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EXPERIMENTAL STUDY ON FLOW AND HEAT TRANSFER CHARACTERISTIC OF AVIATION KEROSENE UNDER SUPERCRITICAL PRESSURES

Abstract

In this paper, characteristics of flow and heat transfer of aviation kerosene were studied experimentally under compressed liquid state, supercritical state and thermal cracked state according to the operation conditions in a regenerative cooling system for scramjet applications. The objective of this paper is to study the flow parameters and to find the law of convective heat transfer properties of China RP-3 aviation kerosene. A two-stage kerosene heating/ delivery system was used to heat the kerosene at temperature up to 1100K and at pressures of 2.6- 5.0 MPa. The wall heat flux was varied from 10 kW/m2 to 300kW/m2. The rate of mass flow at the tube exit is from 4g/s to 100g/s. The test section was made of a stainless steel tube with approximately 20 meters long, 12mm inner diameter and 16mm outer diameter. Distributions of fuel and wall temperatures along the tube were measured with thermocouples at 16 locations along the tube. A 10-species surrogate was selected to simulate the thermo-physical and transport properties of China RP-3 kerosene, using Supertrapp software. Based on the mass and energy conservation law, an unsteady heat transfer analysis was proposed to analyze the experimental data. Result of the kerosene flow and heat transfer properties were obtained based on the analysis and the heat transfer characteristics were summarized and discussed. It was found that convection heat transfer of kerosene at supercritical state is higher than that at compressed liquid state, i.e. heat transfer enhancement. The current experimental results also showed that heat transfer deterioration was observed at certain regions. Based on the experimental data, the heat transfer correlations were obtained for both compressed liquid and supercritical kerosene. Result of thermal cracked kerosene indicated that the chemical heat sink (endothermic capacity) of RP-3 kerosene does not increase with the fuel temperature monotonously; instead, the chemical heat sink gives a maximum at certain temperatures and than decrease as temperature goes up further.