A fluid-structure coupling method to predict the interior ballistic characteristic of gas generator with complex structures

CS209

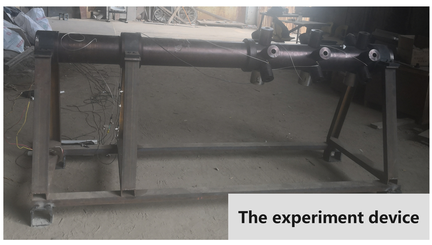
Xinggan LU, Kun JIANG, Shenshen CHENG and Hao WANG

Nanjing University of Science and Technology, Nanjing, 210094, China

1. Introduction

- A coupling model that connects the flow field of propellant combustion and structural evolution is established.
- The traditional classical interior ballistic model and the coupled model are used for simulation.
- The simulation results and precision of the two models are compared.

2. Structure principle and experiment



The experiment device

The propellant ignites and burns in the chamber

The seal diaphragm failed

The gas fills the confined space

The duct and pistons move axially

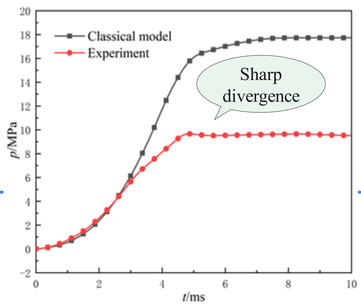
The locating pin is clipped

The gas nozzle opens and the gas flows out

The opening moment

3. Traditional classical interior ballistic model

- The classical model only considers the relationship between the pressure and the combustion degree of the propellant, ignoring the interaction with structural evolution.



4. Coupling model

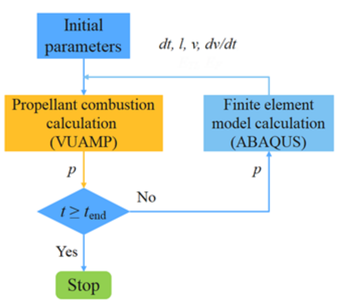
The coupling model is divided into two sub-systems.

The classical interior ballistic model

- One considers the propellant combustion in VUAMP.
- The other one considers the structural evolution in ABAQUS.

The finite element model

Coupling strategy



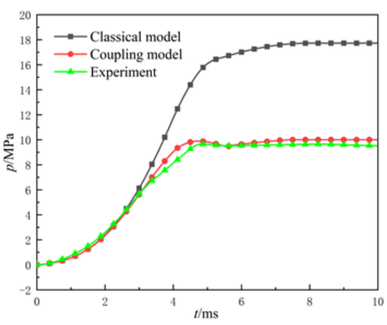


Table 1. The comparison of prediction precision

Source	Pmax/MPa	Error of Pmax	T/ms	Error of T
Experiment	9.4	\	6.4	\
Classical model	17.9	46%	9.7	34%
Coupling model	9.8	4.2%	6.6	3.1%

Conclusion

For gas generator with complex structures, a mathematical method is developed to couple the flow field generated by propellant combustion and the structural evolution in the system, through VUAMP, a subroutine interface in ABAQUS. With experimental verification, the coupled model is capable of accurately predicting the internal ballistic characteristic of gas generator. The error of predicted pressure is less than 5.0%, and the error of T is 3.1%.

Advantages

- A mathematical method couples the flow field and the structural evolution interactions.
- The predicted precision is improved by 41%.

Acknowledgments

My dear teachers and brothers.