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Research on Demulsification Mechanism of Polymer Surfactant Flooding Produced Fluid

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Abstract

There are many various mechanism of break emulsion in the oil field produced liquid have been assumed. Several demulsifiers evaluated through experiment are used to study the demulsification mechanism of polymer surfactant flooding produced fluid. It is assumed that the demulsification mechanism is the interfacial elasticity decreased with the adding of demulsifiers, which not only decreased both the strength and the life of oil film and film thickness, but also the demulsifiers break the film of emulsifier around oil droplets by the long line of functional groups in the molecular branch then water and oil were separated. As for the same serial demulsifiers, the interfacial elasticity lowered with the increasing of demulsifier concentration. The elastic value kept constant when the concentration reached a critical value. As for the different serial demulsifiers, the more the interfacial elasticity lowered, the better effects of dewatering. The rate of dewatering was related to interfacial elasticity. The action mechanism of the different structure demulsifiers was developed according to the experimental results. The demulsifier decreased the interfacial elasticity and partially took places of emulsifier to break emulsifier film.

Keywords : Demulsifier; Polymer surfactant flooding; Demulsification mechanism ; Interfacial viscosity; Interfacial elasticity.

Introduction

Demulsifier added to the polymer surfactant flooding produced emulsion can reduce the viscosity of the continuous phase. Demulsifier can weaken the structural strength of micell and micellar aggregates and make the viscoelasticity of space network reduced which make the oil within non-polar cavity spaces to coalesce by disturbance. Demulsifier which replaces parts of polymer surfactant can be adsorbed at oil-water

interface and make interface viscosity and the elastic characteristics of the interface film to decrease and make the interfacial film easily deformed by the perturbation.

With the increase of polymer surfactant concentration in demulsifier containing emulsion, the elastic characteristics and deformation restoring capacity of system are significantly enhanced. While the increase of polymer surfactant adsorption at the interface increases, the viscosity of oil-water interfacial film and interfacial film elasticity are increased, which make the intensity of interfacial film enhanced.

With the decrease of EO percentage of linear polyoxyethylene polyoxypropylene fatty alcohol demulsifier, the elastic characteristics and deformation restoring capacity of system are declined. The PO chain of demulsifier A which lying on the water-oil interface by multi-point adsorption manner, makes the coverage of demulsifier molecules at the interface to increase. While decrease of EO percentage of demulsifier, the viscosity of oil-water interfacial film and interfacial film elasticity are declined, which make the dehydration ability of polymer surfactant flooding emulsion enhanced. With the increase of EO percentage of linear polyoxyethylene polyoxypropylene fatty alcohol demulsifier, the elastic characteristics and deformation restoring capacity of system are decreased. the viscosity of oil-water interfacial film and interfacial film elasticity are declined, which make the dehydration ability of polymer surfactant flooding emulsion enhanced.

Experimental

Materials

Crude oil：dewatered crude oil from No.4 oil Recovery factory of Daqing Oil Field. Emulsifier Span 80：sorbitan monooleate.

Demulsifier A and B：Oil-solubility formaldehyde resin type.

Demulsifier C and D：Water-solubility polyoxyethylene, polyoxypropylene polyether type. Polymer surfactant：BⅢ.

Equipment

TX550A that measure full range interfacial tension measurement apparatus made by Baovi Corporation USA;

CIR-100 interfacial rheometer that made by Camtel Corporation Britain.

Method

Dewatered crude oil and salt water from No.4 Oil Recovery Factory were mixed into model emulsion according to volume of emulsion in practice and then the demulsifier was added. The rate of dewatering of model emulsion was measured with bottle test method.

Results and discussions

The processes of oil film breaking with/without demulsifiers are shown in Figure 1. When there was no demulsifier in the system, once oil film was formed and its C_m

value that refers to capacitance of film was nearly stability with time. After some time, C_m value increased suddenly and oil film broke. When there was demulsifier, C_m value increased gradually with time and oil film broke gradually after some time. This indicated that demulsifier molecules were adsorbed gradually on oil/water interfacial film and substitute natural emulsifiers at the interfacial film, which decreased both the strength and the life of oil film and film thickness, finally it broken.

