3rd World Conference on Mechanical Engineering

Vienna, Austria 21 - 23 June

Predicting Creep Failure Time of Thick-Walled Spherical Vessels Considering Finite Strains

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Abstract

In this paper, the problem of predicting creep-failure time of thick-walled spherical vessels is investigated. The thick-walled spherical vessels are important structural components that are used in many industries such as oil, chemical, and nuclear industries, etc. and are required to operate under complex thermal and mechanical loadings where creep deformation is prevalent. The fact that continuing deformation under creep may reach a value where the assumption of small strains becomes increasingly invalid has been incorporated by using a finite-strain formulation in the mathematical framework developed to perform the creep-failure prediction times of the vessels. The mathematical analysis is conducted by employing the equilibrium, compatibility, and constitutive equations for the finite (logarithmic) strain theory together with suitable boundary conditions. The creepfailure time prediction relation is developed and solved using analytical and/or numerical methods. The special cases of thin-walled and very thick-walled spherical vessels are discussed, and the creep-failure time relations are derived for them. Parametric studies for various wall thicknesses and pressure magnitudes are performed and presented in the form of graphs. It is expected that this investigation will provide useful guidelines for predicting more accurate creep- failure time and thus result in a safer design of thick-walled spherical vessels.