Automation of Advanced Distillation Curve Apparatus with Computer Based Liquid Level Determination

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The distillation curve of a fluid mixture provides in-depth insight into its behaviour by directly measuring fractional volatility. The information therein is critical to liquid fuel and complex fluid industries as it is a primary design and testing criterion and is closely linked to the fluid's commercial value. The original advanced distillation curve (ADC) apparatus was developed at the National Institute of Standards and Technology (NIST) to address significant shortcomings with industry-standard distillation procedures. While the original ADC enables more accurate, thermodynamically-based measurements of the boiling-point cuts with the added ability of chemical characterisation, it suffers from limitations such as the need for manual volume measurement, and when used to analyse complex fluids with wide-boiling ranges, the variation in the densities of the boiling point fractions gives rise to errors in volume determination. We report here an automated version of the ADC with a redesigned reviver flask that eliminates the deficiencies in volume measurement of complex fluids with wide-boiling ranges. A computer-vision based level determination system was implemented to allow the volume measurement to be automated. The design criteria for the level-sensing system were to (a) use readily available software, (b) incorporate a high degree of flexibility and customisability for different end users, and (c) include error detection and correction capabilities to ensure optimal unattended operation. Measurement of distillation curves with both gasoline and light crude oil demonstrated the new computer-vision level determination system had a volume resolution of 0.25 mL (for a standard definition webcam), and replicated distillation curves exhibited a repeatability of 0.5%. Other advantages of the automated ADC apparatus include reduced operator subjectivity, improved operator safety and potentially improved measurement throughput.