ANALYSIS OF INTERNAL HEATING SHOCK EFFECTS IN REACTOR FUEL COMPONENTS

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Under conditions of rapid fission heating of a reactor fuel element caused by pulse operation or an accident condition, the temperature of the fuel may rise faster than the body can respond by thermal expansion. As a result, a portion of the thermal energy is converted into kinetic energy and dynamic stresses of sufficient magnitude to induce material failure can be produced in the fuel. Several methods have been developed for performing thermoelastic calculations with rapidly heated one- and two-dimensional fuel shapes [1-5]. These methods are strictly limited to elastic materials, and are not capable of including more realistic material behavior, such as elastic-plastic, viscoelastic, and viscoplastic effects. This paper describes calculational techniques applicable to both elastic and more realistic material behavior for one- and two-dimensional cylindrical fuel shapes. Some comparisons are made between calculated results and measured values.

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DISCUSSION

Q

D. COSTES, France

Quel code de calcul est utilisé pour ces déformations élastiques plastiques en axisymétrie ?

Quel est le type de plasticité utilisé ?

A

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The code used in the two-dimensional calculations is an adaptation of the numerical schemes used by Wilkins (24), HEMP Code, Bertholf (25), TOODY II Code, and Hermann (26), TOODY Code.

The type of plastic behaviour used in the calculations is described as bilinear with strain hardening and reversed yielding.

Q

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1. Is U-10% molybdenum strain-rate sensitive, and if so is this considered in any way ? Am I correct in assuming that the "viscoplasticity" implies only a damping effect ?
2. When performing the numerical solution of the Z-d problems did you notice any non-uniform convergence effects in the shear stress component near the intersection of the plane/cylindrical surfaces ?

A

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1. U-10w/o Mo has been shown to be strain rate sensitive in room temperature tensile tests; however, above 600°F the rate sensitive behaviour disappears rapidly. Since the calculations are numerical, a rate sensitive bilinear, elastic-plastic material behaviour could be employed. Yes, viscoplasticity does imply a damping effect.
2. No, there were none of these effects noticed. The finite difference schemes used at corners where the plane and cylindrical surfaces force the boundary conditions to be satisfied.