

Turbulent flame structure of steam-diluted oxygen and hydrogen non-premixed combustion on a multi-cluster burner

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In recent years, global warming caused by CO₂ emission has become a world problem. Oxygen-hydrogen combustion is expected as one of the solutions because it doesn't emit CO₂. Especially, the oxygen-hydrogen semi-closed gas turbine system where steam is a working fluid and then no NO_x production is proposed to use in power generation. Several researches showed that efficiency of this system become higher than those of usual combined gas turbine systems¹. As the burner of this system, a multi-cluster burner is considered. A unit of this burner consists of a fuel jet port and two oxidizer jet ports which has small distance, and several units are distributed on the burner. The oxidizer jets are 45 degrees inclined to collide each other as shown in Fig. 1. The fuel jet is 100% hydrogen and the oxidizer jets are set to oxygen with 60-70% steam dilution. The minimum constitution of multi-cluster burner is three units. The flame structure of this burner has been investigated by our previous DNS². In this study, to investigate the flame structure and stability experimentally, high speed OH PLIF measurement is conducted for three units cluster burner. To investigate the dilution species effects, nitrogen dilution is also investigated.

After showing the flammable limits of this burner both for steam and nitrogen dilutions, local flame structure and its dynamics are investigated by using high speed OH PLIF. The results of PLIF show that flame is maintained by the interaction between a center flame and side flames. From DMD analysis of OH PLIF images, major dynamics mode depends on the equivalence ratio and they represent typical flame dynamics. Furthermore, three-dimensional flame structures are reconstructed by multi cross-section OH PLIF, which shows 3D characteristics of multi-cluster burner with small-scale unit burners

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¹ Takehana *et al.*, *Journal of Japan Society of Energy and Resources*, **42**, 325 (2021).

² Tomisawa *et al.*, *13th Asia-Pacific Conference on Combustion* (2021).

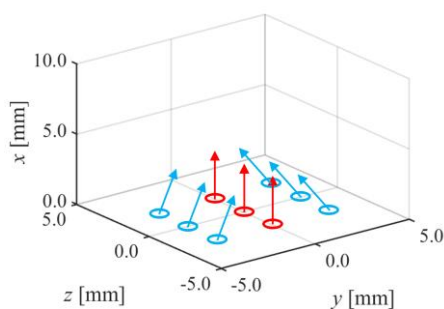


Figure 1: Jet arrangements of the burner. Red: fuel jets, blue : oxidizer jets.

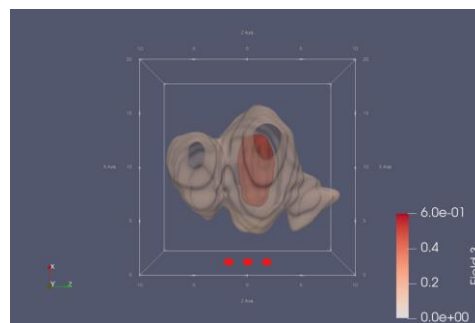


Figure 2: 3D reconstruction of flame structure