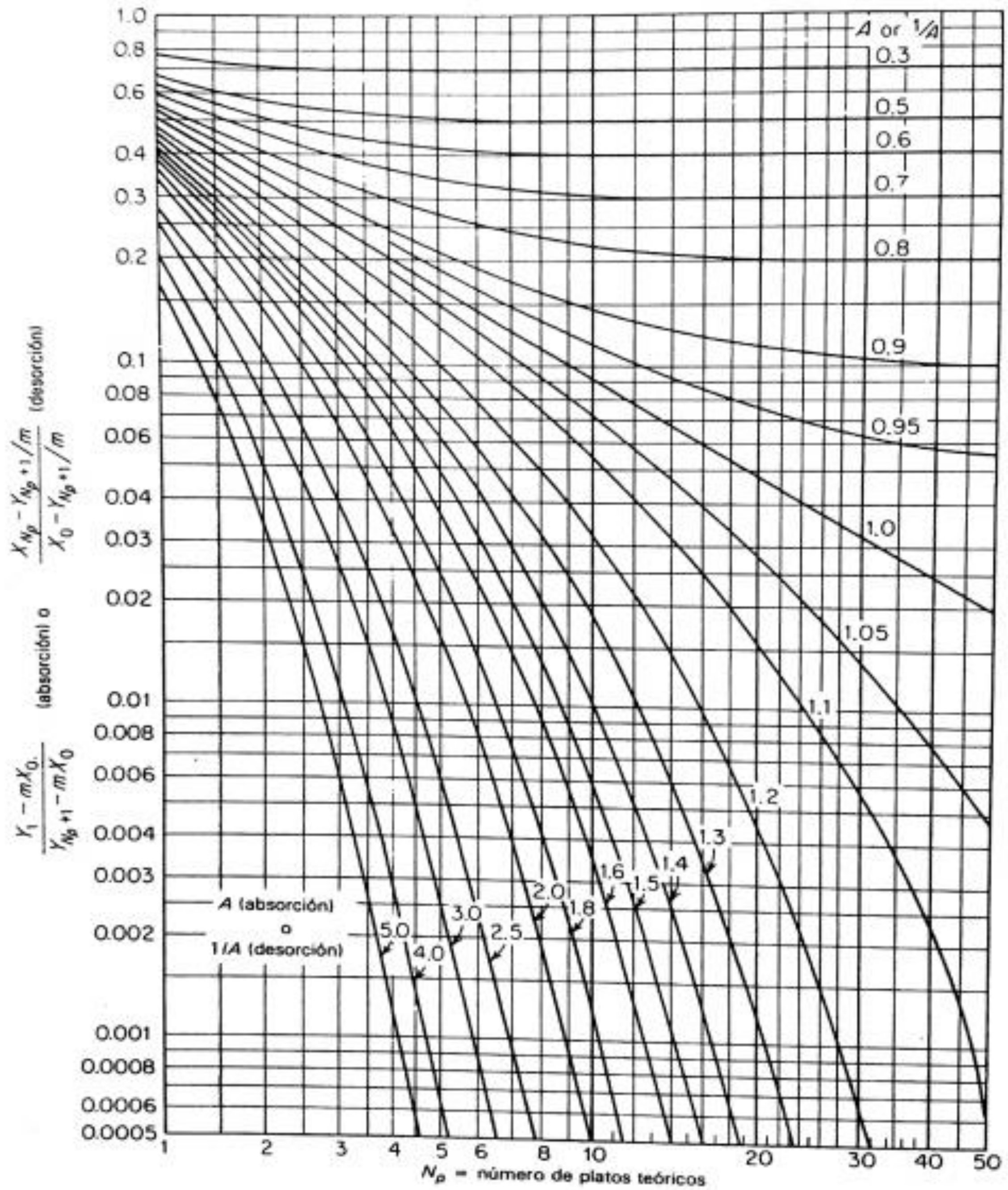



**Figura 5.16** Número de etapas teóricas para cascadas a contracorriente, con el equilibrio de la Ley de Henry y factores de absorción o desorción constantes. [Por Hachmuth y Vance, *chem. Eng. Progr.*, **48**, 523, 570, 617 (1952)].

