Particle Image Velocimetry Measurements of Wire-nonparallel Plates Type Electrohydrodynamic Gas Pump

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ABSTRACT

2D Particle Image Velocimetry (PIV) measurements were performed in a wire-nonparallel plates type electrohydrodynamic (EHD) gas pump. Using simultaneously two CCD cameras allowed obtaining high resolution vector maps which illustrate the flow patterns generated inside the EHD gas pump.

Index Terms—Particle Image Velocimetry, electrohydrodynamic pump, Corona discharges, Non-thermal plasmas

1 INTRODUCTION

WHEN a strong electric field is applied between high voltage and grounded electrodes in a gas medium, a corona discharge is formed by ionization of the gas molecules. Thus ion flux along the electric field transfers its momentum to the neutral molecules and results in the so-called ionic wind or an electrohydrodynamically induced gas flow. When the electrodes configuration forms an unsymmetrical electric field distribution, the unidirectional gas flow can be generated, i.e. electrohydrodynamic (EHD) gas pumping occurs. A several electrode geometries have been proposed for EHD gas pumps such as needle-to-mesh, needle-to-ring, wire-to-rod, wire-nonparallel plates, etc. [1-7].

In this work, the performance of a wire-non-parallel plate push fan (PF) type EHD gas pump is studied by Particle Image Velocimetry (PIV) for measurement of the flow patterns. It was already demonstrated that the PIV technique is capable of measuring the flow velocity fields in the conditions typical of the EHD pumps [8-11].

The dimensions of EHD gas pump as well as electrodes configuration are the same as reported in [7], where the flow characteristics (pressure drop and mean flow velocity at the pump exit) of the EHD gas pump were given. These characteristics show that without detailed study of the flow patterns inside EHD gas pumps, only general conclusions such as the generated flow is turbulent or re-circulating laminar could be made. Therefore, to understand the flow behavior in the EHD gas pump it is necessary to investigate in detail the velocity flow patterns near flow driven electrodes.

2 EXPERIMENTAL SET-UP

The EHD gas pump used in this experiment was a box made of transparent acrylic plates of a thickness of 10 mm. The internal dimensions of the box were 120 mm x 35 mm x 50 mm. Two engraved slits with 3° convergent angle were made in two sidewalls (Figure 1). Two acrylic plates covered with grounded electrodes could slide-in and off in the engraved slits. When these plates with plane grounded electrodes were placed in the slits, the cross sections of the EHD pump inlet and outlet were of 35 mm x 24 mm and 35 mm x 12 mm, respectively. The grounded electrodes (75 mm x 35 mm) were made of aluminum tape of a thickness of 50 μm. They could be shifted along the acrylic plate base, changing their positions in respect to the wire discharge electrode. The discharge electrode was a stainless-steel wire of a diameter of 0.23 mm and width of 35 mm, placed parallel to the plane grounded electrodes. The position of the corona wire electrode was always 60 mm from the EHD pump outlet. Two positions of the grounded electrodes were set: 6 mm from the EHD pump inlet (the pump type called PF-A) and 36 mm from the EHD pump inlet (PF-B) (Figure 1). Two acrylic boxes (110 mm x 140 mm x 400 mm) were connected inlet and exit sections of the EHD gas pump then both ends were

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