SUMMARY AND CONCLUSIONS.

Summary

In the present work measurements and calculations of some plasma parameters are described relating to the positive column of glow and arc discharges with and without magnetic field. The investigation was particularly directed to evaluate the properties of magnetoplasma which are determined by different methods in the following experiments. In the interpretation of the results the basic physical processes operating in the discharge have been sought to be evaluated.

A. Measurement of electron temperature and electron density in low density magnetised plasma by probe method.

A Langmuir probe was utilised to measure the electron temperature and electron density near the axis in ionised molecular gases like air, hydrogen, oxygen and nitrogen. The limitations of the probe theory and precise method in measuring electron temperature and electron density both in the absence and in presence of the magnetic field have been discussed and experiments have been performed under the conditions in which the assumption of probe theory are strictly valid. It has been observed that in case of transverse magnetic field, the electron temperature increases whereas the radial electron density decreases and in case of longitudinal magnetic field, the electron temperature decreases and the axial electron density increases. The results are in quantitative agreement with theoretical deductions which take into account the influences of magnetic field on the plasma balance equation. Further, it is noted that in case of molecular gases the electron energy distribution is Maxwellian in presence of or in the absence of magnetic field, but in the former case it becomes a function of the reduced magnetic field B/p.

B. Measurement of electron temperature in glow discharge in transverse magnetic field by spectroscopic method.

The electron temperature in the positive column of d.c. glow discharge in hydrogen and helium and a.c. (50 Hz) glow discharge in helium as a function of transverse magnetic field in the range of 0 to 1000 G has been obtained by measuring the intensities of two spectral lines. Since the electron number density in the column is of the order of $10^{10} cm^{-3}$, the semicorona model suitably modified has been used to calculate the plasma electron temperature in a magnetic field. After detailed analysis an appropriate cross-section for electron collisional excitation has been utilised, which enables a fair determination of electron temperature.

It has been observed that for low values of reduced magnetic field, the results are in quantitative agreement with existing theoretical deductions.

C. Mercury arc plasma in an axial magnetic field.

The electron temperature of a mercury arc plasma (arc current 2.25 A and 2.5 A) has been measured spectroscopically in an axial magnetic field varying from zero to 1050 G. It has been noted that electron temperature decreases with the increase of magnetic field. Considering the physical processes involved in a mercury arc discharge where the buffer gas is air and the pressure is low, a model has been developed in which ~~ax~~ air plays the role of quenching gas, and it has been found that in this type of discharge both atomic and molecular ions of mercury are present. Assuming the presence of both types of ions, a radial distribution function for the electron density has been deduced and an expression for T_e / T_{eB} has been obtained. Variation of arc current and voltage across the arc with axial magnetic field has also been noted and the variations have been interpreted in terms of the effect of magnetic field on the diffusion of plasma electrons. It has been found that within the range of B/p values used, the experimental results are in quantitative agreement with theoretical deduction. The increase of axial electron density in axial magnetic field determined by probe method can also be explained by the theory developed.

D. Enhancement of spectral intensities of mercury triplet lines in longitudinal magnetic field.

Enhancement of spectral lines of mercury sharp series triplets with longitudinal magnetic varying between zero to 1500 G field has been studied. A theoretical model has been developed which includes the effect of self absorption of the lines to explain the enhancement of intensities. It has been observed that the experimental results agree fairly well with the theoretical model. Moreover, the plasma balance equation of the mercury arc plasma with and without magnetic field has been reconsidered and variation of mercury metastable level population with longitudinal magnetic field has been determined.

E. Persistence times in afterglows in mercury arc maintained by r.f. field in presence of magnetic field.

In presence of an external radio frequency field, when the main arc current is switched off, it has been observed that the glow persists and this glow can be distinctly identified as two individual processes depending upon their time of persistence. The persistence time T_1 which extends throughout the tube is directly proportional to inverse of total pressure, and increases with the increase of intensity of r.f. field whereas persistence time T_2, within the r.f. couplers, first increases with pressure, never diminishes as long as r.f. power is present and then decreases as pressure is incrēased. Regarding the variation with arc current it can be stated that T_1 depends on electron density and hence on current but T_2 is independent of it. The effect of magnetic field is to change the persistent time T_2, but T_1 is not affected by the fiæld. These general observations have been sought to be explained qualitatively by considering the effect of pressure, temperature of the arc and the magnetic field on the process of generation of charged particles, loss by diffusion and the process of recombination.

In general in all the experiments, the discharges chosen ~~was~~ were of low pressure and low input power so that influence of magnetic field on the plasma parameters is fairly measurable.

Conclusions

The investigation shows that the results obtained by different diognostic methods agree fairly with theoretical deductions. In this way the diognostics can be very useful in the investigation of positive column of the low pressure discharges within the range of measurements. The magnetic field influences the plasma loss processes. As the particle losses are changed in magnetic field, the plasma in positive column adjusts by changing the particle generation processes and the plasma parameters change in presence of magnetic field. These investigations thus provide useful information regarding the actual physical processes occuring in glow and arc discharges and how the nature of these physical processes change when the plasma is confined by an external magnetic field.