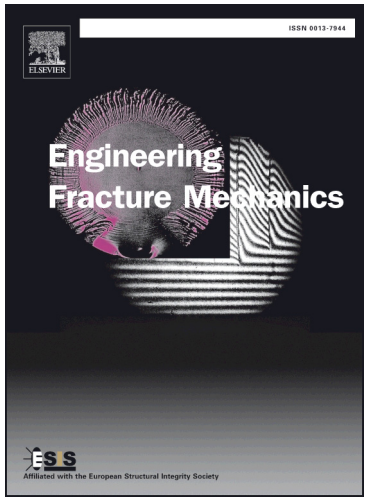

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The Beneficial Effect of Full or Partial Autofrettage on the Combined 3-D Stress Intensity Factors for Inner Radial Crack Arrays in a Spherical Pressure Vessel

by

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ABSTRACT

The distributions of the combined 3-D Stress Intensity Factor (SIF), $K_{IN}=K_{IP}+K_{IA}$, due to both internal pressure and autofrettage along the front of radial crack arrays emanating from the bore of an overstrained spherical pressure vessel are evaluated. The 3-D analysis is performed using the finite element (FE) method employing singular elements along the crack front. A novel realistic autofrettage residual stress field incorporating the Bauschinger effect is applied to the vessel. The residual stress field is simulated using an equivalent temperature field in the FE analysis. Numerous radial crack array configurations are analyzed. SIF distributions are evaluated for arrays of radial cracks containing one to twenty cracks, n=1-20, of crack depth to wall thickness ratios of **a/t**=0.01-0.8, and ellipticities (crack depth to crack length) of a/c=0.2-1.0 prevailing in fully or partially autofrettaged spherical vessels of outer to inner radii R_0/R_i=1.1, 1.2, and 1.7, bearing three levels of autofrettage (ε =50%, 75%, and 100%). In total, about two hundred different crack configurations are analyzed. A detailed study of the influence of the above parameters on the prevailing SIF is conducted. The results clearly demonstrate the favorable effect of autofrettage which may considerably reduce the prevailing effective stress intensity factor, thus delaying crack initiation and slowing down crack growth rate, and hence, substantially prolonging the total fatigue life of the vessel. Furthermore, the results emphasize the importance of properly accounting for the Bauschinger effect including re-yielding, as well as the significance of the three dimensional analysis herein performed.

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