Pilot plant and full scale studies of crude oil desalting

Patrícia S. M. D. Cunha[a,b], Elisabeth Fonseca[a], Raquel C. C. Coutinho[b], Fabrício Machado[c], Rafael Fontes[c], Príamo A. Melo Jr.[b], José C. Pinto[b], Márcio Nele[b,*]

[a] *Petrobras Research Center - CENPES, Rio de Janeiro, Brasil -*
[b] *Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil*
[c] *AIKETECH , Rio de Janeiro, Brasil*
(corresponding author: nele@eq.ufrj.br)*

The water removal treatment from heavy crude oil emulsions is a challenge that the oil industry is increasingly facing as a result of the depletion of light crude oil reserves and of the processing of opportunity crudes. Heavy crude oil emulsions are encountered in both crude oil production and refining operations as a result of the water production or crude oil desalting. During oil exploration, the formation of stable crude oil emulsions is a very significant problem that may cause environmental concerns, pipeline corrosion and prevent oil transportation when standards are not met.

Crude oil emulsions are an intricate subject, crude oil itself is a complicated mixture of chemical compounds ranging from simple linear hydrocarbons to complex molecules such as asphaltenes, naphtenic acids, bases, metallic constituents and even to indigenous solids. Despite of the recent advances in Fourier transform ion cyclotron resonance mass spectrometry [1], the exact composition of crude oil is still unknown and group type fractionation procedures is used to characterize it. The most common procedure involves fractionating the crude oil in saturates, aromatics, resins and asphaltenes (SARA). Not surprisingly, the conclusions about the factors affecting the stability of emulsions whose one phase is a largely unknown mixture fractionated in simpler, but still complex mixtures, are not well understood.

In this study seven crude oil emulsions were studied in pilot plant scale. The crudes had an ^{o}API range from 28 to 13, and experimental variables for the pilot plant tests were temperature (T), voltage gradient (GT in kV/m), residence time between electrodes (τ) and water content in the emulsion feed (H_2O_{in}). The measured response was final water content. The effect of the experimental variables on water content of the dehydrated oil was studied using the statistically designed set of experiments (2^{4-1}). The correlation coefficient between the normalized experimental variables and final water content is shown in Table 1.

An analysis of Table 1 shows that the most important variable was the emulsion residence time between electrodes and that the initial amount of water in the emulsion was not important.

These data were fed in an algebraic model and used to predict the final water cut in four different full scale desalting units in different operating conditions. The model predicted very well the performance of full scale units. Figure 1 shows a typical (not the best) fit of the final water content predicted and the measured in the refinery site.

Table 1: Correlation coefficients for the final water content and normalized experimental variables in pilot plant studies (significant coefficients in bold).

Crude (^{o}API)	T	GT	τ	H_2O_{in} (%w/w)
A (28)	-0.13	**-0.62**	**-0.58**	0.18
B (27)	-0.03	-0.42	**-0.64**	0.07
C (23)	**0.70**	-0.09	-0.53	0.22
D (23)	0.18	-0.10	**-0.62**	-0.24
E (19)	0.08	-0.26	**-0.74**	-0.10
F (17)	-0.09	-0.58	**-0.72**	-0.03
G* (13)	-0.71	-0.33	-0.62	-0.77

* Not all experiments were run due to excessive current between the electrodes

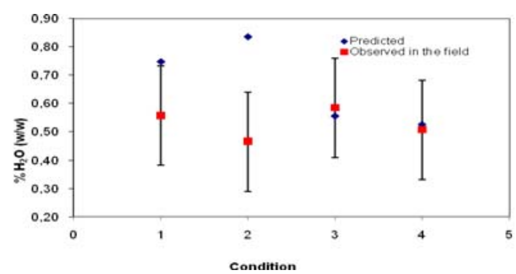

Fig. 1: Comparison between model prediction and field observation.

The model usually predicted a final water content in the crude above the measured (maximum absolute deviation 0.45%). This may associated to a better flow distribution in the full scale units when compared to the pilot plant. `

Physicochemical characteristics of the oils and their emulsions were correlated to dehydration efficiency in order to contribute to the understanding of the factors that lead to the formation of stable water in oil emulsions.

References

[1] Stanford L.A., Rodgers R.P., Marshall A.G., Czarnecki J, Wu X.A., Energy & Fuels 2007, 21(2), 973-98