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Author(s): M. A. Hoffman and G. C. Oates

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ELECTRODE CURRENT DISTRIBUTION IN LINEAR M.G.D. CHANNEL FLOWS*

M. A. Hoffman and G. C. Oates
M.I.T. Dept. of Aeronautics and Astronautics

Abstract

Experimental and theoretical investigations of the distribution of currents to electrodes in linear M.G.D. channel flows have been carried out. The experiments have been performed with two electrode configurations, the first being that of continuous electrodes, and the second being that of segmented electrodes. In each case the electrodes were finely subdivided so that the current distribution to the electrodes could be determined.

Mixtures of nitrogen and argon as well as nitrogen and helium have been used as the working fluids, with potassium used as a seed material in all cases. The gas temperatures ranged from 1400° K to 2000 °K with the pressure close to one atmosphere and flow velocities of the order of 100 meters per second.

Measurements of current distributions to the electrodes and potential distributions in the plasma were obtained for conditions allowing "diffuse" electrical currents to exist. As expected, current concentrations were measured at the edges of the electrodes.

The results of the continuous electrode experiments were compared to the theory of Podolsky and Sherman[1], and in addition were compared to the semi-empirical theory of Rogers[2]. This latter theory assumes a current-dependent boundary condition, the result of which is to remove the mathematical singularity found at the edge of an electrode. It was found that within the limitation of the averaging due to the finite electrode sub-segment sizes, good agreement between experiment and the theories of References 1 and 2 was obtained.

Three pairs of tantalum electrodes with length to channel height ratio of one half were employed for the study of segmented electrodes. The center electrodes were further subdivided into three pieces to allow measurement of the current distribution.

The results of the segmented electrode experiments showed a considerable smoothing or flattening of the current distribution compared to the theory of Hurwitz, Kilb and Sutton[3]. Preliminary data obtained with the plasma in the nonequilibrium conductivity regime indicate a further flattening of the current distribution.

References

1. B. Podolsky and A. Sherman, "Some Aspects of the Hall Effect in Crossed-Field MHD Accelerators," ARS Preprint 1531-60, Dec. 1960.

2. J. W. Rogers, "A Theoretical Investigation of the Inlet Current Distribution in an MHD Channel," E.A.A. Thesis, M.I.T., June 1964.

3. H. Hurwitz, Jr., R. W. Kilb and G. W. Sutton, "Influence of Tensor Conductivity on Current Distribution in a MHD Generator," J.A.P. 32, 205, 1961.

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