Propulsion Systems Demand Accurate Property Data

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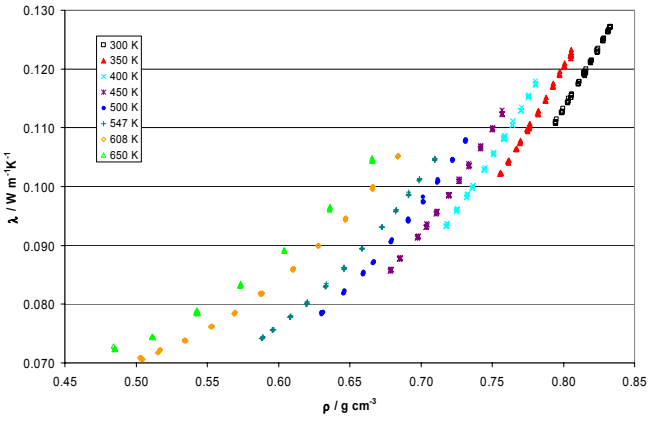
NIST improves the accuracy of thermophysical properties of RFP-1 by developing new measurements and models, removing a key source of uncertainty in propulsion system design.

As part of the Next Generation Launch Technology Program, NASA is designing advanced rocket engines that will combust a kerosene-based fuel known as RP-1. RP-1 is a complex liquid fuel that consists of more than 100 components, for which present-day thermophysical properties models are based on very limited data. NASA has concluded that RP-1 property estimation accounts for 70% of the uncertainty in the propulsion system design. NIST used a gas chromatography–mass spectrometry–infrared spectrophotometry method to chemically characterize RP-1. From its constituents, 20 compounds were selected as part of a surrogate mixture used for measuring and modeling thermophysical properties. Measurements of chemical composition, boiling temperature, density, heat capacity, viscosity, and thermal conductivity were conducted in a range of temperatures up to 700 K and pressures to 60 MPa.

Short equations of state and models for the transport properties were developed and implemented in a user-friendly program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

These accomplishments were presented to rocket fuels specialists during a workshop hosted at the NIST Boulder campus in December 2003. Participants from NASA, the Air Force, commercial rocket engine manufacturers, and academia were eager to use the new results, and interested in continued NIST efforts to explore other features related to fuel properties.



Accurate experimental results for thermal conductivity of RP-1 have replaced estimated values NASA had relied on since the 1950s