# Calculation of column diameter:

## a. Packed tower:

$$U_g = \frac{G * M.wt}{\rho_g * S} = \frac{G * M.wt}{\rho_g * \frac{\pi}{4} D^2}$$

$$U_g = f\,(D)$$

$U_g \ll U_L$ Loading

$U_g \gg U_L$ flooding

$U_L < U_g < U_f$

$U_g = [0.7 - 0.9]\ U_f$

**The diameter of the tray tower can be estimated following the procedure below:**

**1. Calculate $F_{LV}$ from the following equation:**

$$F_{LV} = \frac{L}{G}\sqrt{\frac{\rho_g}{\rho_L}}$$

Where:

$L =$ Liquid mass flow rate, $\frac{kg}{s}$.

$G =$ Gas mass flow rate, $\frac{kg}{s}$.

**2. Using Figure 11.44 to find $K_4$ with the used pressure drop:**

$$K_4 = \frac{13.1\ \overline{G}^2\ F_P\ \left(\frac{\mu_L}{\rho_L}\right)^{0.1}}{\rho_g(\rho_L - \rho_g)}$$

Where:

$\overline{G}$ = gas mass flux ( $kg/m^2.s$).

$F_P$ = packing factor, characteristic of the size and type of packing, see Table 11.3, $m^{-1}$.

$\mu_L$ = liquid viscosity, $Ns/m^2$.

$\rho_L$ , $\rho_g$ = liquid and gas densities, $\frac{kg}{m^3}$

.

$$\bar{G} = \frac{G * Mwt}{S}$$

Where:

G = gas mole rate (kmol/s).

S = cross section area ($m^2$).

Mwt = gas molecular weight.

$$S = \frac{G * Mwt}{\bar{G}} = \frac{\pi}{4} D$$

$$D = \sqrt{\frac{4 * Mwt * G}{\pi \ \bar{G}}} \qquad (\textbf{meter})$$

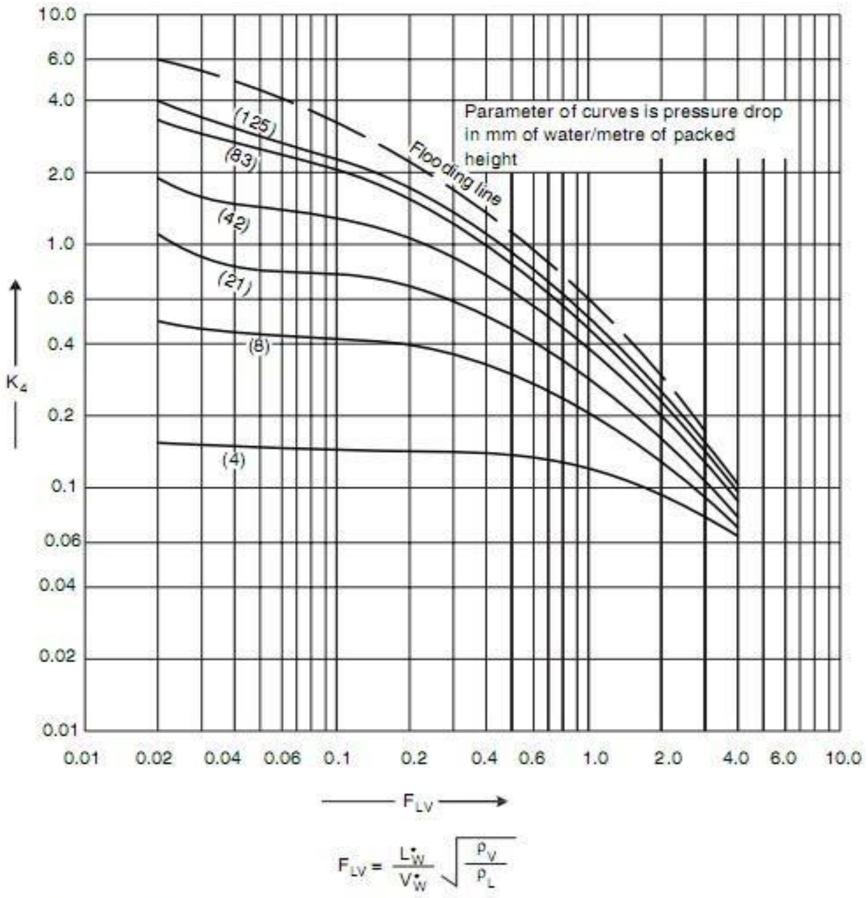


Figure 11.44. Generalised pressure drop correlation, adapted from a figure by the Norton Co. with permission

## b. Tray tower:

The diameter of the tray tower can be estimated following the procedure below:

**3. Calculate $F_{LV}$ from the following equation:**

$$F_{LV} = \frac{L}{G}\sqrt{\frac{\rho_g}{\rho_L}}$$

Where:

$L$ = Liquid mass flow rate, $\frac{kg}{s}$.

$G$ = Gas mass flow rate, $\frac{kg}{s}$.

**4. Using Figure 11.27 to find $K_1$ with the used plate spacing:**

The flooding velocity can be estimated from the correlation given by **Fair (1961)**:

$$U_f = K_1 \sqrt{\frac{\rho_L - \rho_g}{\rho_g}}$$

Where:

$U_f$ = flooding velocity of vapour, $\frac{m}{s}$.

