**Hydrocracking of Athabasca VR Using Ni-Mo-Supported Drill Cuttings**

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## Supporting Material

Table s1 presents a summary of relevant literature pertaining to hydrocracking and slurry hydrocracking of vacuum residue (VR). Hydrocracking catalysts, both solid and dispersed forms have been areas of interest in recent times. However, the use of a waste catalyst, such as drill cuttings, for hydrocracking has not been fully investigated before. Additionally, a direct comparison to thermal cracking control runs has not been provided. This work aims to fill this knowledge gap and provide a starting point for the use of future waste-based metal supported catalysts for hydrocracking.

**Table s1:** Literature review on hydrocracking and slurry hydrocracking of VR.

| Reference | Experimental Conditions (Feed type, mode of operation, catalyst, operating conditions) | Major Conclusions |
|---|---|---|
| Hydrocracking of VR | | |
| Puron et. al [1] | • Vacuum residue<br>• Batch<br>• Ni-Mo/$Al_2O_3$<br>• 400-450 °C, 190 bar, 1 h | • Metal loading insignificant for upgrading in the range of < 450 °C, where thermal cracking reactions were dominant<br>• Higher metal loading led to favorable asphaltene conversion<br>• Initial deposits of coke on catalyst reduced acidity but not activity in a significant way |
| Manek & Haydary [2] | • Modelling of VR<br>• Solid: Ni-Mo/$Al_2O_3$ /dispersed: Mo based | • Dispersed catalyst showed no correlation between sediment formation and bed temperature |

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|---|---|---|
| | • 400-420 °C, 18-20 MPa | • Dispersed catalyst showed higher hydrochlorination with temperature |
| Kim et. al [3] | • Real vacuum residue<br>• Batch<br>• Calgon Filtrasorb 300, Tetralin<br>• 400-450 °C, 1.6-5.3 MPa | • Tetralin improved catalytic activity, and increased catalyst lifespan<br>• Complete residue conversion achieved despite no $H_2$ gas<br>• Tetralin-like industrial solvent could be applied to VR upgrading |
| Catalytic Slurry Hydrocracking | | |
| Yang et. al [4] | • Karamay atmospheric residue<br>• Batch<br>• Molybdenum Dialkyldithiophosphate<br>• 430 °C, 7 MPa, 1 h | • Self-sulfidizing catalyst<br>• Low coke yield despite large asphaltene aggregates remaining, suggesting high hydrogenation activity |
| Kim et. al [5] | • Korean vacuum residue<br>• Batch<br>• $MoS_2$ dispersed catalyst<br>• 400 °C, 6-15 MPa, 1-6 h, 500-2000 rpm | • High $H_2$ pressure (~15 MPa) maximized yield of light products, while minimizing coke formation<br>• $MoS_2$ active phase favored over shorter Mo-S and Mo-Mo coordination |
| Kim et. al [6] | • Korean vacuum residue<br>• Batch<br>• $MoS_2$,$Co_9S_8$,$Ni_3S_2$<br>• 400 °C, 9.5-10 MPa, 1-6 h | • Mo based catalyzed was found to have highest activity based on dispersability<br>• Intermediate oxidation state of Mo catalyst important for hydrocracking activity |
| Hur et. al [7] | • Vacuum residue<br>• Batch<br>• NiWS(x)<br>• 400 °C, 70 bar, 4 h | • Ni content determines degree of sulfidation of W<br>• NiWS(0.02) found to have best catalytic performance based on dispersability, formation of light products and conversion of asphaltenes |

**References**


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