

Study material for B.Sc-III (Paper-7th) By - Dr. Bharat Singh  
Sri Chaitanya College

Q. - How can Plasma be Produced in Laboratory?

Ans: - Production of Plasma in laboratory: - Several methods have been devised for the production of plasma in laboratory. These are collision ionisation, photo ionisation, thermal ionisation, production by break down of gases. A method that has been recently developed is the technique of Plasma gun.

Of these methods, Plasma gun method is the most accurate method. A Plasma gun is a device for producing and accelerating in to vacuum bursts Plasma with a velocity of  $10^7$  cm/sec. This method has the advantage that the plasma can be produced in an external system and then transferred in to another region where it is to be studied. Plasma gun described by Marshall (1960) consists of two co-axial cylinders which serve as electrodes.

The length of the cylinders varies from 30 cm to 100 cm. No magnetic field is used, Gas is admitted through a fast gas valve symmetrically in the space between the two cylinders. The gas is discharge by Power supplied from the discharge of a bank of capacitors. This produces a large current through the discharge. The Plasma is accelerated due to  $\vec{J} \times \vec{B}$  forces on the radial discharge current  $\vec{J}$  and  $\vec{B}$  azimuthal magnetic field due to current flow along the co-axial conductors. The force is given by

$$F = \int_{r_1}^{r_2} \frac{B^2}{8\pi} dA$$

where  $r_1$  and  $r_2$  are the radii of the cylinders and  $dA$  is cross sectional area between the cylinders. If  $r$  be the distance of a point in the space between the cylinders, If  $r$  be the distance of a point in the space between the cylinders from the axis and  $dr$ , the thick of the imaginary co-axial cylinder passing through the point, then  $dA = 2\pi r \cdot dr$ .

$$\therefore F = \int_{r_1}^{r_2} \frac{B^2}{4} r \cdot dr \quad \text{But } B = 2l/r$$

$$\therefore F = \int_{r_1}^{r_2} \frac{l^2}{r} dr = l^2 \int_{r_1}^{r_2} \frac{dr}{r} = l^2 \log\left(\frac{r_2}{r_1}\right)$$

$$\therefore \text{Impulse delivered } \int_0^T F \cdot dt = l^2 \int_0^T \log\left(\frac{r_2}{r_1}\right) dt = \log\left(\frac{r_2}{r_1}\right) \int_0^T l^2 dt$$

where  $T$  is the time for the current pulse and in the absence of friction. As a result of this impulse the plasma is accelerated forward and an ion density of the order of  $10^{17}$  is produced and a velocity of the order  $10^5$  m/sec is reached.