International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Removal of Organic material contaminants from wastewater of a petroleum refinery by Employing Ultrasound

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Received 01 Jan 2018, Accepted 04 March 2018, Available online 07 March 2018, **Vol.8, No.2 (March/April 2018)**

Abstract

In this study, the reduction of organic pollutants from wastewater was investigated. Ultrasonic radiation was approved as the usage method. Effective parameters such as the period of ultrasonic radiation (10-35min), ultrasonic power (40-200watt) and initial organic material concentration (123-150 mg/l) were tested to determine their effects on organic material removal percentage and turbidity regress. It has been found that a time interval of 30 minutes of continuous exposition of dissolved organic material to the field of ultrasound come to 76% removal at initial organic material concentration of 123 mg/l. Significant temperature change occurred which was about (20-33℃) rise in 35 minutes. However, this temperature change had no significant influence on efficiency of the treatment .Also it was found that the turbidity deceases with time from 98 to 34 at 35 min of exposure to Ultrasonic irradiation.

Keywords: *Ultrasonic ,organic pollutantas, wastewater treatment , advanced oxidation process*

1. Introduction

The reuse of wastewater is increasingly confirmed as a method for protect reduced freshwater sources and as a means of preserving the aqueous environment due to pollutants in wastewater. Although secondary and tertiary treated wastewater is often throw away into the river, it cannot be recycled without more treatment. One of the factors that concern human and environmental health is the composition of organic matter. Organic contamination is the expression used when huge amounts of organic compounds. They originate from local sewage, urban, industrial wastes, sludge and refineries. This waste organic matter should be carefully described so as to find the best treatment method for water recycle (Ali *et al*, 2012).

Different methods of treatment can be used to reduce organic materials. These processes involve flocculation, adsorption, biofiltration, ion exchange, advanced oxidation process, and technology of membrane. The elimination efficiency is examined in terms of total organic carbon removal, endocrine-hydrophobic and hydrophilic, the molecular weight distribution of organic material wide varieties of mercantile chemicals are applied organic compounds, resulting in producing of various types of wastewater with large amounts of organic waste composition.In recent years, advanced oxidation processes (AOPs) have arisen as hopeful new technologies for the dissolution of organic pollutants. These processes consist of photochemical degradation, radiolysis, and sono-chemical degradation. Ultrasonic irradiation is the technology that has been widely used as an advanced oxidation process (AOP) for treatment of wastewater (N. Mahamuni *et al*, 2010).

AOPs are described as the processes that produce hydroxyl radicals in necessary amounts to be capable to oxidize most of the complex chemicals found in the discharge water (P.R. Gogate *et al*, 2004).Cavitations is one of the main oxidation processes, defined as the phenomenon in which a large amount of energy is released in less than a microsecond by micro bubbles and small cavities that form, enlarge and implode (K. Suslick, 1989).

In the case of acoustic cavitation, the occurrence of alternate compression and rarefaction cycles is due to sound waves with high frequency (as ultrasound) in the range of 16 KHz-100 MHz [3, 5]. This leads to sonochemical pyrolytic reactions recognized by high temperature and pressure within the cavitations bubbles formed by ultrasonic irradiation (W.Songlin *et al*, 2008). Thus, free radicals such as H, OH, and H2O are created in a very short (millisecond) time in solution. These roots are included in the fast oxidation of inorganic and organic substances and degradation of complex composition in solution (E.Ozturk *et al*, 2015). The capacity to remove toxic elements from wastewater by ultrasonic technique depends on different process parameters (N.Matei, 2014) such as pollutant initial concentration, intensity and frequency of irradiation, treatment time, temperature, pH, and

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DOI: https://doi.org/10.14741/ijcet/v.8.2.9

sample volume and treatment type (continuous or intermittent). Also, cavitational medium (whether in a stable vibration the bubble keep on or it is changed into a transient collapse), occurs according to additional parameters such as original size of the bubble, surface tension and viscosity (J.Huang *et al*, 1995).

US is longitudinal wave with frequency above 20 KHz and this frequency is above the acoustic range (20 Hz to 20 KHz) that humans can hear and under the mega-acoustic zone (>600 KHz) (Deymier *et al*., 2004(10) , Wong, 2002)(11).In US waves, energy is transmitted by vibration of the molecules in the environment where the wave is propagated (Bello *et al*., 2005)(12).

The aim of this study was to investigate the effects of ultrasonic irradiation as a new clean technology for the removal of Organic Material contaminants from wastewater of a petroleum refinery , the effects of increasing ultrasound times (10-35 min) , ultrasound power ((40-200W)) and Organic Material initial concentration(123mg/l,150mg/l) on the removal percentage was studied.

