Numerical investigation of the supersonic intake

Report Number: R20ETET10
Subject Category: Skills Acquisition System
URL: https://www.jss.jaxa.jp/en/ar/e2020/14403/

Responsible Representative

Takashi Aoyama, Aeronautical Technology Directorate, Numerical Simulation Research Unit

Contact Information

Manami Fujii(m-fujii@moegi.waseda.jp)

Members

Manami Fujii

Abstract

JAXA and universities have been forwarding a plan to realize a hypersonic passenger airplane. As the first stage to actualize this plan, a flight experiment called HIMICO (High-Mach Integrated Control Experiment) is being planned to actualize the integrated control technologies of the airframe and the engine. In this experiment, the performance of the ramjet engine is important for the stable flight. Therefore, we investigate the performance of the intake of the ramjet engine aiming at the stable operation.

Reasons and benefits of using JAXA Supercomputer System

The flow inside the intake is complex and its calculation cost is large. However, it became possible to grasp the performance of the intake under various conditions and the characteristics of the unsteady phenomenon by using JAXA Supercomputer System.

Achievements of the Year

We investigated the effect of the angle of attack on the performance of the intake aiming at the stable operation of the ramjet engine in High-Mach Integrated Control Experiment, HIMICO. The ramjet engine for HIMICO is shown in Fig.1. As a result of simulating the performance of the intake with -2.5 deg, 0 deg and +2.5 deg angles of attack, it was found that mass capture ratio (MCR) and total pressure recovery (TPR) become larger as shown in Fig. 2 when the angle of attack is positive. This is the same tendency with the results of the theoretical calculation (TFD) supposing the inviscid flow. Also, the results of CFD showed that the transition to the buzz is delayed when angle of attack is positive and this is contrary to the results of theoretical calculation. The cause of this difference is thought to be the existence of the pseudo-shock wave shown in Fig.3. It was found that the total pressure loss in the low-speed region due to the pseudo-shock wave make TPR small. Therefore, modeling the total pressure loss caused by pseudo-shock wave is thought to be the next step to the more accurate theoretical estimation.

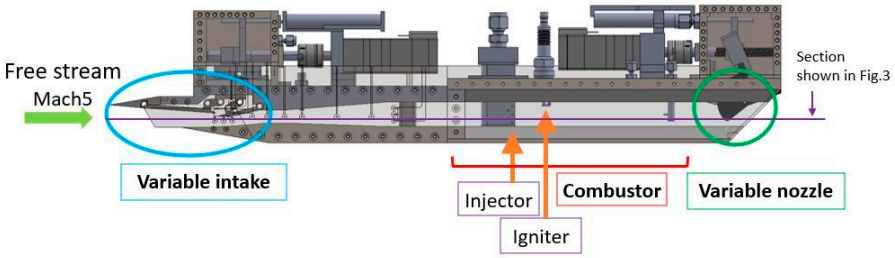
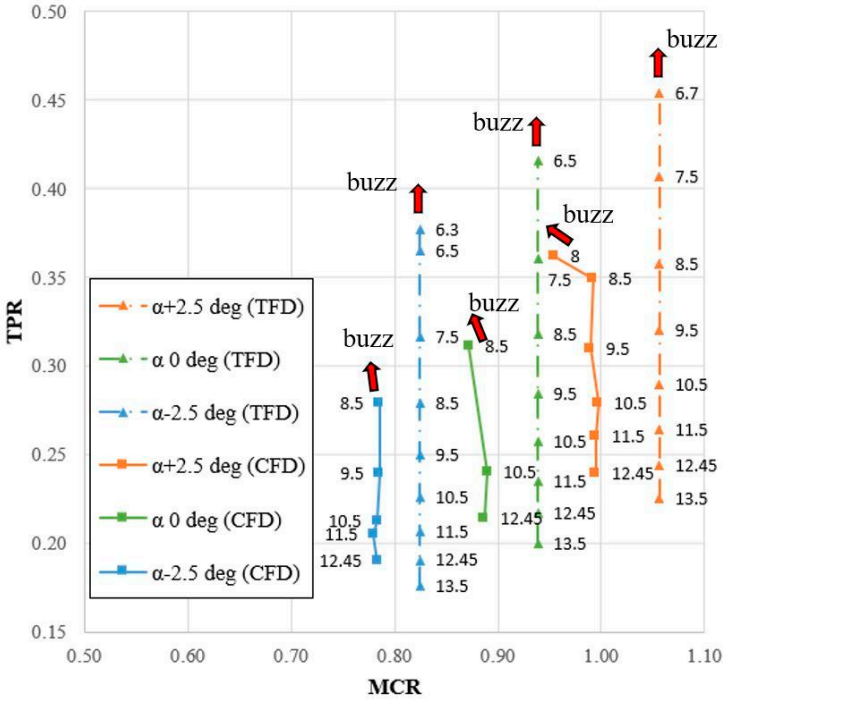


