Three-dimensional flow and turbulence structure in electrostatic precipitator

Stereo PIV is employed to study the three-dimensional velocity and turbulence fields in a laboratory model of a negative corona, barbed-wire, smooth-plate, electrostatic precipitator (figure 1). The study is focused on determining the parametric effects of axial development, mean current density $J_m$ and bulk velocity $U_0$ on secondary flows and turbulence levels and structures due to the action of the three-dimensional electrostatic field on the charged gas. At constant bulk velocity ($U_0 = 1 \text{ m/s}$) and current density ($J_m = 0.4 \text{ mA/m}^2$), secondary flows in the form of rolls of axial vorticity with swirl numbers up to $S = 0.3-0.4$ are found to level off after 4-5 electrodes, being most regular in the central unit cells defined by the periodic geometry of pin-electrodes. The corresponding image-mean turbulence intensity increases to about 20% from the 1st to the 7th electrode with a consistent anisotropy of normal Reynolds stresses. The effects of $U_0$ and $J_m$ on $S$ and $T_u$ (at a fixed position between 6th and 7th electrode) are reasonably correlated by the electrohydrodynamic modulus $\text{NEHD} = (J_m/b_i)\rho/\left(\frac{1}{2}rU_0^2\right)$, where $b_i$ denotes the ion mobility and $\rho$ the electrode-plate distance.

General information
State: Published
Organisations: Fluid Mechanics, Department of Mechanical Engineering
Contributors: Ullum, T. U., Larsen, P. S., Özcan, O.
Publication date: 2002

Host publication information
Title of host publication: 11th Intl. Symposium on Applications of Laser Techniques to Fluid Mechanics
Place of publication: Lisboa, Portugal
Publisher: Instituto Superior Técnico
Source: orbit
Source-ID: 62513
Research output: Research - peer-review › Article in proceedings – Annual report year: 2002