

# Aerospace Europe Conference 2023

## Joint 10<sup>th</sup> EUCASS – 9<sup>th</sup> CEAS Conference

---

Abstract #XXX

Preferred Topics: AEROFLIPHY / CFDMPS / FLOCON

Corresponding author: Sang Hun Kang

e-mail of corresponding author: aeroksh@konkuk.ac.kr

Type: Oral

Status of corresponding author: Regular

For student corresponding author: student member of one of the following:

3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

---

### Title

## Numerical Study on the Ducted Scramjet Combustor

### Authors

Sang Gon Lee <sup>1</sup>, Sang Hun Kang <sup>2\*</sup>

*\* Corresponding author*

<sup>1</sup> Department of Aerospace Information Engineering, Konkuk University, 05029 Seoul, South Korea, samho2116@konkuk.ac.kr

<sup>2</sup> Department of Mechanical and Aerospace Engineering, Konkuk University, 05029 Seoul, South Korea, aeroksh@konkuk.ac.kr

### Abstract

In the process of supersonic flight of scramjet engines, the captured and compressed air through the inlet is mixed with fuel inside the combustor and combustion proceeds. Most of the fuel used in the scramjet engine is in gas or liquid phase. And many studies on those fuels have been conducted for a long time. However, studies on the characteristics of the solid fuel in the scramjet engine is relatively rare. This is because the combustion efficiency and specific impulse of the solid fuel are lower than those of gas or liquid fuels and its fuel-to-air ratio cannot be controlled. Thus, Lv et al. proposed a new concept solid fuel scramjet engine called "Solid-Fuel Rocket Scramjet" to improve the disadvantages of solid fuel [1]. In the present study, it is named "Ducted Scramjet".

Ducted scramjet is a type of scramjet engine that combines a solid rocket and a scramjet, and consists of an inlet, a solid fuel gas generator, a supersonic combustor, and a nozzle. The operation process is as follows. In the gas generator, fuel-rich solid propellant burns first and the unburned fuel from the gas generator is injected into the main combustor. And the unburned fuel from the gas generator is mixed with the supersonic flow from the inlet and results in the secondary combustion in the main combustion chamber. Since the temperature of the unburned fuel is sufficiently high, a separate igniter is not required. And it also has the advantages of easy flame holding and adjustable fuel-to-air ratio.

In this study, the combustion characteristics within the Ducted Scramjet combustor is analyzed using numerical simulation. The test model is employed from Li [2]. The model is three-dimensional, and the total length including the isolator and combustor is 1300 mm. The design condition of the combustor is Mach number of 6, the altitude of 25 km and the equivalence ratio of 0.5. For the numerical simulation, Fluent, a commercial code, is used. Compressible flow considering turbulence is simulated using 'Density based solver' and 'k-omega SST' model, and the chemical reaction model is finite-rate/eddy-dissipation. In addition, a Discrete Phase Model (DPM) is used to analyze the behavior of carbon. Two phase(solid/gas-phase) combustion analysis in the combustor of "Ducted Scramjet" is performed using numerical simulation. As a result of the analysis, the present results are well matched with the results of Li et al., qualitatively.

This work was supported by the Scramjet Combined Propulsion System Specialized Research Laboratory (No. 16-106-501-035) of Korea.

### References

- [1] Lv Z., Xia Z., Liu B., and Liu Y. 2016. Experimental and Numerical Investigation of a Solid-Fuel Rocket Scramjet Combustor. J. of Propulsion and Power 32(2):1-6
- [2] Li C., Xia Z., Ma L., Zhao X., and Chen B. 2019. Experimental and Numerical Investigation of a Solid-Fuel Rocket Scramjet Combustor. J. of Propulsion and Power 12(7) :1-17