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Steady State Modelling and Validation of Once Through Steam Generator

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One dimensional steady state model is developed for counter current shell and tube once through steam generator for PFBR with water flowing through tubes and sodium through shell. All the heat transfer processes i.e. preheating, evaporation of water and superheating of the steam happen along the length of the tube. The length of the steam generator is divided into a number of control volumes. For modelling water side, continuity, momentum and energy equations are solved for single phase water, two phase steam and super heated vapour over the length of the tube using homogeneous model. The momentum and continuity equation on the sodium side are not solved as the density variation of sodium with pressure is negligible. The differential equations are discretised to linear algebraic equations using finite difference scheme. All three terms (advection, frictional and gravitational) are considered in momentum equation of water, while only advection and source term are considered in energy equation of water and sodium. The discretisation of the advection term is carried out using upwind scheme and of frictional term by backward differencing. The continuity equation for water is discretised using backward differencing. The linear algebraic equations are then solved simultaneously using numerical methods to get the temperature and pressure profiles in the tube and shell side.
Water side heat transfer coefficient is calculated using Steiner and Taborek asymptotic model and Subbotin correlation is used for sodium side heat transfer coefficient. The code developed can be applied to simulate similar steam generators of any length with any number of tubes. Towards validation of the mathematical model and the solution method, 19 tube steam generator tested in in-house steam generator test facility (SGTF) has been simulated and the predicted results are compared with the measured data. Results from the code match well with experimentally observed data from the facility. In addition, grid sensitivity studies have been carried out to establish consistency in the solution.

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