Derived Measurement of the Enthalpy of Vaporization of Complex Fuels Using a Variable Pressure Distillation Curve Approach

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During the vaporization process of a fuel droplet, the composition is evolving as the fluid is being distilled. This results in transitioning thermo-physical and chemical properties of the fluid, which must be accounted for to accurately simulate the droplet regression and the combustion of the vapor phase. Typical vaporization models assume constant properties, primarily because of the lack of data available for complex fuels as a function of fluid distilled. One particular property of interest in describing the vaporization of a fluid is the enthalpy of vaporization. The enthalpy of vaporization is traditionally determined using calorimetry which does not lend itself as a viable technique to measure the evolving vaporization enthalpies of a distilling complex fluid. Alternatively, the Clausius-Clapeyron equation can be rewritten to provide an expression for the enthalpy of vaporization as a function of the fluid's vapor liquid equilibrium. To implement this strategy, the fluid's saturation temperature as a function of pressure must be measured. For a complex fluid, the saturation temperature as a function of fluid distilled can be determined using an improved distillation curve measurement technique. Using a variable pressure distillation apparatus in concert with thermodynamic principles, the continuous saturation temperature versus pressure is measured and used to evaluate the evolving enthalpy of vaporization as function of volume distilled for a complex fluid. This technique is applied to determine the varying enthalpy of vaporization of a diesel fuel and is validated by comparing values determined using a previously published compositional based technique. Initial data has demonstrated the potential of a variable pressure distillation curve approach to determine the evolving enthalpy of vaporization of a fuel as the fluid is distilled.