معالجة السوائل الزيتيه الناتجه عن مصانع التكرير بطريقة التصبن والترويب

TREATMENT OF REFINERY PLANTS OILY WASTEWATERS BY SPONIFICATION/COGULATION PROCESS

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الملخص العربى

تكنولوجيا معالجة مياه الصرف الصناعى تتنوع من طرق بسيطة إلى طرق متقدمة إعتمادا على مصدر المياه والخصائص المطلوبة بعد معالجتها. وتهدف هذه الدراسة إلى تطبيق المعالجة الكيميائية لسوائل الصرف الصناعى لوحدات التكرير او التى تحتوى على الزيوت من خلال محاولة تطبيق مفهوم التصبن باستخدام قلوى (NaOH) ثم تطبيق عملية الترويب و الترسيب بعد عملية التصبن باستخدام بعض المروبات مثل (Alum, Ferrous sulfate, Ferric chloride) و كذلك تطبيق عملية الترويب و الترسيب منفردة للتخلص من الزيوت الموجودة بمياه الصرف الصناعى. وقد تم قياس كفاءة المعالجة عن طريق تحديد احتياج الأكسجين الكيميائى (COD) حيث أوضحت النتائج من خلال المقارنة بين العمليات الثلاث (التصبن ثم الترسيب ، التصبن ثم الترويب والترسيب، الترويب ثم الترسيب) أن افضل تركيز للصوديوم هيدروكسيد المستخدم فى عملية التصبن هو 10 مجم/لتر ، كما أن عملية الترويب و الترسيب بعد التصبن أعطت كفاءة اعلى للتخلص من الزيوت بمياه الصرف الصناعى حيث وصلت نسبة الازالة الى 84 % تقريبا عند استخدام كلوريد الحديديك بتركيز 40 ملليجرام / لتر.

Abstract

The treatment of industrial wastewater technology is varies from simpler technology to the more advanced technology. This study was based on evaluation of the possibility of applying saponification/coagulation followed by sedimentation to reduce oils content from refinery plants oily wastewaters. Sodium hydroxide solution (strong base) was used as saponifier for oily wastewater. Ferrous sulfate; ferric chloride and alum were tested by jar test analysis as coagulants to determine the best removal% of COD. The results show that sodium hydroxide, 1 molar concentration; with dosage 10 ml was more efficient for saponification. The comparison between the three different types of treatments methods (sponification followed by sedimentation, sponification followed by cogulation with sedimentation and cogulation followed by sedimentation) indicated that ferric chloride with 40 mg/l dosage is more efficient for coagulation and sedimentation treatment after saponification of refinery plants wastewaters & give a removal efficiency of about 84%.

Key Words: Saponification; Coagulation; Sedimentation; Chemical oxygen demand (COD); Coagulants.

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1. Introduction

Wastewater treatment refers to the processes used to treat or remove contaminates (such as soluble organic matter, suspended solids, pathogenic organisms, and chemicals) from industrial waters that are released into the environment [1]. Major industrial sources of oily wastewater include petroleum refining, metal manufacturing, machining and food processing [2]. Removing oil and grease is important because it is deleterious to the treatment plant's effluent and it can clog and reduce the performance of filters and other treatment equipment [3]. Recent trends indicate that there will be new requirements to monitor and perhaps regulate the emerging groups of contaminants [4]. New developments in the area of membranes filtration, disinfection/oxidation methods, ion exchange resins, sorption technologies, as well as water management methods utilize information and control capabilities [5]. Thorough knowledge of the oils physicochemical properties and a better understanding of oil-containing water treatment processes would permit improvements in the existing methods and the development of new treatment techniques [6]. Chemical aids, or coagulants, are used to allow individual droplets of emulsified oil to agglomerate into a larger floc, which is more easily separated from the water [7]. Nano filtration membrane based water purifier was developed without the need for a storage tank [8]. A combination water filter tank was designed to remove settle able solids from water [9]. A drinking water filter was developed to remove major contaminants from tap water and other drinking water sources, and adjust pH [10]. Ion exchange filter system was developed to reduce ions contained in a liquid medium used in fuel cell system [11]. A method was developed for oxidizing carbon absorbable organic compounds in controlled manner with a bed of activated carbon [12]. A system was developed to enable a plant operator to assess biomass development, determine the optimum flushing rates and distributor speed options [13]. Wastewater treatment system using oyster shells was developed as the biological growth media in the aeration chamber [14]. A new method was developed for separating dissolved materials (i.e., organic and inorganic solids and volatile constituents) from aqueous solutions [15]. There are two types of soap making, cold-process and hot-process in which heat may be required for saponification [16]. This study deals with chemical means coagulation or saponification followed by coagulation for removing oil from industrial wastewater.

