THE INFLUENCE OF DEFECTS ON FUEL ELEMENT CLADDING STRESSES*

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SUMMARY

During the irradiation history of a Liquid Metal Cooled Fast Beerder Reactor (LMFBR) fuel element, significant geometric and structural changes are known to occur. These changes, which include grain boundary attack or material defects in the clad, and fuel migration and cracking, can result in local stress and strain distributions which differ significantly from the average or nominal stress and strains predicted by currently available axi-symmetric fuel element performance codes. An analysis of cladding stress magnification adjacent to a fuel crack has been presented by Gittus *et al.* However this analysis assumes a thin-walled cladding and is therefore independent of the radial position through the cladding wall. Moreover the discontinuity in the fuel loading adjacent to cracks is not modelled.

In the present study, two-dimensional, planar finite element solutions are obtained for the stress and strain distributions in LMFBR fuel element cladding, in the presence of a large variety of internal as well as external discontinuities or flaws, loaded by fluid pressure and/or a mechanical fuel load. By adjusting the boundary conditions in the finite element model, stick or slip conditions between the fuel and clad surfaces can be readily simulated.

In addition, the method permits the simulation of fuel cracking, fuel particle wedging or the interaction between the spacer wire-wrap and the outer surface of the fuel element cladding. The influence of non-uniform circumferential temperature distribution on local cladding stresses also can be evaluated by the finite element procedure.

During the initial phase of this study linear elastic analyses have been performed. The results demonstrate the relatively higher severity of gas pressure loading on fuel element cladding with an internal flaw as compared with an equivalent mechanical or solid fuel load. This is because in the former case the flaw surface is loaded directly by the gas.

Nonlinear finite element analyses are being performed currently to evaluate the time-dependent changes in the local stress and strain distributions in the fuel element cladding. These results could be used to modify the predictions made by general-purpose fuel element performance codes and to compute instantaneous values of strain energy release rates for use in fracture analysis studies.

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