# EFFECTS OF SPECIMEN SIZE ON FRACTURE TOUGHNESS OF PHOSPHOROUS ADDED F82H STEELS

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Reduced-activation ferritic (RAF) steels are the promising candidate structural material for fusion reactor blanket components, but they may suffer non-hardening embrittlement (NHE) by a large amount of He on grain boundaries over 500-700 appm of bulk He without hardening. Understanding and evaluating the ductile to brittle transition behavior and fracture toughness of RAF steels are critical in the design and operation of the reactor. In order to effectively produce irradiation database, furthermore, the reduction of the specimen volume is required. In the ITER Broader Approach (BA) project, applicability of small specimen test techniques has been examined to evaluate irradiation-induced degradation of fracture toughness of F82H. The master curve method is specified as a standard test method for determination of reference temperature for ferritic steels in the transition range provided by the American Society for Testing and Materials (ASTM). However, application of the method to RAF steels may have some difficulty passing the requirement of method for example, large constraint loss in small specimens of RAF steels and possible fracture mode change to intergranular due to precipitation of transmutation helium on to grain boundaries. In the present study, constitutive data and widely obtained fracture toughness data sets at transition temperatures of F82H is investigated to establish the master curve method for RAF steels from viewpoints of fracture mechanics. Small specimen tests to evaluate fracture toughness and Charpy impact properties were carried out for F82H steels with different levels of phosphorous addition in order to simulate the effects of NHE on the shift of transition curve. Yield strength (YS) and ultimate tensile strength (UTS) are increased by increasing the level of phosphorous addition, but it is not significant. It was found that the ductile to brittle transition temperature (DBTT) after phosphorous addition is shifted to higher temperatures and the upper shelf energy (USE) is decreased. Effects of specimen and phosphorous on fracture toughness were evaluated using the different size specimen (1 CT, 1/2 CT and 1/4 CT). Phosphorous added steels fractured in a brittle manner showing intergranular fracture even at temperatures of transition region. The master curve approach for evaluation of fracture toughness change by the degradation of grain boundary strength was carried out by referring to the ASTM E1921. The relationship between $\Delta\sigma_Y$ and $\Delta$DBTT or $\Delta T_0$ is investigated to simulate the effects of NHE accompanied by intergranular fracture.