Density and Viscosity Modeling of Refrigerants Based on the f-Theory and a Non-Cubic EOS

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In previous works, the friction theory (f-theory) has been successfully applied to the viscosity modeling of a large variety of fluids. The f-theory allows for accurate viscosity-pressure-temperature (η-p-T) modeling based on a van der Waals type of equation of state (EOS), i.e. an EOS built on a balance between a repulsive pressure term and an attractive pressure term. Thus, popular cubic EOS, such as the SRK EOS and the PR EOS, have been applied in order to obtain accurate η-p-T models. However, even though an f-theory model based on a cubic EOS can accurately reproduce the viscosity behavior of, at least, non-polar fluids, the accuracy of the density predictions is still limited by the algebraic structure of such EOS. Thus, in an effort to extend the f-theory concepts to a larger variety of fluids, modified f-theory models have also been proposed for BWR types of EOS. However, for the coupling with an f-theory viscosity model, a BWR type of EOS has the shortcoming of not being structured on a balance between repulsive and attractive pressure terms. In this work, a non-cubic van der Waals type of equation of state is introduced for the accurate modeling of the density and viscosity of polar and non-polar fluids. The proposed EOS has a simple mathematical structure and a low number of parameters, which makes it attractive for a wide variety of applications. Although not to a reference level, the achieved accuracy, for both the density and viscosity fluid properties, is close to or within experimental uncertainty and applies to wide temperature and pressure ranges.