Thematic Section: Research into New Technologies. **Full Paper**
Subsection: Supercritical Fluid Technologies. *Reference Object Identifier* – ROI: jbc-01/18-56-10-127
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/18-56-10-127
Submitted on October 24, 2018.

Some equilibrium properties of thermodynamic systems involved in the processes of utilization of oil sludge and wooden railway sleepers using supercritical fluid working media

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Keywords: solubility, supercritical propane/butane, binary system, optical cell, oil sludge, critical pressure, critical temperature.

Abstract

The phase transition is very important in many chemical processes and separation processes carried out at high temperatures and pressures, especially in supercritical fluid processes, where the phase state can significantly affect the speed, selectivity, mass transfer of the reaction and other parameters. The phase state for many years has been the object of research. Numerous methods have been developed to study the phase state of fluid mixtures.

In the framework of this work, the characteristics of phase equilibria of the naphthalene – propane/butane, sulfur – SC propane/butane, phenol – propane/butane, and anthracene – SC propane/butane binary systems were investigated. The phase behavior of these systems is very difficult to predict, because real systems are often very complex in the sense that, due to the multicomponent nature of hydrocarbons, which vary considerably in size, shape, structure and polarity of molecules, a large variety of phase behavior occurs in combination with critical phenomena. Knowledge of the phase equilibria of these substances in propane/butane will allow us to find the optimal parameters for the extraction of hydrocarbons from oil sludge, spent sleepers and the regeneration of ion-exchange and nickel-molybdenum catalysts. If according to the phase equilibrium "naphthalene – propane/butane", "phenol – propane/butane" we determine the depth of sludge processing, then according to the phase equilibrium "sulfur – SC propane/butane" "anthracene – SC propane/butane" we can predict the sulfur content and anthracene in the product extraction of hydrocarbons.

The phase equilibria of pure propane and propane/butane mixture were considered as part of trial measurements. Difficulties in the experimental determination of critical parameters are the presence of impurities in the samples of the study, they cause significant differences in the results obtained by various researchers. The critical density is difficult to accurately determine experimentally because of the infinite compressibility at the critical point and the associated difficulty of achieving thermodynamic equilibrium. To test the installation, pilot experiments were conducted to study the solubility of naphthalene in SCF CO_2. A good convergence of the data obtained in this work with the literature data was obtained.

The phase equilibrium "naphthalene – propane/butane" and "phenol – propane/butane" containing 60.9% propane and 39.1% butane were studied in a molar ratio, in the pressure range 4-10 MPa and in the temperature range 403.15-443.15 K. The analysis of the influence of the thermodynamic parameters of the process on the phase behavior of the naphthalene – propane/butane and phenol – propane/butane systems was carried out.

The graphic material of the work includes a flow chart of a static experimental setup with an optical cell and a flow chart of a dynamic setup, graphs of the results of studying phase equilibrium in propane/butane, and solubility in SCF propane/butane.

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