

A Comparison of the Hypersonic Vehicle Fuel JP-7 to the Rocket Propellants RP-1 and RP-2 Using the Advanced Distillation Curve Method

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JP-7 is a hydrocarbon-based kerosene fraction with a low volatility and high thermal stability. JP-7 was developed in the 1950s to meet the more stringent requirements necessary for the development of high-altitude reconnaissance aircraft that fly at speeds exceeding Mach 3. The extreme temperatures encountered due to the heat transmitted from compressed air on the aircraft, and air resistance, required the development of fuels with improved thermal stability and higher flash points. While JP-7 also meets the operational demands for hypersonic aircraft (Mach 3-5+), this fluid is no longer produced. Currently, there is a desire in the hypersonic vehicle community to replace JP-7 with the rocket propellant RP-1 or RP-2; however, research and testing is necessary to determine if this substitution will be possible. We applied the advanced distillation curve (ADC) method to a representative sample of the hypersonic vehicle fuel, JP-7, and compared the results with the results with previous measurements performed on the rocket propellants RP-1 and RP-2. The distillation curves of the three fluids exhibit similar shapes; however, the JP-7 fuel is less volatile at lower fractions and more volatile at higher fractions. The temperatures measured are true thermodynamic state points that can be used to model each fluid with an equation of state. The ADC metrology allowed for a detailed, fraction-by-fraction chemical analysis of JP-7, including calculation of the composite enthalpies of combustion of each distillate fraction. When compared on a mole-basis, all three fuels exhibit increasing enthalpy of combustions with increasing percent distillate fraction. This work provides a basis of comparison among these fuels in terms of the fundamental thermophysical properties. This comparison will be critical in determining the applicability of substitute fuels and the refinement of future fuels for hypersonic vehicles.