Phase Behavior of Heavy Oil & Tar Mats

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Abstract

Hydrocarbon production and refining have entered their second century as global, industrial scale processes. There is a tendency to treat them as sunset industries with only limited research and development needs and potential, as large thermophysical property databases have been created, and a panoply of experimental techniques, and commercial computational tools have been available for some time. While it can be argued that for natural gas and light oil processing, this is so, even for these cases critical exceptions arise particularly with respect to phase behavior and physical property prediction quality that affect process safety and optimization [1, 2]. For unconventional hydrocarbon resources (e.g.: heavy oil, bitumen, tar mats), a growing segment of the hydrocarbon energy and petrochemical industries, this is certainly not the case. Customary experimental and computational tools are of limited value because these hydrocarbon resources include nanodispersed and self assembled phases, are opaque to visible light, include solid phases even at elevated temperatures, and comprise large molecules that are ill-defined [3, 4]. Process identification, design and optimization present formidable challenges for engineers and researchers both from experimental and theoretical perspectives. Phase equilibria and transport properties are not readily measured or predicted. Much experimental and theoretical work is conducted blind or by analogy with simpler materials and it is not clear whether existing processes are appropriate much less optimized. With such a level of uncertainty, the subtitle of the conference “nuisance or resource” is an appropriate one. Key aspects of the complex and polymorphic phase behavior of asphaltene-rich hydrocarbon resources, revealed through the combined use of calorimetry and rheometry [5], densitometry, and non-standard techniques from x-ray transmission tomography [6], to nanofiltration [7] and polarized light microscopy are presented [8]. Computed phase behavior results [9, 10, 11] are also discussed along with limitations and challenges for both experimental and theoretical investigations.

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