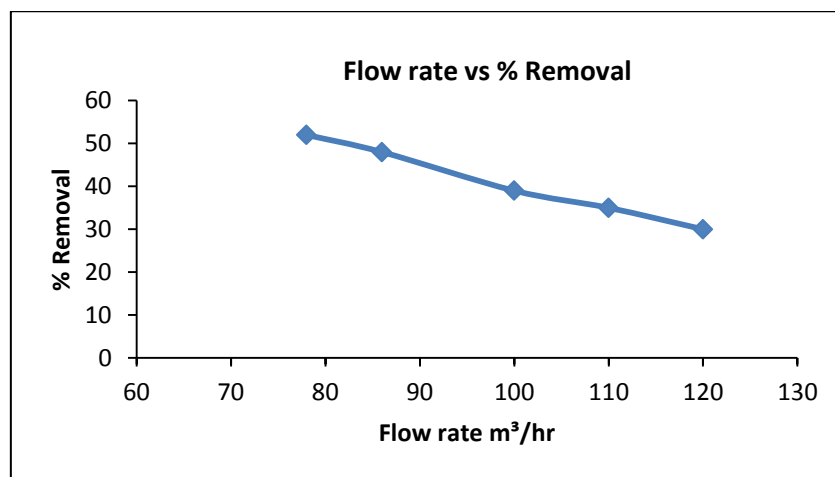


Figure (11) Effect of flow rate on the oil and grease removal pH=6

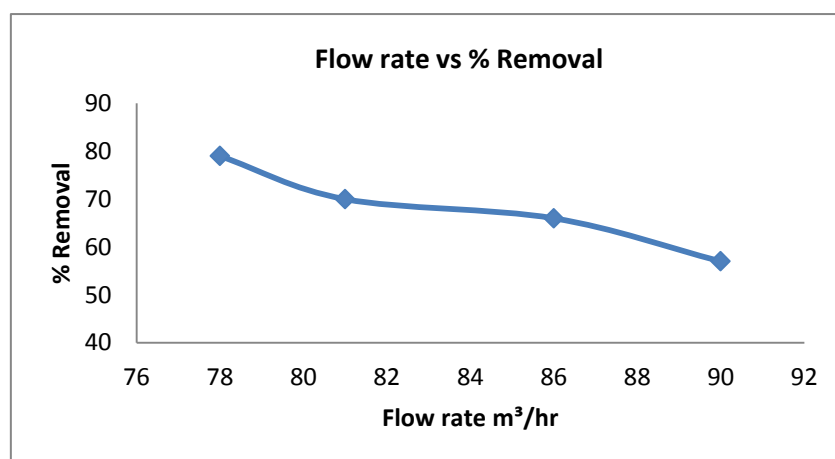


Figure (12) Effect of flow rate on the oil and grease removal at pH=8

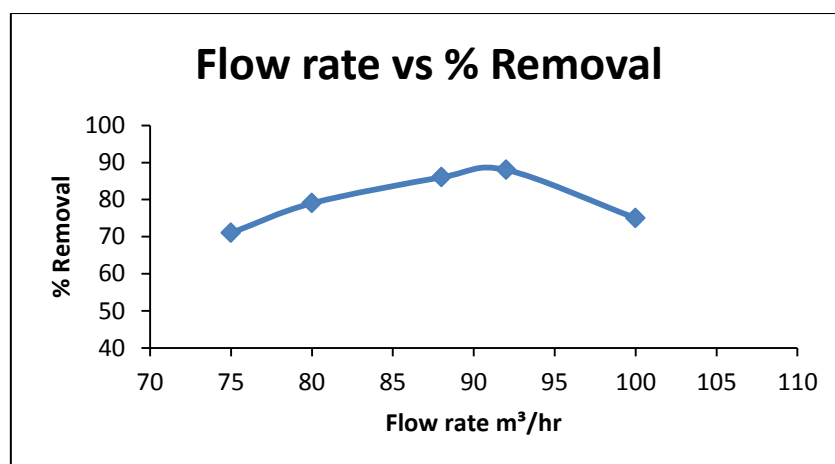


Figure (13) Effect of flow rate on the oil and grease removal at pH=9.2

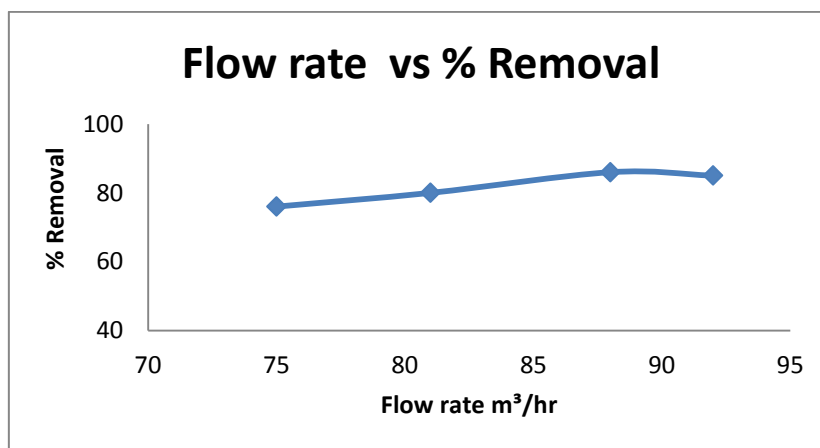


Figure (14) Effect of flow rate on the oil and grease removal at oil content = 33 mg/l

5. CONCLUSION

On the Basis of influences of the three processing parameters on the removal effectiveness of Oil and Grease, COD and BOD by using refinery wastewater, various observations were attained:

1. The wastewater that produced from the Kawergosk oil refinery contained high levels of oil and grease.
2. The best percent removal of oil and grease was 85% at pH 9.
3. From experimental data are obtained direct proportional between initial oil content and oil and grease percent removal, COD and BOD.
4. From the experimental tests obtained the rise in the flow rate results decreasing in the oil deletion, the appropriate flow rate is 88m³/hr gives optimal percent removal.
5. Overpressures have a negative effect on the elimination of Oil and grease because of the incidence of turbulent flow, which disturbs the fluid in the column and eliminates floc creation.

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