Contribution ID: **202** Type: **Poster**

Engineering Feasibility of the Double Decker Divertor

Friday 17 October 2014 14:00 (4h 45m)

The term "double decker divertor"refers to a novel divertor concept in which the inboard leg of a single null poloidal field divertor is pulled around the interior of the vacuum vessel to allow it to be treated as an outboard leg. This topology reduces the inboard leg parallel heat flux by increasing the target radius, moving the plasma wall interaction to an area of lower magnetic field. Both divertor legs are pulled outwards in major radius to form a horizontal 'double deck'. The volume of each divertor leg is further increased by passing the divertor legs through regions of low poloidal field.
This class of strongly shaped field in the divertor region requires the placement of poloidal field coils within the toroidal field coil cage. A semi monocoque structural design is proposed to hold six divertor coils within the toroidal field coils of a reactor. Vertical coil loads of up to 35MN are transferred through a highly stressed EUROFER skin wrapped around radial spars cantilevered inwards from the external structure. A boundary of 0.8m has been allowed around each coil for neutron shielding, thermal insulation and structural features.
A magnetic potential solver developed to provide a rapid indication of permissible positional errors, suggests a tolerance on maximum vertical displacement of ±5mm.
A structural analysis of the radially symmetric cantilevers shows the design to be displacement limited with maximum equivalent stress of ~100MPa in the 130mm thick skin. This value lies below the ~400MPa yield limit for unirradiated EUROFER at 500℃.
Comparison of the magnetic parameters of the inner leg in the double-decker and conventional divertor topologies is given. The double-decker shows significant potential improvements:- placement of the inner leg target at an increased radius, R, reduces the magnitude of the magnetic field, |B|, at the target by a 30%, the SOL volume, V, is increased almost 4-fold and the 3D connection length, L3D, is increased almost 2-fold (taken from the equatorial low field side).

This work was funded by the RCUK Energy Programme under grant EP/I501045 and the European Communities under the contract of Association between EURATOM and CCFE. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Country or International Organisation

UK

Paper Number

FIP/P8-9

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Session Classification: Poster 8