
PROBLEM 12-11N QUESTION

Nucleate Boiling And CHF In A PWR Steam Generator

The steam generator for many PWR reactor systems is a U-tube arrangement. Focus on the hot leg of one tube idealized in Fig. 1. The secondary side coolant is in upflow in an annulus surrounding the tube in which primary flow is also in upflow. Operating conditions and properties are given in Tables 1 and 2. In this solution, neglect the subcooled boiling regime and assume fully developed flow on both the primary and secondary sides and ignore pressure changes and hence property changes with length.

QUESTIONS

- Find the axial location, z , at which the equilibrium flowing quality of the secondary side coolant equals zero.
- Sketch the outside (i.e., wall in contact with secondary side coolant) tube wall temperature as a function of axial location. Explain and justify the shape of the profile and particularly consider whether the flowrate on the secondary side of the tube goes through a boiling crisis.

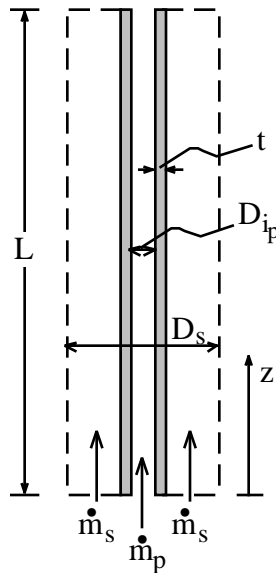


Figure 1

Table 1

Operating Conditions

	Primary	Secondary
Pressure (MPa)	15	5.5
Inlet temperature (°C)	324	225
Flowrate per unit cell (kg/s)	0.895	0.082
h_1 (W/m ² K)	38,000	2,230
h_2 (W/m ² K)	N/A	10,000

Table 2

	Properties			Geometries
	Primary	Secondary	Tube Wall	
(kg/m ³)	726	767	--	t = 1.2 mm
k (W/m K)	0.56	0.581	26	D_{ip} = 16.6 mm
μ (kg/m s)	92×10^{-6}	1.0×10^{-4}	--	L = 8 m
c_p (J/kg K)	5,700	4,900	--	D_s = 3.23 cm
T_{sat} (°C)	345	270	--	
h_f (kJ/kg)	1629	1185	--	
h_g (kJ/kg)	2596	2789	--	
h_{in} (kJ/kg)	1490	970	--	