

MEASUREMENTS OF THE ELECTRIC WIND IN A
CORONA DISCHARGE WITH LASER-DOPPLER-VELOCIMETRY

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ABSTRACT

The electric wind in a negative point-to-plane or a negative point-to-ring corona discharge is measured with a Laser-Doppler-Velocimeter. The velocity profiles in different planes within the discharge region are determined and compared with calculations.

1. INTRODUCTION

The velocity of the electric wind in a corona discharge can be of the order of several m/s and can, therefore, influence gas flow properties wherever it is present, e.g. in electrostatic precipitators (1), small ventilators (2) and electrical breakdown (3).

The electric wind is a result of electrical forces on volume charges in the discharge region.

The electrical wind velocity has been measured using pitot probes (3), the Schlieren technique (1) and/or hot wire anemometry (4, 5). These methods are either indirect or suffer from inherent inaccuracies. The Laser-Doppler-Velocimeter (LDV) allows a very accurate and direct determination of the electric wind velocity with a high spatial resolution. The motion of the scattering particles used in this experiment is negligibly affected by the electric forces: their motion is completely determined by their interaction with the gas molecules. This is shown by measurements of others (6, 7) and also by our calculations of the maximum charge on the particles.

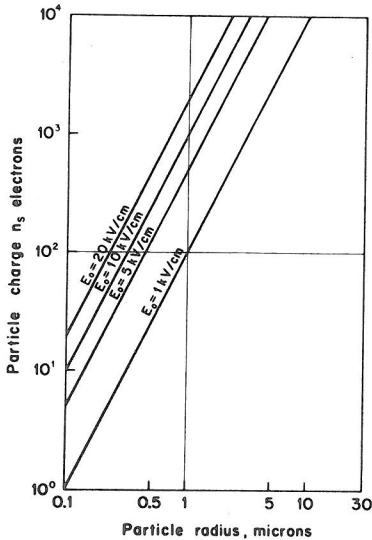


Fig. 4: Saturation charge of oil droplets as a function of the particle radius for different electrical field E_0 .

and the oil droplets have a diameter between 0.1μ and 1μ . The saturation charge n_s is therefore between 3,5 and 350 electron charges. This charge is reached within a characteristic time of the order of 10 ms (6), which is larger than the dwell time of the particles between the electrodes. The maximum obtainable charge on a particle with 1μ diameter and a dwell time of 2 ms for the given field is about 60 electron charges. Stokes relation for the maximum possible droplet velocity with this charge gives 8 cm/s. This additional velocity is negligible compared to the measured wind velocity.

5. CONCLUSIONS

The velocity of the electrical wind in a point-to-plane corona discharge has been measured with LDV, and the influence of the particle charging on this velocity has been found to be negligible.

In addition, measured values of the wind velocity confirm theoretical predictions. Thus, it seems that the physical processes causing the electric wind are reasonably well understood and that the proposed formulas can safely be

used to describe gas transport phenomena in electric discharges.

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