DETERMINATION OF MAGNETOHYDRODYNAMIC FLOW DISTRIBUTION IN A HCLL BLANKET MODULE THROUGH ELECTRIC POTENTIAL MEASUREMENTS

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An experimental campaign has been carried out in order to investigate liquid metal magnetohydrodynamic flows in a scaled mock-up of a helium cooled lead lithium (HCLL) blanket. Here the liquid metal, which serves as breeder material, flows under the influence of the strong magnetic field that confines the fusion plasma inducing electric currents and Lorentz forces. The established magnetohydrodynamic (MHD) flow is affected by the magnitude of the external magnetic field and by the flow rate.

For liquid metal flows exposed to intense magnetic fields like in a fusion reactor, electric potential measurements give essential information on the flow structure in the breeder units, since this quantity can be interpreted as an approximate flow streamfunction. In other words, lines of constant potential on the walls perpendicular to the magnetic field can be interpreted as hydrodynamic streamlines. Hence the approximate flow rate or mean velocity in sub-channels formed by cooling and grid plates can be estimated as the difference between electric potential values recorded at those internal walls.

It has been observed that, even for strong magnetic fields, the distribution of flow among sub-channels between cooling plates is not completely uniform, i.e. inertial entrance and exit conditions still affect the flow partitioning in the breeder units. Moreover, depending on the balance between inertia, viscous and electromagnetic forces in terms of Reynolds and Hartmann numbers, regions with almost stagnant or even reversed flow are observed. Because in closed recirculation loops the accumulated tritium could cause a safety problem, their occurrence is investigated in a detailed parametric study.