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**Title**

# Numerical Analysis on the Film-cooling Effect with Varying Coolant Flow-rate in $GCH_4$-LOx Liquid Rocket Engines

## Authors

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## Abstract

The rocket engines developed for space exploration are in need of a cooling system to protect the surface of the combustion chamber exposed to high temperature and pressure gas during operation. Film-cooling, which is a principal method used for cooling of liquid rocket engines, has a simple structure and relatively high cooling efficiency, but a disadvantage that the decrease in efficiency of propellant due to the excessive coolant, which leads to reduction in the engine thrust performance [1]. Therefore, a study is needed for film-cooling condition that has an optimal cooling effect and acceptable loss in thrust performance.

In this study, a computational simulation was performed to observe the temperature distribution and energy change in a rocket engine using $GCH_4$-LOx as propellant with the film-cooling applied. The 2-D single-phase model considering chemical reaction was verified with reference to numerical model from open literature, then the analysis was conducted to simulate the flow structure of the combustion chamber. The calculation zone from the injector face to the chamber outlet was selected. Oxygen, the oxidizer, was chosen as film coolant, and the cooling effects were observed with varying the mass flow-rate of the coolant ejected to the interior surface of the chamber through the coolant injector slots.

As a result, It could be seen through the temperature distribution on symmetry surface of the combustion chamber that the inner wall of the engine was protected from hot combustion gas. The decrease in thrust performance was also predicted by comparing the change in combustion chamber pressure and internal energy according to the mass flow-rate of the coolant. Finally, the optimal condition of the oxygen coolant flow-rate is to be presented.

## References

[1] Yin, L. and Liu, W. 2018. Gaseous film cooling investigation in a multi-element splash platelet injector. *Acta Astronautica*. 144(4): 353-362.