

Why Fuel Property Data Matters to Aircraft and Rockets

Tim Edwards and Matt Billingsley^{C, S}

U.S. Air Force Research Laboratory, AFRL/RZSA, Wright-Patterson Air Force Base, Ohio, U.S.A.

Accurate knowledge of thermophysical properties is necessary for current fuel development activities within the Air Force for two primary reasons. First, physical properties are a key part of Air Force and commercial efforts to certify alternative (non-petroleum) aviation fuels for use with existing aircraft engines and subsystems. The current goal is to develop "drop-in" replacements for conventional fuels (Jet A, JP-8). Physical property measurements enable the assessment of the safe operation of aircraft systems with these alternative fuels. For example, accurate operation of aircraft fuel gauging equipment requires that density, dielectric constant, and speed of sound (as a function of temperature) fall within the "experience base" of current fuels. That is, alternative fuels are being qualified for use in existing systems. Second, the design and development of advanced propulsion systems, such as high pressure liquid rocket engines and fuel-cooled hypersonic vehicles, requires obtaining property data outside the current knowledgebase. In this case, the emphasis is on obtaining properties at unprecedented operating system temperature and pressure. Since the fuel is the working fluid in various engine systems, its thermophysical properties must be well characterized to help inform their design. In the developmental stage of advanced propulsion systems, accurate fuel thermodynamic and transport properties are needed for developing and improving computational tools and for properly interpreting experimental test data. Additionally, when fuels are exposed to extreme environments, characterization of material compatibility and decomposition rates and products may be required. If significant compositional changes are made to a conventional fuel to enable high performance operation, an assessment of the impact on physical properties may be necessary. Clearly, reliable physical property information is important as the Air Force proceeds with fuel certification and propulsion system design and development efforts.