THE IC ENGINE COMBUSTION SIMULATION USING HIERARCHICAL CARTESIAN MESH FRAMEWORK

Wei-Hsiang Wang [1], Chung-Gung Li [2], Rahul Bale [3], Keiji Onishi [4] and Makoto Tsubokura [5,6]

[1] RIKEN AICS, Kobe, Japan, 6500047, wei-hsiang.wang@riken.jp, http://www.aics.riken.jp/en/
[2] Kobe University, Kobe, Japan, 6570013, cgli@aquamarine.kobe-u.ac.jp, http://www.kobe-u.ac.jp/en/index.html
[3] RIKEN AICS, Kobe, Japan, 6500047, rahul.bale@riken.jp, http://www.aics.riken.jp/en/
[4] RIKEN AICS, Kobe, Japan, 6500047, keiji.onishi@riken.jp, http://www.aics.riken.jp/en/
[5] RIKEN AICS, Kobe, Japan, 6500047, mtsubo@riken.jp, http://www.aics.riken.jp/en/
[6] Department of Computational Science, Kobe University, Kobe, Japan, 6570013, tsubo@tiger.kobe-u.ac.jp, http://www.kobe-u.ac.jp/en/index.html

Key Words: *IC Engine, Combustion, Building Cube Method.*

The IC engine is investigated numerically by Cartesian mesh system. The Building Cube Method [1] is adopted to generate the mesh partition for complicated engine geometry and parallel computation. The fully compressible flow solver by Roe scheme [2] and 5th order MUSCL is used to calculate the flow field with high pressure and temperature deference.

The species transport equations are solved with 11 species of combustion in this framework. The chemical reaction of combustion is conducted by equilibrium solver of Cantera [3] module, which is used for evaluate the equilibrium state of the reacting flow, and merged with the flow solver and G-equation flame front treatment.

In order to simulate the engine motion, the geometry and engine moving piston is calculated by Immersed Boundary Method [4]. The flow field of temperature, pressure and flame due to the combustion and engine motion is shown in the results.

The validation is done by the Rapid Compression and Expansion Machine simulation with the comparison of experimental data. The flame front shape and flame propagation speed of this framework are well consistent with the experimental results.

REFERENCES

[1] K. Nakahashi, *Building-Cube Method for Flow Problems with Broadband Characteristic Length*, Comput. Fluid Dynamics, pp. 77-81, 2002.
[2] P.L. Roe, *Approximation Riemann solver, Parameter Vectors, and Difference Schemes*, J. Comput. Phys., Vol. **43**, pp. 357-372, 1981.
[3] D.G. Goodwin, H.K. Moffat, and R.L. Speth, *Cantera: An object- oriented software toolkit for chemical kinetics, thermodynamics, and transport processes*, http://www.cantera.org, 2017. Version 2.3.0.
[4] C.G. Li, M. Tsubokura and R. Bale, *Framework for simulation of natural convection in practical applications*, Int. Commun. Heat Mass Transf., Vol. **75**, pp. 52-58, 2016.