Novel Method to Isolate Interfacial Material

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Results and Discussion

Isolation of crude oil components that concentrate at the oil/water interface [i.e., interfacial material (IM)] facilitates their molecular identification and quantitation, which is critical for advances in optimal petroleum production and processing. For a given crude oil, the molecular composition of IM determines its emulsion stability and identifies those chemistries that disproportionately contribute to the interfacial layer. Here, we describe a scalable, simple, quick, and efficient procedure to isolate IM from petroleum crude oils and/or other organic matrices. Hydrated silica (∼26 monolayers of water on a silica surface) enables separation of interfacially active species through their interaction with the immobilized water. Species with little or no interaction with the hydrated silica (water-laden) surface are eluted with a 1:1 (vol) mixture of heptane/toluene (heptol). The interfacially active species are subsequently isolated through the addition of methanol to the eluting solvent mixture, which partially strips water from the silica surface and releases the interfacially active species. Molecular-level characterization of the two fractions (fraction 1, non-interfacially active; fraction 2, interfacially active) by Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) reveals that isolated IM contains a higher abundance of acidic oxygen- and sulfur-containing compounds relative to the parent crude oil. Emulsion stability tests of the isolated fractions demonstrate that fraction 2 (interfacially active) produces a much more stable emulsion than fraction 1 (non-interfacially active). Finally, a comparison of molecular-level characterization results obtained by the wet silica technique to that of the heavy water (Wu) method reveals a similarity between chemical functionalities (heteroatom classes) of isolated, interfacially active species.

![Figure 1A](image1a.png)  ![Figure 1B](image1b.png)

Figure 1. Heteroatom class distribution for the whole oil (red), fraction 1 (blue), and fraction 2 (green) from an Arabian heavy crude oil (Figure 1a, left) and Gulf of Mexico crude (Figure 1b, right) derived from (∼) ESI 9.4 T FT-ICR mass spectra collected with a TMAH modified solvent composition. The Arabian heavy crude oil IM shows higher relative abundance of a larger variety of O,S,S species than the IM isolated from the Gulf of Mexico crude oil. Both light and heavy crude oils show N,O,S,S in higher relative abundance than the parent crude; however, the Gulf of Mexico crude oil contains a higher relative abundance of N,N,N, N,O,S,S species. Thus, from a limited data set, it appears that the heteroatom chemistry of the IM can be tied back to the most abundant heteroatoms (N or S) of the parent crude oil, modified simply by the addition of oxygen.

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References