Improved Tait-Type Equation to Predict High Pressure Liquid Densities of Fatty Acid Esters

Jiajia Yin S, Hanxiao Lang and Xiaopo Wang C
School of Energy and Power Engineering, Xi’an Jiaotong University, Xi’an, Shaanxi, China
wangxp@xjtu.edu.cn

Fatty acid esters are important chemicals in a variety of industrial applications. For example, fatty acid methyl esters (FAMEs) and fatty acid ethyl esters (FAEEs) are the main components of biodiesel, which is considered as a potential alternative of diesel. The densities of FAMEs and FAEEs play an important role during the fuel injection in the diesel engines, and the injection is usually performed at high-pressures (about 15-50 MPa) and moderate temperatures (about 300-350 K). Hence, having a good knowledge of high-pressure experimental density data and predictive equation of fatty acid esters is essential. The Tait equation is generally regarded as the best correlation for high pressure liquid densities of substances. In this work, different types of Tait equation were compared based on the densities of seven linear alkanes, and a new simple density model was proposed to predict the high pressure liquid density of fluids. The new model was extended to the fatty acid esters, including six fatty acid methyl esters (methyl caprate, methyl laurate, methyl myristate, methyl palmitate, methyl oleate, and methyl linoleate) and five fatty acid ethyl esters (ethyl pentanoate, ethyl caprylate, ethyl nonanoate, ethyl laurate, and ethyl myristate). In addition, in order to validate the prediction capability of the model, the densities of six other fatty acid methyl esters (methyl butyrate, methyl valerate, methyl caproate, methyl heptanoate, methyl caprylate, and methyl pelargonate) were measured from 283.15 to 363.15 K at pressures up to 60 MPa using a vibrating tube densimeter. The new experimental data were compared with the calculated results from the model. The results show that the average absolute deviation is less than 1.04 % between the calculated data and experimental values.