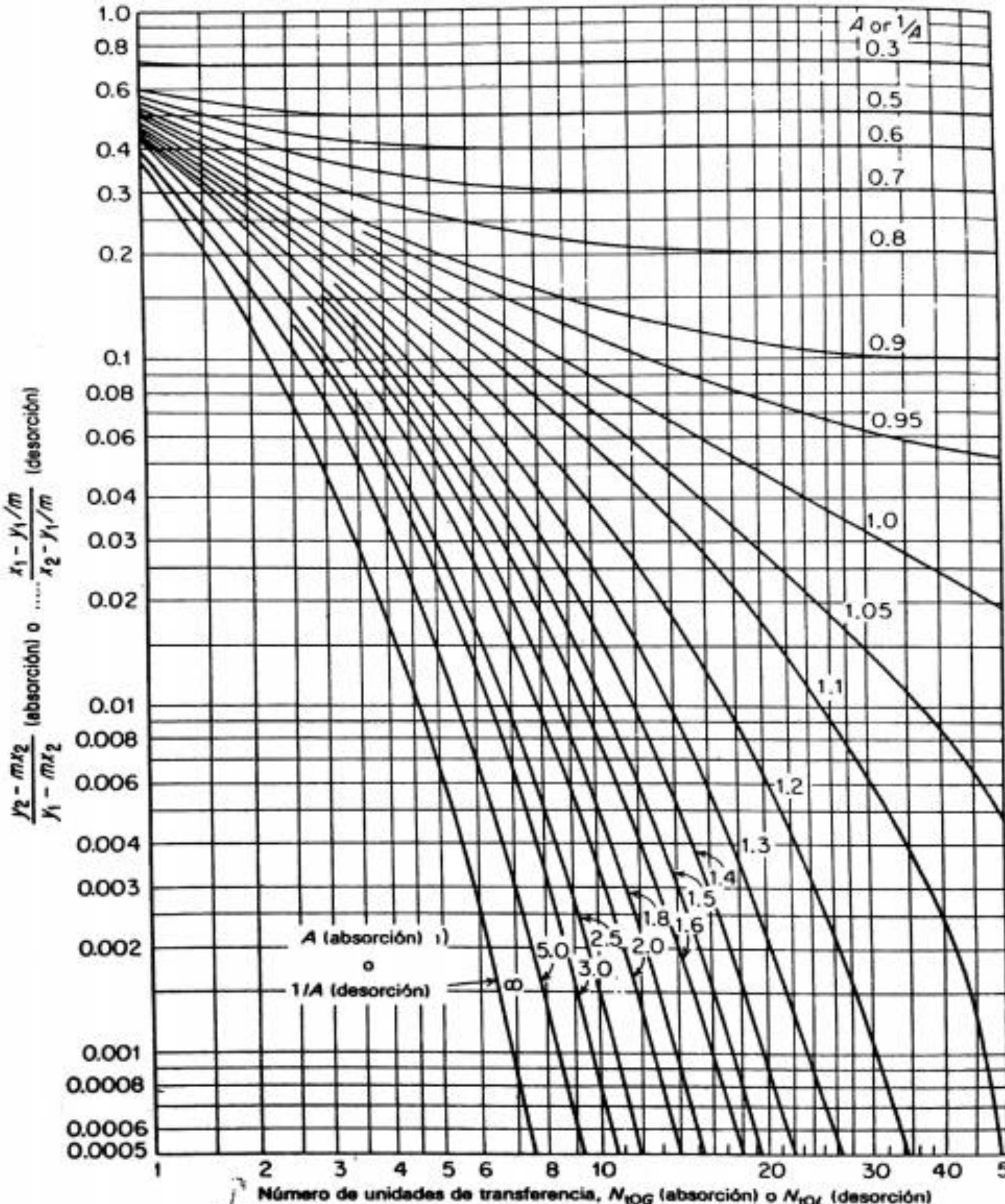



**Figura 8.20** Número de unidades de transferencia para absorbedores o desorbedores con factor de absorción o desorción constante.

