ELASTIC-PLASTIC-CREEP ANALYSES OF BRAZED CARBON-CARBON/OFHC DIVERTOR TILE CONCEPTS FOR TPX*

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The 7.5 MW/m^2 heat flux requirements for the TPX divertor necessitate the use of high conductivity carbon-carbon (C-C) tiles that are brazed to annealed copper (OFHC) coolant tubes. Significant residual stresses are developed in the C-C tiles during the braze process due to large differences in the thermal expansion coefficients between these materials. Analyses which account for only the elastic-plastic strains developed in the OFHC tube may not accurately characterize the behavior of the tube during brazing. The elevated temperature creep behavior of the copper coolant tubes intuitively should reduce the calculated residual stresses in the C-C tiles. Two divertor tile concepts, the monoblock and the archblock, were analyzed for residual stress using 2D finite element analysis for elastic-plastic-creep behavior of the OFHC tube during an assumed braze cooldown cycle. The results show that the inclusion of elevated temperature creep effects decrease the calculated residual stresses by only about ten percent when compared to those analyses in which only elastic-plastic behavior of the OFHC is accounted for. The primary reason that creep effects at higher temperatures are not more significant is due to the low yield stress and nearly flat-top stress-strain curve of annealed OFHC. Since high temperature creep plays less of a role in the residual stress levels than previously thought, future scoping studies can be done in an elastic-plastic analysis with confidence that the stresses will be within approximately ten percent of an elastic-plastic-creep analysis.

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