A Principle of Corresponding States for Packed Column Pressure Drops

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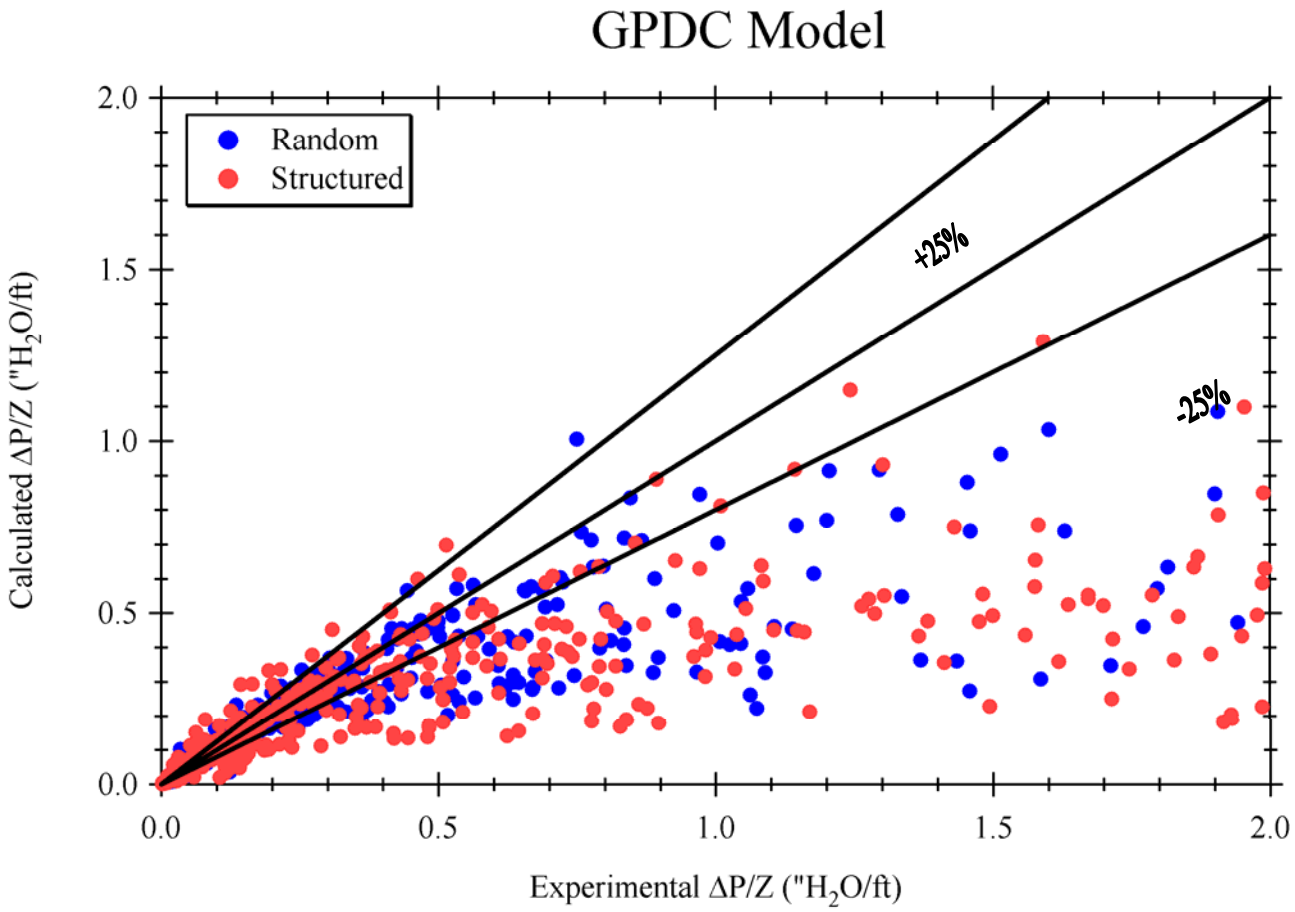
Pressure Drop Models - How Well They Do

Data Courtesy of A.F. Seibert, SRP



