§38. Mock-up of LHD Divertor Plates

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The concept of the divertor plates has been summarized as follows (Fig. 1) [1]:

- Water Cooled C-Cu Brazed Divertor Bar Elements
- Helically Running Discrete Bar Array
- Maximum expected heat load of 10 MW/m^2 for 10 seconds.

The main reasons of this configuration are (1) magnetic lines of force is parallel to the poloidal direction at the striking points of the divertor legs[2] and (2) the striking points are lying not on a flat plain but running three dimensionally. The plates are divided into 3 degree sub-units in toroidal direction. The total number of the sub-units is 480 because the LHD configuration has 4 divertor legs. They will be assembled finally inside the vacuum vessel.

Test fabrication of a 3 degree sub-unit have been tried to find a reliable procedure of the fabrication. Angle of the headers and elements were calculated and set so that the axis of each element agreed with poloidal direction. Stainless steel sockets were welded to the headers of stainless steel. Copper tubes to a header, and C/C composite armors to the copper tubes were brazed in a vacuum furnace. Six elements were assembled in the sub-unit this time. Six armors were brazed to two of the six elements as a test. Figure 2 is the drawing and photograph of the sub-unit. Deformation over 10 mm was observed in some copper tubes after the brazing procedure. However, a possible way how to reduce the deformation within a few millimeters has been found through investigations of the present procedure.

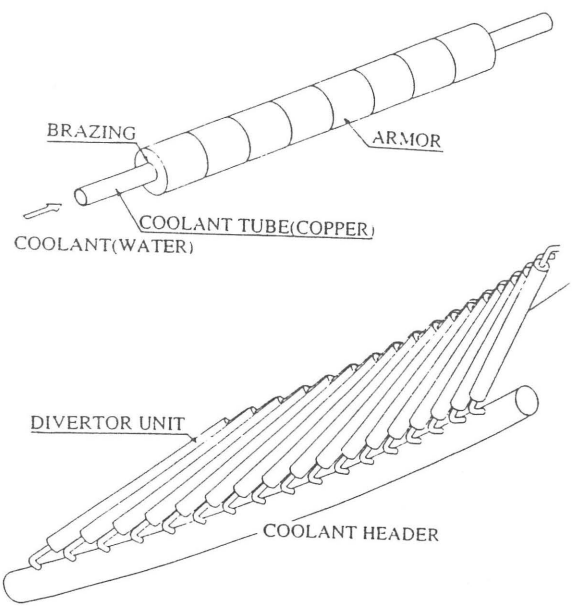

Fig. 1 Concept of a divertor element (top) and a sub-unit (bottom).

Another difficulty is arrangement of the elements. Distance between two elements does not look sufficiently close each other in Fig. 2. Heat and particle flux might possibly pass to the backside of the plates if we would adopt the present design. Some modifications have been under consideration to solve this problem.

In the first step of the LHD experiment, we start using mechanically jointed carbon armors to cooling tubes. We are planning to replace the mechanically jointed sub-units to the brazed one above described with step-by-step according to the observed heat load distribution. Heat-load test of mechanically-bonded elements has started in parallel to test of brazed elements.

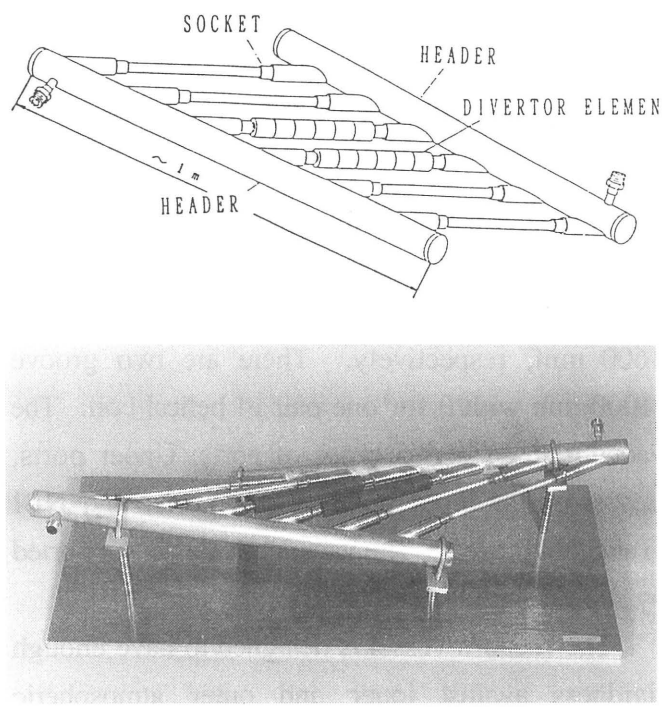

Fig. 2 Drawing (top) and photograph (bottom) of the sub-unit.

References

1) Noda, N. et al., "Fusion Technology 1992", (Proc. 17th SOFT, Rome) 1993, Elsevier Science Publishers, Amsterdam. p.325.
2) Ohyabu, N. et al. , J. Nucl. Mater. 196-198 (1992) 276.