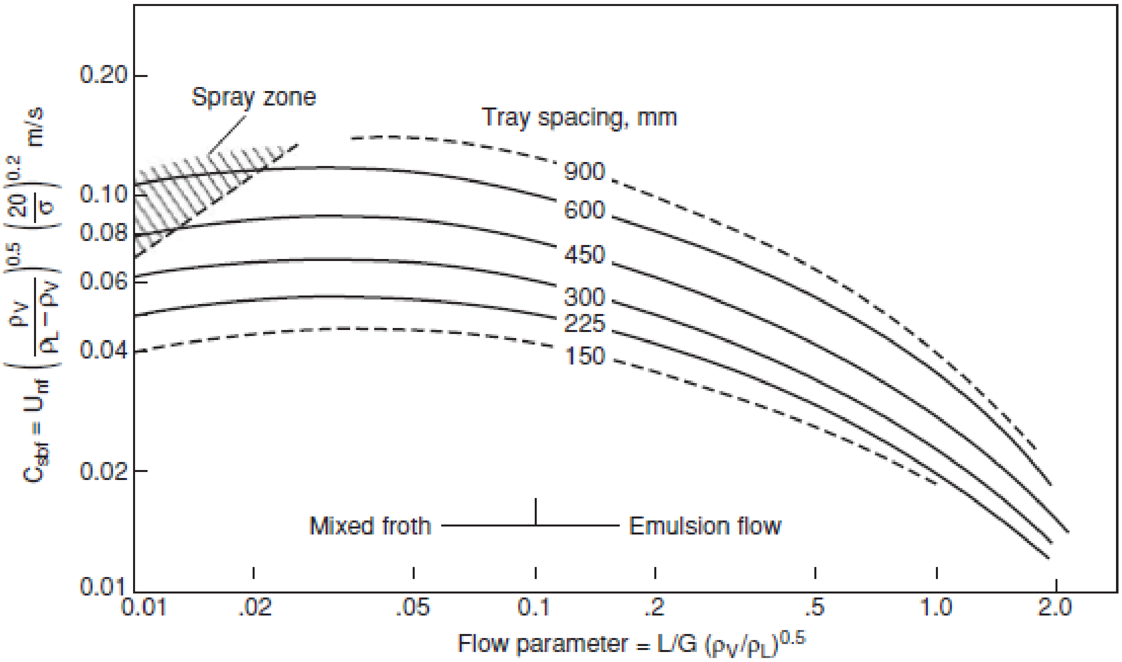
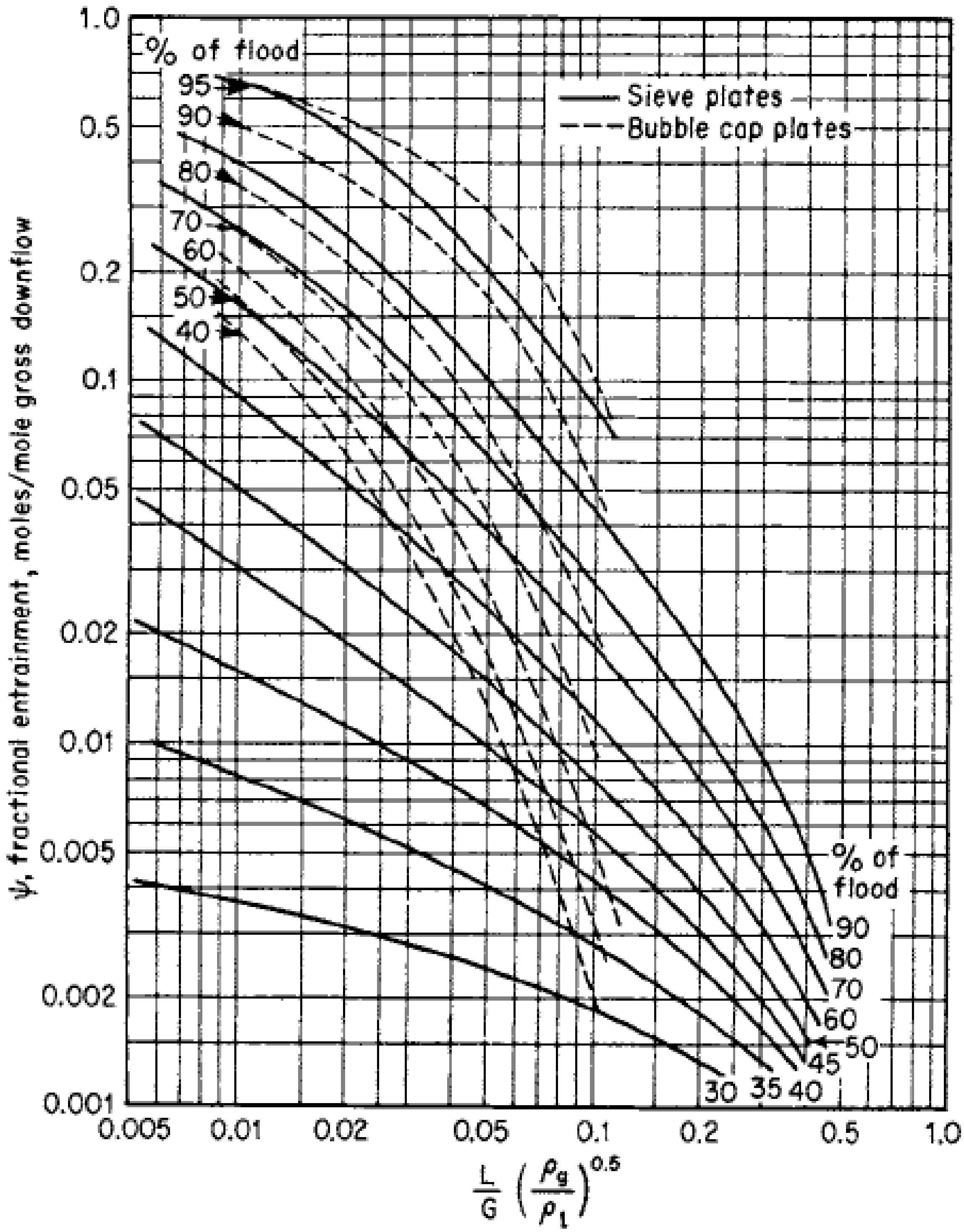