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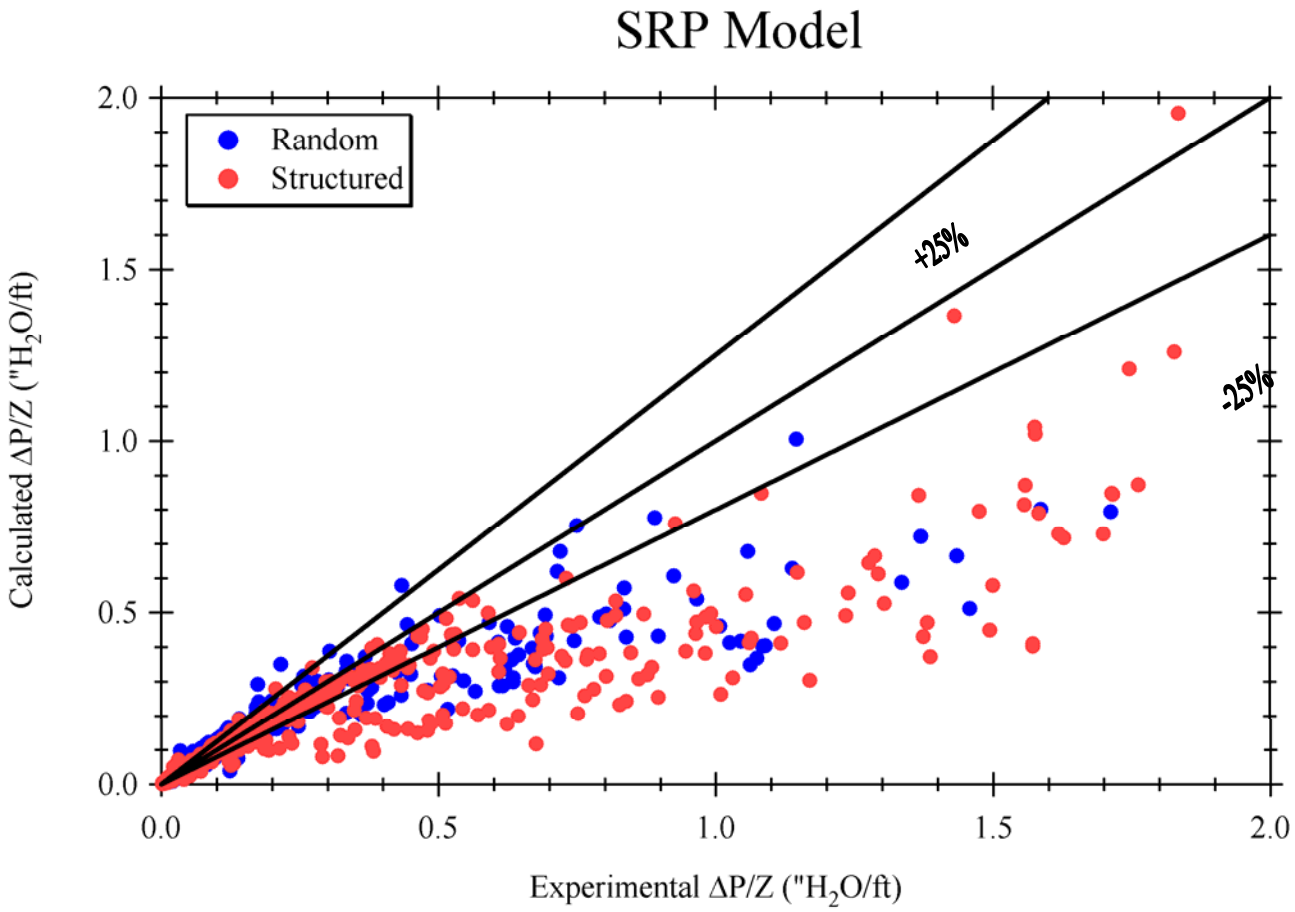

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