ANALYSIS OF STRESSES AND DEFORMATIONS
IN NUCLEAR FUEL PELLETS

ABSTRACT

In a nuclear reactor, the fuel elements in general and the fuel pellets in particular are subjected to complex loading due to typically prevalent thermoirradiation environment. The recent research activities relating to the evaluation of the performance of the fuel elements through computer modelling consider various aspects categorised under chemical,mechanical, nuclear and thermal separately in order to assess their individual contribution to the overall performance of the fuel elements. The present thesis is devoted to determine the temperature distribution in the nuclear fuel pellet under different conditions of pellet-clad contact designated suitably by means of symmetric and asymmetric models, and to analyse the deformation and stresses for all such models. The methodology adopted in the present investigation is the finite element technique. A number of computer codes has been developed on the basis of two-dimensional triangular as well as isoparametric finite elements to carry out both thermal and mechanical analyses. In the last phase of the present thesis, optimization studies on time of pellet-clad contact due to irradiation induced creep rate have been undertaken. As regards the deformation results available for the fuel pellet through implementation of the aforementioned codes, the deformation pattern

for each model indicates overall diametral contaction and the zones of the pellet cracking and supports the experimental findings reported by other authors on the basis of either post-irradiation tests or in-pile tests conducted for the fuel pellet. The stress results evaluated finally in terms of the effective stresses due to VonMises criterion show fairly good agreement with the pattern of distribution especially for symmetric cases available from the established codes developed for evaluation of the performance of the fuel elements and also indicate the regions in the pellet section where the fracture gets initiated. The optimization studies yielding the optimum time of pellet-clad contact due to irradiation creep component reveal the remote possibility of occurrence of this type of contact for water reactors whereas for fast breeder reactors associated with high surface temperature this mode of contact is of significance and has to be duly considered in assessing the mechanisms responsible for pellet-clad contact.