Simulation of the Behavior of Spherically Expanding H_2-Air Premixed Flame

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Abstract We performed the two- and three-dimensional simulations to investigate the behavior of spherically expanding H_2-air premixed flame by using XiFoam. The equivalence ratio was set to unity. The ignition started from the center of domain, and the flame expanded spherically and became wrinkle. The obtained flame radius has the agreement with the experimental result.

Keywords: Simulation, H_2-air, Premixed flame, Flame radius, XiFoam

1. Introduction

The risk of hydrogen combustion and explosion from the contamination and distribution of hydrogen gas generated from radioactive wastes under the long-term storage lets us to pay attention on management and analysis methods concerned with hydrogen safety. As hydrogen mixes with air prior combustion or explosion inside of the waste vessels, we considered H_2-air premixed flame in closed vessel and investigated the mechanisms and spherically expanding behavior.

2. Simulation method and results

New flame speed model was added and some modifications were made in the default XiFoam solver of OpenFOAM [1] for validation with the experimental result. The simulations were performed with two-dimensional (2D) rectangular model (1.5m in both sides), three-dimensional (3D) one-eighth of cubic model (0.3m in all sides) and spherical model (0.26m in radius). The computational time and time step interval were set to 0.02s and 5×10^{-6}s, respectively. The ignition period was set to 0.003s. The initial temperature and pressure were set to 298K and 1. 01325×10^5Pa. The obtained results of flame radius are compared with the experimental result [2] and shown in Fig.1.Temperature distribution of premixed flame in rectangular and cubic domains at t = 0.02s are shown in Fig.2.

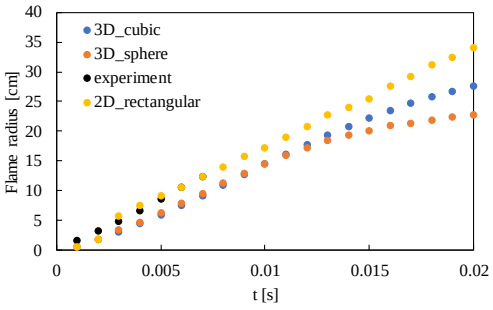

Figure.1 Flame radius of different models.

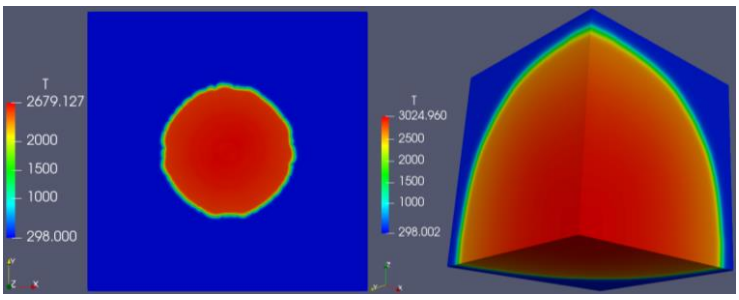

Figure.2 Temperature distribution of premixed flame.

3. Conclusion

From this study, we can conclude that the simulation results have the agreement with the experimental one, and we will study the effects of parameter, equivalence ratio, unburned-gas temperature, mesh size and dimension of models for new flame speed model in the future.

References

[1] OpenFOAM User Guide v1712, https://openfoam.com/releases/openfoam-v1712/

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