Study on the Flocculation of Oilfield Wastewater by Microwave

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Abstract. Using microwave technology enhanced flocculation treatment of oilfield wastewater containing polymer .Chose the wastewater COD removal efficiency as an evaluation index, investigated four kinds of flocculants, such as $AlCl_3$, $FeCl_3$, PAC, PAF in the microwave irradiation and no microwave irradiation two types of test flocculation conditions, and offered to fly ash as adsorbent adsorption-microwave flocculation combined process to enhance wastewater treatment effect, with no secondary pollution can be achieved by waste. The experimental results show the effect of microwave has a significant promote to ferric flocculants' flocculation process, and fly ash adsorption-microwave process is better than simple microwave flocculation process, in the solid-liquid ratio of 1: 100, stirring speed 200 $r \cdot min^{-1}$, the adsorption time 30min, microwave flocculation time 90s, the conditions under microwave irradiation power of 400W, COD removal rate can be increased by 25%.

Introduction

Currently, most oil fields use more polymer flooding and ASP flooding enhanced oil recovery technology, resulting in waste oil contains large amounts of polymer that makes a more stable nature of oilfield wastewater and brings matter to the wastewater treatment[1-6]. Traditional "Grease - Coagulation - Filter" removal efficiency on oil and suspended solids in wastewater is better, but for COD removal efficiency is not ideal[7]. In this paper, Daqing Oilfield wastewater containing polyethylene is the research object, used microwave enhanced flocculation technology to remove COD of oilfield wastewater as the main goal, through a variety of experiments investigated the effect of flocculation in the microwave field, and to find the best microwave flocculation technology conditions.

Equipments and Materials

Water Samples. In this study, water samples were taken from a production plant in Daqing oil field joint station after the separation of the sample port. Water quality test results were shown in Table 1.

Table 1 Quality of oilfield wastewater

Index/Unit	COD/mg·L^{-1}	pH	Oil/mg·L^{-1}	PAM /mg·L^{-1}	Turbidity/NTU
Data	600-800	7-8	150-200	300-400	60-80

Instruments. The main instrument used in the experiment is made by Qingdao Michael Granville Microwave Applications Technology Co., Ltd. of MKJ-J1-5 desktop test microwave oven, the output power was continuously adjustable from 0 to 800w, time setting range was 0~99h99min. MHJ-3 Microwave leak detection equipment is made by Nanjing HuiYan Microwave Systems Engineering Department Co., Ltd.

Flocculants. In this experiment, four kinds of inorganic flocculants were used. Various flocculants' parameters were shown in Table 2.

Table 2 Flocculants

Name	Aluminium chloride	Ferric chloride	Polyaluminium chlide (PAC)	Polymerization ferric chloride (PFC)
Molecular	$AlCl_3$	$FeCl_3$	$[Al_2(OH)_nCl_{6-n}]_m$	$[Fe_2(OH)_nCl_{6-n}]_m$

Methods and Results

General Flocculation. Took 100ml oily wastewater, into 250ml high beaker (microwave penetration has a limit in the water, so the diameter of the container shouldn't be too large) [8]. Then added $AlCl_3$, $FeCl_3$, PAC, PFC four kinds of flocculants, each of flocculation dosage of agents were 50mg.L^{-1}, 100mg.L^{-1}, 150mg.L^{-1}, 200mg.L^{-1}, 250mg.L^{-1}, 300mg.L^{-1}, with rapid stirring 30s, static settling 30min after completion of the reaction, measured the water samples supernatant COD value, drew different flocculation effect curves under conventional conditions. The results were shown in Fig. 1.

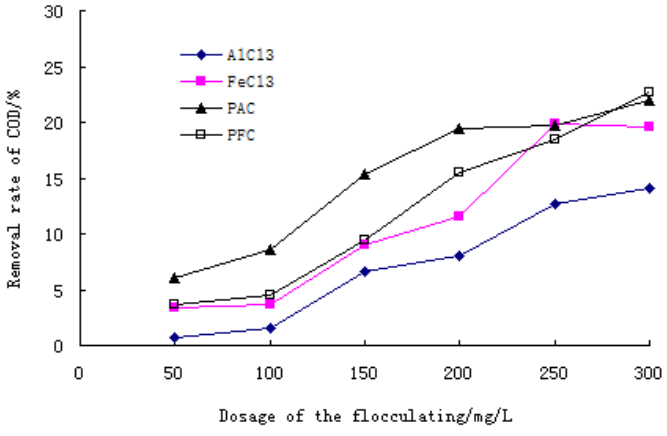

Fig.1 Flocculation effect comparison of several flocculants in normal conditions

As can be seen from Fig.1, the flocculants dosage within 50mg.L^{-1}-300mg.L^{-1} range, inorganic polymer flocculants PAC and PFC flocculation are better, $AlCl_3$ flocculation is worst. This is due to the inorganic polymer flocculants already hydrolysis polymerized before into the water in the preparation phase, and the hydroxyl polymer meets with colloidal particles in water by adsorption, and it plays electrical neutralization and bridging role in the colloidal particle, therefore dosage less, pH changes on water adaptability[9]. Ferric applies a wide pH range, floc formation has a dense body than aluminum salt flocculation, the effect to treat low temperature or low turbidity water is better than aluminum[10].

