Federal University of Santa Catarina (UFSC)
Joinville Technological Center (CTJ)
Graduate Program in Engineering and Mechanical Sciences (Pós-ECM)

Course: Plasmas and Electrical Discharges in Gases (ECM410054)
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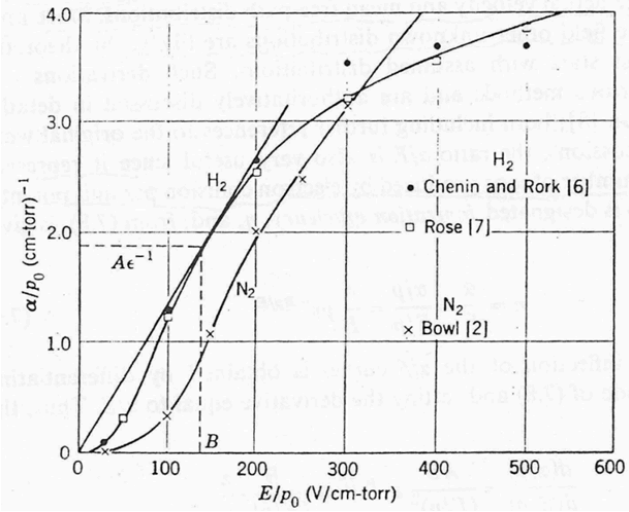
Behavior of charged particles in a gas in electric fields of high E/p (List 6)

1. Determine the first Townsend ionization coefficient for hydrogen for the E/po range of 20 to 600 V /em-torr and plot your results as a/po against E/po. Use A and B values from table below (Table 7.1 from Nasser):

Gas	*A* ionizations/cm-torr	*B* V/cm-torr	*E/p* Validity Range V/cm-torr
Air	15	365	100–800
N_2	12	342	100–600
H_2	5.1	138.8	20–600
He	3	34	20–150
Ne	4	100	100–400
A	14	180	100–600
Kr	17	240	100–1000
Xe	26	350	200–800

and compare your curve with that of figure below (Fig. 7.3 from Nasser):



2. From the data of problem 1, calculate (a) the mean free path of electrons in hydrogen at p = 1 torr, (b) the ionization potential of hydrogen. Discuss discrepancies, if any, with values obtained previously using other methods.

3. From the above, calculate η_{max} for H_2.

4. In an experiment to measure a for a certain gas, it was found that the steady-state current is 3.8×10^{-8} A at a voltage of 8 kV and a distance of 0.4 cm between the plane electrodes. Keeping the field constant and reducing the distance to 0.1 cm resulted in a current of 3.8×10^{-9} A: (a) calculate α; (b) calculate the number of electrons emitted from the cathode per second.

5. At the conditions of problem 4, determine the electrode spacing that would lead to an electrode multiplication factor of 10^8.

6. In a nonuniform field near an anode, a was found to be given by:

$$\alpha = b - a\sqrt{x} \ \text{cm}^{-1}$$

where $b = 3.5 \times 10^3$ and $a = 10 \times 10^3$ and the origin is at the anode surface. If an electron starts its motion toward the anode at a distance of 0.1 mm, determine the total number of electrons reaching the anode.

7. If an electron starts at a distance of 0.5 mm in a field where $\alpha = b - x$ (cm^{-1}), find the distance it must travel to produce an avalanche of 1020 electrons. Use the *a* and *b* constants of the above problem.

8. In the field given in problem 7, determine the *minimum distance* from the anode from which an electron may start an avalanche having a total number of electrons of 10^{20}.