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**ALTERNATIVE AVIATION FUELS—WATER
SOLUBILITY & DEMULSIBILITY IMPACT**

Executive Summary

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Executive Summary

A set of 36 aviation fuel samples – seven neat petroleum derived fuels, eight synthetic fuels/feedstocks, and twenty-one fuel blends – were subjected to detailed analysis of their interactions with water, i.e., water solubility, water settling, and fuel–water interfacial tension as well as fuel–air surface tension. In addition to temperature, water interactions versus composition were of prime interest, therefore, detailed hydrocarbon type compositions are reported. The samples have a broad distribution of hydrocarbons, e.g., aromatics ranging from about 0 to 97 % vol, cycloparaffins ranging from 0.5 to 79 % vol, and iso-paraffins ranging from 0.5 to about 100 % vol. The range of sample compositions provided a wide range of sample densities from 760 to 875 kg/m³, which is well outside the constraints of ASTM D1655, i.e., 775 to 840 kg/m³.

Observed trends of water solubility, with respect to temperature, were consistent with the literature, i.e., solubility increased in an exponential fashion with increased temperature. The range of solubility values recorded at 50°C was from 141 to 502 ppm wt, while solubility ranged from about 40 to 195 ppm wt at 20°C, and 9 to 60 ppm wt at 0°C. Measurements at –40°C ranged from 0 to 34 ppm wt. A positive correlation between water solubility and aromatic content was observed. The correlation proposed by Lam et al. (2014), which describes solubility as an exponential function of both temperature and aromatic content, appears to be well suited to predict water solubility near ambient temperatures.

Water settling characteristics were assessed using a combined experimental and theoretical approach. Experimental relative water settling rates varied by approximately an order of magnitude due to differences in physical properties, e.g., density and viscosity. Nevertheless, experimental settling data were well correlated and described by theoretical models, i.e., Stokes' law, giving confidence in using the simple physical model to describe traditional gravity separation for a variety of fuel compositions.

Finally, trends of surface tension (ST) and interfacial tension (IFT) were consistent with the literature for hydrocarbons, i.e., both ST and IFT decrease linearly with temperature. Values of ST ranged from about 22 to 30 mN/m at 20°C and IFT values ranged from about 40 to 53 mN/m at 20°C. Surface tension appears well correlated to density, while interfacial tension appears well correlated with aromatic content.