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Numerical Analysis of Various V- rib Cross-section to Optimize Thermal Performance of the Rocket Engine

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Abstract : In regenerative-cooled rocket engines, understanding the coolant behaviour within cooling channels is essential to enhance engine performance and maintain chamber walls at low temperatures. However, modelling and testing the rocket engine's cooling channels is challenging due to the high temperature of the chamber walls, supercritical flow, and high Reynolds number. Therefore, a numerical analysis of five different V-rib cross-sections to optimize rocket engine cooling channels' performance is developed and validated in this work. Three-dimensional CFD simulations are employed by the Shear Stress Transport (k- ω) turbulent model at Reynolds number 42,500. The study findings illustrate that the V-ribbed channel performance is optimized by 59.5% relative to the plain/flat channel. Additionally, the chamber wall temperature is decreased to 726.4 K, and the right-angle trapezoidal V-rib (Case 4) improves thermal augmentation up to 74.3 % with a slightly high friction factor.

Keywords : computational fluid dynamics CFD, regenerative-cooled system, thermal performance, V-rib cross-sections
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