Flocculation by Microwave. Measured 100ml wastewater, type and quantity of added flocculants were the same as above, with rapid stirring 30s, into the microwave reactor. Set the microwave power 400W, irradiation time 90s, static sink 30min after the reaction, took the supernatant liquid, measured COD of water samples, drew different flocculation effect curves under microwave irradiation conditions, results were shown in Fig.2.

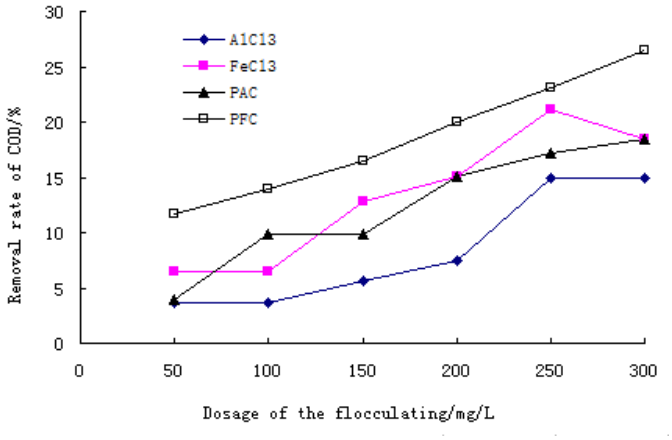

Fig.2 Flocculation effect comparison of several flocculants by microwave

As can be seen from Fig.2, the flocculants dosage within 50mg·L^{-1}-300mg·L^{-1} range, $FeCl_3$ and PFC flocculation significantly improved, while $AlCl_3$ and PAC flocculation do not change significantly. It explains that microwave promotes ferric flocculants flocculation process. This is due to the flocculation process is endothermic reaction. Iron is microwave absorbing material, in the microwave field can absorb large amounts of microwave energy, make wastewater local rapid warming, form hot spot effect, and promote flocculation reactions[11]. Al is microwave transparent material, and no significant chemical activity in the microwave field[12]. So ferric flocculation under microwave irradiation is significantly better than conventional flocculation, while aluminum salts flocculation effect were not significantly changed.

Adsorption-flocculation.

(1) Adsorption. Measured 100ml of oily wastewater into two groups, each 1g of fly ash (fly ash as raw material, microwave-assisted hydrothermal synthesis of zealots), stirred them for 30minutes at a speed of 200r·min^{-1}[13].

(2) Flocculation. The first water sample was added PFC flocculants, flocculation experiments routine repeated. The second group also joined PFC, repeated microwave flocculation experiments. The supernatant was measured COD of water samples, drew flocculation and adsorption-flocculation in comparison results whether the microwave-assisted conditions, as shown in Fig.3.

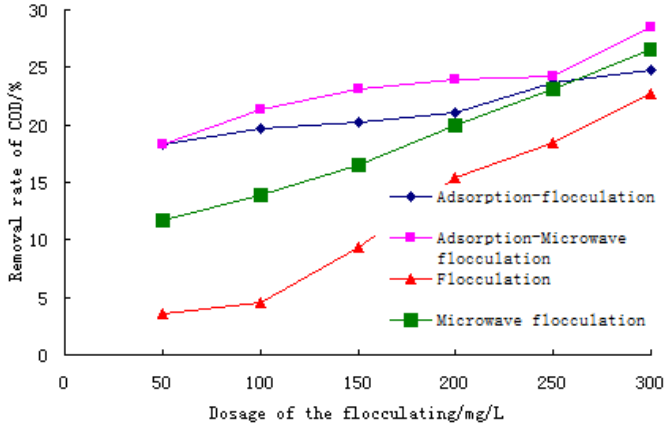

Fig.3. Adsorption-flocculation and flocculation's effect under the conditions of microwave were compared

From Fig.2, we can find that the fly ash adsorption-flocculation PFC combination microwave-assisted process has significantly higher COD removal than fly ash adsorption-PFC flocculation process. And adsorption-microwave flocculation process compared with microwave flocculation process, COD removal efficiency increased by 8%; compared with conventional flocculation process, COD removal efficiency increased by 25%. We can make a conclusion that

adsorption process of ash has a good effect for oilfield waste water soluble organics removal, and fly ash for oily waste water treatment doesn't cause secondary pollution and it also achieves the waste recycling economy concept. So ash adsorption-microwave-assisted flocculation process will be an environmentally friendly method of wastewater treatment.

Conclusions

(1) Iron has a strong microwave absorption capacity, and microwave can promote the flocculants $FeCl_3$ and PFC.
(2) Fly ash for oily wastewater has a good effect to remove dissolved organic, achieves by waste at the same time and does not produce secondary pollution.
(3) Fly ash adsorption-microwave combination flocculation process to remove COD is best. Adsorption conditions is that the liquid ratio (adsorbent and watery mass volume ratio) of 1:100, stirring speed of 200 $r \cdot min^{-1}$, adsorption time 30min, flocculation conditions is that PFC dosage of 300 $mg \cdot L^{-1}$, microwave irradiation time 90s, microwave irradiation power 400W. COD removal efficiency can be increased by 25%.

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