2. Experimental

Materials

Wastewater was collected from the effluent outlet from AL-Daura petroleum refinery.

Ultrasound Device

An ultrasound device equipped with a sonotrode horn (horn tip with 5mm diameter) was turned at 24 KHz (Figure 1).

Figure 1 Ultrasound device

The US radiation source has been equiped to the laboratory building reactor. The applied US power was adaptable from 40 to 200W.The reactor was exposed to the air. The probe was injected into the middle of the 3000 mL reactor with an inner diameter of 8.5 cm and 8.8 cm heights. The wastewater capacity in the reactor was 2000 mL that horn was injected in 25 cm from bottom of reactor. At laboratory temperature the setup was operated.This part of experimental work was performed at different power densities (40-200 watt). The sonochemical degradation of the organic materials was evaluated using 2 different initial concentrations 123 and 150 mg/L with aduration of ultrasonic irradiation from (10min to 35min).

Table 1: Characteristics of ultrasound apparatus

Technical Data	UP200S
Dimensions	(L× W × H) 257× 157 × 130 mm
Operating Frequency	24 KHz
Pulse range	0-100%
Power	200 W
Power control	Amplitude 20-100%
Power supply	230V, 2A, 50-60Hz110-120V, 4A,
Weight	1,5 Kg
Capacity Sonotrode	0.1-3000 mL

3. Results and Discussion

3.1 Effect of Ultrasound Power

In this study, experiments were conducted with difference in the US radiation strength. The time interval was applied using 30 min of power range (40-200W). Figure (2) shows the effect of the power density on the sonolysis process.

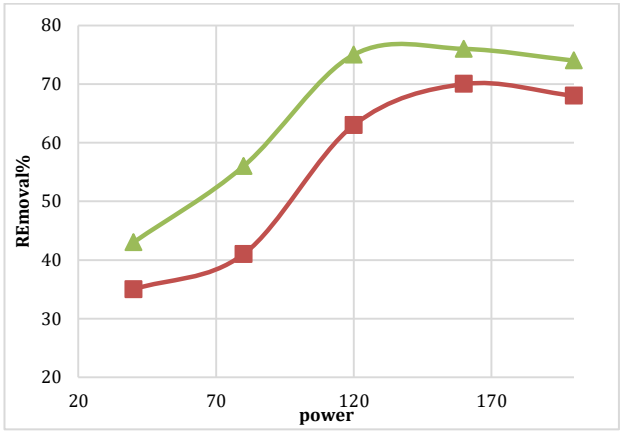

Figure 2 Percent of Removal at various US powers (Concentration of initial DOM 123 mg/L and 150 mg/L), Time 20 min, PH =7.8

It can be observed that greater power density led to deterioration of dissolved organic material faster because of increased cavity rate in the unit volume of solution of the highest degrees of total pressures pulses (pressure pulse due to the collapse of single cavity × number of cavities) and more active root production. In sonolysis of aqueous solutions the thermal dissociation of water to hydrogen atom and hydroxyl roots. Increased US intensity has been shown to increase the rate of degradation of organic compounds. Moreover, the pulse and bubble collapse in the reaction cell occurred more rapidly, increasing the number of cavitation bubbles and concentrated OH radicals by increasing the strength of the US. These

radicals reacted OH with DOM in the solution. In a higher power of irradiation, a great number of cavities or gas bubbles in the solution were made and the sound waves were dispersed to the walls of the container or back to the transducer. Then, a smaller level of energy fixing or strength occurred although the container was subjected to greater and greater concentrations.

Figure (2) shows that the most efficient power was 160 watt with70% and76% removal efficacy for intial concentration of 123 mg/l, 150 mg/l respectively.The same conclusion was obtained by (Sponza and Oztekin 2013) (13).

3.2 Ultrasound Time Effect

Tests were accomplished with 10 to 35 min of radiation time and the collected samples were examined. The difference of percentage degeneracy in DOM removal was shown in figure(3) with time at 120 W power and initial concentrations of oil (123-150) mg/L. With process time oil degeneracy has been increased and the higher values of degeneracy occurs in 30 min. Because after 30 min a great variation did not happen, this time was chosen as the perfect time. Comparable results are seen in the workof Katsumata *et al*. (2007) (14). Where in 30 min of US, the dissolved gases occurrence in the medium increased and enhance the extent of cavitation due to possible intents. Also, the cavitations may be occur due to the severity of the cavitations in result of a high total pulse pressure volume. Gogate *et al*. (2003) (15) found similar effects with tests on decay of aqueous fluvic acid solutions in the US setup.

