No. 2002

Demulsification of Oil Field Water with Seawater-New Interface Modification Method by Microwaves

Yusuke Asakuma

Graduate School of Engineering, University of Hyogo

Summary

Because microwave passes through the non-polar oil phase, it can reach the polar aqueous phase. After that, it is absorbed and exponentially decays inward. In our previous studies, we have discovered surface modification by surfactant desorption caused by microwave irradiation to the liquid-liquid interface. We thought that this method could be used for de-emulsification process of the emulsion obtained during crude oil mining. However, in the case of offshore oil field, although the accompanying water contains salt. In this way, when the aqueous phase contains salt, the characteristics of microwave absorption around the interface change drastically. For example, at high concentrations, the penetration depth becomes dramatically thinner, and microwave is locally absorbed at the interface. Finally, this energy concentration causes phenomena such as boiling. Therefore, in this study, through observation of the liquid-liquid interface between the aqueous phase and the oil phase with different salt concentrations during microwave irradiation, we attempted desorption of the surfactant with a long hydrophilic group by microwave local heating. As a method for evaluation of the desorption level, the interfacial tension during and after microwave pulse irradiation was calculated, and the desorption mechanism of the surfactant and the optimum operation method were examined by the dimensionless number proposed by our group.

From the results of interfacial tension during and after microwave irradiation, it was found that surfactant with a long hydrophilic group becomes more stable at the interface due to the interaction between its polar substituent and sodium ions or chloride ions in the aqueous electrolyte solution. Therefore, surfactant desorption from the interface becomes more difficult even by vibration or rotation of polar substituents and surrounding water molecules by microwave irradiation. Higher power irradiation is required for the desorption of the stable surfactant molecule from the interface, but its energy concentration causes boiling. In this case, balance between the energy concentration and distribution at the interface by high-power pulse irradiation is most important factor for the optimum desorption. As a result, by changing the irradiation mode, rapid interface modification became possible. To estimate the microwave irradiation mode for this interface modification, the dimensionless number proposed in our previous study was used. Finally, it was confirmed that the dimensionless number is a good index for determining the irradiation mode such as power, irradiation time, and interval, and for suppressing the boiling phenomenon from the interface.

.