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Experimental investigation and simulation of an ion anemometer and studying the effect of the air boundary layer on its performance

M Qalekhani, I hosseini, and M Hashemzadeh

Faculty of physics, Shahrood University of Technology, Shahrood, Iran

E-mail: imanhosseini@shahroodut.ac.ir

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Abstract

In this article, an attempt has been made to measure the speed of air flow by releasing and tracking electric ions in it. In fact, if an electrical discharge plasma is exposed to air flow, some of its ions move along with the flow, and ion anemometers measure the air speed by tracking these ions. In this research, a wind tunnel has been designed and prepared. Then an ion anemometer is made and installed on its wall. According to the obtained results, the effect of the boundary layer adjacent to the wall on the movement of ions causes the speed measured by the ion anemometer to show a certain proportion with the speed of the air flowing inside the wind tunnel. In order to properly understand the physical mechanism involved in this problem, first the movement of ions in the boundary layer has been investigated using simulation and then it has been studied more analytically. The results of the experiments, together with the simulation data and the analytically calculated values, show that the tracked ions, instead of moving in the uniform background flow, move downstream in the boundary layer adjacent to the wall at a lower speed, so that this proportionality phenomenon defines the measured velocities and shows the effect of the boundary layer on the performance of ion anemometers.

Keywords: boundary layer, plasma, corona discharge, ion anemometer, electrohydrodynamic flow

For full article, refer to the Persian section