2. Material and Methods

2.1. Experimental protocol

Two liters volume of synthetic oily wastewater similar to that obtained from refinery plants wastewaters, was drawn into a beaker and placed on a magnetic stirrer to mix for a period of 30 minutes then diluted by 20 liters of pure water. The pH of synthetic oily wastewater (emulsion) was 6.3 and COD was about 4600 mg/l.

2.2. Experimental Design

Three sets of experiments were performed in this study. the first set, test of saponification, proper amount of strong base of sodium hydroxide (5g) was measured on an analytical balance & then dissolved in one liter of distilled water and added to 500 ml of emulsion cylinders at various concentrations (10, 20, 30, 40, 50ml) using water bath apparatus at 80 °C. Then the samples were left for another 30 minutes for cooling. The samples were then analyzed for pH, and COD. In the second sets of experiments, test for coagulation, coagulants with various concentration (20, 30, 40, 50, 60 ml) were mix for a period of 30 minutes using jar test to ensure that the coagulant was completely dissolved, then sedimentation took place. Complete settling was achieved after 30 minutes. The treated wastewater was then analyzed for PH and COD. In the third set of experiments, test of saponification/coagulation, coagulation was carried out after saponification to determine the optimum concentrations of NaOH, and coagulant at various concentrations.

3. Results and Discussion

3.1. Determination of optimum NaOH for saponification of oily wastewater

The highest COD removal efficiency was about 48% and 54% when the concentration was 10 ml and 20 ml of sodium hydroxide solution respectively. Fig. (1) and Fig. (2) shows the effect of NaOH added on total dissolved solids and on removal of the oil from the treated portion of industrial waste water as indicated by COD value at different dose of sodium hydroxide solution. TDS increases from 3100 mg/l to 14770 mg/l due to adding of sodium hydroxide solution up to 50 mg/l. It can be shown that a NaOH concentration of 10ml was enough to achieve a residual COD value of about 2300 mg/l (see fig. 2).

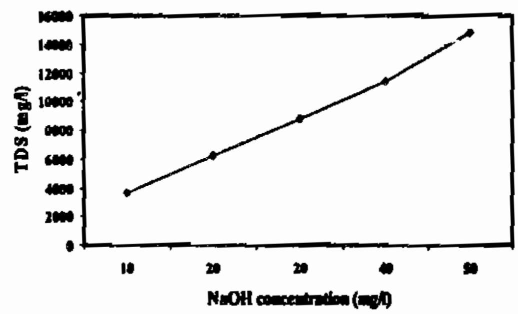

Fig. (1): Effect of NaOH concentration on TDS for oily wastewater

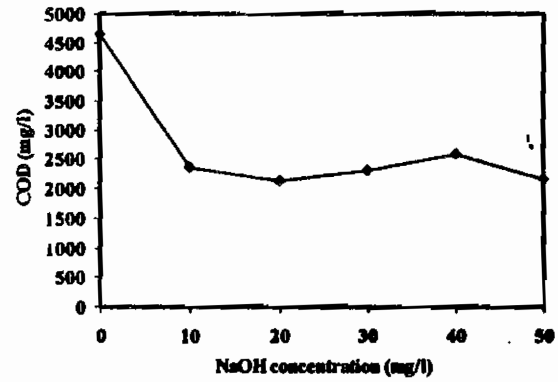

Fig. (2): Effect of NaOH concentration on COD for oily wastewater

3.2 Saponification/Coagulation of Oily Wastewater

Fig. (3) shows that their effect of removal efficiency of TDS of coagulants type on coagulation/sedimentation experiments of the treated industrial wastewater. Percent removal varied between 87% and 77% at 40 mg/l of aluminum sulfate and 30 mg/l of Ferric chloride respectively. Also, COD removal efficiency of the treated portion of oily wastewater was 84%, 81% and 76% for Ferric chloride, ferrous sulfate, and Aluminum sulfate respectively (Fig.4). The concentration of all reagent wa 40 mg/l at a maximum removal efficiency.