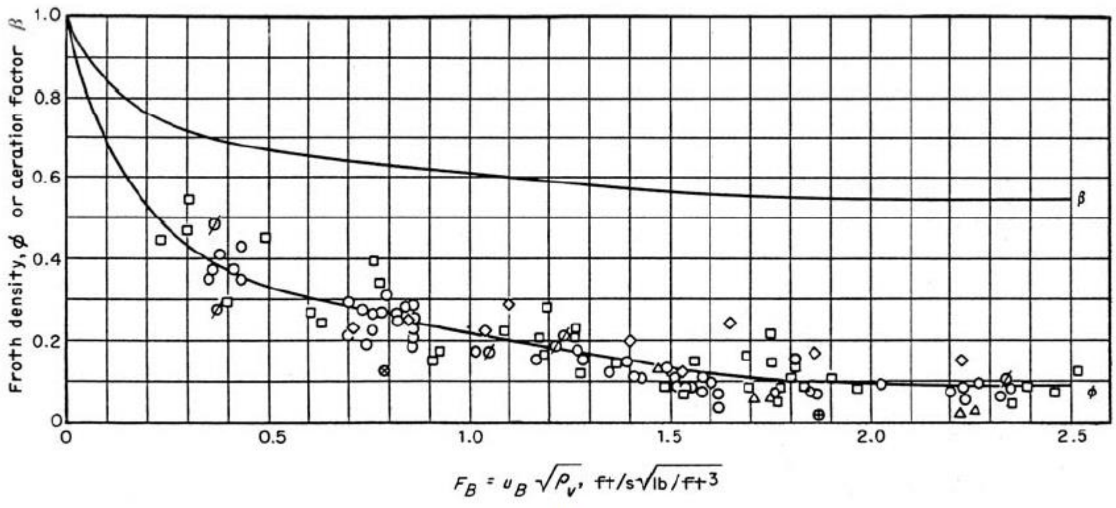