$K_1$ = a constant obtained from Figure 11.27

$\rho_L$ , $\rho_g$ = liquid and gas densities, $\frac{kg}{m^3}$.

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**5. Find the tower diameter:**

$$U_{act} = [0.7 - 0.9]\ U_f$$

$$U_{act} = \frac{G * M.wt}{\rho_g * S} = \frac{G * M.wt}{\rho_g * \frac{\pi}{4} D^2}$$

$$D = \sqrt{\frac{4\ G * M.wt}{\pi\ \rho_g * U_{act}}}$$

Where:

**$D$ = column diameter, m .**

$S$ = column cross section area, $m^2$ .

$M.wt$ = gas molecular weight, $\frac{kg}{kgmol}$

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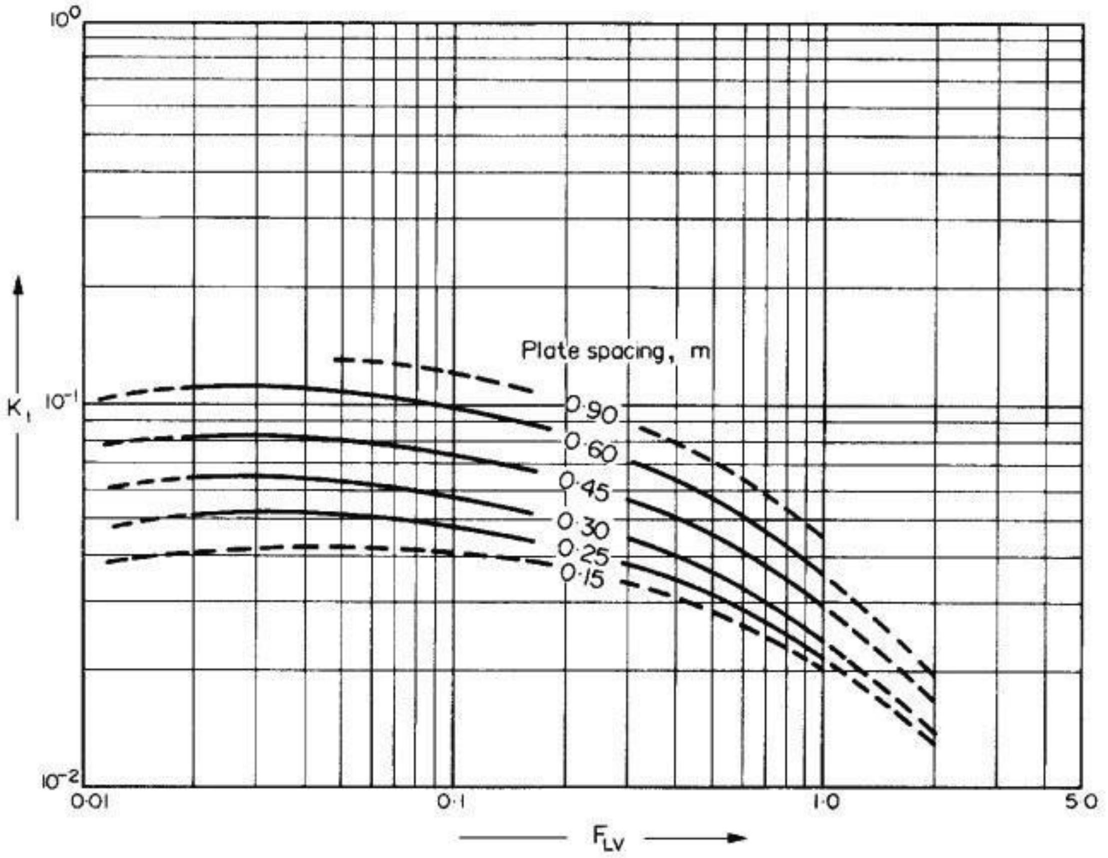


Figure 11.27. Flooding velocity, sieve plates

## Choice of plates or packing:

The choice between a plate or packed column for a particular application can only be made with complete assurance by costing each design. However, this will not always be worthwhile, or necessary, and the choice can usually be made, on the basis of experience by considering main advantages and disadvantages of each type; which are listed below:

1. Plate columns can be designed to handle a wider range of liquid and gas flow-rates than packed columns.
2. Packed columns are not suitable for very low liquid rates.
3. The efficiency of a plate can be predicted with more certainty than the equivalent term for packing (HETP or HTU).
4. Plate columns can be designed with more assurance than packed columns. There is always some doubt that good liquid distribution can be maintained throughout a packed column under all operating conditions, particularly in large columns.

5. It is easier to make provision for cooling in a plate column; coils can be installed on the plates.
6. It is easier to make provision for the withdrawal of side-streams from plate columns.
7. If the liquid causes fouling, or contains solids, it is easier to make provision for cleaning in a plate column; manways can be installed on the plates. With small-diameter columns it may be cheaper to use packing and replace the packing when it becomes fouled.
8. For corrosive liquids a packed column will usually be cheaper than the equivalent plate column.
9. The liquid hold-up is appreciably lower in a packed column than a plate column. This can be important when the inventory of toxic or flammable liquids needs to be kept as small as possible for safety reasons.
10. Packed columns are more suitable for handling foaming systems.
11. The pressure drop per equilibrium stage (HETP) can be lower for packing than plates; and packing should be considered for vacuum columns.
12. Packing should always be considered for small diameter columns, say less than ***0.6 m***, where plates would be difficult to install, and expensive.