

Study of Corrosion Properties ITER In-Wall Shield (IWS) Fasteners and Structural Integrity of IWS

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In-Wall Shield(IWS) Blocks will be inserted between inner and outer shell of ITER Vacuum Vessel. These blocks comprise of number of plates of Stainless Steel stacked together using fasteners of XM-19 and M30 size. Plates are tightened with pretension of 107 kN to withstand EM force of 1.83×10^4 N during ITER operation. These bolts are spot welded with blocks to lock any type of rotation. There are approximate 1500 such bolts exposed to vacuum in one vessel sector with approximate surface area of 70.5 m². Hence, surface condition of these fasteners play an important role while leak testing of VV. XM-19 material is very corrosion resistant but, if the fasteners are exposed to normal or humid environment for a long time its surface may get oxidised and catch the corrosion which may further impact the ITER operation in three ways: (a) Reduced Structural Integrity of blocks (b) Gas load due to Outgassing(c) Generation of corrosion products in Cooling Water System. This corrosion has been assessed by (a) Measuring the Corrosion rate (CR) of XM-19 fasteners (exposed in natural environment) and (b) XM-19 washer exposed to water with ITER operating temperature and pressure. This study is carried out using Scanning Electron Microscope (SEM) and Electrochemical Polarization Technique. For SEM analysis, samples were polished and corrosion depth was measured and accordingly CR was calculated. In Electrochemical Polarization Technique, samples were induced with corrosion at room temperature and high temperature in water medium. Pt electrode was used as cathode and Ag-AgCl₃ as reference electrode. CR was calculated with the help of corrosion current. Tafel curves of corroded samples show that, reverse polarization path do not intersect the forward path and indicate no tendency of pitting corrosion. Maximum corrosion observed by using Tafel curve is 0.1067 mpy. Outgassing rate of naturally corroded XM-19 bolt was measured 6.06×10^{-8} Pam³s⁻¹m⁻² which is less than the acceptable limit for IWS. Total corrosion product for one Vessel sector was calculated with the help of CR and surface area in one vessel sector and found 3.20 Kg/year. It can be removed by appropriate filters. Study shows that corrosion and out gassing properties of corroded XM-19 fasteners are acceptable for ITER IWS. Detailed experimental set up and results of corrosion study will be presented in this paper.

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