Thermophysical Property Measurements over a Wide Temperature Range using a Sequence of Heating Pulses

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The transient hot-wire method is a well-established technique for the measurement of the liquids' thermophysical properties in stable states [1]. Due to complexity of experimental conditions, the property measurements in the region beyond the line of absolute stability are very experimentally challenging. The experimental technique used in this work, the method of controlled pulse heating of a thin wire probe, allows overcoming some limitations of the conventional hot-wire method and can be used for investigation of thermophysical properties in the region of elevated temperatures [2]. In our previous studies, the probe was heated by a single pulse. In the present work, the heating is carried out with a sequence of distinct pulses. A series of rapid heating-cooling events allows collection of multiple data points at similar conditions (temperatures), thus potentially increasing the accuracy of the measurements. The probe combines functions of both heater and resistance thermometer. The method is characterized by short (0.1-10 ms) heating time. The entire histories of the probe temperature and the heat-flux density in a continuous fluid are recorded in the course of experiment. The applied heating power is orders of magnitude higher than those typical of the conventional hot-wire method. Consequently, the analytical linear model based on the assumption of constant properties is not applicable here: wide variations of temperature require taking into account properties' temperature dependencies. To interpret the experimental results, full transient heat transfer problem is solved numerically using the finite difference method. The property temperature dependencies are recovered via non-linear optimization procedure based on genetic algorithm. The performance of the method over temperature ranges up to 700 K was demonstrated using a set of saturated hydrocarbons.

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