Observation of Liquid Crystals in Heat Treated Athabasca Bitumen + Water Mixtures

Chuan Qin and John M. Shaw
Department of Chemical and Materials Engineering, University of Alberta

Liquid crystals comprising an anisotropic shell surrounding an isotropic core were observed in unreacted heavy fractions extracted from Athabasca bitumen and other hydrocarbon resources and resource fractions [Bagheri et al., Energy & Fuels, 2010, 24 (8), 4327–4332]. Transfer of these dispersed and surface-active hydrocarbon domains to a water rich phase during SAGD or other water rich production process conditions is the subject of this exploratory study because their presence is expected to present unanticipated technical challenges that may complicate water re-use and disposal. In this exploratory contribution, 50 wt % mixtures of water and Athabasca bitumen were placed in a high-pressure micro reactor. The reactor was inserted in a sand bath equipped with a shaking mechanism for 30 minutes at 320 °C. The reactor was then removed from the sand bath, cooled to room temperature where the water-rich upper phase and the bitumen rich lower phase separated rapidly and were sampled. Liquid crystal domains, identified by the presence domains exhibiting characteristic Maltese cross patterns using cross-polarized light microscopy, were found in the water-rich phase. Their diameters ranged from 2.6 μm to 6 μm. These liquid crystal domains are mobile and they tend to accumulate at the rim of water-rich liquid drops, an effect accentuated as the drops evaporate. As the solubility of water in bitumen and the solubility of bitumen in water-rich are substantially greater at 320 °C than at room temperature, the mechanism for transferring the liquid crystals from the bitumen-rich phase to the water-rich phase is unresolved.