Abstract Transactions, **SMiRT-24**
BEXCO/Centum Hotel, Busan, Korea - August 20-25, 2017

Creep Rupture Behavior of TIG Weldment of CLAM Steel

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Abstract

China Low Activation Martensitic (CLAM) steel has been chosen as the structural material in the designs of PbLi blankets for series of fusion reactors (named FDS series) and China fusion engineering test reactor (CFETR) blanket in China. Especially, it has been chosen as the primary candidate structure material for Chinese Test Blanket Module (TBM) for ITER by China International Nuclear Fusion Energy Program Execution Center (CNDA). The R&D activities on welding CLAM steel by different welding methods were being conducted with wide international and domestic cooperation.

In this manuscript, creep rupture behavior of TIG weldment CLAM steel was studied in the temperature range of 500 - 600 ℃ and at stresses of 155 - 260 MPa. Under similar conditions, the creep resistance of the weldment was lower than that of the base metal. The heat affected zone (HAZ) of the weldment consisted of coarse prior-austenite grain (CGHAZ), fine prior-austenite grain (FGHAZ) and intercritical (ICHAZ) regions in a sequence from the fusion boundary to unaffected base metal. The type IV failure in the FGHAZ was found to be the typical failure mode. The failure was associated with localized creep deformation coupled with creep cavitation. The fracture morphology of the crept welded specimens was found to be a mixture of transgranular and intergranular mode. A lot of cavities formed at grain boundaries during creep, which indicated that the coarse precipitates of Laves phase were considered as the preferential nucleation sites for cavities.

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