2. Kettle-type Reboiler

Heat Transfer Coefficient Estimations

Tube side heat transfer coefficient:

For condensing steam on the tube side, the heat transfer coefficient can be taken to be constant as 8000 W/m^2.K.

Shell side Heat Transfer coefficient:

Boiling Heat Transfer Coefficient Estimation

The reduced pressure correlation as given below, by **Mostinski** (1963) shall be used:

$$h_{nb} = 0.104(P_c)^{0.69}(q)^{0.7}\left[1.8\left(\frac{P}{P_c}\right)^{0.17} + 4\left(\frac{P}{P_c}\right)^{1.2} + 10\left(\frac{P}{P_c}\right)^{10}\right]$$

where P = operating pressure, bar,
P_c = liquid critical pressure, bar,
q = heat flux, W/m^2.

Note. $q = h_{nb}(T_w - T_s)$.

Check for prevailing heat flux:

The modified Zuber equation can be written as:

$$q_{cb} = K_b\left(\frac{p_t}{d_o}\right)\left(\frac{\lambda}{\sqrt{N_t}}\right)[\sigma g(\rho_L - \rho_v)\rho_v^2]^{0.25}$$

where q_{cb} = maximum (critical) heat flux for the tube bundle, W/m^2,
K_b = 0.44 for square pitch arrangements,
= 0.41 for equilateral triangular pitch arrangements,
p_t = tube pitch,
d_o = tube outside diameter,
N_t = total number of tubes in the bundle,

Palen and Small (1964) suggested that a factor of safety of 0.7 be applied to the maximum flux estimated from equations.

Shell Diameter Calculations:

For the heat flux prevailing in the reboiler, choose the shell dia to tube bundle dia ratio from the guidelines as given below:

Heat flux W/m^2	Shell dia./Bundle dia.
25,000	1.2 to 1.5
25,000 to 40,000	1.4 to 1.8
40,000	1.7 to 2.0

The freeboard between the liquid level and shell should be at least 0.25 m.

Maximum Vapor Velocity

The maximum vapour velocity (m/s) at the liquid surface should satisfy the following criteria:

$$\hat{u}_v < 0.2 \left[\frac{\rho_L - \rho_v}{\rho_v} \right]^{1/2}$$