Acta Physica Academiae Scientiarum Hungaricae, Tomus 50 (3), pp. 263—273 (1981)

ON A TRANSVERSE ABNORMAL GLOW DISCHARGE BETWEEN TWO CYLINDRICAL ELECTRODES IN NITROGEN

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(Received 3. II. 1981)

Measurements of current-voltage characteristics of an abnormal glow discharge between two cylindrical electrodes in nitrogen atmosphere have been made for various cathode filling factors. The characteristics are expressed in analytical form in terms of reduced parameters. The external cases are described by empirical functions agreeing in form with equations reported in the literature referring to plane parallel electrodes and hollow cathode discharges.

I. Introduction

The abnormal glow discharge between two coaxial cylindrical electrodes is of great technological importance. The discharge phenomena occurring in such a configuration correspond to those to be found in industrial plants for ion treatment of steel surfaces in nitrogen atmosphere [1]. In order to optimize the technological process of surface treatment it is necessary to study the physical phenomena occurring in the process and to describe them by mathematical formulae.

Theories developed for various types of abnormal glow discharge, e.g. glow discharge with single plane cathode, the discharge with double cathode consisting of two parallel metallic surfaces, or cylindrical hollow cathode discharge can be found in literature [1, 3, 4, 5].

However, all those examples are of little use in describing conventional glow discharge between two cylindrical electrodes because in this case the discharge conditions differ significantly.

The present work is an attempt of simplified presentation, in terms of reduced discharge parameters, of voltage-current characteristics of abnormal glow discharge between two cylindrical electrodes in nitrogen.

The object of experimental study consisted of two stainless-steel cylinders of different size (one placed coaxially inside the other), the outer being the cathode and the inner being the anode. Several values of anode radii were tried in the experiment in order to assess how the discharge parameters and current-voltage curves depend on the cathode/anode radius ratio. Since this ratio is the decisive factor determining to what extent the radiation contributes to the generation of charge carriers at the cathode surface we supposed that its changes might effect also the discharge mode and hence its parameters.

II. Experiment

The diagram of the discharge chamber is shown in Fig. 1. The inner diameter of the cathode cylinder R_c was fixed at 23 mm, while the anode cylinders of external diameters R_a equal to 1.5 mm, 5 mm and 16 mm were used alternatively.

The anode-cathode geometry can be described by the filling factor of the cathode volume defined as

$$W = \frac{R_c - R_a}{R_c} . \tag{1}$$

In our experiment the values of W for the three anodes were 0.93; 0.78 and 0.28, respectively.

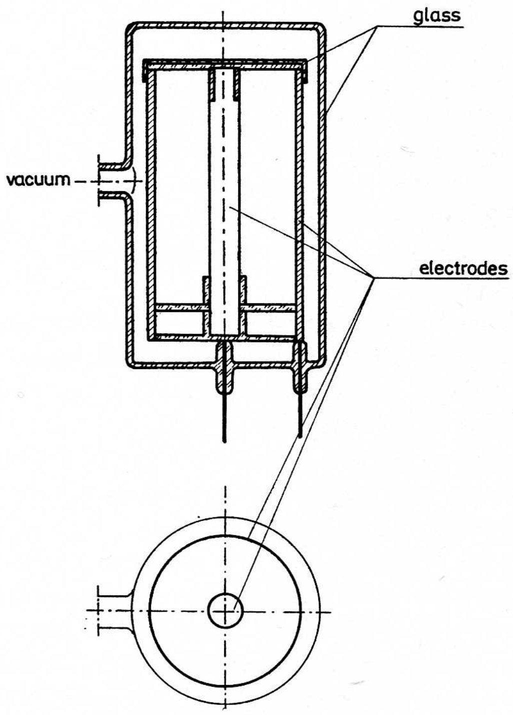

Fig. 1. Scheme of the discharge chamber

The discharge surface was limited by special profiled glass plates at the edges of the cylinders. In this way such phenomena as sparking and generation of an electric arc were avoided.

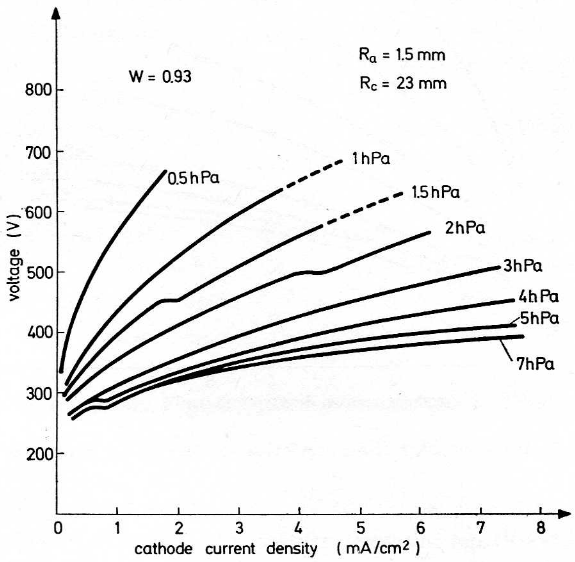

Fig. 2a. Voltage-current characteristics for the filling factor $W = 0.93$

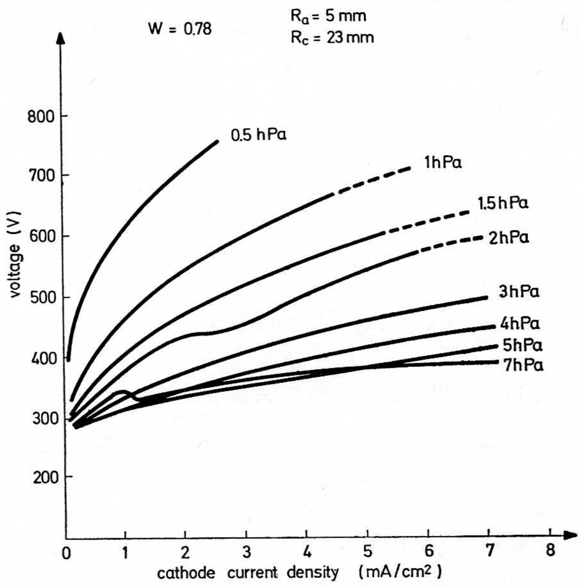

Fig. 2b. Voltage-current characteristics for the filling factor $W = 0.78$