USE OF THE MONTARDI SCHEME WITH SEGMENTED ELECTRODES FOR MHD DEVICES WITH AN ISOTROPICALLY CONDUCTING WORKING FLUID

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In [1] it was shown that it is possible to increase considerably the working voltage in liquid-metal electromagnetic pumps and generators with segmented electrodes in comparison with the familiar MHD dc machines. In this scheme, the channel length rather than its width appears in the working relationships for the voltage.

In this report an attempt is made to confirm experimentally the possibility of creating MHD pumps (generators) with higher voltages.

The experiment was performed with an EGDA-9/60 integrator. The conducting medium was electrically conducting paper, which duplicated the effect of an isotropically conducting stationary fluid. The conductors, which are made of an electrically conducting paper foil, are supplied with a dc voltage which is assigned a value of 100%. Segmented electrodes (made of foil) are placed along the edges in the working section of the electrically conducting paper (channel); these electrodes are connected obliquely by short-circuited connecting pieces placed outside the paper, as shown in the figure. To make this problem similar to the Montardi problem a fairly large number of electrodes were used (20 pairs).

The experiment provides us with a picture of the potential distribution on the electrically conducting paper; this is shown in the figure for the left half of the channel (in the right half this distribution is obtained by rotating the figure 180° around point O in the plane of the drawing). The figure shows curves for the equipotentials in 5% increments of the total voltage. From the experimentally obtained equipotential curves the current-density lines were constructed. It is clear from the figure that the current density has a strong effective transverse component in a considerable portion of the channel length (with the exception of the conductor zone). When a constant magnetic field is applied in a direction perpendicular to the plane of the channel, this component creates a useful pressure in the longitudinal direction.

Physically, the process involved in the appearance of a transverse current-density component governing longitudinal pressure can be explained as follows. We assume that at first there are not short-circuiting connecting pieces between the electrodes. In this case, when a longitudinal voltage is applied to the conductors only a longitudinal current-density component will appear. Here the potential on each electrode at the upper edge will be greater than on this electrode's lower counterpart since the upper electrodes are closer to the positive pole. When similar electrodes are connected through the connecting piece a current will flow through this piece because the electrode circuit is closed by the fluid; in this case, the appearance of a transverse current-density component superimposed on the initial longitudinal one is unavoidable.

It is interesting to note that the dc potential lines connecting upper and lower electrodes at the same potential (because of the short-circuiting connector piece) are not present in the electrically conducting paper. The only equipotential connecting similar electrodes is the connecting piece itself. Thus, for example, electrodes with ordinal number eight have a potential of 42.6% whereas the lower electrode is surrounded by an equipotential line with a potential of 40%. The same situation holds for all electrodes. This result is found to agree with the theoretical solution of this problem given in [2].

REFERENCES

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