Fig. 1: Ramjet engine for HIMICO



※Subscripts are values of nozzle throat height

Fig. 2: MCR-TPR map

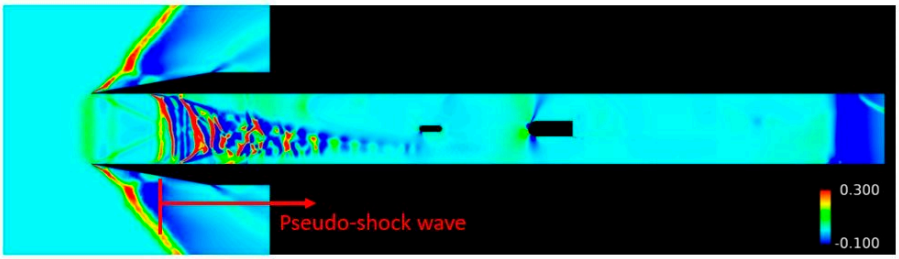


Fig. 3: Gradient of density inside the engine

Publications

- Peer-reviewed papers

Hidekazu YOSHIDA, Masakazu SANO, Sho WAKABAYASHI, Takahiro CHIGA, Toshiya YOKOI, Atsushi HASHIMOTO, Keiichi MURAKAMI, Takayuki KOJIMA, Hideyuki TAGUCHI, Tetsuya SATO, Numerical Study on the Intake Performance with Side Clearance for the High Mach Integrated Control Experiment (HIMICO), TRANSACTIONS OF THE JAPAN SOCIETY FOR AERONAUTICAL AND SPACE SCIENCES, AEROSPACE TECHNOLOGY JAPAN, 2021, Vol. 19, No. 2, p. 135-143

- Oral Presentations

Manami Fujii, Shogo Ogura, Masakazu Sano, Tetsuya Sato, Junichi Oki, Hideyuki Taguchi, Takayuki Kojima, Atsushi Hashimoto, Takashi Takahashi, Supersonic Wind Tunnel Test and Numerical Simulation of the Air Intake with an Angle of Attack for High-Mach Integrated Control Experiment (HIMICO), AJCPP2021.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	512
Elapsed Time per Case	40000 Second(s)

Resources Used(JSS2)

Fraction of Usage in Total Resources[*1](%): 0.32

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	1,505,163.09	0.28
SORA-PP	24,114.02	0.19
SORA-LM	9,111.00	5.35
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	238.42	0.22
/data	4,882.81	0.09
/ltmp	976.56	0.08

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	0.07	0.00

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources*1(%): 0.27

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	1,298,801.49	0.28
TOKI-RURI	37,690.14	0.22
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	238.42	0.16
/data	9,765.63	0.16
/ssd	47.68	0.02

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	0.07	0.00

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage：Percentage of usage relative to each resource used in one year.