**FIG. 14-31** Fair's entrainment flooding correlation for columns with crossflow trays (sieve, valve, bubble-cap). [*Fair, Pet/Chem Eng 33(10), 45 (September 1961).*]

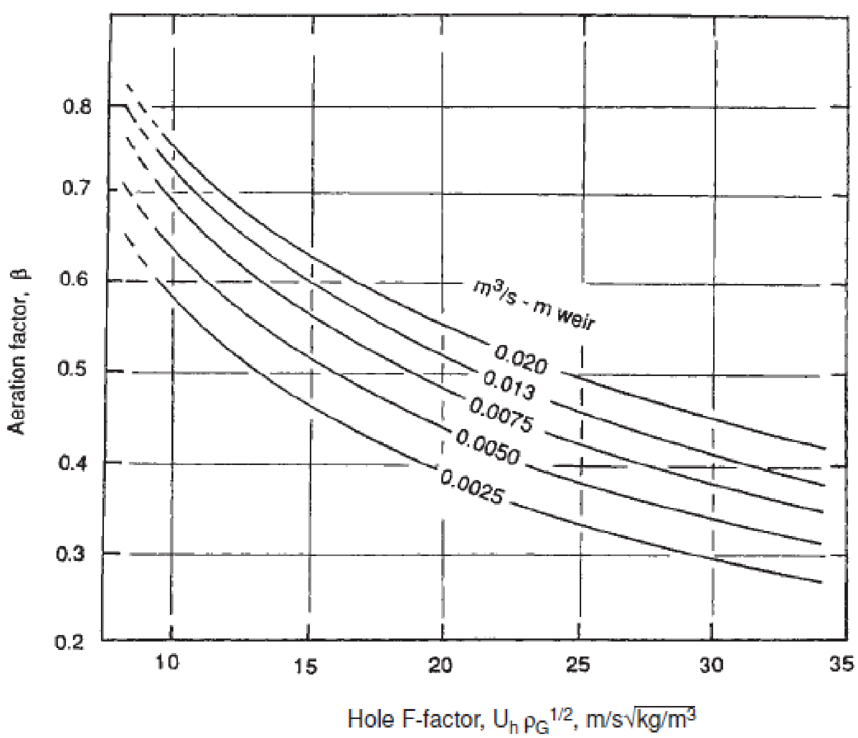

% of flood
95
90
80
70
60
50
40
Sieve plates
Bubble cap plates
1.0
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
$\psi$, fractional entrainment, moles/mole gross downflow
0.005
0.01
0.02
0.05
0.1
0.2
0.5
1.0
$\frac{L}{G}\left(\frac{\rho_g}{\rho_l}\right)^{0.5}$
% of flood
90
80
70
60
50
45
40
35
30




(b)

**FIG. 14-37** Aeration factor for pressure drop calculation. (*a*) Sieve trays. [*Bolles and Fair,* Encyclopedia of Chemical Processing and Design, *vols. 16, 86. J. M. McKetta (ed.), Marcel Dekker, New York, 1982.*] (*b*) Valve trays. (*From G. F. Klein,* Chem. Eng., *May 3, 1982, p. 81; reprinted courtesy of* Chemical Engineering.)

## EQUIPMENT FOR DISTILLATION AND GAS ABSORPTION: TRAY COLUMNS



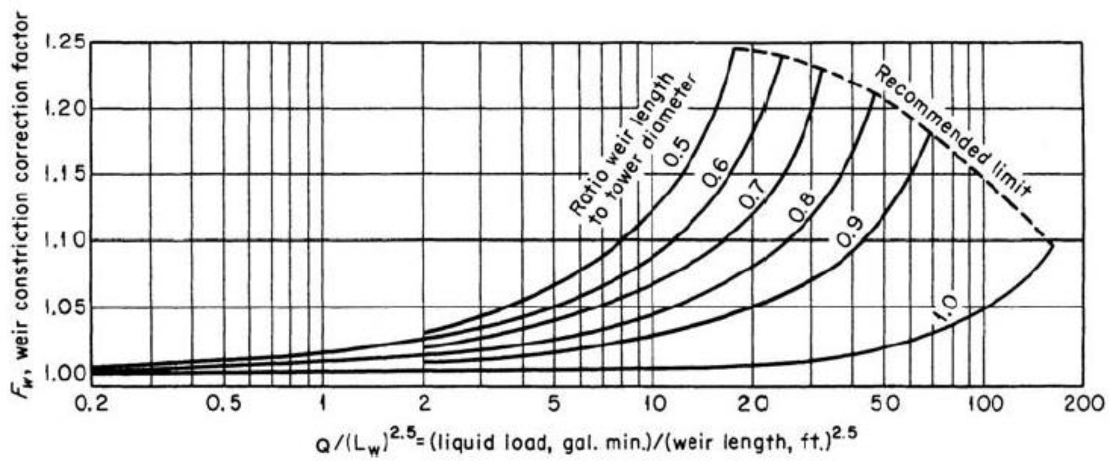



**FIG. 14-38** Correction for effective weir length. To convert gallons per minute to cubic meters per second, multiply by $6.309 \times 10^{-5}$; to convert feet to meters, multiply by 0.3048. [*Bolles*, Pet. Refiner, **25**, *613 (1946)*.]

