Initial Flow Structure Control of Jet diffusion by using Coaxial Type DBD Plasma Actuator

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Keywords: DBD plasma actuator, Jet flow diffusion, Induced flow, Flow control

Abstract

In the control of a current jet flow, various researches on the control that have been used many control methods; sound wave, flap type actuator, controlled coaxial flow, MEMS actuator etc. In this experiment, diffusion control of the jet flow was tried using a dielectric barrier discharge (DBD) plasma actuator. DBD plasma actuator has been investigated as a device for flow control by many laboratories. DBD plasma actuator is applied to the jet diffusion control. In this experiment, the jet flow was controlled using the coaxial type DBD plasma actuator which generates an induced flow in the same direction as the jet direction. We investigated the difference in influence in the main jet flow which the induced flow by DBD plasma gives, when changing voltage and frequency. As a result, it turned out that an induction flow becomes strong by increasing frequency and voltage. And diffusion of the jet flow was promoted.

Figure 1 shows the section of the coaxial type DBD plasma actuator set up at the round nozzle exit, the main jet, and the overall view of the induced flow. The DBD plasma electrodes consist of the outside electrode, the inside electrode, and the dielectric layer. In an axial symmetry velocity made of acrylic fiber uniform nozzle of d=10mm in the inside diameter, the electrode was arranged in the same axis. Plasma was generated adding the alternating voltage of impressed voltage 2kV~6kV and frequency 4kHz~15kHz from the power supply (PSI: PSI-PG1040F), and the diffusion of the jet flow is tried by the induced flow of the DBD plasma.

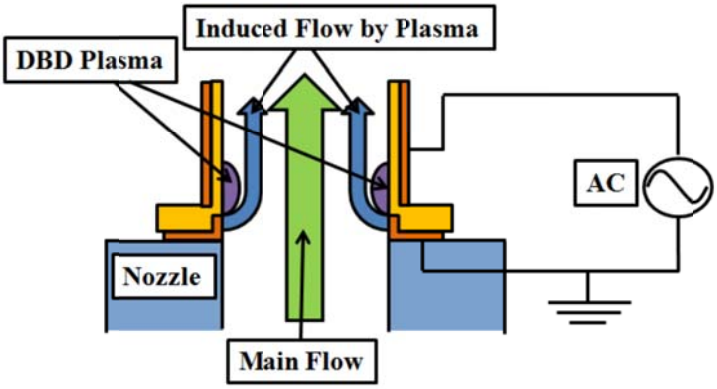

Figure 4. Overall view of induced flow.

The nozzle was circular converging nozzle. The compressor supplied air to the nozzle on the condition of Re=1000 in the experiment. It made on the jet flow axis center visible by the laser light seat method that used it issued from the nozzle after the seed particle of about 1μm was mixed with air to the perpendicular upper side in the atmosphere, and the Nd:YAG laser (made of Omicron : in the jet flow LA-D40-CW and λ=532 nm). It took a picture of the jet flow made visible within the range to x/d=6 with a high speed camera. Distance and y from the nozzle exit show the distance in the direction of the diameter from the nozzle center in x. And the visualization picture was PIV analyzed.

Figure 2 shows the image of making to visible, and verifies the change in the generation flow by making the frequency constant: 4kHz, and changing the voltage. (a) is an image of making to visible when the DBD plasma is not generated by Reynolds number 1000. (b) is an image of making to visible when the frequency 4kHz and 3.38kV in the voltage are impressed to the jet flow of Reynolds number 1000. (c) is an image of making to visible when the frequency 4kHz and 4.75kV in the voltage are impressed to the jet flow of Reynolds number 1000. (d) is an image of making to visible when the frequency 4kHz and 5.59kV in the voltage are impressed to the jet flow of Reynolds number 1000. When (a) is compared with (b), the spreading effect is hardly seen. However, it is understood that the induced flow is generated of the vortex ring in the primary jet by raising the voltage from (c) and (d). In (d), it is understood to diffuse at the position of x/d=4. It is thought that the induced flow generated by plasma by the thing that the voltage rises from this increases and the disorder given to the primary jet is diffusing.

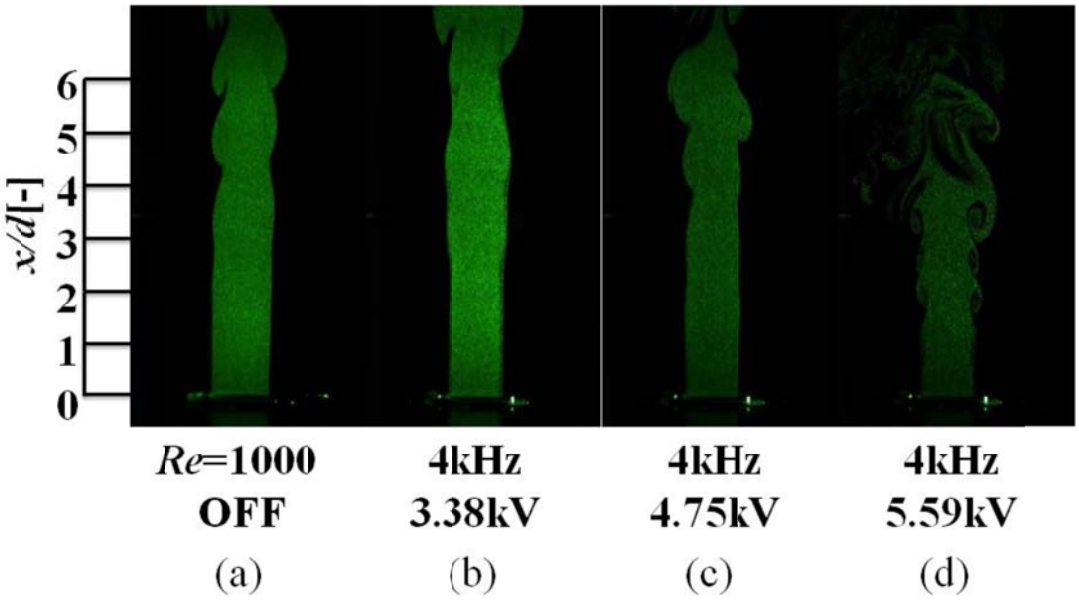

Figure 2. Flow visualization by voltage change (air).