Effect of recycle stream on the Kinetics of slurry hydrocracking of vacuum residue

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Slurry-phase hydrocracking is a developing technology to completely upgrade vacuum residues (VR). Recycle operating mode (ROM) is necessary to maximize the conversion of vacuum residues. In this work, various experiments were conducted in continuous bench-scale test facility with recycle stream to study the effect of recycle stream on hydrocracking reactions. The conditions are the following: pressure, 160 bar; molybdenum catalyst 500 wtppm in fresh feed (FF); hydrogen to oil ratio, 2000 – 3800 Nm^3/m^3, temperature, 410 – 422℃; space velocity, 0.2 -0.367 h^{-1}; recycle ratio (Unconverted Residue/FF VR), 0.55 – 1. VR conversion and hydrocracking product yields in once through mode (OTM) and ROM were compared. In ROM, the per-pass VR conversion decreased because the unconverted residue becomes more refractory to be hydrocracked. Moreover, the mild reaction conditions with the recycle stream increased the production of gas. A kinetic model based on our previous study (Pham et al., 2020) was used with a modified Arrhenius equations to include both recycle ratio and temperature effects on the hydrocracking kinetics. The model gave a good fit with the experimental data.