

# Experimental Research of Viscosity Reduction and Dehydration of Crude Oil by High Frequency Radiation

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\*Study on high frequency dehydration technology of water-cut crude oil in low permeability oil field. 12JSO81

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Abstract: Aiming at the problem of high viscosity and difficult dehydration of the heavy oil during the exploitation and utilization, based on the principle of high frequency radiation, it is investigated by using high power high frequency radiation experimental equipment designed by ourselves, and analysed on influence of high frequency radiation time on the viscosity reduction and the dehydration ratio. The results show that high frequency radiating crude oil can reduce the viscosity of crude oil, meanwhile, high frequency radiation dehydration effect is good, radiation time increases, dehydration rate increases sharply. It is shown that microwave technology provides an important reference and has a better application prospect in the field.

## 1 INTRODUCTION

In the petroleum industry, the production and pipeline transportation of viscous crude oil are all caused by its high viscosity, which has brought great difficulties to the pipeline transportation of oil and caused great energy waste and environmental pollution[1,2]. The viscosity is very high. In the transportation technology of heavy oil, a lot of money is spent to reduce the viscosity of heavy oil effectively. At present, the process of pipeline transportation of waxy crude oil is mainly heat insulation transportation, dilution transportation of hydrocarbon substances or combination of dilution and heating. However, there are many problems, such as high fuel consumption, large labor and equipment consumption, difficulty in starting after the accident stopping transportation. In the process of production of crude oil, crude oil is moisture, along with the deepening of oilfield development, use of water flooding oil field water content of crude oil is higher gradually, this cause that there is a certain lack of oilfield production. Heavy oil containing water can easily lead to pipeline blockage and corrosion. Therefore, it is urgent to develop an efficient, fast and clean treatment process. Through the application of crude oil viscosity reduction and dehydration technology, the quality standard of the crude exportation can be achieved and the

production management target of the oil field can be met[3,4].

In order to study the ability of high frequency electric field to reduce the viscosity of crude oil and the dehydration effect of water cut crude oil, high frequency electric field technology and indoor experimental method are adopted in this paper. This research is a new technology which applies high frequency technology to the gathering and transportation of crude oil. High frequency electromagnetic field on crude oil not only has good viscosity reduction effect, using the technology in crude oil viscosity reduction transportation, it can reduce the heat pump stations, costs of gathering and transportation, protect the environment, improve product quality and increase economic efficiency. High frequency electromagnetic field dehydration equipment small volume, can reduce the probability of voltage breakdown, less energy consumption.

## 2. EXPERIMENTAL DEVICES AND METHODS

In order to reduce adhesion and dehydration, a new treatment system was designed. The system consists of high frequency source, high frequency control

system and plate capacitor. The schematic diagram of the experimental device is shown in Fig. 1. We are fulling plane-parallel capacitor water cut of crude oil or crude oil in the experiment, applying high frequency electromagnetic field on the capacitor, respectively before and after radiation were measured the change of viscosity and water ratio of crude oil, experiment content and steps are shown in Fig.2.

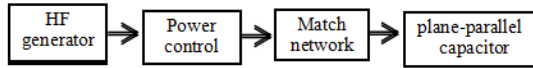


Fig. 1.A block diagram of the experimental apparatus.

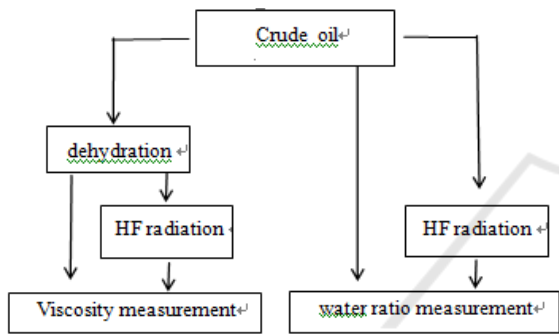


Fig. 2. Experiment content and procedure block diagram.

### 3. EXPERIMENTAL RESULTS

#### 3.1 Viscosity Reduction of Crude Oil by High Frequency Radiation

Changes in viscosity of crude oil samples S01,S02,S03 and S04 in S oilfield after high-frequency radiation at 240s,600s, 900s and 1500s (Table 1) are shown in Table 2 and Fig. 3.

