ABSTRACT

Water – fuel mixtures reduce harmful raw-emissions in combustion engines. Here, because of their thermodynamic stability and distribution of water in fuel on the nano-scale micro-emulsions are superior compared to ordinary emulsions. In a patent application [DE10334897A1] *Strey* and co-workers pointed out the utility of bicontinuously structured water – fuel microemulsions for combustion in diesel-engines already in 2003. In the present work, fuel microemulsions of the type water/antifreeze – fuel – oleic acid/ethanolamine/oleic acid diethanolamide containing water amounts up to 40 wt% were formulated which feature temperature invariant phase behavior. Diesel-engine emissions, in particular soot and NO_X, were studied as function of water content. Applying fully combustible, inexpensive and bio-derived surfactants, diesel fuel microemulsions were optimized with respect to emissions, anticipated future price developments and sustainability. Furthermore, the solubilization of water in alternative diesel-like marine gasoil (MGO) allowed the extension of the application to heavy duty off-shore power generators. Finally, the renewable gas-to-liquid fuel (GtL) was formulated into a fully renewable and clean fuel microemulsion. The optimal structure of water – fuel microemulsions was examined and proved by systematic small angel neutron scattering (SANS), dynamic light scattering (DLS), transmission electron microscopy (TEM) and nuclear magnetic resonance (NMR-) diffusometry as well as measurements of electrical conductivity. Collectively, these mutually supporting techniques confirm a self-consistent picture of the fundamental bicontinuous structure. The present study constitutes an understanding of fuel microemulsions in unprecedented depth with their properties classified in a scientific context. In cooperation with heavy duty engine producers, *mtu* and *MAN*, microemulsions were shown to exhibit a drastic reduction of black-soot up to 96 % as well as nitrogen oxide emissions up to 60 %, more than ever documented before, while at the same time the specific fuel consumption was reduced.