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DEPENDENCE OF INTERMEDIATE HEAT EXCHANGER LIFE ON PRIMARY SODIUM HEATING RATE DURING POWER RAISING

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During start-up of the reactor, the rate at which the power raising is to be done is a critical issue. As a safe practice, the power raising can be done slowly by increasing the sodium temperature at the rate of 5K/hr, 10K/hr or 20K/hr. But this takes a long time for start-up, i.e., 80, 40 and 20 hours per cycle respectively to raise the sodium temperature from the initial temperature of 453 K to the full power temperature of 820 K. On the other hand, to minimize this time, the power raising can be done at a higher rate, i.e, 40 K/hr, 60K/hr, 80K/hr or maybe 100K/hr or even higher. But higher heating rate causes creep and fatigue damages to the reactor components like Control Plug, Intermediate Heat eXchanger (IHX) and Inner Vessel, which are in contact with the hot primary sodium. Hence, a thermo-mechanical analysis has been carried out to optimize the heating rate during power raising.

In this study, the damage possible in the IHX as a function of the heating rate at a critical region has been determined by developing a numerical model, and the dependence of IHX life on the heating rate is estimated. The heating rates considered in this investigation are 20K/hr, 40K/hr and 60 K/hr. The fatigue damages caused due to power raising at the free level of sodium for heating rates 20 K/hr, 40 K/hr and 60 K/hr are 7.19E-17, 1.64E-08 and 4.95E-05 respectively and the corresponding creep damages are 0.013, 0.099 and 0.145 for 861 cycles. The number of allowable cycles determined by considering the creep and fatigue damage values at full power, along with the values at power raising are 2798, 2187 and 1958 cycles at heating rates 20 K/hr, 40 K/hr and 60 K/hr respectively. Hence, a sodium heating rate of 60 K/hr is acceptable during power raising in view of IHX life. This reduces the power raising duration from 20 hours to 6.6 hours.

The full paper will present the methodology adopted for identifying the critical location in IHX, procedure for estimation of the damage and the final conclusion about power raising duration in a typical medium size pool-type fast breeder reactor.

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