Tray Design

TRAY DESIGN CRITERIA

The following design rules are valid for most systems and may be used to estimate valve tray design and predict hydraulic performance.

HAT have developed computer software to optimise the design of Trays which incorporate various design model to provide more rigorous designs as well as analysing all permutations of tray geometry. Included are correlations which consider the effects of system properties as well as indicating the requirement for tray features not listed below such as anti-jump baffles and notched weirs. This facility should therefore always be used to provide consistent, reliable and cost effective final designs.

NUMBER OF FLOW PATHS

Design Criteria: Max Weir Load = 0.085 x Tray Space (m) - 0.02 $m^3/m.s$

Weir Load (U_d) = $\dfrac{\text{Liquid Rate } (m^3/s)}{\text{Number of Flowpaths} \times \text{Weir Length } (m)}$ $m^3/m.s$

Min. Flow Path Length = 430mm

Min. Weir Length = 0.6 x Column Diameter

ACTIVE AREA

Design Criteria: Max Jet Flood = 85 %

Where:

[1] Capacity Factor (CF_0) = $0.14 \times \left(\dfrac{\text{Tray Space (mm)}}{610}\right)^{\frac{1}{3}} - \left(\dfrac{\text{Tray Space (mm)}}{610}\right)\dfrac{\rho_g}{3724}$ m/s

[2] Vapour Load (C_{SA}) = $\dfrac{\text{Vapour Rate } (m^3/s)}{\text{Tray Active Area } (m^2)} \cdot \sqrt{\dfrac{\rho_g}{(\rho_L - \rho_g)}}$ m/s

[3] Jet Flood = $\dfrac{100}{FF \times CF_0 \times 0.79\,\sigma^{0.1}} \cdot \left(C_{SA} + \dfrac{\text{Liquid Rate } (m^3/s)}{N_p \times W_{fp}}\right)$ %

N_p = Number of Flow Paths
W_{fp} = Flow Path Width (Active Area/Flow Path Length) m
FF = Foam Factor
σ = Liquid Surface Tension mN/m
ρ_g = Vapour Density kg/m^3
= Liquid Density kg/m^3

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NUMBER OF TRAY VALVES

Design Criteria: Tray Pressure Drop within process limitations at maximum vapour load.

Orifice Vapour Velocity (V_o) above weep point at minimum vapour load.

Where:

[4] Dry Tray Pressure Drop = $\frac{175 \times V_o^2 \times \rho_g}{\rho_L}$ (valves full open) mm liquid

Dry Tray Pressure Drop = $\frac{105 \times V_o^2 \times \rho_g}{\rho_L} + \frac{800 \times M_v}{\rho_L \times A_v}$ (valves part open) mm liquid

V_o = Vapour Rate (m^3/s) / (0.0012 x Number Valves / Tray) m/s
M_v = Mass of each valve (0.04 for 16g valves) kg
A_v = Valve Disc Area (=0.0016) m^2

[5] Clear Liquid Height (H_c) = $406 \times \left(\frac{\text{Liquid Rate } (m^3/s)}{C_{SA} \times L_w \times N_p}\right)^{\frac{1}{3}} \times (H_w)^{\frac{2}{3}}$ mm

L_w = Weir Length m
H_w = Weir Height m

[6] Tray Pressure Drop = Dry Tray Pressure Drop (maximum) + H_c mm liquid

[7] V_o(weep point) = $\frac{4.413 \times H_d \text{(weep point)}}{1000} \times \left(\frac{\rho_L - \rho_g}{\rho_g}\right)^{\frac{1}{2}}$ m/s

DOWNCOMER AREA

Design Criteria: Maximum Downcomer Back-up (as clear liquid) = 0.4 x Tray Space

Maximum Downcomer Inlet Velocity (V_d) = 0.9 x DC Velocity Limit

Where:

[8] Downcomer Head Loss = $51 \times \left(\frac{\text{Liqui Rate}(m^3/s)}{N_p \times L_w \times H_i \times C_d}\right)^2$ mm liquid

[9] Downcomer Back-up = H_c + (Tray + DC Head Loss) x $\left(\frac{\rho_L}{\rho_L - \rho_g}\right)$ mm liquid

[10] DC Velocity (V_d) = $\frac{\text{LiquicRate}(m^3/s)}{N_{dc} \times \text{Downcome InletArea}}$ m/s

N_{dc} = Number of downcomers on tray.

[11] DC Velocity Limit = $0.008 \times \left(\text{Tray Space (m)} \times (\rho_L - \rho_g)\right)^{\frac{1}{2}}$ x FF m/s