

The constant α is called Townsend's first ionization coefficient and is defined as the number of ions produced by the electron per cm in the direction of the field. The value of α depends upon the pressure P and field E . Then after integrating,

$$n = n_0 e^{\alpha d}$$

$$\frac{n}{n_0} = e^{\alpha d} = \frac{n}{n_0}$$

where n_0 is the initial number of electrons produced at the cathode per sec and i_0 is the initial current at the cathode, and d is the distance between the two electrodes.

As per assumption made by Townsend for the ionization of the gas by electron collision is that the energy gained by the electron in traversing a distance d must be equal to the ionization energy of the gas. Hence

$$e \cdot E = e V_i \quad \text{or} \quad i = \frac{V_i}{E}$$