CHEMICAL ENGINEERING DESIGN & SAFETY

CHE 4253

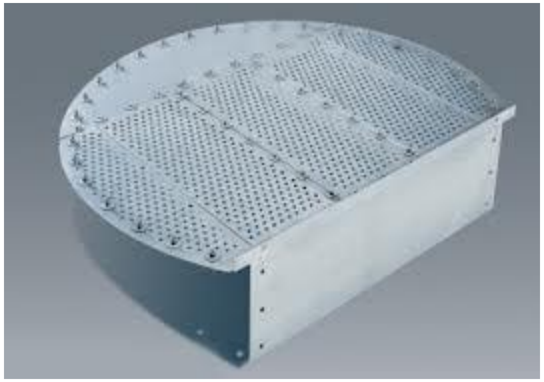
Prof. Miguel Bagajewicz

Distillation/Absorption Tray Design

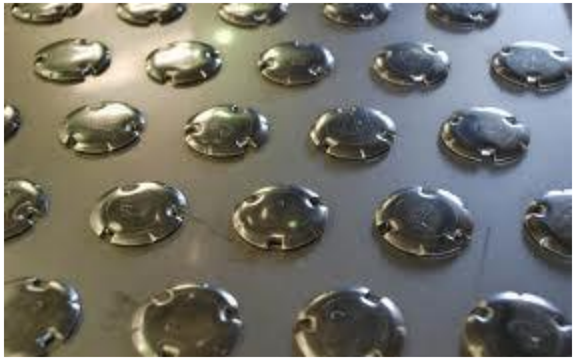
DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Trays types