Through the radiation experiment of S oilfield crude oil, it is shown that the viscosity of crude oil after high frequency radiation has also been significantly reduced, that is, the high frequency radiation crude oil can reduce the viscosity of crude oil and has the effect of viscosity reduction. At 50 °C, the viscosity from 494.4 mPa. S to 176.7 mPa. S. At a certain plate voltage, the decreasing range of viscosity increases with the extension of radiation time.

Table 1.high frequency radiation parameter.

Radiation parameter	Specimen number			
	S01	S02	S03	S04
time ( s )	240	600	900	1500
frequency ( MHz )	1.6	1.6	1.6	1.6
voltage ( V )	1100	1100	1100	1100

Table 2. viscosity of crude oil before and after radiation.

temperature ( °C )	Viscosity(mPa.s)			
	S01	S02	S03	S04
50	494.4	316.8	245.6	176.7
53	386.9	251.1	180.6	92.74
55	286.6	197.6	138.2	61.54
57	219.5	159.5	111.5	46.98
60	173.7	130.3	89.7	37.81
65	139.7	105.9	73.22	30.8
70	114.7	87.69	60.76	25.78
75	96.34	62.14	51.5	21.82
80	82.25	54.53	44.45	19.14

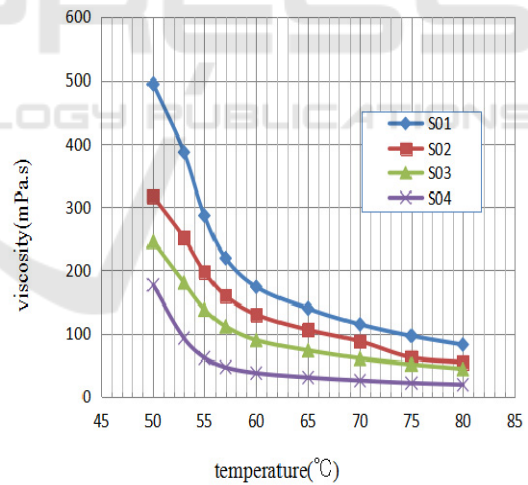


Fig. 3. viscosity-temperature curve of before and after radiation.

#### 3.2 Dehydration of Crude Oil by High Frequency Radiation

The changes of water ratio and dehydration rate of crude oil samples S01,S02,S03 and S04 in S oilfield after high-frequency radiation at different times (Table 3) are shown in Table 3, Fig.4 and

Fig5. When the water ratio of crude oil is 15.0% and the high frequency radiation is 180s, the water content of crude oil is 0.5%, which meets the requirement crude exportation in oil field transportation. The water ratio is within the range of 15%~19%, and there is a trend that the dehydration rate increases with the radiation time.

Table 3. water ratio and dehydration ratio of crude oil before and after radiation.

	Specimen number		
	L001	L003	L002
voltage (V)	1150	1000	1150
time (S)	120	150	180
water ratio (%)	19.5	18.1	15.0
water ratio after radiation	5.2	0.9	0.5
dehydration ratio (%)	73.3	95.0	96.7

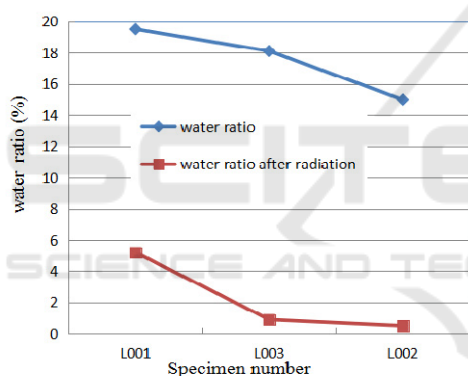


Fig. 4. water ratio of crude oil before and after radiation.

