

## Batch scale studies of electrostatic coalescence of water in crude oil emulsions: Effect of field strength and frequency

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Several operations in the petroleum industry can lead to the formation of water in crude oil emulsions. Emulsifying agents such as asphaltenes, resins, finely dispersed solids, etc. in can severely increase the stability of the water in oil emulsions. [1]

Compared to other widely used solutions (centrifugation, thermal treatment, chemical demulsification, microwave, etc.), electrostatic coalescence is the most efficient water-in-crude-oil (W/O) demulsifying technology, and have been adopted in upstream (dehydration) and downstream (desalting) operations. [2]

In this study, the efficiency in the electrostatic coalescence of water in heavy oil emulsions was investigated modifying the voltage between electrodes and the AC field frequency. The temperature between the electrodes was measured at the end of the experiment and the efficiency of the process was evaluated by measuring the final water content by Karl Fischer Titration. Typical results are presented as follow.

The oil ( $^{\circ}\text{API}<20$ ) and deionized water were previously heated in water bath at 60 °C until thermal equilibrium. Emulsions (10%w/w) were prepared using a high shear mixer for 4 min at 13,000rpm. The mixture at 60°C was subjected to the electric field with submerged live electrodes for 10min. It was applied 2kV, 4kV and 6.5 kV voltages at different frequencies. The results are shown in figure 1.

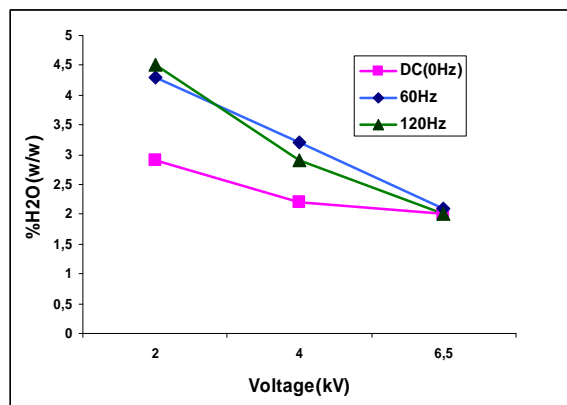


Fig. 1. Final water content (%w H<sub>2</sub>O) measured in different voltages (kV) at DC and 60Hz and 120Hz.

Figure 1 shows that the water content decreases as the electrical field strength increases for both frequencies and that there is no noticeable difference in the dehydration efficiency for 60 e 120Hz for all conditions. It was observed that the final temperature between the electrodes also increases as the voltage increases explaining partially the improvement in dehydration as the voltage increases.

The results for increasing AC frequency for a fixed 2kV voltage are presented in Table 1.

Table 1:  
Final water content in function of AC frequency at 2kV.

Frequency (Hz)	Water content (%w H <sub>2</sub> O)	Temperature (°C)
DC	2.9	53
60	4.3	53
120	4.5	53
240	3.4	55
360	5.8	54
480	5.3	50
720	4.7	51

The frequency variation studies show that there are two clear maximum efficiencies at DC and 240Hz for this crude oil emulsion. The origin of this minimum at high frequency is unclear but it may arise from a resonance between the electric field and the water droplet interface.

Different crude oils and modulated frequencies were also tested and they showed the same general behavior, that is, a maximum efficiency at DC and at higher frequencies than 60Hz. Physico-chemical characteristics of the oils and their emulsions were correlated with dehydration efficiency.

### References

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- [2] Noik, C. Chen, J., Dalmazzone, C. SPE 103808. 2006 SPE International Oil & Gas Conference, China, 5-7 December, 2006.