Electrical Conductivity Experiments In A Mpd Generator

Author(s): I. R. McNab

Session Name: All

SEAM: 6 (1965)

SEAM EDX URL: https://edx.netl.doe.gov/dataset/seam-6

EDX Paper ID: 136

ELECTRICAL CONDUCTIVITY EXPERIMENTS IN A MPD GENERATOR

I.R. McNab
International Research and Development Co. Ltd.
Fossway, Newcastle upon Tyne, U.K.

During MPD experiments with the IRD loop unsatisfactory operation of the expansion nozzle has been apparent[1,2]; thus although the design Mach number at exit was 2.3 the highest value achieved in practice was 0.79 (reference 2). To remedy this the nozzle was redesigned with a 30 per cent larger throat area and a further series of MPD experiments carried out on 7 September 1964.

Loop operating parameters during this series were

graphite element temperature	: up to 2550°K
gas stagnation temperature	: up to 1850°K
channel Mach number	: 0.55 to 0.60
static gas temperature	: 1500 to 1600°K
static gas pressure	: 0.4 to 0.8 ata
helium mass flow	: 5.5 to 9.8 g/s
cesium seeding fraction	: 0.1 to 0.2 atomic per cent

The channel was identical to that described in reference 2; the main experimental differences were the 200°C higher static gas temperature and the slightly lower Mach number and flow velocity. Experiments similar to those described in reference 2 were performed.

Open circuit voltages of about 0.4 x BUd were observed at magnetic fields between 0.2 and 1.0 Tesla (the highest with this magnet). Voltage-current characteristics enabled gas conductivities to be determined in the channel. In most cases the conductivities were within a factor of three of the thermal equilibrium (Saha) value; this seems good evidence for the non-occurrence of extra-thermal ionization in view of the uncertainties introduced experimentally. Several exceptions did however occur, notably when the magnetic field strength was reduced below one Tesla, for example with B = 0.62T conductivities varying between 0.5 and 8.0 mho/m were derived from the voltage-current characteristics for a case when the Saha conductivity was 0.45 mho/m.

Several experimental difficulties make these results difficult to reproduce, and therefore uncertain.

(i) Efficient cesium recovery has not yet been achieved consequently continuous cesium injection is not possible and during the seeding period considerable (and rapid) variation of the seeding fraction occurs.

(ii) Highly conducting thin films are found on the inner surfaces of the channel after the MPD experiments. Analysis of the nature of these conducting films is difficult because of their very thin nature. In view of the high purity of the main gas stream it appears likely that these films result from the materials used in the MPD generator.

(iii) The present method of obtaining the experimental data (feed out of load voltages on a UV recorder trace) is inaccurate at low voltages where the voltage current curves are important.

Considerable effort is currently being made to solve these problems and further MPD experiments are to be performed within the near future. Modified instrumentation, new cesium separation equipment and line reversal techniques for temperature measurement will be employed in these experiments. Direct comparisons of wall mounted electrodes and electrodes placed in the gas stream will also be made and a new expansion nozzle will be used. The progress to date and these new experiments will be reported at the conference.

References

1. Lindley, B.C., Brown, R. and McNab, I.R. MPD experiments with a helium-cesium loop. International Symposium on MHD Electrical Power Generation, Paris 6-11 July 1964, paper 108.

2. McNab, I.R. Extrathermal electrical conductivity measurements in a magnetoplasmadynamic generator. Nature, Vol. 204, p. 275-276, 17 October 1964.