Evaluation of the Extraction Method and Characterization of Water-Soluble Organics from Produced Water by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry

A.T. Lewis (FSU, NHMFL, Chemistry), T.T. Tekavec (Shell), J.M. Jarvis (FSU, NHMFL, Chemistry), P. Juyal (Nalco Energy Services), A.M. McKenna (NHMFL, Chemistry) A.T. Yen (Nalco Energy Services), and R.P. Rodgers (FSU, NHMFL, Chemistry)

Results and Discussion

An alternative method to extract, quantify, and characterize water-soluble organic (WSO) species in produced water from steam-assisted gravity drainage (SAGD) is evaluated by various techniques. Here, we use a 70:30 mixture of cyclohexane/butyl acetate as the solvent for extraction of WSO species from produced water. The ability of the 70:30 cyclohexane/butyl acetate mixture to efficiently isolate higher O_x species (**Figure 1**) that are readily identified in production deposits is demonstrated by use of Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometric analysis and fluorescence spectroscopy. These results are compared to industry standard methods that employ extraction with *n*-hexane and cyclohexane. Results reveal that the 70:30 cyclohexane/butyl acetate solvent system not only extracts more material from produced water than *n*-hexane or cyclohexane but is also more efficient at extraction of polar species implicated in deposits of interest. Results suggest that a 70:30 cyclohexane/butyl acetate mixture is a better solvent for the quantitative extraction and analysis of WSO in produced water.

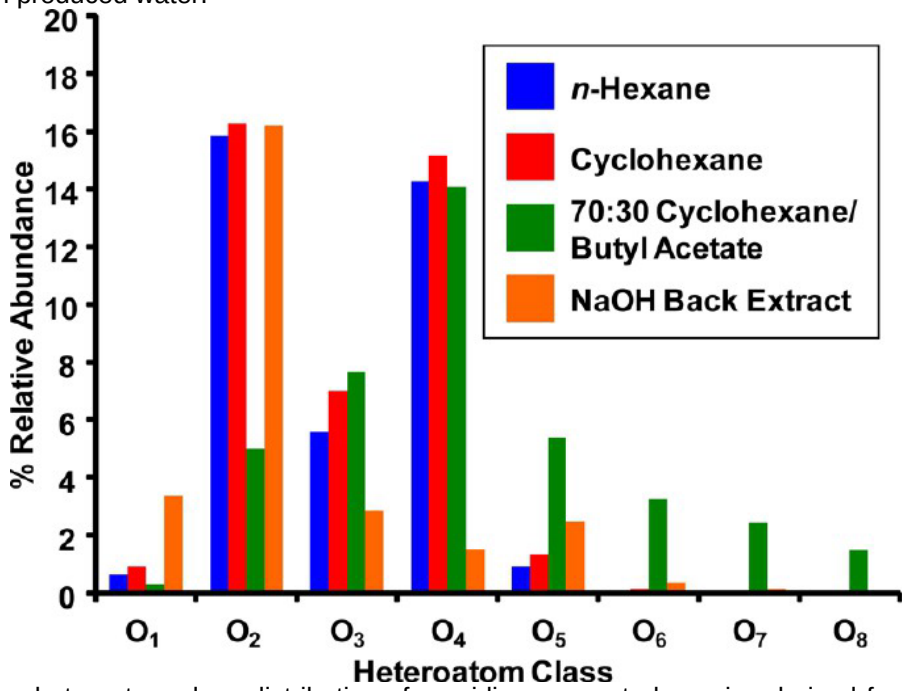

Figure 1 Qualitative heteroatom class distributions for acidic oxygenated species derived from negative-ion ESI FT-ICR mass spectra for produced water-solvent extracts (hexane, cyclohexane, and cyclohexane/butyl acetate) and sodium hydroxide back-extract. Note that the y axis is unweighted with respect to the sample volume extracted (which is significantly higher for the 70:30 cyclohexane/butyl acetate extract) and reflects only relative abundance within each sample.

Acknowledgments

The authors thank Nalco Energy Services (An Ecolab Company) and Chevron Energy Technology Company. This work was supported by NSF Division of Materials Research through DMR-11-57490, Florida State University, and the State of Florida.

References

[1] Lewis, A.T, *et al*., Energy & Fuels., **27**, 1846-1855 (2013)