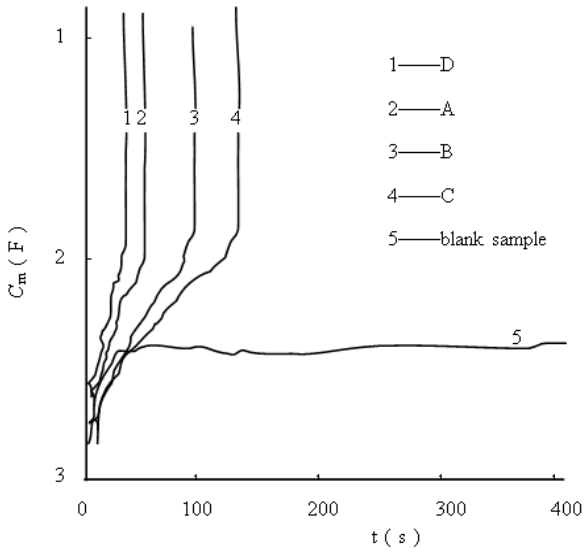

Figure 1 Procedure of oil film break by different demulsifiers

The influence of four demulsifier s on oil film life is shown in Figure 2. The breaking rate of oil film is apparently quickened at the presence of demulsifiers. This indicates that part of the crude inherent interface active components is substituted from interface by the demulsifier adsorbed on oil/water interfacial film, which varies character of interfacial film and formed a interfacial film whose resisting coalescent capacity is small and quicken the speed of interfacial film thinning. Oil film life was shortened with the increasing in of demulsifier s concentration. When concentration of demulsifier reached a certain value, film life inclined to equilibrium. This showed that the number of adsorbed demulsifier on the oil film increased with the increasing of demulsifier concentration, which strengthened the capabilities of changing oil film character, sharply reduced film strength and stability, increased the rate of oil film thinning and increased effect of demulsification. When the concentration reached a certain value, demulsifier molecules adsorbed on oil/water interface reached saturation, thus the effect demulsifier s concentrations on oil film life inclined to equilibrium.

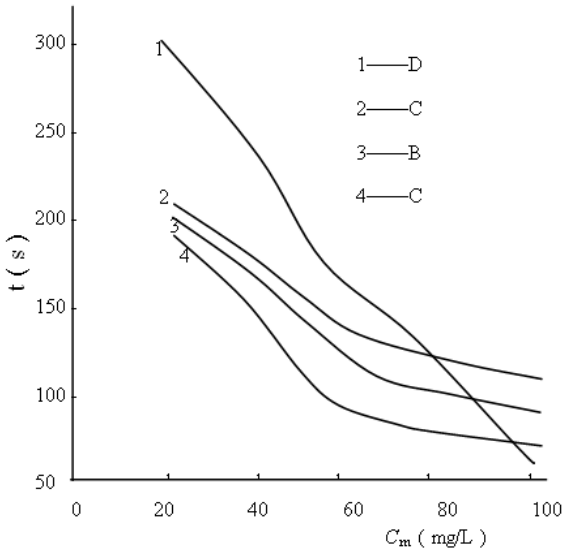

Figure 2 Broken time of oil film in different demulsifiers

The effect of demulsifiers concentration on the thinning rated of oil film is shown in Figure 3.

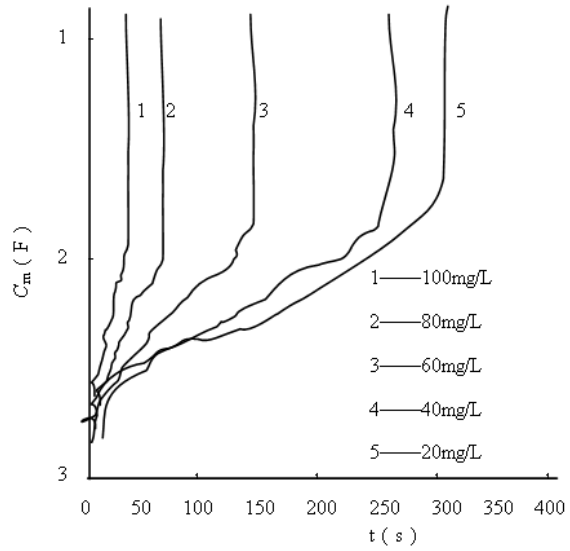

Figure3 Thinning rate of oil film at different concentrations of the demulsifiers

