Research on the performance improvement of practical aero-engine fuel injector

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Abstract

Our study is focusing on the improvement of fuel injector performance. Numerical simulations on air-flow, atomization, fuel/air mixing, combustion, and thermal analysis on such injectors in realistic shapes are of our interest.

Reasons and benefits of using JAXA Supercomputer System

In order to analyze air-flow, atomization, fuel/air mixing, combustion, and thermal analysis of a realistic shape fuel nozzle precisely, we conduct the flamelet combustion analysis using large size of database, and the use of super computer is necessary.

Achievements of the Year

In order to avoid fuel coking in fuel circuits of a coaxially-staged lean-burn fuel injector, improvement of thermal-protection design and its numerical evaluation were carried out. After a series of design improvements, at all flight conditions considered in this research, the wet-wall temperatures of the fuel circuits were below our target (upper-limit) value except the regions close to their exits where the residence time left was short enough.

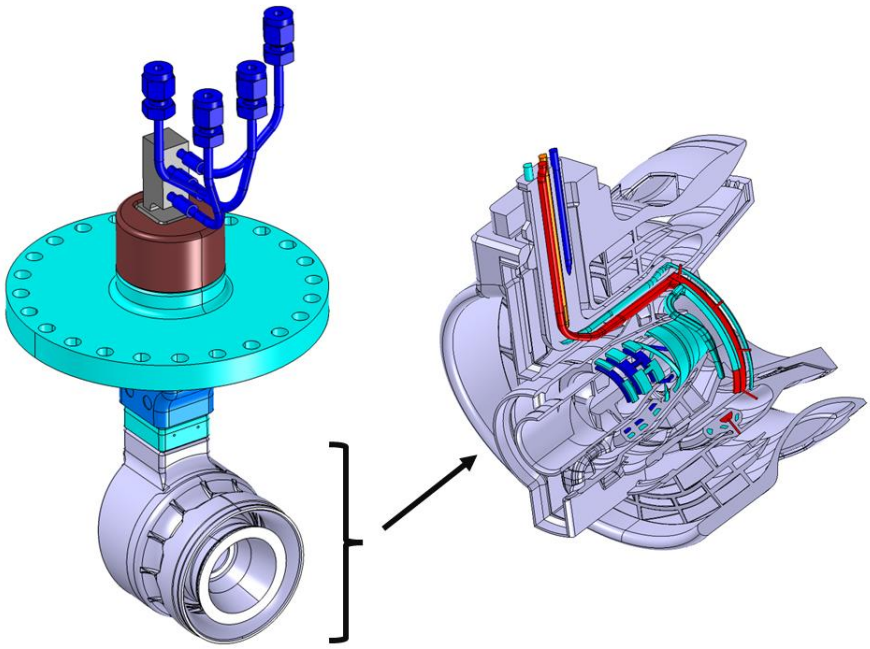

Fig. 1: Schematic illustration of coaxially-staged lean-burn fuel injector with thermal management function.

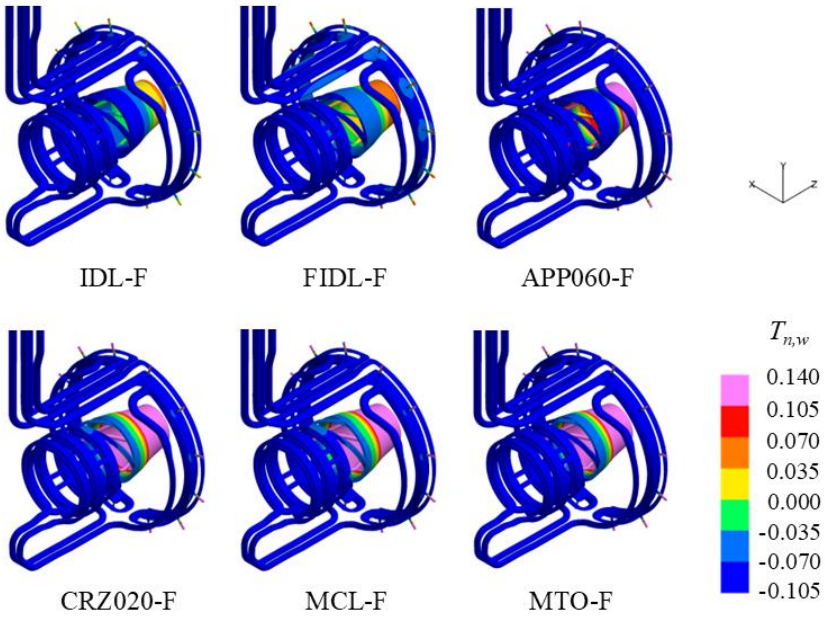

Fig. 2: Normalized wet-wall temperatures of fuel circuits at flight conditions.

Publications

- Non peer-reviewed papers

MATSUURA, K. and YAMAMOTO, T. : Development of anti-coking thermal management technologies for a coaxially-staged lean-burn fuel injector for high-pressure-ratio aero-engines. ~ First report: Evaluation of thermal protection performance and validation of numerical analysis by experiments in realistic environments. ~, JAXA-RM-24-008E (2025).

- Web

https://jaxa.repo.nii.ac.jp/records/2001693

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1024
Elapsed Time per Case	144 Hour(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 3.79

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	103,172,044.09	4.72
TOKI-ST	30,797.43	0.03
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	350.95	0.24
/data and /data2	178,176.67	0.85
/ssd	30,720.00	1.65

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	0.09	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.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage*2 (%)
ISV Software Licenses (Total)	825.91	0.56

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