Grain Size Dependency of Continuum Damage Mechanics Approach on Creep Deformation Behaviour of 304HCu SS at 923 K in the Framework of Genetic Algorithm Optimization

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Abstract

In the present study, the influence of grain size on the creep deformation behaviour of 304HCu SS, one of the candidate material on Advanced Ultra Super Critical (AUSC) fossil fired power plants was evaluated in the stress level of 180 MPa at the temperature of 923 K for a wide range of grain sizes from 10 to 180 μm. At this stress level, intermediate grain size of 30 μm showed highest rupture life and lowest value of minimum creep rate. The effect of grain size has been characterized using scanning electron microscope/transmission electron microscope and modelled in the frame work of microstructure based continuum creep damage mechanics (CDM) approach. This approach is made up of set of coupled constitutive rate equations for creep strain, normalized kinematic back stress and microstructural based damage evolution during creep such as particle coarsening, cavity nucleation which can further be integrated with appropriate boundary conditions. Among all microstructure based damage evolution, damage due to cavity nucleation was phenomenologically developed by incorporating the observed characteristic nature of counter balance effect of grain size. A new objective function was designed to solve the complex set of differential equations and genetic algorithm based optimization code was developed to optimize all the material constants. A good agreement between experimental and predicted creep strain was observed.

Keywords: 304HCu SS, Creep, Grain size, CDM, Genetic Algorithm.