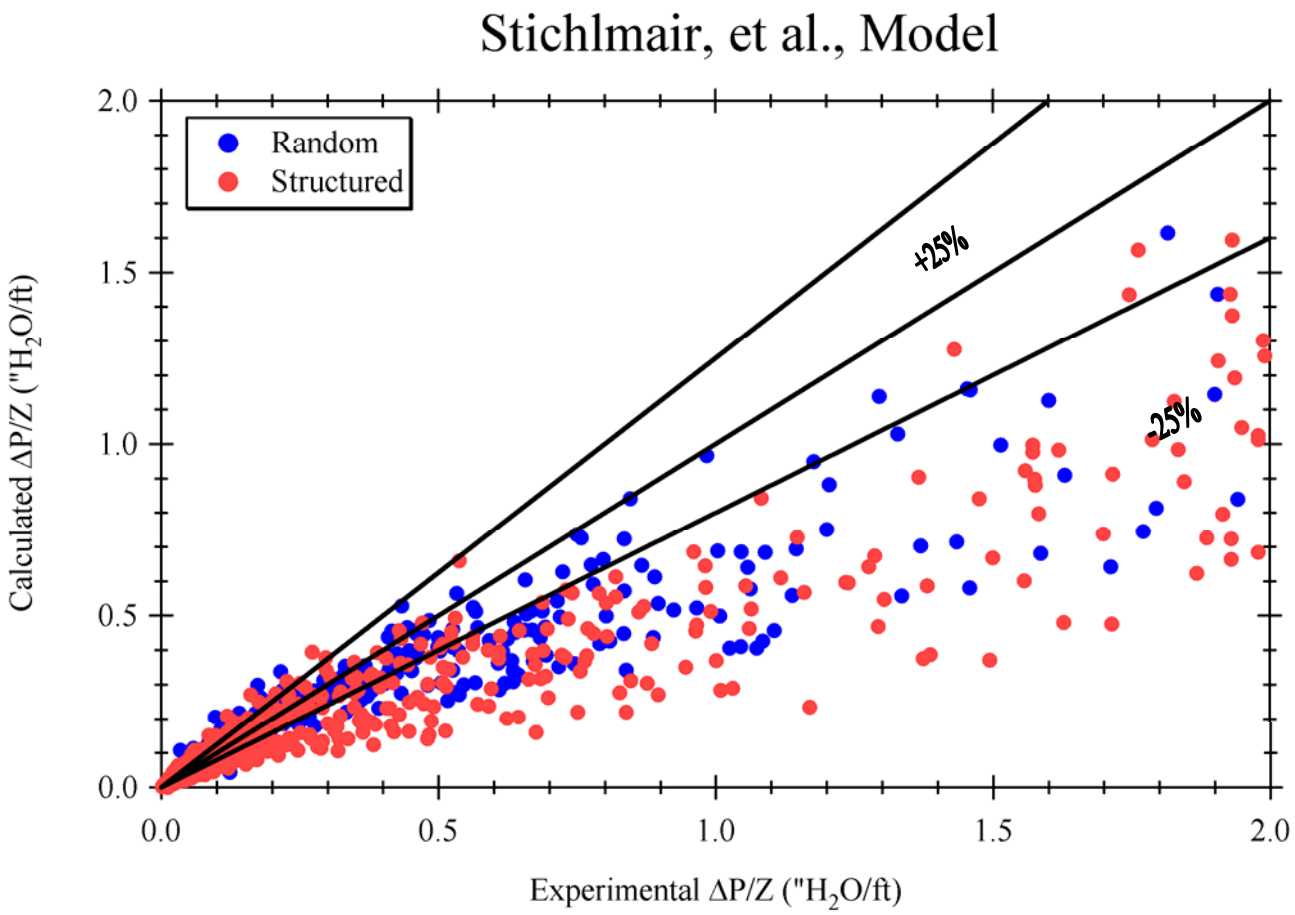

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