Heavy oil and Bitumen Viscosity Prediction –
Impacts of Oil Characterization and Non-Newtonian Rheology

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There is a growing recognition that heavy hydrocarbon resources such as Maya crude oil from Mexico, and Athabasca bitumen from Canada, and heavy hydrocarbon resource fractions, such as Safaniya vacuum residue from Saudi Arabia are multiphase fluids [1-3] and exhibit non-Newtonian rheological behaviors [4] particularly at low temperatures. In this work, the phase behaviour of such fluids is briefly reviewed and the deviation between an integrated heavy oil characterization and Newtonian viscosity prediction approach [5,6] and complex viscosity data sets comprising whole crudes and whole crudes partitioned using nanofilration, without solvent addition, into pentane asphaltene enriched retentates and maltene enriched permeates, as well as chemically separated maltene and asphaltene fractions is examined. The range of asphaltene contents in the nanofiltered samples is ~ 2 to ~ 70 wt %. The data sets include steady shear rheology measurements ranging from 0.1 to 50 s-1, and oscillatory shear measurements where shear amplitude is varied as well as shear frequency. In this exploratory work, systematic deviations between measured and predicted viscosities are probed so that the impacts of oil characterization and non-Newtonian behaviours on the quality of viscosity prediction can be parsed. Impacts of characterization on prediction quality are identified under conditions of temperature and composition where Newtonian behaviour obtains. Non-Newontian contributions to viscosity are identified in the balance of data sets. Deviations exceeding an order of magnitude are observed under industrially relevant conditions. The contributions of characterization, maltene phase behavior, and asphaltene content to these systematic deviations are presented and discussed.

References

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