Gas Flow and Ablation in a Rocket Nozzle Investigated by Computer Simulation

Jatuporn Thongsri [1*] and Adulyasak Boonpan [2]

Received 24 June 2021, Revised 22 July 2021, Accepted 25 July 2021

Abstract

The design of high-performance rockets requires knowledge of a Thermal Protection System (TPS). In the TPS, a nozzle has an insulation layer to prevent the heat generated by combustion from too high a temperature, resulting in damage on a metal layer that may degrade rockets' performance. When the propellant burns, the heat generated by the gas flow will cause the insulation surface to be ablated and deteriorated. Overseas, simple mathematical models were developed based on heat transfer, chemical reaction, and fluid dynamics theories to describe ablation, gas flow, and temperature within the insulation layer, widely accepted and applied in practical applications. However, with modern technology, rockets have been developed rapidly, so the mentioned mathematical models have limitations in their uses. To avoid the limitations, computer simulation such as finite element analysis and computational fluid dynamics have been effectively employed to solve gas flow, ablation, structure, and other problems related to heat transfer in the nozzle. Therefore, this article is a theoretical review and compilation of high-performance rocket design with computer simulation to investigate gas flow and ablation in the nozzle to further develop a propulsion system. Results of investigation will be reported in the next article of Defence Technology Academic Journal.

Keywords : Computer simulation, Heat transfer, Ablation, Gas flow, Rocket nozzle

[1] College of Advanced Manufacturing Innovation, King Mongkut's Institute of Technology Ladkrabang.

[2] Propulsion Systems Division, Defence Technology Institute.

* Corresponding author, E-mail: Jatuporn.th@kmitl.ac.th