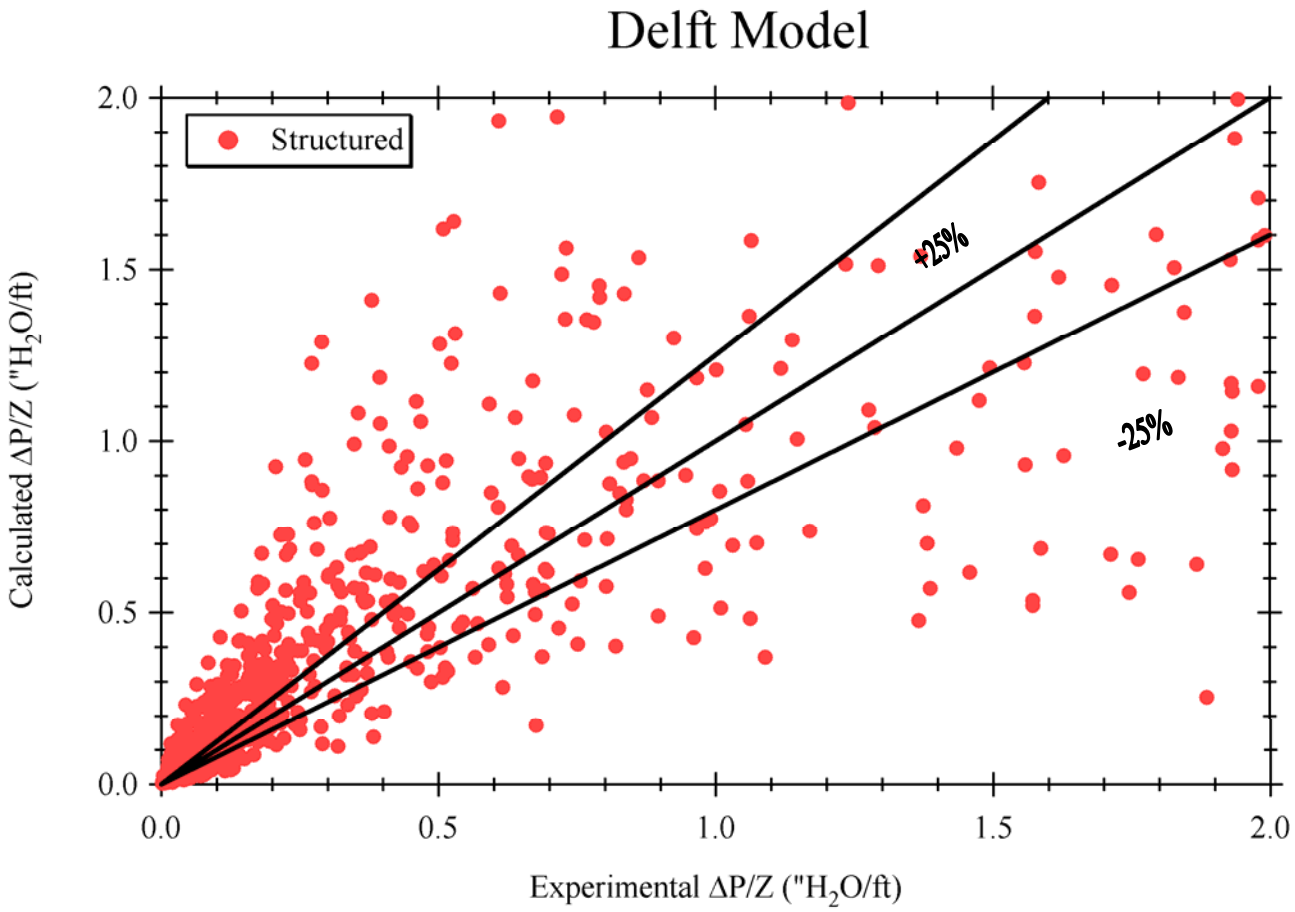
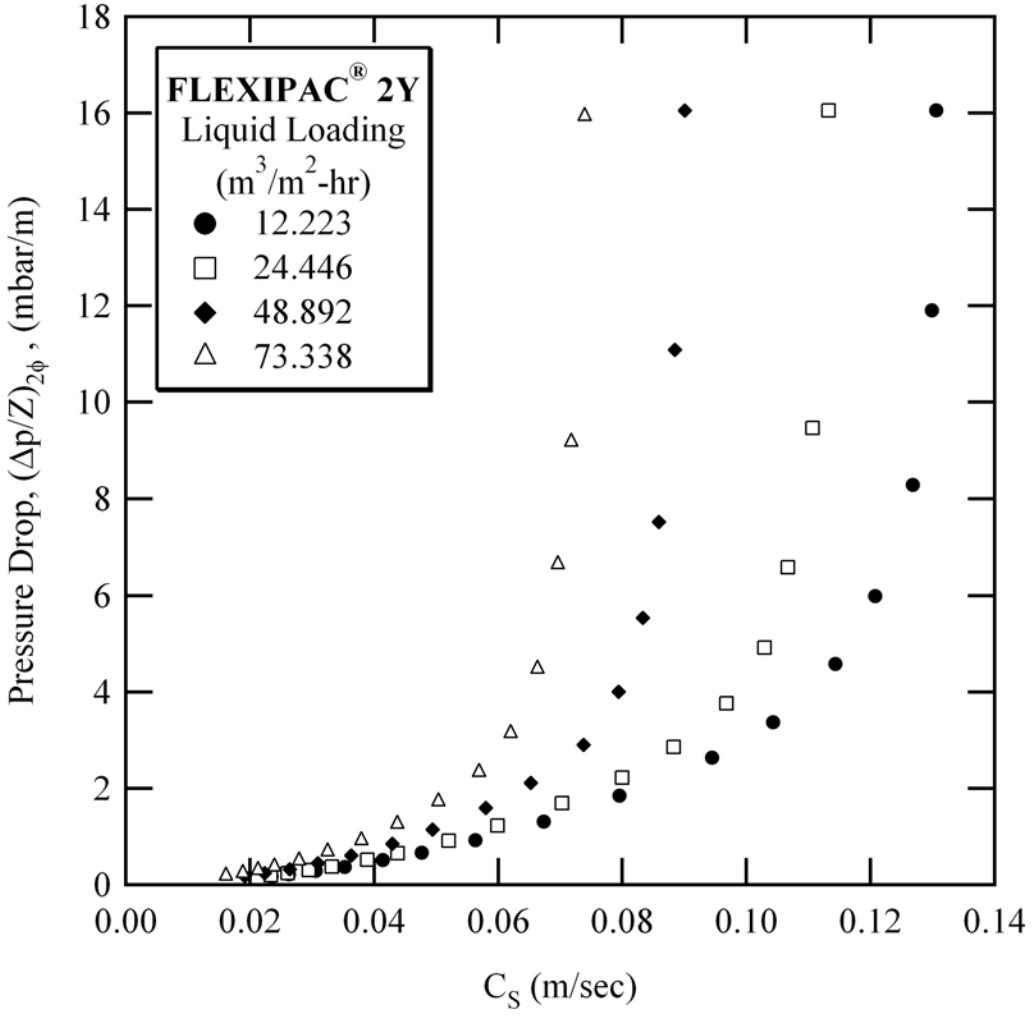
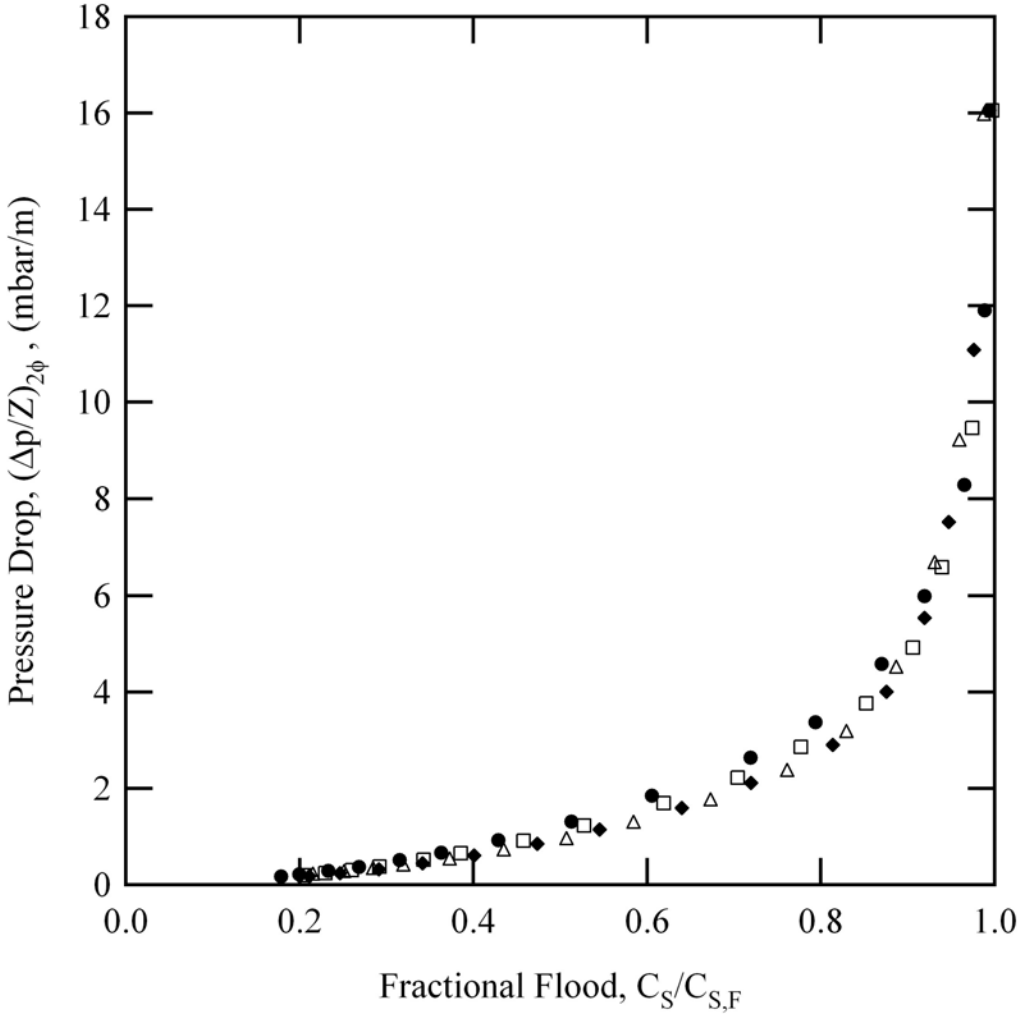