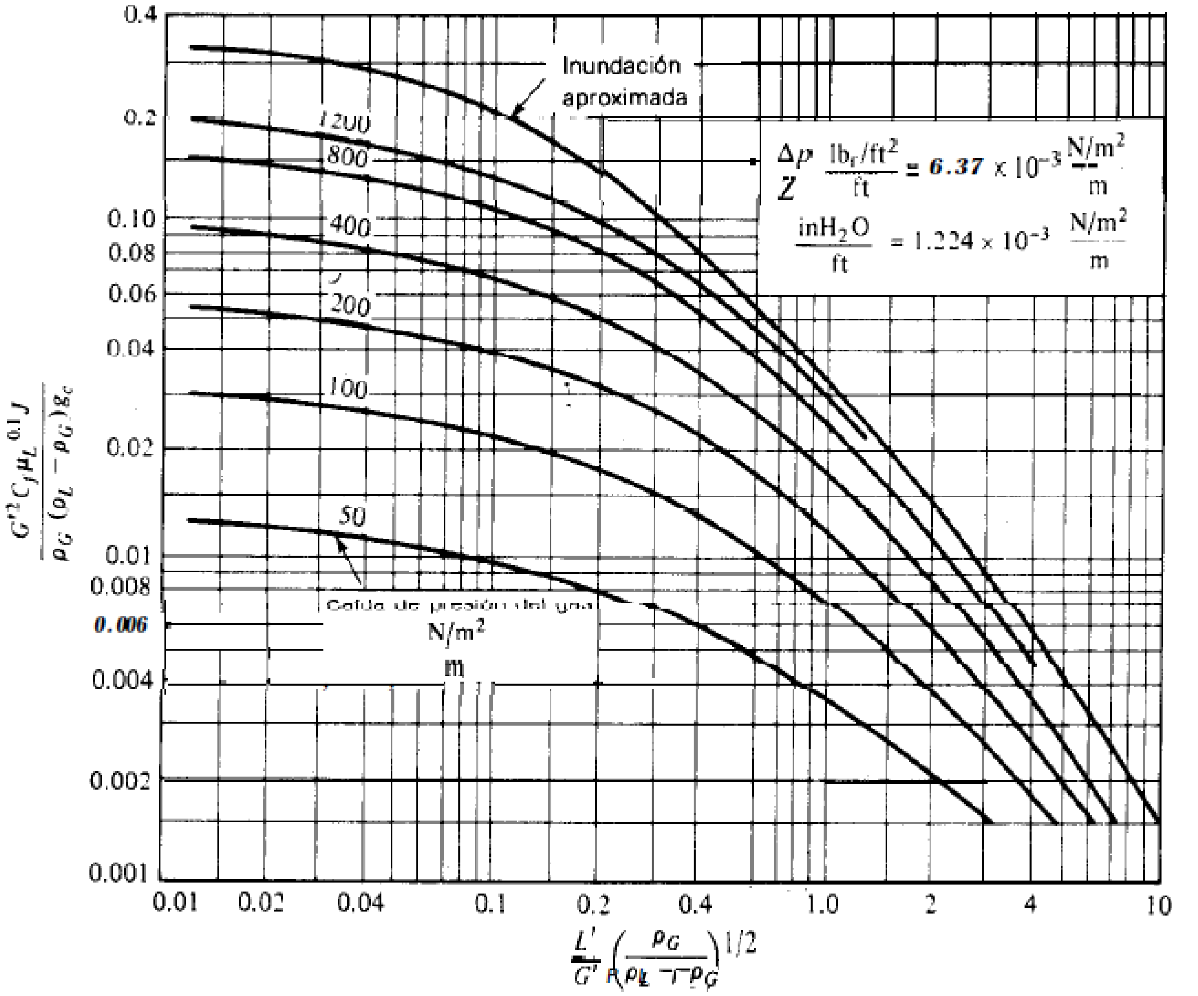



Figura 6.34 Inundación y caída de presión en torres con empaques al azar (coordenadas de Eckert [37], *Chemical* **Process Products** *Division, Norton* Co.) Para unidades SI (kg, m . s), $g_c$ = 1, $C_f$ de la tabla6.3, y utilizar $J$ = 1. Para G' = $lb_m/ft^2 \cdot h$, $\rho = lb_m/ft^3$, $\mu_L$ = centip., $g_c = 4.18(10^8)$, $C_f$ de la tabla 6.3, y utilizar $J$ = 1.502.