Sieve

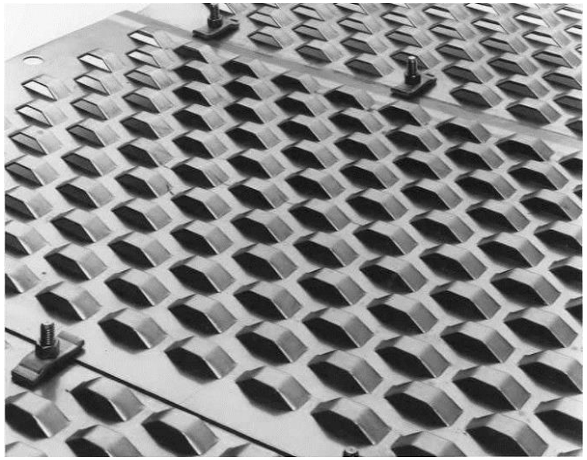


Valve



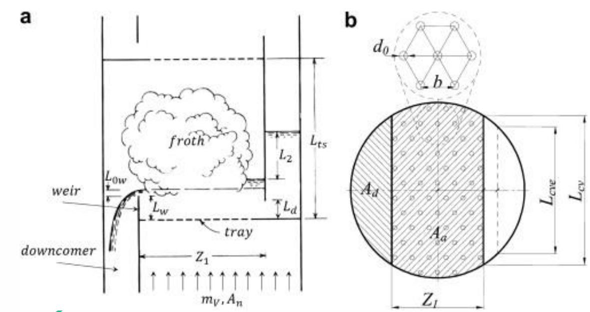
Bubble cap

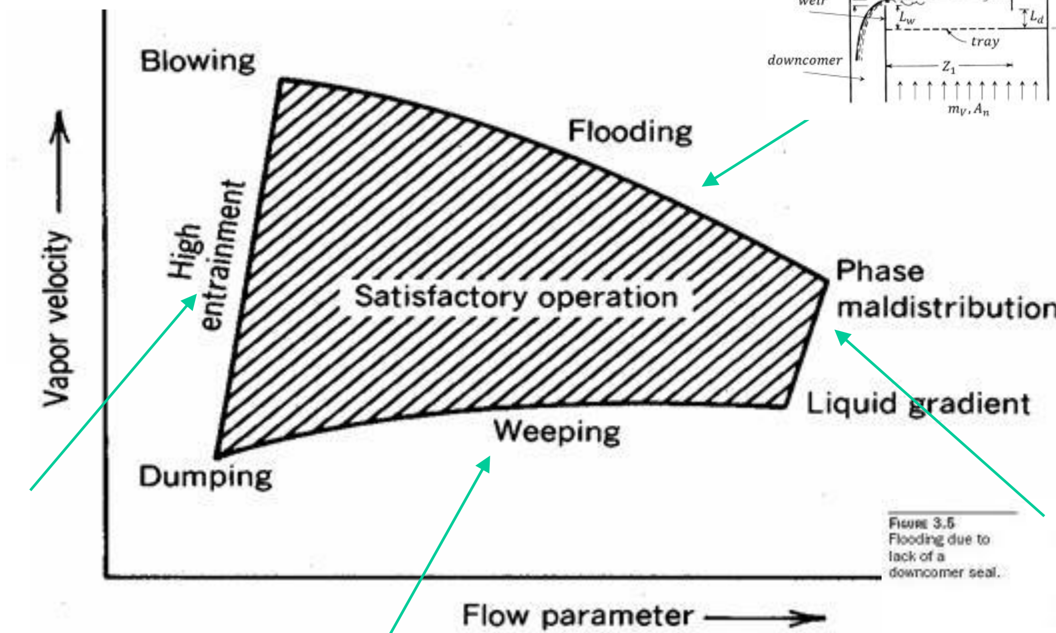
Enhance Deck (Sulzer)

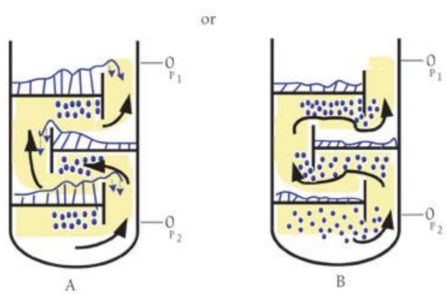


DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Operational limits for trays.







