Modified Cubic Equation of State for Improved Oil Density Prediction

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Abstract

Cubic equations of state (EOS) have many applications in petroleum and chemical industries to optimize and enhance the productivity of various processes and practices. One of the main challenges among various popular cubic Equations of state was the lower oil density estimations. This thesis is concerning about deriving a modified cubic EOS by considering the molecules covolume in the pressure repulsion term of van der Walls EOS for obtaining reliable liquid density predictions. A new density solving workflow was tested by which cubic EOS is solved and the density is calculated for each component individually then mixing of all component's density occurs at the final stage. Conceptual insights for proposing both the modification in the covolume and the new mixing workflow is elaborated in this thesis. Using laboratory data of 14 points for 10 different crude oil samples, the new EOS was mathematically regressed by a coefficient to reduce the absolute deviation error. The final outcome is a new cubic EOS that utilizes a new density solving workflow which reduces the liquid density average absolute deviation errors to 11% compared to 57% (original van der Walls), 44% (Redlich and Kwong), 38% (Soave, Redlich and Kwong), 21% (Peng and Robinson), 52% (Petal and Teja) and 39% (Schmidt and Wenzel). The results were validated using two additional oil crude samples with 19 points of liquid density measurements at different pressures and temperatures. The validation indicates average absolute deviation error of 9%.