Tabla 6.3 Características de los empaques **aleatorios**[a]

| Empaque | 6 ($\frac{1}{4}$) | 9.5 ($\frac{3}{8}$) | 13 ($\frac{1}{2}$) | 16 ($\frac{5}{8}$) | 19 ($\frac{3}{4}$) | 25 (1) | 32 ($1\frac{1}{4}$) | 38 ($1\frac{1}{2}$) | 50 (2) | 76 (3) | 89 ($3\frac{1}{2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Tamaño** nominal, mm **(in)** | | | | | |
| | | | | | | Anillos de Raschig | | | | | |
| Ceramica: | | | | | | | | | | | |
| Espesor de pared, mm | 0.8 | 1.6 | 2.4 | 2.4 | 2.4 | 3 | 4.8 | 4.8 | 6 | 9.5 | |
| $C_f$ | 1600 | 1000 | 580 | 380 | 255 | 155 | 125 | 95 | 65 | 37 | |
| $C_D$ | | | 909 | 749 | 457 | 301 | | 181.8 | 135.6 | | |
| $\varepsilon$ | 0.73 | 0.68 | 0.63 | 0.68 | 0.73 | 0.73 | 0.74 | 0.71 | 0.74 | 0.78 | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | 787 (240) | 508 (155) | 364 (111) | 328 (100) | 262 (80) | 190 (58) | 148 (45) | 125 (38) | 92 (28) | 62 (19) | |
| **Metal** | | | | | | | | | | | |
| 0.8 mm pared | | | | | | | | | | | |
| $C_f$ | 700 | 390 | 300 | 170 | 155 | 115 | | | | | |
| $\varepsilon$ | 0.69 | | 0.84 | | 0.88 | 0.92 | | | | | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | 774 (236) | | 420 (128) | | 274 (83.5) | 206 (62.7) | | | | | |
| 1.6 mm pared | | | | | | | | | | | |
| $C_f$ | | | 410 | 290 | 220 | 137 | 110 | 83 | 57 | 32 | |
| $C_D$ | | | 688 | 431 | 485 | 304 | | 172.9 | 133.5 | | |
| $\varepsilon$ | | | 0.73 | | 0.78 | 0.85 | 0.87 | 0.90 | 0.92 | 0.95 | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | 387 (118) | | 236 (71.8) | 186 (56.7) | 162 (49.3) | 135 (41.2) | 103 (31.4) | 68 (20.6) | |
| | | | | | | Anillos de **Pall** | | | | | |
| Plástico | | | | | | | | | | | |
| $C_f$ | | | | 97 | | 52 | | 40 | 25 | | 16 |
| CD | | | | 207 | | 105.2 | | 61.8 | 47.5 | | 23.9 |
| $\varepsilon$ | | | | 0.87 | | 0.90 | | 0.91 | 0.92 | | 0.92 |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | 341 (104) | | 206 (63) | | 128 (39) | 102 (31) | | 85 (26) |
| Metal | | | | | | | | | | | |
| $C_f$ | | | | 70 | | 48 | | 28 | 20 | | 16 |
| $C_D$ | | | | 133.4 | | 95.5 | | 56.6 | 36.5 | | |
| $\varepsilon$ | | | | 0.93 | | 0.94 | | 0.95 | 0.96 | | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | 341 (104) | | 206 (63) | | 128 (39) | 102 (31) | | |
| Flexirings | | | | | | | | | | | |
| $C_f$ | | | | 78 | | 45 | | 28 | 22 | | 18 |
| $\varepsilon$ | | | | 0.92 | | 0.94 | | 0.96 | 0.96 | | 0.97 |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | 345 (105) | | 213 (65) | | 131 (40) | 115 (35) | | 92 (28) |
| **Hy-pak:**‡ | | | | | | | | | | | |
| $C_f$ | | | | | | 45 | | | 18 | 15 | |
| $C_D$ | | | | | | 88.1 | | | 28.1 | 26.6 | |
| $\varepsilon$ | | | | | | 0.96 | | | 0.97 | 0.97 | |