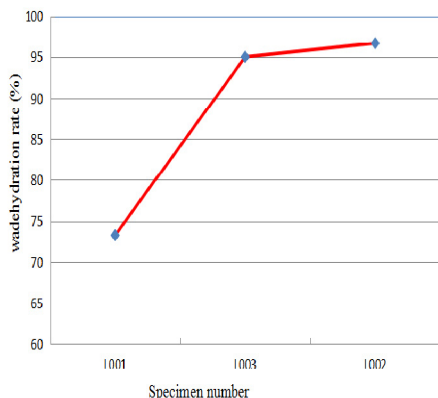


Fig. 5. dehydration ratio of crude oil after radiation.

The changes of water ratio and dehydration ratio of sample S301, S302, S303 and S304 of water-bearing crude oil in S oilfield after high-frequency radiation at different times (Table 3) are shown in

Table 4 Fig. 6 and Fig. 7. When the water ratio of crude oil is 40.5% and 25.0% respectively, and 220s and 180s respectively radiated by high frequency radiation, the water content of crude oil is 0.5%, which meets the requirement of crude exportation.

When the water ratio of crude oil is 40.5%, the dehydration rate reaches a maximum of 98.7% after 220s of high frequency radiation. Compared with S302 and S301, S302 and S301, it is obvious that the radiation time increases to cause dehydration rate increasing sharply.

Can be seen from the experiment, for different crude oil dehydration effect of high frequency difference is very big, for example, for S oilfield water cut of crude oil, the high frequency radiation after 180 S, moisture content is reduced from 25% to 0.5%, and for L oilfield, water cut of crude oil, the high frequency radiation after 180 S, the moisture content is reduced from 15% to 0.5%.

Table 4. water ratio and dehydration ratio of crude oil before and after radiation.

	Specimen number			
	S302	S301	S304	S303
voltage (V)	1150	1150	1150	1150
time (S)	150	220	170	180
water ratio (%)	39.0	40.5	25	25
water ratio after radiation (%)	3.8	0.5	3.9	0.5
dehydration ratio (%)	90.3	98.7	84.4	98

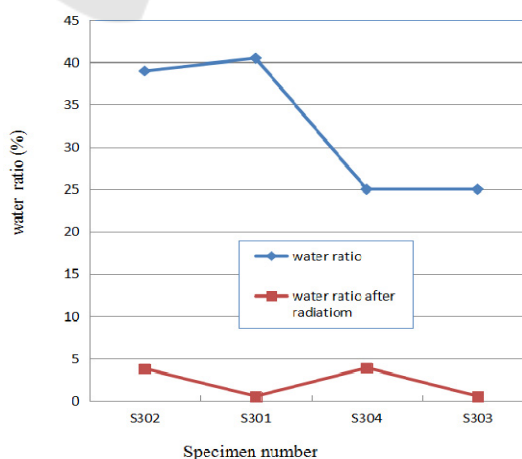


Fig. 6. dehydration ratio of crude oil after radiation.

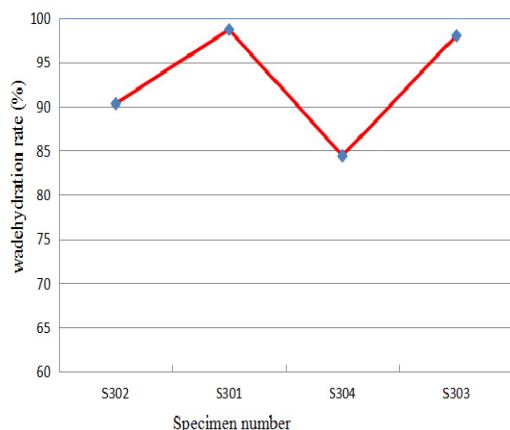


Fig.7. dehydration ratio of crude oil after radiation.

## 4 CONCLUSIONS

1. Through experiment of S oilfield crude oil show that high frequency radiation can reduce viscosity of crude oil, That is, high frequency radiation crude oil has viscosity reduction effect. And viscosity reduces with an increase in radiation time.

2. For water-cut crude oil, high frequency radiation has good dehydration effect, while radiation time increases, dehydration rate increases sharply. However, for different crude oil, the effect of high frequency dehydration is very different.

3. High frequency viscosity reduction and dehydration technology has potential application value in crude oil gathering and transportation.

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