EN 634 Nuclear Reactor Thermal-Hydraulics and Safety

Assignment 10

You are strongly advised to solve this assignment using excel or any other programming mode to minimise time during repetitive calculations.

1. The fuel rods in a PWR are 11.5 mm OD and 3.5 m long. The rods are arranged in a square lattice with a pitch of 16.5 mm. The core operates at 15 MPa, and the water temperature at the inlet is 100 K subcooled. Heat flux along one of the channels is assumed to be uniform and is equal to 1×10^6 W/m^2. The flow is assumed to be one-dimensional and the equilibrium quality at the exit of the channel exit is -0.05. (You may use the steam-Excel table for water properties
   a) Calculate the coolant velocity at the inlet.
   b) Calculate the distance from entrance of the location of the ONB point as computed by Bowring's model.
   c) Calculate the wall temperature at just before nucleation (infinitesimal distance before ONB point).
   d) Calculate the wall temperature just after the ONB point (infinitesimal distance after nucleation). Note that this is the discontinuity at the ONB point.
   e) Calculate the distance from entrance of the location of the FDSCB point.
   f) Calculate the wall temperature at just before the FDSCB point (infinitesimal distance before FDSCB point).
   g) Calculate the wall temperature just after the FDSCB point (infinitesimal distance after the FDSCB point). Note that this is the discontinuity at the FDSCB point.
   h) Calculate the distance from entrance of the location of the NVG point.
   i) Calculate the true quality at the exit of the channel using the profile fit model.
   j) Assuming that homogeneous model is valid, compute the void fraction at the exit of the channel
2. Now consider a BWR with the same geometric configuration operating at 70 bar. The inlet subcooling is 15 K and the exit equilibrium quality is 0.16. The heat flux from the fuel rods may be assumed as uniform at 0.6 MW/m^2.
   a) Check the location of ONB from the entrance using Davis and Anderson correlation.
   b) Check the location of the FDSCB point using Bowring correlation
   c) Compute the location of NVG point.
   d) Compute the location of the onset of saturated boiling correlation
   e) Using a profile fit model find the location where the true quality and equilibrium quality shall be within 1% accuracy.
   f) Using the true quality, estimate the heat transfer coefficient at the middle and exit of the channel Use Chen's correlation