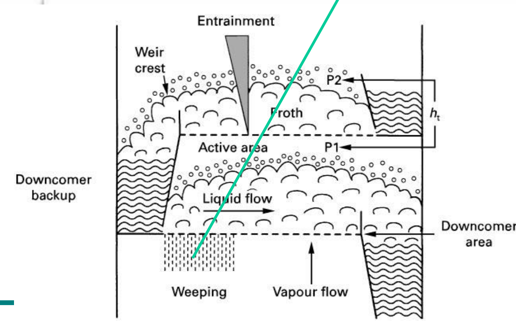
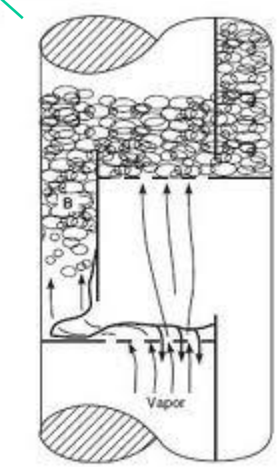
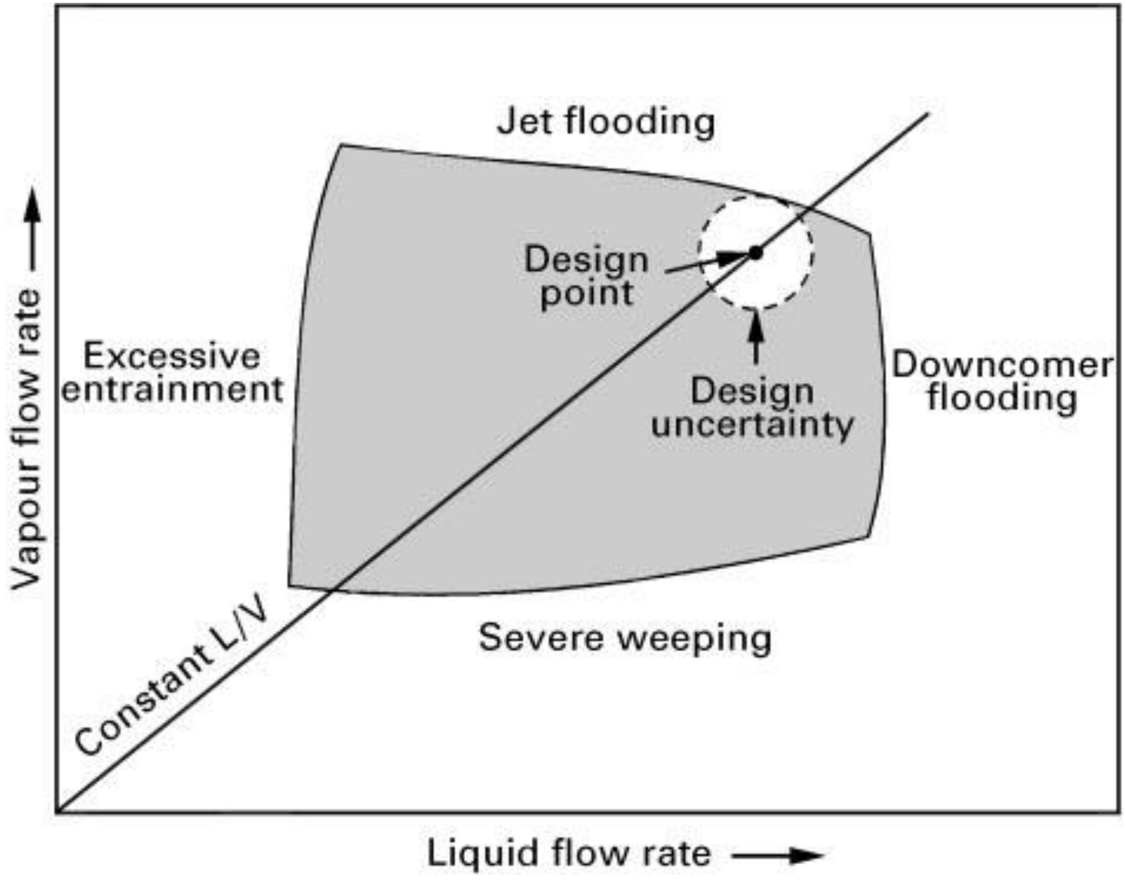


FIGURE 3.5 Flooding due to lack of a downcomer seal.



DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

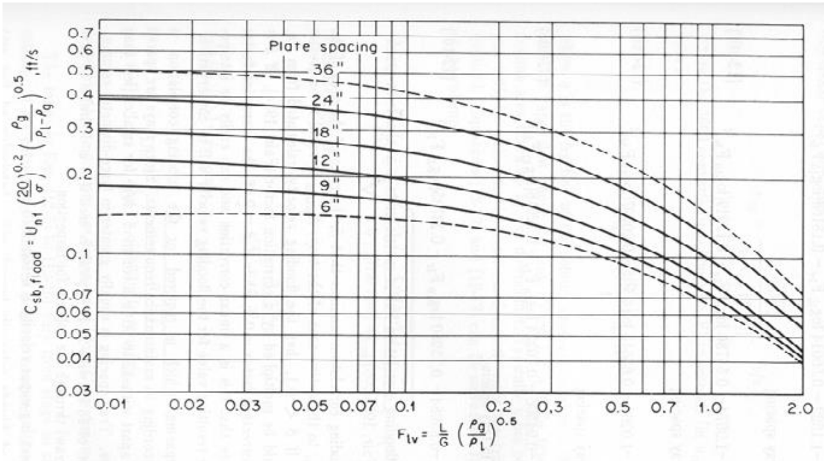
Design Point

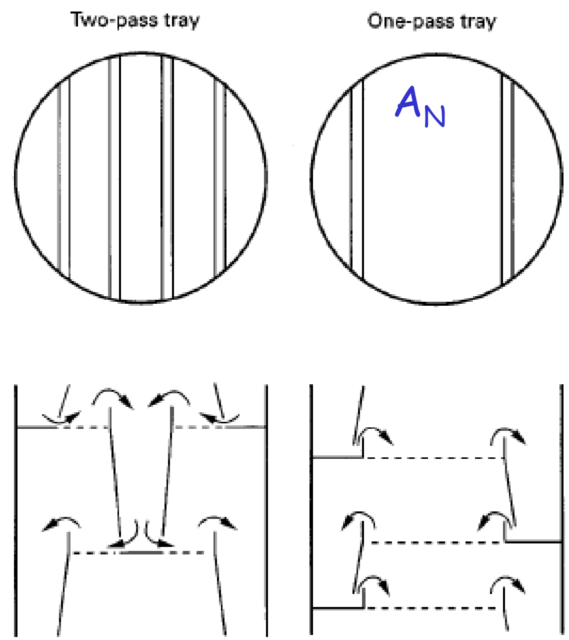


DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Diameter first. Design for velocity. Flooding velocity given by (are you surprised?)

Fair correlation





$$U_{N,f} = C_{SB}\left(\frac{\rho_L - \rho_V}{\rho_V}\right)^{0.5}\left(\frac{\sigma_L}{20}\right)^{0.2} \qquad F_{lV} = (L/V)(\rho_V/\rho_L)^{0.5};$$

L, V (Mass rates)

$$\log10(C_{SB}) = -0.94506 - 0.70234\log10(F_{LV}) - 0.22618\left[\log10(F_{LV})\right]^2$$

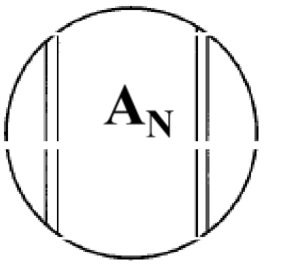
for 24" spacing;(similar formulas exist for other spacings).

Use ~80% of flooding velocity. Diameter is a function of the NET area A_N

Tray Spacing: Large if froth is expected, also allow space for crawling (12" to 24").

DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

$$A_N = \widehat{Q_v} / (0.8\, U_{n,f})$$



Heuristics: $A_{dc} = 0.1\, A$

But $A = A_N + 2\, A_{dc}$

Then: $A = A_N + 0.2\, A$ ➔ $A = A_N / 0.8$

➔ $$D = \sqrt{\frac{4\,A}{\pi}}$$

DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Hole diameter: 3/16 to ¼ in.

Total Hole Area: Such that the velocity through the holes does not form jets

$$\frac{A_{All-holes}}{A_{holes}} = K\left(\frac{hole-diameter}{hole-pitch}\right)^2 \qquad K = 0.905(equilateral\ triangular\ pitch) \quad K = 0.785(rectangular\ pitch)$$

Number of Holes: Hole area/Total hole area

Height of weir: Francis formula

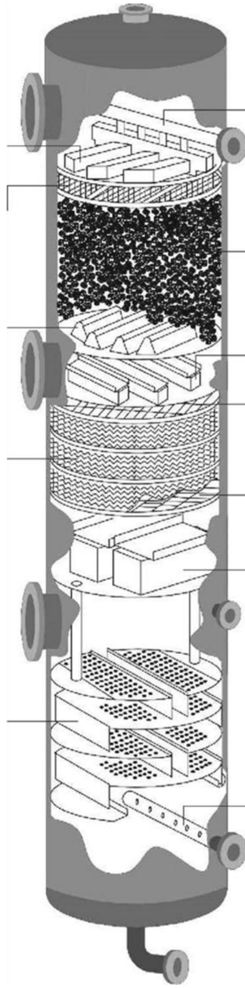
$$h_{ow} = 0.48\left(\frac{L}{l_{weir}}\right)^{2/3}$$

Pressure drop: to be watched. Do not want it to be too large (5-10"). Typical value ~0.1 psi

We omit number of holes and pressure drop calculations in this class.

