Thermophysical Properties of OME_X Synthetic Fuels

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A huge share of the CO_2 emissions into Earth's atmosphere comes from combustion of fuels in engines. While diesel is a widely used fuel because of its high thermal efficiency, its combustion generates a great deal of air pollution. Reducing diesel fuel use in engines is a pressing matter for the transport sector.

Short-chain oxymethylene oligomers (OME_x with x<6 oxymethylene units and methoxy end groups) are a promising substitute (or partial substitute) for diesel fuel. OME_x refers to a homologous series of oligomeric polyethers with C_1 structure according to the structural formula CH_3-O(-CH_2O)$_n$-CH_3.

Upon injecting of an OME_x fuel into a cylinder, a large depressurization results in a significant change in the thermophysical properties of the fluid, which are important for optimal design of diesel engine combustion, high-pressure fuel mixture injection, modelling and optimization of spray formation, vaporization and combustion, and pollutant formation.

This work presents the thermophysical properties of OME_x (x = 1 to 5) synthetic fuels. The density $\rho(p,T)$ at temperatures T = (273.15 to 468.15) K and pressures up to p =140 MPa were determined using a high pressure – high temperature Anton-Paar DMA HMP vibrating tube densimeter. The dynamic viscosity $\eta(p_0,T)$ was investigated at temperatures T = (273.15 to 468.15) K and ambient pressure using an Anton Paar SVM 3000 Stabinger Viscometer and Anton Paar Rheometer MCR 302. The speed of sound values $u(p_0,T)$ were investigated at ambient pressure and temperatures of T = (278.15 to 343.15) K, using the Anton Paar DSA 5000M vibration tube densimeter and sound velocity meter. Vapor pressure P measurements at temperatures T = (274.15 to 468.15) K have been performed using two high-accuracy static experimental set ups. An empiric equation of state (EOS) for modelling the (p,ρ,T) data of OME_x (x = 1 to 5) synthetic fuels was developed as a function of pressure, temperature, and molecular mass of OME_x. This EOS is used for the determination of the various thermophysical properties at a wide range of temperatures and high pressures.