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DEVELOPMENT OF COOLANT VOIDING MODEL FOR FAST REACTOR CORE

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Unlike thermal reactors, LMFBR core is not in the most reactive configuration. Any undesirable event may raise the reactivity in the core and can result in increase of the reactor power. Liquid metals used in LMFBRs have high boiling points and there is considerable margin between normal operating temperatures and their boiling points. By design, liquid metals used as coolant are not expected to boil under any normal operating conditions of the reactor. However, in case of loss of flow accidents due to pipe rupture, pump failure along with the failure of reactor shutdown systems, boiling of the coolant in reactor core is possible. Such accidents are termed as Unprotected Loss of Flow Accidents (ULOFA). Boiling of coolant in reactor core can also be caused by uncontrolled increase in power. Such accidents are termed as Transient Overpower Accidents (TOPA).

Improved understanding of the mechanics of sodium ejection in case of ULOFA or TOPA is of critical importance for an LMFBR safety. A reduction of sodium density can result in either a positive or a negative reactivity, depending on the location and extent of the vapour void. Therefore, an accurate description of the voiding process with respect to space and time is necessary. NaBOIL, which stands for Natrium Boiling Onset Influence in LMFBRs, is a code developed for predicting boiling behaviour of liquid metals in channels of a reactor core. It calculates the heat transfer from the fuel pin to the coolant until at some location (in coolant channel) and time the coolant reaches a specified superheat. At this point, onset of boiling occurs. The stages of bubble growth are approximated by a thin bubble assumed to occupy the entire coolant channel area, except for the liquid film remaining at the clad wall. The coupled solution of the energy and hydrodynamic equations of the coolant, and the heat transfer equations of the fuel pin are then continuously solved during the voiding process. The main purpose of this model are to predict the extent and rate of voiding that can be used for voiding reactivity calculations and to predict the heat removal from the cladding surface after the onset of boiling, for fuel and cladding temperature calculations.

Country/Int. organization

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