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EXPERIMENTAL AND THEORETICAL STUDY OF SCALE EFFECTS OF HYBRID ROCKETS USING LOW-MELTING-POINT FUELS

Abstract

Hybrid rockets have attracted considerable attention because of their high safety and low cost. However, the main drawback of hybrid rockets is the low thrust due to their low fuel regression rate. Therefore, low-melting-point fuels are expected to provide higher thrust than conventional fuels, such as hydroxylated polybutadiene (HTPB) and polyethylene (PE). Low-melting-point fuels can achieve higher fuel regression velocities than conventional fuels. One reason for this is the entrainment phenomenon that occurs when low-melting-point fuels burn. The entrainment phenomenon refers to the shearing of the liquid layer on the fuel surface by the gas flow and accompanying droplets. Previous studies have reported the scale effect of HTPB and PE, which have been used as fuels for hybrid rockets. As the hybrid rocket combustor size (mainly the fuel port diameter) increases, the fuel regression rate tends to decrease for the same mass flux. However, the scale effects of low-melting-point fuels have not yet been clarified. Scale effects of low melting point fuels, once understood, will allow prediction of large-scale propulsion performance from small-scale experiments with high accuracy. In this study, the fuel regression rate of paraffin wax was experimentally measured at scale ratios of 1.0, 1.5, and 2.0 using the methods of a previous study by Gany et al.. Oxygen gas was used as the oxidizer, and FT-0070 made by Nippon Seiro Corporation was used as the fuel. The theoretically verified fuel regression rate of pentane was compared with the fuel regression rate in the combustion experiment of FT-0070 used in this study. The average error of the fuel regression rate at a scale ratio of 1.0 was about 2.3