

Wide Ranging Viscosity Measurements of Rocket Propellant RP-2 with an Oscillating Piston Viscometer

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Continuing earlier viscosity measurements of rocket propellants with an open gravitational capillary viscometer from 293 K to 373 K at atmospheric pressure, the viscosity of rocket propellant RP-2 was measured over a wide range of temperatures from 270 K to 450 K with pressures from atmospheric to 137 MPa. The instrument employed in this study was an oscillating piston viscometer which had been calibrated and adjusted by the manufacturer. The instrument was modified and recalibrated at NIST with dodecane as a reference fluid over the full temperature and pressure range. These comparisons demonstrated a need to revise the adjustment by the manufacturer. They showed also that the applicable viscosity range of each of the three sensing pistons used in this study is smaller than stated by the manufacturer. Based on the recalibrations, the repeatability of the measurements was found to be approximately 2 % while the uncertainty of the instrument is estimated at 5 %. The measured viscosities of RP-2 were compared with values calculated with a five-component surrogate mixture model developed at NIST Boulder. The experimental data are up to 29 % higher than the calculated values because the measured viscosities have a stronger pressure dependence than the mixture model. To examine their internal consistency, the measured viscosities were plotted in terms of the Ashurst-Hoover thermodynamic scaling parameter θV . With a value of the repulsion exponent γ that is consistent with those for the major pure components in RP-2, all data of the mixture collapse on a single line. This relation allows safe extrapolation of viscosities beyond the range of the measurements.