**Tabla 6.3 Continuación**

| Packing | Tamaño nominal, mm (in) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 6 ($\frac{1}{4}$) | 9.5 ($\frac{3}{8}$) | 13 ($\frac{1}{2}$) | 16 ($\frac{5}{8}$) | 19 ($\frac{3}{4}$) | 25 (1) | 32 ($1\frac{1}{4}$) | 38 ($1\frac{1}{2}$) | 50 (2) | 76 (3) | 89 ($3\frac{1}{2}$) |
| | | | | | Sillas de montar de Berl | | | | | | |
| **Cerámica** | | | | | | | | | | | |
| $C_f$ | 900 | | 240 | | 170 | 110 | | 65 | **45** | | |
| $C_D$ | | | 508 | | 295 | 184 | | | | | |
| $\varepsilon$ | 0.60 | | 0.63 | | 0.66 | 0.69 | | 0.75 | **0.72** | | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | 899 (274) | | 466 (142) | | 269 (82) | 249 (76) | | **144 (44)** | **105 (32)** | | |
| | | | | | Sillas Intalox | | | | | | |
| Cerámica | | | | | | | | | | | |
| $C_f$ | **725** | **330** | **200** | | 145 | 98 | | 52 | 40 | 22 | |
| $C_D$ | | | 399 | | 256 | 241.5 | | 36.2 | 71.3 | **40.6** | |
| $\varepsilon$ | **0.75** | | 0.78 | | 0.77 | 0.775 | | 3.81 | 0.79 | | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | **984 (300)** | | 623 (190) | | 335 (102) | 256 (78) | | 195 (59.5) | 118 (36) | | |
| Plástico | | | | | | | | | | | |
| $C_f$ | | | | | | 33 | | | 21 | 16 | |
| $C_D$ | | | | | | **96.7** | | | 56.5 | 30.1 | |
| $\varepsilon$ | | | | | | 0.91 | | | 0.93 | **0.94** | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | | | **207** (63) | | | 108 (33) | 89 (27) | |
| | | | | | **SuperIntalox** | | | | | | |
| **Cerámica**[c] | | | | | | | | | | | |
| $C_f$ | | | | | | **60** | | | *30* | | |
| $C_D$ | | | | | | 123 | | | 63.3 | | |
| $\varepsilon$ | | | | | | 0.79 | | | 0.81 | | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | | | 253 **(77)** | | | 105 (32) | | |
| **Plástico**[d] | | | | | | | | | | | |
| $C_f$ | | | | | | 33 | | | 21 | 16 | |
| $C_D$ | | | | | | 79.5 | | | 53.5 | 30.1 | |
| $\varepsilon$ | | | | | | 0.90 | | | 0.93 | 0.94 | |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | | | **207 (63)** | | | 108 (33) | 89 (27) | |
| | | | | | Tellerettes | | | | | | |
| Plástico | | | | | | | | | | **67-mm** | **95-mm (R)** |
| $C_f$ | | | | | | **40** | | | 20 | | |
| $\varepsilon$ | | | | | | 0.87 | | | 0.93 | 0.93 | 0.92 |
| $a_p$, $m^2/m^3$ ($ft^2/ft^3$) | | | | | | 180 (55) | | | **112 (34)** | 112 (34) | |

[a] Los datos son para el empaque arrojado húmedo. Cortesia: **Chemical Process Products** Division, Norton Co.; Koch **Engineering** *Co.;* Ceilcote *Co.; Chemical* ***Engineering*** *Progress; Chemical* ***En-****gineer.*

[b] **Tamaño** nominal y espesor de la pared, mm, **resp.:** 6, 0.8; 9.5. 1.6; 13 a 19. 2.4; 25. 3; 32 y 38, 4.8; **50, 6;** 76, 9.5.

[c] $a_p$ en $m^2/m^3$ ($ft^2/ft^3$)

[d] **Tamaños 1, 2 y 3**