Flow control by means of plasma actuation - a study of the electric wind

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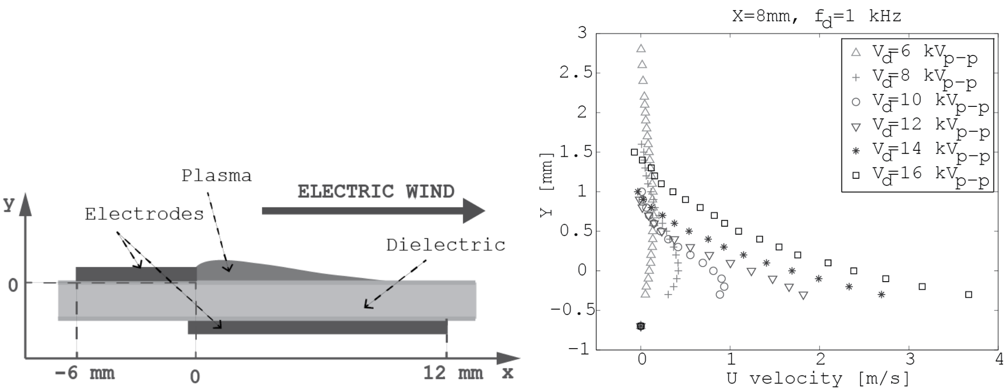
Reducing the aerodynamic drag on heavy vehicles is the mission of the **F**low **R**esearch on **A**dvanced and **N**ovel **C**ontrol **E**fficiency (FRANCE) project. The ability of Dielectric Barrier Discharge (DBD) plasma actuators to actively delay separation of the flow around the front corners of a truck cabin is under study. DBD plasma actuators are made of two electrodes asymmetrically placed on each side of a dielectric material, see Fig. 1(a). Plasma actuators present, among others, the advantage of not having any moving parts making them more robust than other types of actuators. By applying a high alternating voltage between the electrodes a plasma region is formed on the surface of the dielectric. This plasma is a consequence of accelerated electrons which ionize the surrounding medium: repulsion of positive ions during the ionization process induces momentum similar to a wall-jet, which here is called an electric wind. The present investigation focuses on the airflow induced by in-house made plasma actuators placed on a half-cylinder. The chosen geometry can be seen as a generic model of the flow around the corners of a truck cabin. Parameters such as driving voltage, frequency, dielectric thickness and their influence on the efficiency of the actuator are investigated by means of velocity measurements of the electric wind using Laser Doppler Velocimetry (LDV).

Mean velocity profiles show that the plasma actuators are able to produce wall jets with velocities of several meters per second. Increasing the driving voltage and frequency increases the jet velocities and its maximum moves closer to the wall, see Fig. 1(b). Because the actuator adopts the shape of the model, results show that the induced electric wind follows the surface of the cylinder, which is an advantage for future separation control. Close to the actuator the airflow becomes periodic in time due to the alternating driving current and the time variations of the electric wind were investigated through phase-averaged LDV measurements. The increase of induced velocities during both the forward and backward stroke of the high-voltage cycle shows agreement with the PUSH-push mechanism theory[1] of DBD plasma actuators.



(a) (b)

Figure 1: (a) Sketch of the DBD plasma actuator used for this project. (b) Wall-normal profiles of the mean streamwise velocity component induced by the actuator plotted for different driving voltages (V_d) at the driving frequency f_d=1 kHz.

[1]Corke, Enloe and Wilkinson, *Annu. Rev. Fluids Mech.*, **42**, 505-529, (2010)