

## Assessment of the Compositional Variability of RP-1 and RP-2 with the Advanced Distillation Curve Approach

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RP-1 is a long-established hydrocarbon fuel that continues to be widely used as the kerosene component in rocket propulsion systems. The desire in recent years to use rocket engines many times, rather than a single time, has led to reformulations of RP-1, and to the formulation of RP-2. In terms of processing, increased hydro-treating of the component feedstock fluids used in the manufacture of RP-1 can lower the sulfur, olefin and aromatic content significantly. The resulting fuels have demonstrably lower metal corrosion effects, and are thus more amenable to multiple use rocket engines. In recent years, the reformulated RP-1 mixtures have been extensively studied in terms of thermophysical properties, combustion processes and kinetics, and performance. Still unknown is how compositional variability resulting from the various blending strategies affects both the properties and our ability to correctly predict the fluid behavior with mathematical models. To address this question, we have obtained 11 batches of RP-1 that were prepared to represent the range of formulation recipes. For each of these representative formulations, we have assessed the compositional variability with the advanced distillation curve (ADC) metrology. This method is an improvement of classical boiling curve techniques. It features (1) a composition explicit data channel for each distillate fraction (for both qualitative and quantitative analysis), (2) temperature measurements that are true thermodynamic state points that can be modeled with an equation of state, (3) temperature, volume, and pressure measurements of low uncertainty suitable for equation of state development, (4) consistency with a century of historical data, (5) an assessment of the energy content of each distillate fraction, (6) trace chemical analysis of each distillate fraction, and (7) corrosivity assessment of each distillate fraction. In this paper, we will employ all applicable data channels of the ADC to show the compositional variability, and also discuss how the variability will impact predictive modeling. We use these data to conclude that the variabilities of RP-1 and RP-2 are significant, and perhaps higher than expected.