Modeling of the Solubility of Light Gases in Heavy Hydrocarbons and Their Mixtures

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Information on the solubility of light gases such as methane, ethane or hydrogen in hydrocarbons and their mixtures is important in processes related to petroleum production and processing. Natural gas (mainly methane and ethane) is injected into petroleum reservoirs for improving production especially for reservoirs containing heavy oils. Hydrogen is added to heavy petroleum residues to improve the hydrogen content of the oil and its upgrading through processes such as hydrocracking. Hydrogen is also added to coal liquids for desulfurization processes. Design and operation of equipment for these processes require knowledge of gas solubility in liquid oil under various operating conditions of pressure and temperature.

As experimental determination of solubility data for various oils under various conditions is difficult, time consuming and expensive, if not impossible, accurate prediction of such data is important. Usually such data are calculated through equations of state which require binary interaction parameters (BIP) and critical properties of the oil. BIPs should be determined from available experimental data and critical properties of petroleum mixtures especially heavy oils cannot be accurately estimated. For these reasons other approaches to estimate solubility data that do not need such input data become increasingly attractive. More sophisticated equations of state such as SAFT do not need critical properties but still their parameters must be determined from experimental data. Recently Riazi and Vera [1] showed that Scatchard-Hildebrand solubility model can be used to calculate solubility of gases in petroleum fractions through their PNA composition.

In this paper we present modified solubility parameters for gases such as methane, ethane and hydrogen that can be used for hydrocarbons in the molecular weight range of 150 to 500 using single carbon number approach [2]. While the proposed model does not require any interaction parameter or critical properties of oil, it predicts solubility data with accuracy similar to those of equations of state reported in the literature. We show some results calculated from this model for pure hydrocarbons, petroleum fractions, crude oil and coal liquid. The input parameter for the model can be calculated from known characterization methods using molecular weight, distillation data or density of the oil [2].

Acknowledgement: The work is supported by Kuwait University through Research Project EC01/05.

[1] M.R. Riazi, J.H. Vera, *"Method to Calculate the Solubilities of Light Gases in Petroleum and Coal Liquid Fractions on the Basis of their P/N/A Composition,"* Industrial and Engineering Chemistry Research, **44**, 186-192 (2005).

[2] M.R. Riazi, *"Characterization and Properties of Petroleum Fractions,"* Manual 50, ASTM International, Conshohocken, PA, pp. 435 [http://www.astm.org/mnl50.htm] (2005).