Liquid-Propellant Propulsion System Simulation

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Abstract

Next generation of space transport systems need not only to reduce costs with high perfoemance propulsion for a particular mission but also to meet requirements of various missions, for example moon lander, reusable upper stage rocket, Mars mission, and so on. Liquid-Propellant System Analysis has an important roll to develop the next generation space transport system. Utilizing 3D numerical simulation results of the liquid rocket compornents, componet models are developed for the system analysis. The system analysis will use for evaluation of the development and operation for liquid rocket or spacecraft.

Reasons and benefits of using JAXA Supercomputer System

Component models of liquid propulsion systems are conventionally very simple and sometimes not consistent with physics of fluid dynamis or structural behaivor of propulsion systems. However, because of the recent development of computer science, even computationally expensive models can be used for numerical analysis for designs. In addition, high-fidelity CFD clarified physical phenomena in the component, and it enhances to develop more accurate component models. Concequently, high-fidelity CFD analyses are essential to clarify the phenomena in the liquid propulsion system. JSS enables us to carry out trade-off studies with a wide range of parameter, which contribute to build new models and find out new insights of liquid propulsion systems.

Achievements of the Year

Pressure spikes, so-called water hummer, happen to liquid propulsion systems of spacecraft when thruster valves are closed in a very short time. The water hummber induces steady pressure oscillations in certain resonant frequencies, and such pressure oscillations are possibly enhanced if frequencies of thruster operations meet those of resonant frequencies of hydraulic systems. Introduce of buffer tanks which have larger volumes than feed pipes is one of the ways to supress the pressure resonance because the buffer tanks can damp the pressure oscillations. A drawback of the buffer tanks is the mass weight. So, the present study explored if any inner devices of the buffer tanks can enhance the damping effects of the pressure oscillations by running CFD simulations.

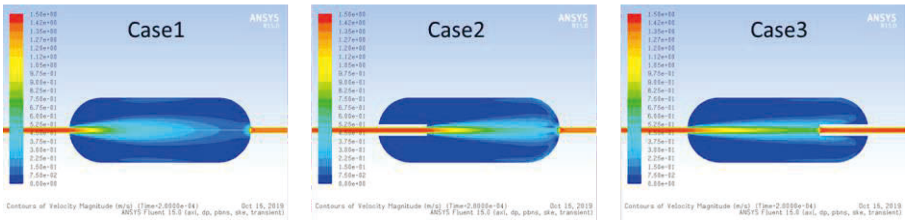

Fig. 1: Instantaneous profiles of the absolute velocity in buffer tanks

Publications

N/A

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	1 - 16
Elapsed Time per Case	10 Hour(s)

- **Resources Used**

Fraction of Usage in Total Resources*1(%): 0.59

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
SORA-MA	212,429.01	0.03
SORA-PP	1,544,724.78	10.01
SORA-LM	15.46	0.01
SORA-TPP	564.83	0.03

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	558.68	0.47
/data	22,866.18	0.39
/ltmp	13,273.96	1.13

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	1.60	0.04

*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.