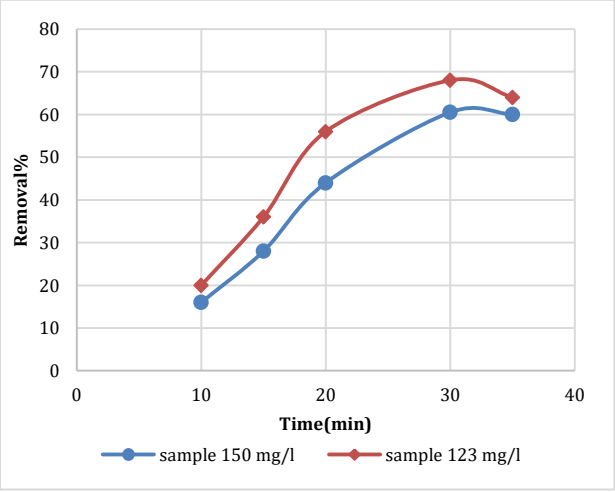

Figure 3 Percent Removal at various US powers (DOM initial concentration 123 mg/L and 150 mg/L), Time 20 min, PH =7.8 and Amplitude 60%

3.3 Initial concentration of DOM Effect

Figure (3) shows the influence of initial concentration of DOM (123-150 mg/L) with DOM disgrace in 30 min and 120 W ultrasound. Apparently, the disgrace was reducing in DOM maximum concentration. The effects showed an increasing decay with time but at high concentration the decay was lower. These outcomes showed that the rate of disgrace was in reverse relative to the DOM concentration initially taken.

The current research notes are in good agreement with the earlier results found by Maleki *et al*. (2007) (16) and Kobayashi *et al*. (2014)(17).

Effect of Ultrasound on the properties of the remaining solution

Ultrasound effect on temperature

The temperature rises with sonication in an ultrasonic reactor, if not controlled. The temperature increase in 35 min was about 20-33℃, and due to the cavitation. The temperature increase at 24 KHz frequency was about 2-5 ℃ more than at the frequency of 130 KHz, but this difference was not significant ($p>0.05$).

Effect of Ultrasound on Turbidity

Turbidity is the main physical distinguishing property of water. It is affected by hanging or dissolved substances such as soil, sludge, poorly divided inorganic and organic material, dissolvable organic complexes, (plankton and other microscopical organisms).Figure(4) shows the variation of the turbidity over time, it was clear that the turbidity deceases with time.

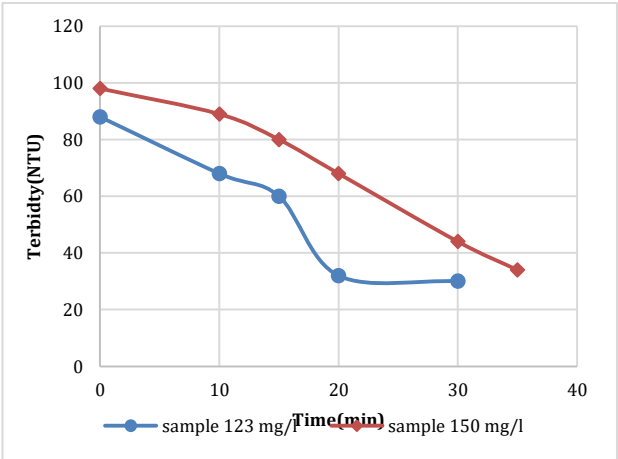

Figure 4 Effect US on Turbidity at different times (DOM at initial concentration 123 mg/L & 150 mg/L) , Frequency 24 KHz , power 200 watt and PH =7.8

Conclusions

It seems that the sonochemical degradation technique bodes well for many organic compounds, controlled by pyrolysis and/or free radical reactions. The degree of degradation depends on both acoustic parameters (time, power, initial concentration of DOM).When power is larger, transmission of ultrasonic energy into the container also become larger leading to a higher

cavitations activity caused by a higher concentration of OH radicals. In the lower frequency, more violent cavitations will be formed, causing in higher temperatures and pressure. The most effective power was found to be 160 watt with 70% and 76% removal efficiency for intial concentration of 123 mg/l, 150 mg/l respectively. The removal rate was also increased with the increase in exposure time and the highest removal rate was 30 times. The results showed that the percentage removal decreases the concentration of dissolved organic substances in the initial increases.

Significant temperature change happened which was about (20-33℃) increase in 35 minutes.The turbidity was deceased from 98 to 34 at initial organic material concentration of 150 mg/l.

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