Development and Evaluation of Transient Analysis Tool for Rocket Engine

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Abstract

Liquid rocket engines operate at very severe condition where high temperature hot gas of 3600K and cryogenic coolant are separated by a thin wall while the requirements for performance, reliability and weight are raised close to the limits in order to carry heavy payloads. Besides, liquid rocket engines start up and shut down in a few seconds to and from that severe condition, which causes a high thermal stress, and controlling transient behavior by the timing of several valves is important but not easy. A lot of troubles happened during start and shutdown transient in a lot of past engines. Therefore predicting of transient behavior is one of the most important design efforts in a engine development.

In order to address it, MHI developed its own engine dynamic simulation code called VISREC (**V**isually **I**ntegrated **S**imulator for **R**ocket **E**ngine **C**ycle). VISREC is a one-dimensional flow and heat analysis program using node-link network approach with features as follows.

(a) Treat fluid and heat flow.
(b) Can handle two-phase flow as homogeneous.
(c) Have wide range of fluid properties including combustion gas.
(d) Have elements to set boundary conditions and logic circuit.
(e) Can evaluate stability margin against low cycle combustion instability.

VISREC has the user-friendly visual interface to build engine models, to run the programs and to output the data. Graphic image of analysis model of VISREC is shown in Fig. 1.

In this paper, features of VISREC and some analysis results compared with the actual test data are presented. Especially difference of transient behavior between open expander cycle and closed expander cycle is investigated using the analysis models for both engine cycles which are validated by the analyses for the existing engines.

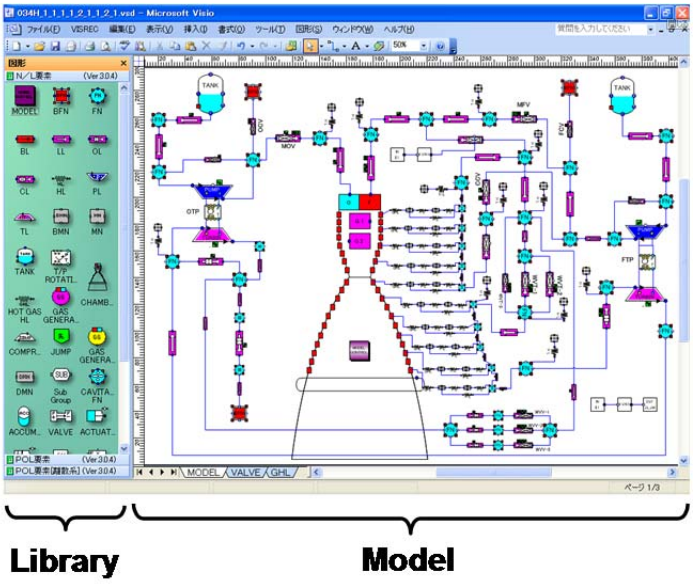

Fig.1 Example of VISREC Analysis Model