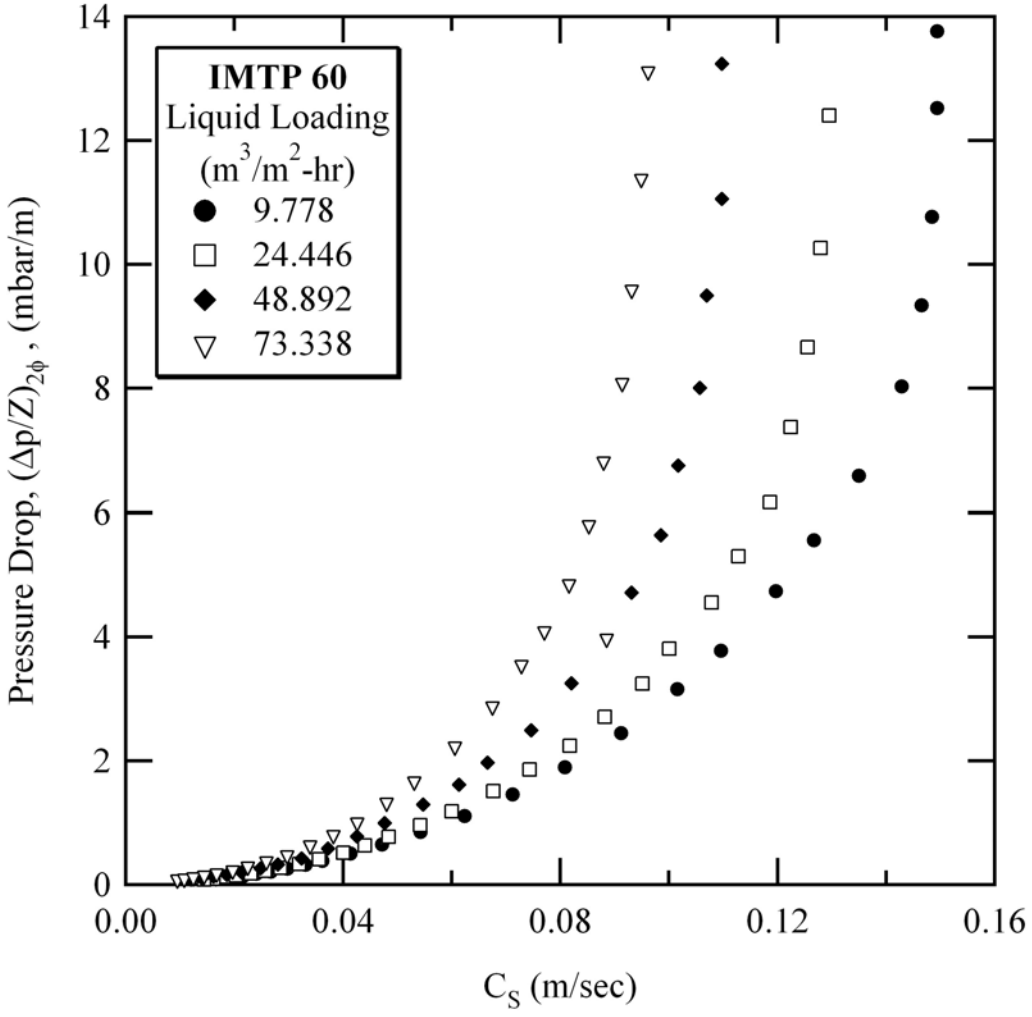
Typical Two-Phase Pressure Drop Data



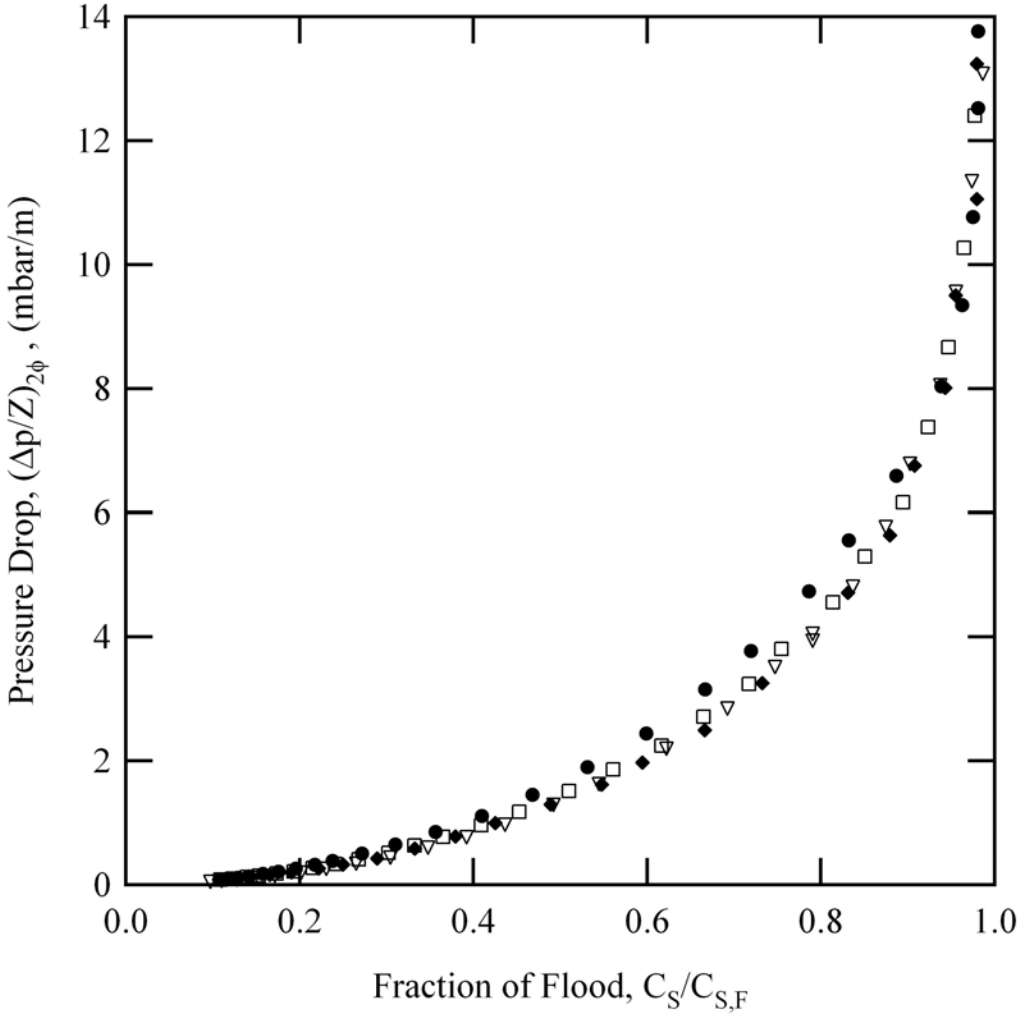
