346f Thermal Cracking and Coke Formation inside Tubes of Petrochemical Fired Heaters

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This work presents a model to predict coke formation due to thermal cracking of the heavy petroleum residue coming from the vacuum distillation column inside tubes of refinery fired heaters in the petrochemical industry. The prediction is based on an in-house two-dimensional CFD (Computational Fluid Dynamics) axi-symmetric model. Laminar and turbulent flows were analyzed for several mass flow and temperature specifications. The petroleum is represented by a model of seven pseudo-components (lumps) which are dissolved in the liquid phase (petroleum) at the tube entrance. The model solves numerically the discrete form of the equations for the mass, momentum and energy conservation. Physical properties are dependent on temperature due to the high temperature gradient inside these tubes. In order to predict the coke formation, the model uses a ternary diagram to test if the pseudo-component asphaltene precipitates (only asphaltene can lead to coke formation). Since there are high temperature gradients inside the tube, the model equations take into consideration not only the radial and axial variations for the temperature, velocity and concentrations but it also considers viscosity, density, thermal capacity and thermal conductivity as a function of temperature. The numerical model used to discretize the conservation equations is the finite volume method. The results show that the model is suitable to predict coke formation inside heater tubes, since it indicates operational conditions in which coke formation is minimized.