DISTILLATION/ABSORPTION PACKED COLUMN DESIGN

Packed Towers



DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Random Packing

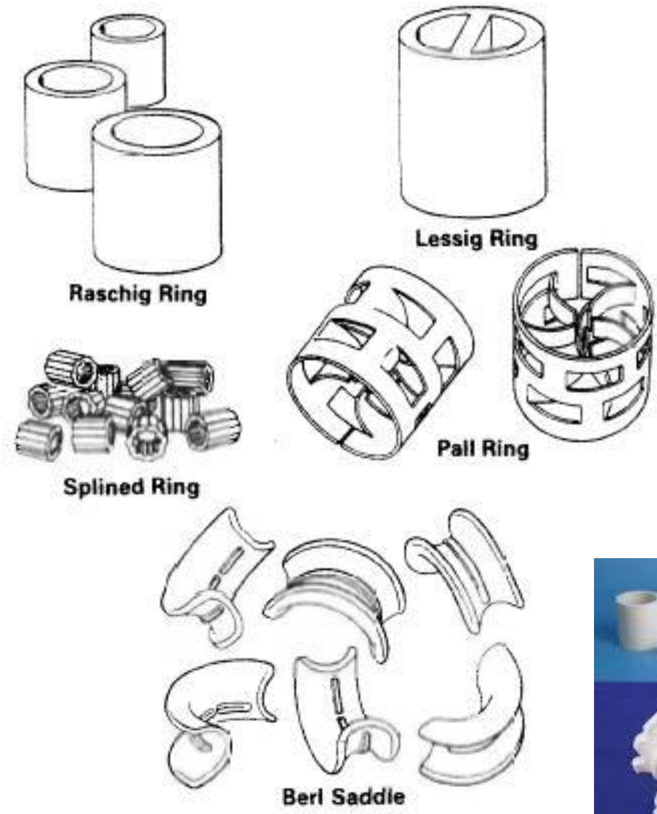
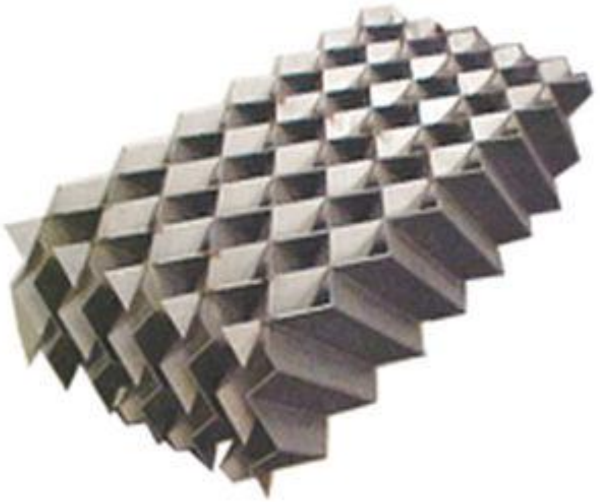


Figure 6-8. Various types of packing.

DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

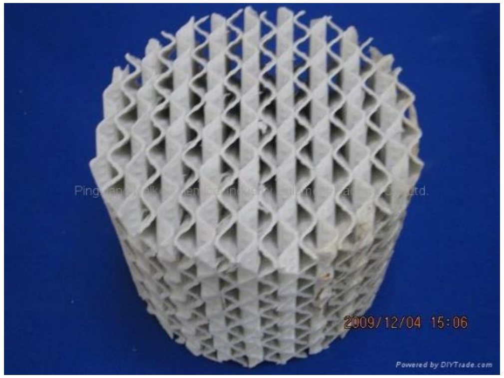
Structured Packing

Flexipack (Koch)→



Sulzer

Ceramic



DISTILLATION/ABSORPTION COLUMN TRAY DESIGN

Packing Height: Number of equilibrium stages x HETP (Height Equivalent to a Theoretical Plate)

HETP: Typically a function of gas rate (ft/sec) and the packing, as well as the mixture.

Packing Diameter: Similar graph to Fair's graph