Data Re-plotted in Terms of Fractional Flood



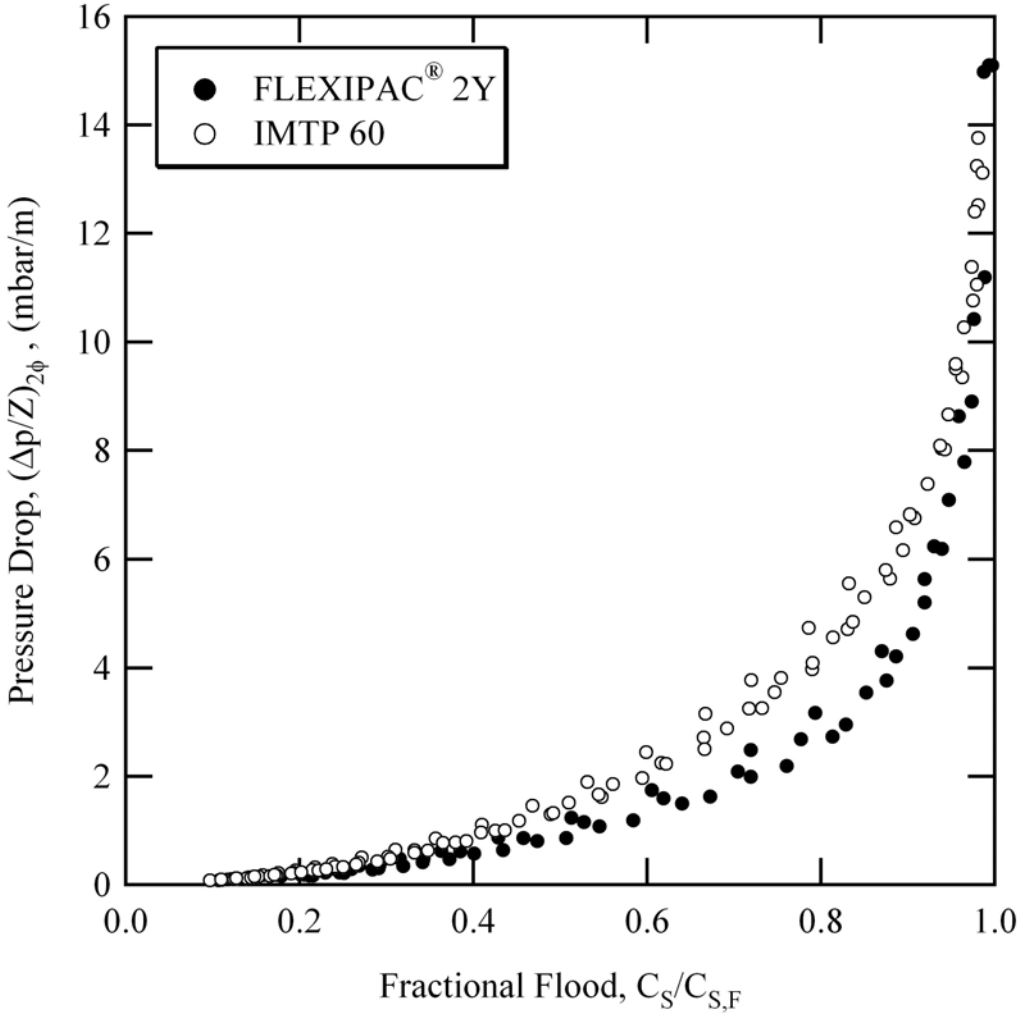
More Typical Two-Phase Pressure Drop Data



