

Vapor Phase Cracking of Bitumen-Derived Heavy Gas Oil

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The kinetics of vapor phase cracking of Athabasca bitumen-derived heavy gas oil and the quality of its liquid products were investigated at temperatures of 600-700 °C. Complete vaporization of feed was achieved by optimizing nozzle tip position and flow rates of helium sweep gas. Fixed and condensed gases were analyzed by gas chromatography. The quality of liquid products was characterized using simulated distillation, elemental analysis and ^{13}C NMR. Coke yields were determined based on the particles separated from liquids and collected at the outlet of reactor. Consistent with gas-phase cracking behavior, the coke yields were well below 2 % at most operating conditions. The yields of $\text{C}_1\text{-C}_4$ olefins were 2 to 17 % at residence times of 0.3-1.2 s over the temperature range. The corresponding yields of $\text{C}_1\text{-C}_4$ alkanes were only 0.6 to 5 %. Hydrogen content of liquid product was lost significantly, while aromatic carbon content increased linearly with increase of conversion. Aliphatic groups are reactive while aromatic rings remain intact in thermal cracking, therefore, the apparent first-order rate constants decreased at high conversion range due to the accumulation of aromatics. A two-step kinetic model including fast dehydrogenation and slower cracking was proposed on the basis of chemical structure of reactant. The activation energy of the overall cracking reaction on reactive materials was 215 kJ/mol.