
PROBLEM 12-8N QUESTION

Shell And Tube Horizontal Evaporator

A shell-and-tube horizontal evaporator is to be designed with 30 tubes 1 cm diameter. Inside the tubes water at 100 psia (690 kN/m^2) enters at one end at 130°C and leaves at the other end at 120°C . The water velocity (V) in the tubes is 3 m/sec. In the shell, atmospheric pressure steam is generated at 100°C .

Calculate:

1. The length of the tubes
2. Rate of evaporation, kg/sec
3. Rate of flow of the water, kg/sec
4. Pressure drop in the tubes on the water side.

(Assume fully developed flow and neglect entrance and exit losses).

For the boiling side take $C_{sf} = 0.013$ in Eq. 14-22, *Boiling Condensation and Gas-Liquid Flow*, P.B. Whalley.

Make your calculations for heat flux at mid-point where the liquid is at 125°C . Neglect thermal resistance of the thin tube wall.

$$\text{H}_2\text{O}: \quad P = 1 \text{ atm} \quad T_{\text{sat}} = 100^\circ\text{C}$$

	Liquid		Vapor
ρ (kg/m^3)	960		0.60
c_p ($\text{kJ/kg } ^\circ\text{C}$)	4.2		1.88
μ (kg/m s)	0.0003		0.000013
K ($\text{W/m } ^\circ\text{C}$)	0.68		0.025
σ (N/m)		0.06	
$i_{\ell g}$ (kJ/kg)		2280	
Pr	1.9		0.97

Assume properties of liquid inside the tubes at 690 kPa in the range 120-130°C are the same as the above at 1 atm and 100°C.