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ABSTRACT

We developed the numerical method to solve the electric field (E-field) on the reacting flows—a detailed ion-mechanism has been proposed for the quantitative agreement with experimental results. We calculated the current behavior with applied voltages and found improved results of V-I characteristics than in previous studies. We analyzed the flow responses under the electric field. When we changed the polarity of the E-field, different flow motions were found.

Key Words: 1D diffusion flame, Electric field, ion chemistry

Positive ions and electrons are generated from the chemi-ionization process in the reaction zone. The charged species migrate to each corresponding electrode when the electric fields are externally applied to the flames, ions, and electrons [1]. This movement generates a bulk flow modification of flow fields called ionic wind. The ionic wind commonly blows toward the cathode due to the movement of positive ions. Meanwhile, the effect of the electrons was negligible [2].

However, Min et al. found the ionic wind blowing toward both directions; an anode and a cathode [3]. They hypothesized that O_2^- generated the ionic wind blowing toward the anode via the electron attachment to oxygens, and the H3O+ caused the opposite direction of the ionic wind.

Analysis of the ion wind was mainly conducted by visualizing the flow field experimentally, and numerical analyses have been conducted recently [3-6]. Therefore, the mechanism of the electric field affecting the flame has not yet been clearly understood.

The previous studies have conducted the numerical analysis of ionic wind on the flame, and they have shown the change of the flow field due to the electric field. However, the simplification of the ion chemistry caused the incorrect prediction of V-I characteristics compared to the experimental results. Therefore, the numerical study applying a detailed ion mechanism is essential to find a fundamental understanding of the electric field effects of the flame.

In this regard, we applied the detailed ion-chemistry proposed by the literature.

We obtained the improved results of the V-I characteristic compared to the previous studies. And we analyzed the flow responses under the given applied voltages: the electric field to oxidizer (ETO) and the electric field to fuel (ETF). Figure 1 shows the flow modification due to the electric field. The flame moved toward the fuel side (cathode) when the negative voltage was applied (ETO case). In the case of the ETF, the flow modification toward the oxidizer side was found. However, the flow fields are different between the two cases because the negative ions generated on the oxidizer side affected the ionic wind in the ETO case.

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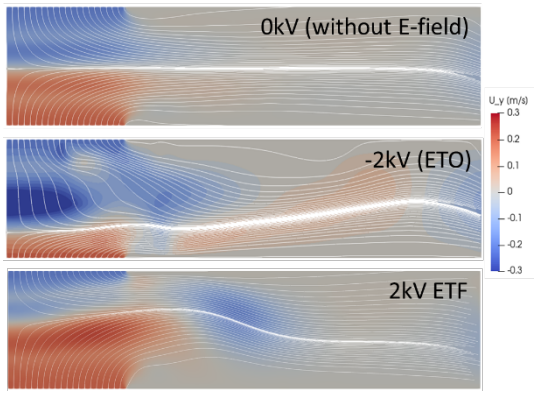

Fig. 1 Velocity fields with the streamlines of the applied electric fields.

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