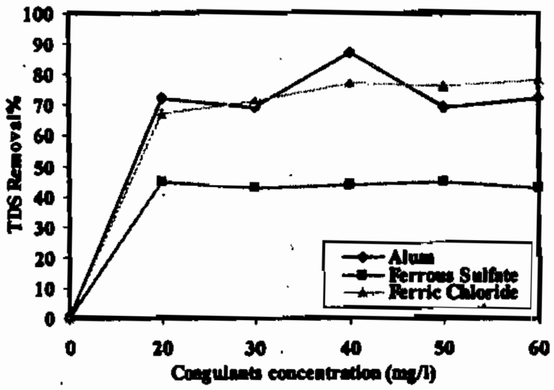

Fig.(4): Effect of coagulant concentration on TDS removal% after saponification of oily wastewater.

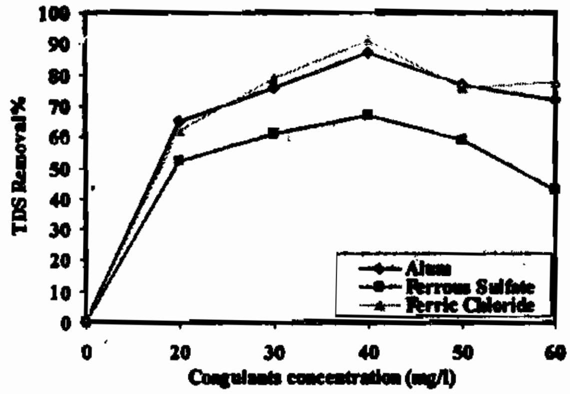

Fig. (5): Effect of coagulant concentration on TDS removal%.

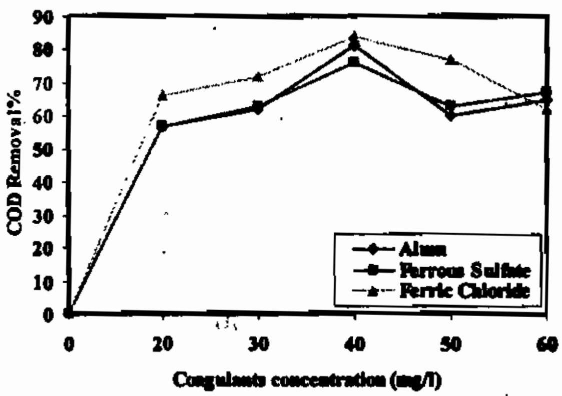

Fig.(4): Effect of coagulant concentration on COD removal% after saponification of oily wastewater.

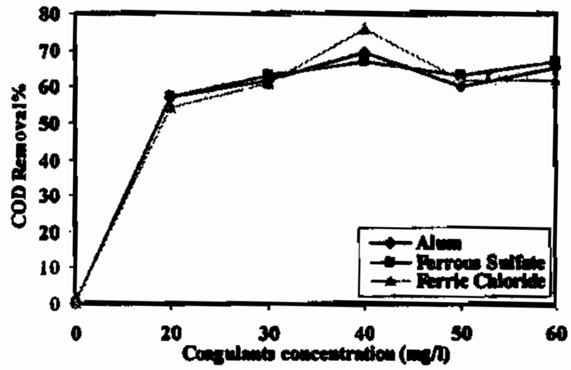

Fig. (6): Effect of coagulant concentration on COD removal%.

3.3 Coagulation and Sedimentation of Oily Wastewater

Fig.(5) shows that Increasing the coagulant concentration from 30 to 60 mg/l decreased the total solids of the treated wastewater by 91, 87 % for Ferric chloride, aluminum sulfate at chemical concentration of 40mg/l, and for Ferrous sulfate the reduction of total solids of the treated wastewater was 67% at chemical concentration of 40mg/l.

Fig.(6) shows that Ferric chloride was the most effective coagulating agent. It reduced the COD of the wastewater by 75.6% (compared to 69.6% and 66.7% for aluminum sulfate and ferrous sulfate), respectively.

4. Conclusions:

From the study we can conclude that:-

- Sodium hydroxide at a dosage of 10 ml with a concentration of 1 molar solution was found to be the most effective for saponification.
- Ferric chloride at a dosage of 40 mg/l was found to be the most effective coagulant for coagulation after saponification processes.
- Finally, saponification/coagulation processes can be used as a preliminary treatment for the oily wastewater to reduce oil content.

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