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非定常加熱を考慮した数値計算を用いた二液滴の自発点火時における冷炎振動の分析

Analysis of Cool Flame Oscillation at Spontaneous Ignition on Droplet Pair using Numerical Calculation with Transient Heating

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Prediction of cool flame dynamics with transient heating was conducted by 2 dimensional axisymmetric unsteady calculation of droplet pair as a basic study of PHOENIX-II Project [1)]. For this simulation, the fuel is *n*-decane of 1 mm in diameter. The reduced reaction mechanism including 287 reactions among 77 species is employed [2)]. Ambient temperature and ambient pressure are 600 K and 0.1 MPa respectively. Inter-droplet distance is 8 mm, and single droplet case is also carried out for a reference. Mass flow rate of fuel is estimated by the difference of the heat flux between gas phase side and liquid phase side adjacent the droplet surface. Droplet shrinks by evaporation that is calculated from mass flow rate.

As a result, cool flame oscillation was captured as shown in **Fig. 1**. For the analysis of cool flame oscillation, POD [3,4)] (Proper Orthogonal Decomposition) was carried out. POD is one of the analysis methods to extract characteristic modes from time-series data. The input data for POD is time-series data of spatial distribution that includes temperature and mass fraction of 9 species that are possible to contribute to cool flame appearance. Cool flame oscillation was decomposed into 4 proper orthogonal modes (POMs) by POD as shown in **Fig. 2**.

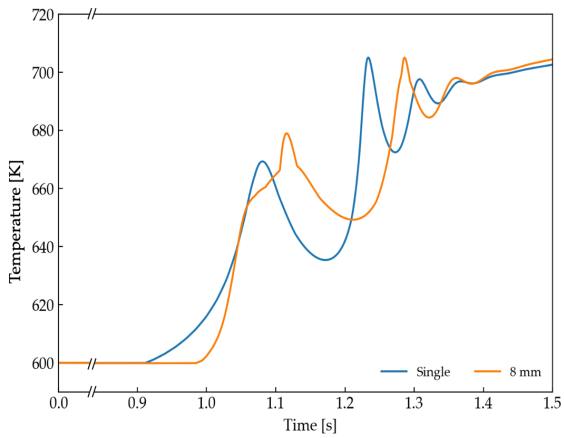

Fig. 1 Temperature history

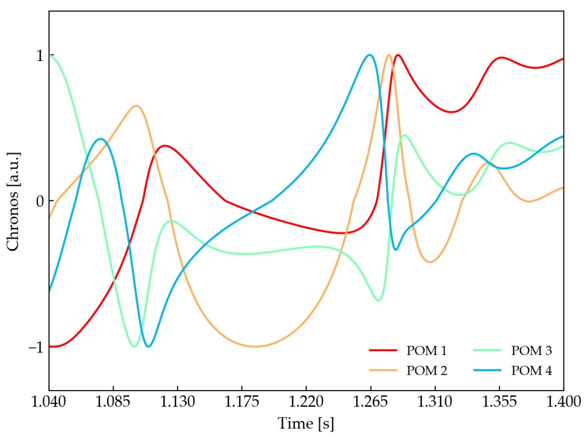

Fig. 2 Chronos (8 mm case)

Figure 3 shows the mode map (Topos) of two dominating species each of the POMs. Topos for POM 1 and POM 2 are concentric. In POM 3, the features of inter-droplet and that of outside of droplet pair are different. Thus, it is considered that POM 3 captures the effect of droplet interaction. In POM 4, the distribution is similar to POM 1 and POM 2, but the brightness changes inside and outside of droplet pair. Therefore, it is thought that POM 4 captures the feature of the oscillation of each species. From **Fig. 2** and **Fig. 3**, it is thought that it is possible not only to specify the species that are included in each oscillation, but also to capture the effect of the droplet interaction. Therefore, it can be expected POD is effective to specify factors that contribute to cool flame oscillation. We will discuss the system of cool flame oscillation with POD analysis.

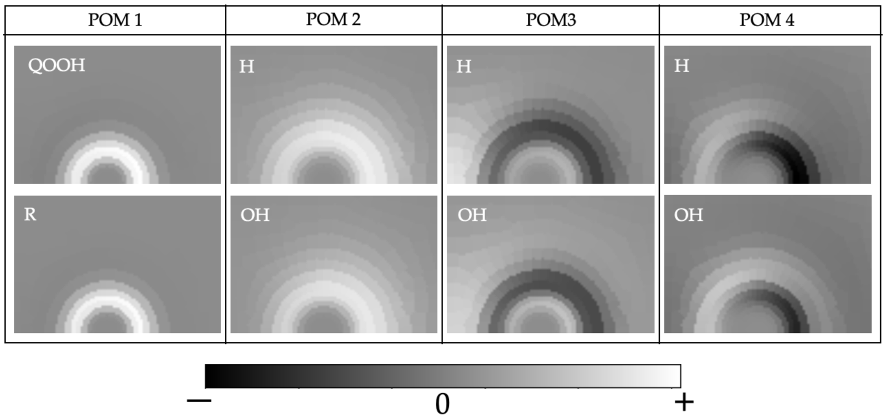

Fig. 3 Topos of the dominating species of each of the POMs (8 mm case)

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