The C_m value represents of film thickness, so curve of C_m-t presents the change of oil thickness with time. The influence of demulsifier on the dewatering effective of model emulsifier is shown in Figure 4.

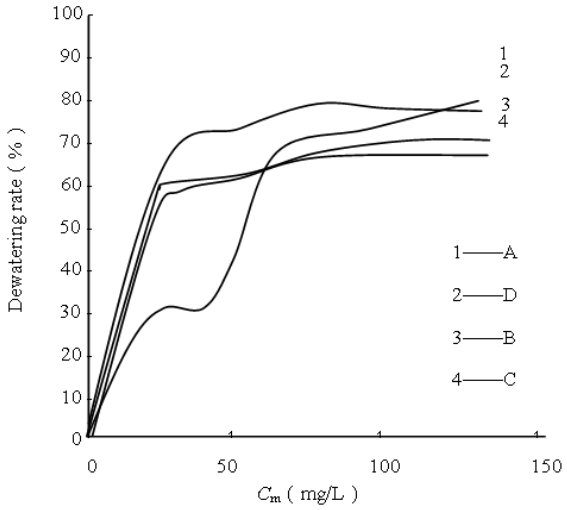

Figure 4 Dewatering rate with different concentration of the demulsifiers

There are corresponding relation between effect of demulsifier s on oil film life and thickness and dewatering rate of model emulsion. The more oil film life reduced and oil film thinning quickened, the better the dewatering rate of model emulsion. Through analysis the results showed that the interfacial elasticity decreased a and substituted emulsifiers on the interfacial film, which decreased both the strength and the life of oil film and film thickness. When the thinning of film thickness came to a critical value, the film broke. Then from oil/water interfacial film character, the macrocosmic phenomena were discussed.

The effect of concentrations of demulsifiers on interfacial tensions between model oil/water is shown in Figure 5.

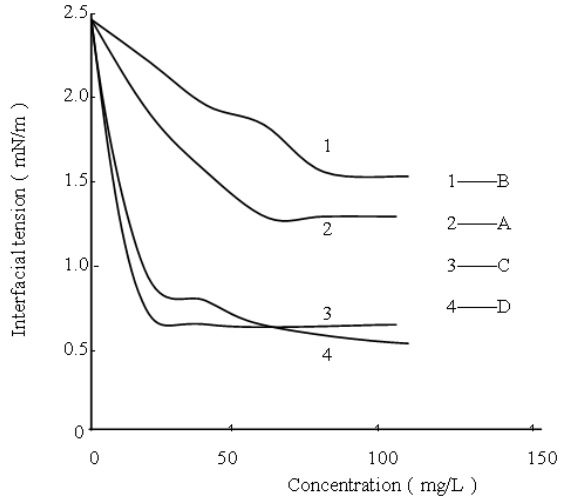

Figure 5 Interfacial tensions of demulsifiers between oil/water interface

Decreasing extent of interfacial tension acted by water-solubility C, D demulsifiers is bigger than by oil-solubility A, B demulsifiers. Comparing with Figure 4, the results indicated that same kind of demulsifiers decreasing capacity of oil/water interface tension have relation with demulsification, that is, with the increase demulifier concentration, interfacial tension decreased and dewatering rate increased.

Four kinds of demulsifiers all decreased oil/water interfacial viscosity is shown in Figure 6. The result showed that effect of different kinds of demulsifiers on dewatering rate of model emulsion has no connection with the effect on oil/water interficial viscosity. Four kinds of demulsifiers all decreased oil/water interfacial elasticity and decreasing of different kinds of demulsifier on oil/water interfacial elasticity accorded with effect of demulsification.

