THERMAL HYDRAULIC ANALYSIS OF THE TPX PLASMA FACING COMPONENTS*

C.B. Baxi, E.E. Reis, K. Redler, E. Chin, R. Boonstra,
K.M. Schaubel, P.A. Anderson, E. Hoffmann
General Atomics, San Diego, California 92186-9784

The purpose of the Tokamak Physics Experiment (TPX) is to develop and demonstrate steady-state tokamak operating modes that can be extrapolated to reactor conditions. TPX has a double-null divertor with an option to operate in a single-null mode. The maximum input power is 45 MW, the pulse length will be 1000 s or longer and the major and minor radii are 2.25 m and 0.5 m, respectively. The maximum DD fluence will be less than 4×10^{22} cm^2 and hence the thermophysical properties of PFCs will not be significantly altered by radiation effects.

The plasma facing components (PFC) material for TPX is carbon fiber composite (CFC). The cooling is provided by subcooled water at an inlet pressure of up to 2 MPa and inlet temperature of 65°C. The heat flux on the PFCs varies from <0.20 MW/m^2 of line-of-sight shields to 7.5 MW/m^2 on divertor surfaces. The maximum allowable temperature on the divertor surface is 1400°C and all other PFCs is 600°C.

The PFCs for TPX fall into the categories: (1) for heat flux (q") <0.05 MW/m^2, the cooling is by radiation to rest of the surface, (2) for 0.05 MW/m^2 < q" < 0.4 MW/m^2, CFC tiles bolted to water-cooled corrugated titanium structure or copper plates will be used, (3) for 0.4 MW/m^2 < q" < 4.0 MW/m^2, CFC tiles brazed to water-cooled copper plates/tubes with smooth flow channels will be used, (4) for 4.0 MW/m^2 < q" < 7.5 MW/m^2, CFC tiles brazed to water-cooled copper tubes with heat transfer augmentation will be used. Thermal flow analysis has been performed to calculate the temperatures and pressure drops in the CFC components. R&D programs to verify the contact conductance and thermal hydraulic correlations are planned.

The total coolant flow rate requirement is estimated to be ~50 m^3/s (13,200 gpm) and the maximum pressure drop (in the divertor) is estimated to be less than 1 MPa.

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Submitted by:

Signature

Typed Name: C.B. Baxi

Institution/Company General Atomics

Address P.O. Box 85608

City, Province, State/Postal Code
San Diego, California 92186-9784

Country USA

Phone: (619) 455-3150

Fax: 619 455-2266

E-mail: baxi@gav.gat.com