Phase behavior representation of oil-asphaltene-propane mixtures during the supercritical process deasphalting

Ayda Karina León Ayala*, Maria Regina Wolf Maciel

*Department of Chemical Engineering, State University of Campinas, P.O. Box 6066, 13081-970, Campinas, SP, Brazil (*corresponding autor:karinaleon@feq.unicamp.br)*

Asphaltenes are polar compounds which are stabilized in crude oil by the presence of resins. If the oil is diluted by light hydrocarbons, the concentration of resins goes down and a point may be reached where the asphaltene is no longer stabilised and it flocculates. The separation of this solid phase to the oil it is namely deasphalting and commonly it is used supercritical propane as a solvent. In order to make improvements in this process, the research about the phase behavior of these complex mixtures it has been increasing. Reliable and versatile models of the phase equilibrium thermodynamics are needed for their use in process design and economic feasibility studies. In this research the modeling was made to represent the behavior in supercritical or near supercritical conditions of asphaltene-propane-oil mixtures.

A molecule of asphaltene was defined and characterized in the simulator ASPEN PLUS. First, it was selected the representation of asphaltene´s molecule from literature review corresponding to a vacuum residue of Arabian crude [1]. A second step was a properties estimation using correlations, and finally, a characterization of a new component in the simulator database. The last step was been done too for the oil characterization from experimental data.

Multiflash equilibrium calculations were made for the binary mixture propane-oil by the use of a extension InfoChem Multiflash in ASPEN HYSYS, (advanced software package for performing complex equilibrium calculations). It was used the PSRK cubic equation of state (Predictive Soave Redlich Kwong). The phase envelope plotting it's presented in the figure 1. The left curve represents the vapor pressure of the solution of oil in propane. Up to 165°F the mixture has only a liquid phase, but in this temperature a second liquid phase begins to appear (LCTS). The binary diagram agrees with the one presented by McHugh and Krukonis [2] and reflects the expected behavior in the phase separation that occurs when the resins, heavy and naphthenic constituents are separated from the lubricating oil with increasing temperature.

Figure 2 presents the ternary diagram obtained for the oil-propane-asphaltene mixture a 580 psia (near supercritical conditions for propane).

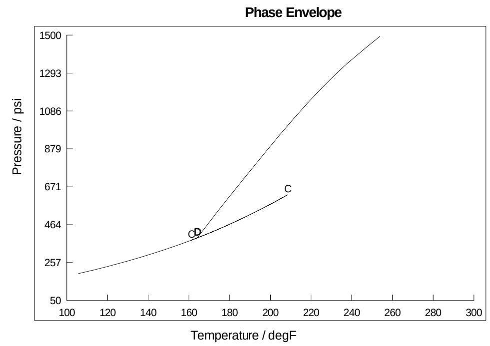

Fig. 1. Phase envelope for the propane-oil mixture

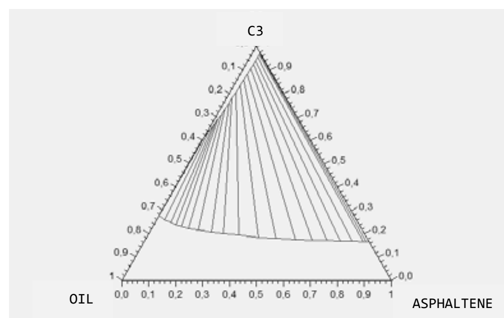

Fig. 2. Ternary diagram for the oil-propane-asphaltene mixture.

As the physical properties of propane increases with temperature, near the critical point it dissolves a smaller amount of oil, making possible to recover the solvent by decantation without need of vaporization. The results reflect the behavior observed in the industrial deasphalting supercritical process. The thermodynamic PSRK model presented accuracy results in the correlation of solubilities.

References

[1] Verstraete, J.J., Dulot, H., Hudebine, D. Molecular reconstruction of heavy petroleum residue fractions. Chemical Engineering Science, 2010: 311-312.

[2] McHugh, M.A.,, Krukonis, V.J. Supercritical Fluid Extraction Principles and Practice. 2nd. Washington: Butterworth-Heinemann, 1994.