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Mass Diffusivities of Mixtures Related To a Surrogate Biofuel at High Temperatures and High Pressures by Dynamic Light Scattering

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Standards for fuels and gasoline direct injection (GDI) engines are motivated by the reduction of greenhouse gas emissions and on the increase of engine efficiencies. GDI engine efficiency and emissions depend on fuel composition, evaporation, and thus, mixture formation inside the combustion chamber. Thereby, a reliable modeling of the evaporation process is necessary for understanding and controlling combustion processes. Due to the multicomponent nature of fuels, intra-droplet diffusion has to be accounted for a correct modeling of the dynamics of the evaporation process. However, few experimental mass diffusivity data of mixtures relevant for biofuels with a specification of their uncertainties are available in the literature, particularly under relevant temperatures, pressures and compositions.

In the present contribution, mass diffusivities of mixtures related to a surrogate biofuel were measured by dynamic light scattering (DLS) at macroscopic thermodynamic equilibrium in the compressed liquid phase. The surrogate fuel components are ethanol, isopentane, isooctane, toluene and *n*-decane. In total 19 mixtures including all equimolar binary mixtures, a concentration dependency study, as well as a quaternary and a quinary mixture were studied at temperatures between 303 and 523 K close to the bubble point line. With DLS, the relaxation behavior of microscopic equilibrium fluctuations in the properties of state is analyzed to determine the diffusivities in an absolute way without any calibration procedure. For binary mixtures, DLS allows to determine the mass diffusivity, while for multi-component mixtures the eigenvalues of the Fickian diffusion matrix are determined. The present measurements document the reliability of our experimental setup to provide reference mutual diffusivity data for GDI engine simulations with typical expanded uncertainties smaller than 2%. The influence of the ethanol content in the surrogate is discussed in form of an effective pseudo mass diffusion.