With the increase of same kinds of demulsifiers concentration model oil/water interfacial elasticity decreased and dewatering rate increased, which accorded with effect of demulsification. (Figure 7 and Figure 4). So there is close connection between effect of demulsifiers on oil/water interfacial elasticity and effect of demulsification. Demulsifiers which can be adsorbed on the oil/water interfacial and affected interfacial elasticity have better interfacial activity than emulsifiers.

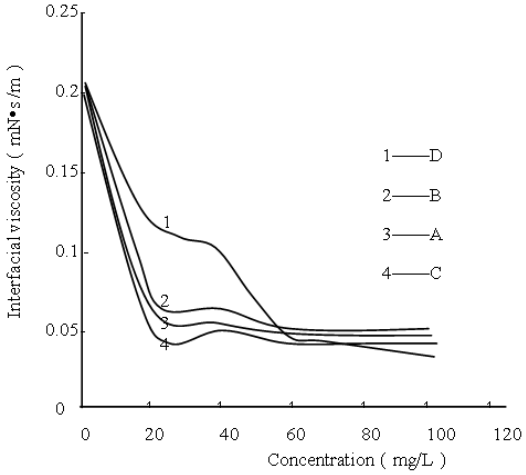

Figure 6 Interfacial viscosity of demulsifiers between oil/water interface

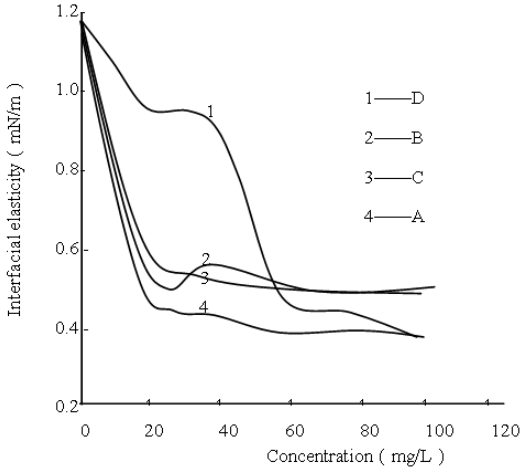

Figure7 Interfacial elasticity of demulsifiers between oil/water interface

There is different degree decreasing action about demulsifiers on oil/water interfacial tension, interfacial viscosity and interfacial elasticity. Decreasing action of the same kinds of demulsifier s on oil/water interfacial tension, viscosity and elasticity have corresponding connection with effect of demulsification. With the increase of demulsifiers concentration, interfacial tension, viscosity and elasticity decreased and dewatering rate increased. When concentration of demulsifier s reached certain value, change of interfacial tension, viscosity and elasticity with concentration of demulsifier s was very small. Decreasing action of the different kinds of demulsifier s on oil/water interfacial tension, viscosity and elasticity have no corresponding connection with

effect of demulsification. But there is corresponding connection between effect of demulsifiers on oil/water interfacial elasticity and effect of demulsification. Demulsifier C, D with long line of functional groups in the molecular branch demulsification better than A, B because the polyoxyethylene polyoxypropylene fatty alcohol molecular can weak the film construction and then it broken quickly.

Conclusions

1. The demulsification mechanism of polymer surfactant flooding produced fluid can be assumed that the interfacial elasticity is close connection between effect of demulsifiers on oil/water interfacial elasticity and effect of demulsification, the lower interfacial elasticity the lower emulsion stability and the better effect of demulsification. Interfacial elasticity of water/oil can be an important parameter for evaluating properties of demulsifiers.
2. When there are no demulsifiers, oil film is stable first, then oil film broke suddenly when there are demulsifiers, thickness of oil film thins gradually, then it broken. Demulsifier C, D with long line of functional groups in the molecular branch demulsification better than A, B because the polyoxyethylene polyoxypropylene fatty alcohol molecular can weak the film construction and then it broken quickly.
3. Interfacial elasticity decreased as demulsifiers adsorbed on interface and substituted emulsifiers on the interfacial film, which decreased both the strength and the life of oil film and film thickness.

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