

## **An Experimental Study of High Temperature, High Pressure, Multi-phase Reactions between Sulfur and Hydrocarbons; Phase Behavior and Reaction Results**

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Sulfurized hydrocarbon materials play a wide role in the chemical process industry. Due to thermodynamic limitations of sulfur and most hydrocarbon systems, most industrially operated processes are conducted in large batch reactors. In order to reap the benefits of continuous operation, the reaction rate must be enhanced significantly via changes in operating conditions or use of catalysts.

In the present work, laboratory-scale batch experiments were conducted as control and compared to operation under "intensified" process conditions. The batch reactor control was conducted at 160-190 C (with a vapor space constituting about 20 vol% of the reactor) at low pressure, governed by the vapor pressure of the organic reactants. Initially, the system exhibited a liquid sulfur (S)-rich phase, a hydrocarbon (HC) rich liquid phase, and a vapor phase rich in light hydrocarbon vapor and volatile by-products (e.g. H<sub>2</sub>S). The S-rich phase is consumed within the first hour, leaving a single liquid phase that contains S, HC, sulfurized products and volatile by-products. High conversion requires a prolonged hold time (~5-10 hours).

Next, three process intensification strategies were assessed in a windowed, variable-volume, agitated Inconel reactor rated to 300 C and 40000psi. First, at 160-190 C, pressure was maintained at a high enough value to suppress formation of a vapor phase, forcing all volatile by-products and intermediates into the liquid reaction phase(s). Second, the reaction was conducted at temperatures up to 300 C and extremely high pressures great enough to maintain a single liquid or supercritical fluid phase after the consumption of the S-rich phase. Third, an attempt was made to identify either heterogeneous or homogeneous S-tolerant catalysts. The phase behavior and reaction results will be discussed in detail in the presentation.