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INFLUENCE OF INDUCED FLOW ON PREMIXED COMBUSTION FLAMES USING A COAXIAL DBD PLASMA ACTUATOR

Hiroshi TSUCHIDA, Masato AKIMOTO, Motoaki KIMURA*

Department of Mechanical Engineering
College of Science & Technology
Nihon University
Kanda Surugadai, Chiyoda-ku, Tokyo, Japan
*E-mail: kimura@mech.cst.nihon-u.ac.jp

Abstract

A DBD plasma actuator (DBD-PA) was applied to control the flame by premixed combustion. By using a coaxial DBD-PA with a premixed flame of propane and air, combustion can be continued even at low equivalence ratios that would otherwise cause blowout. The cause may be induced flow generated by DBD-PA, chemically activated species, etc. We focused on the induced flow that affects the flow, visualized the flow using incense particles, and measured the average velocity distribution and the turbulence intensity distribution using LDV.

A coaxial DBD-PA using a cylindrical electrode and a dielectric was disposed at the tip of a circular nozzle with an inner diameter of d = 6 mm. By applying an alternating voltage to the incorporated electrode, DBD plasma is generated on the inner wall of the cylinder, an induced flow is generated, and the fluid is controlled. The developed DBD-PA consists of upper, middle and lower three electrodes. Case A is a case where the induced flow is generated in the direction along the main flow by the upper and middle electrodes, and Case B is a case where the induced flow is generated in the direction against the main flow by the lower and center electrodes. The following three steps were conducted. (1) Flame shape photography using a high speed camera. (2) Visualization to investigate the influence of the induced flow generated by the DBD plasma on the flow inside the flame. (3) Flow velocity measurement inside the flame using the LDV.

The results of using a coaxial DBD-PA for premixed combustion flames were obtained. 1) The coaxial DBD-PA was driven at an applied voltage of 4kV, 10kV and 14kV with an equivalence ratio of 0.95, and it was possible to suppress blowout of the flame in the lean state. In addition, combustion can be continued up to an equivalence ratio of 0.85 at an applied voltage of 10 kV. 2) From flow visualization, it was confirmed that the induced flow changes the velocity of the premixed gas at an applied voltage of 10 kV and 14 kV, and the flame shape changes (Fig.1). 3) From the flow velocity measurement, it was confirmed that the change in velocity distribution and turbulence intensity distribution due to the induced flow was different depending on the presence or absence of the flame at an applied voltage of 14 kV. In addition, it is considered that the combustion speed changes and the blowout are suppressed by the change of the flame shape.

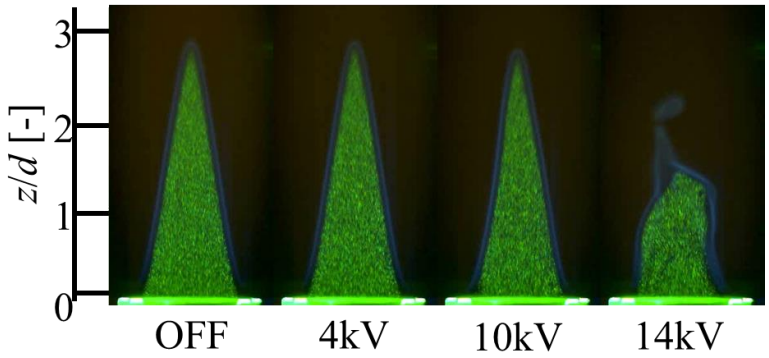

Figure 1 Flow Visualization in case of Case B (Flame Interior)

Keywords: DBD plasma actuator, premixed combustion, jet, flame visualization, flow visualization