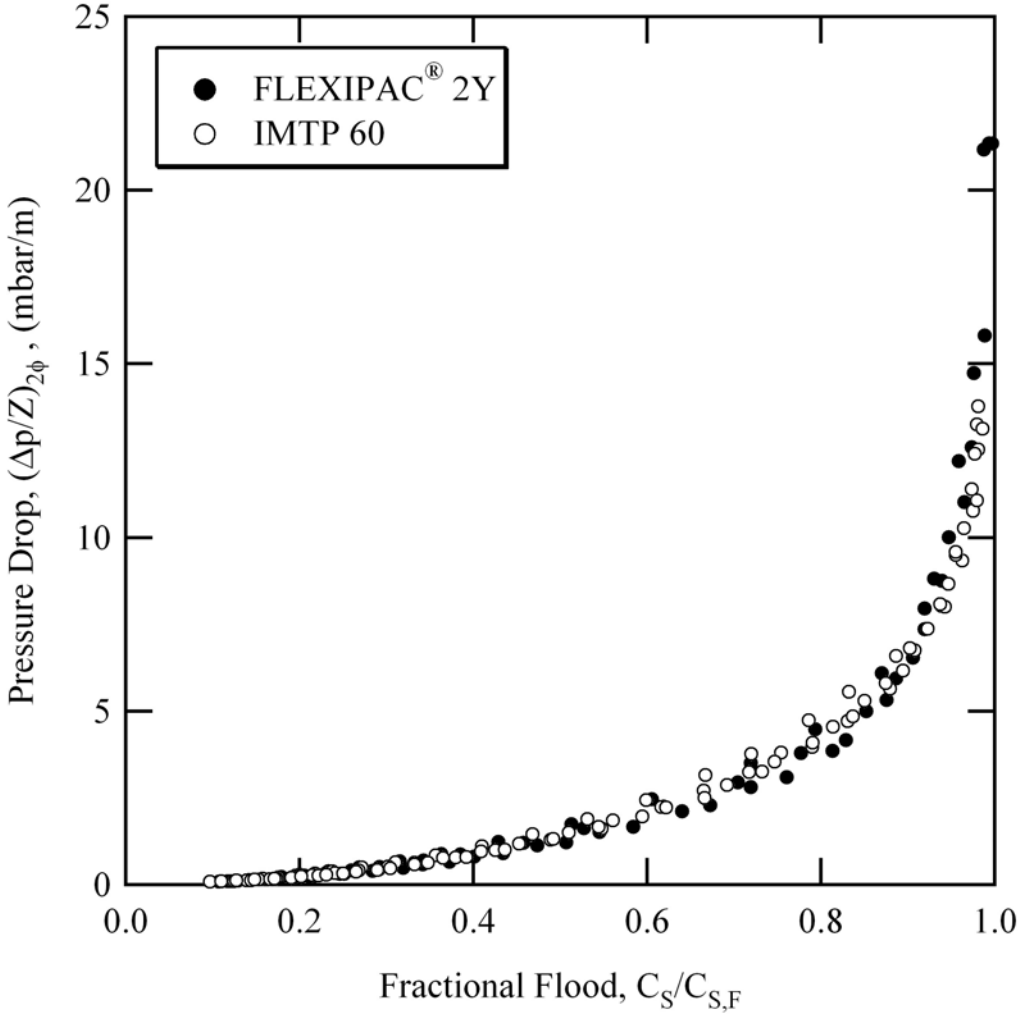
Data Re-plotted in Terms of Fractional Flood

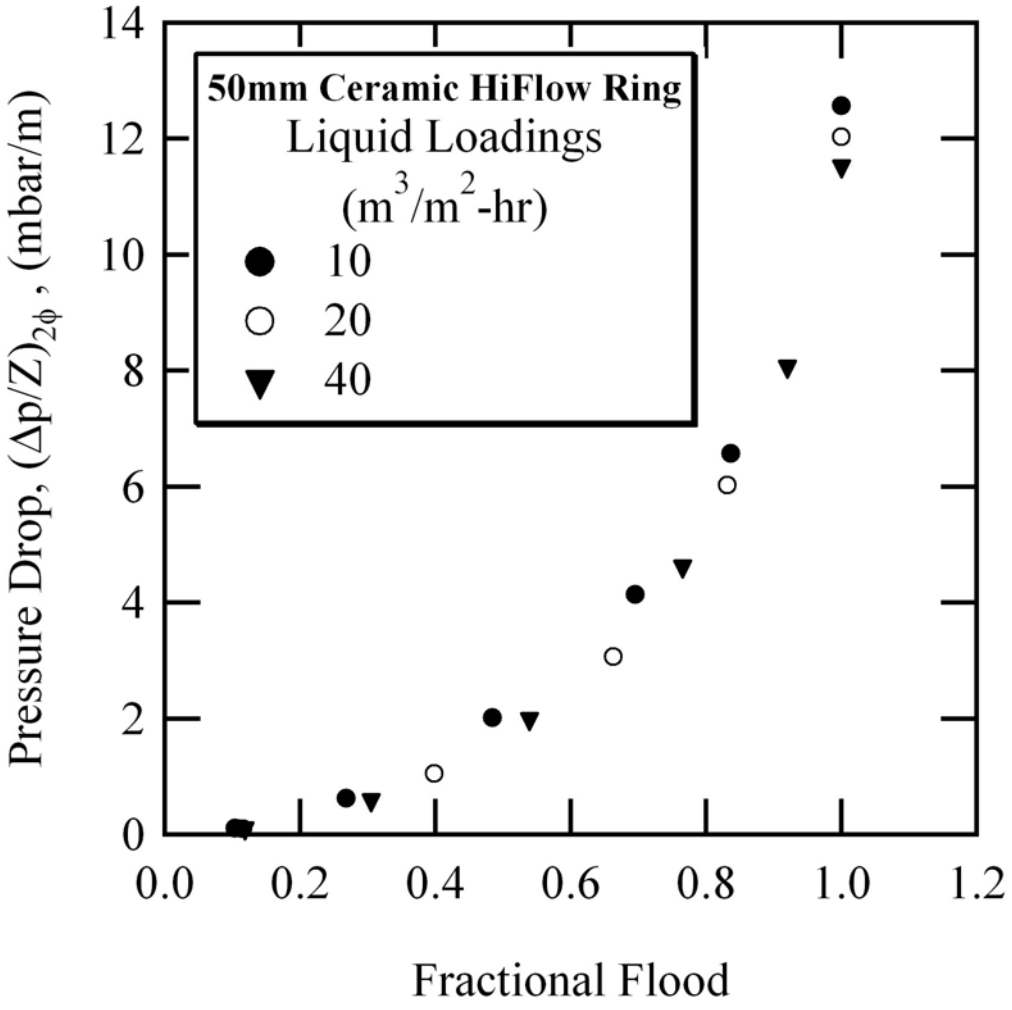


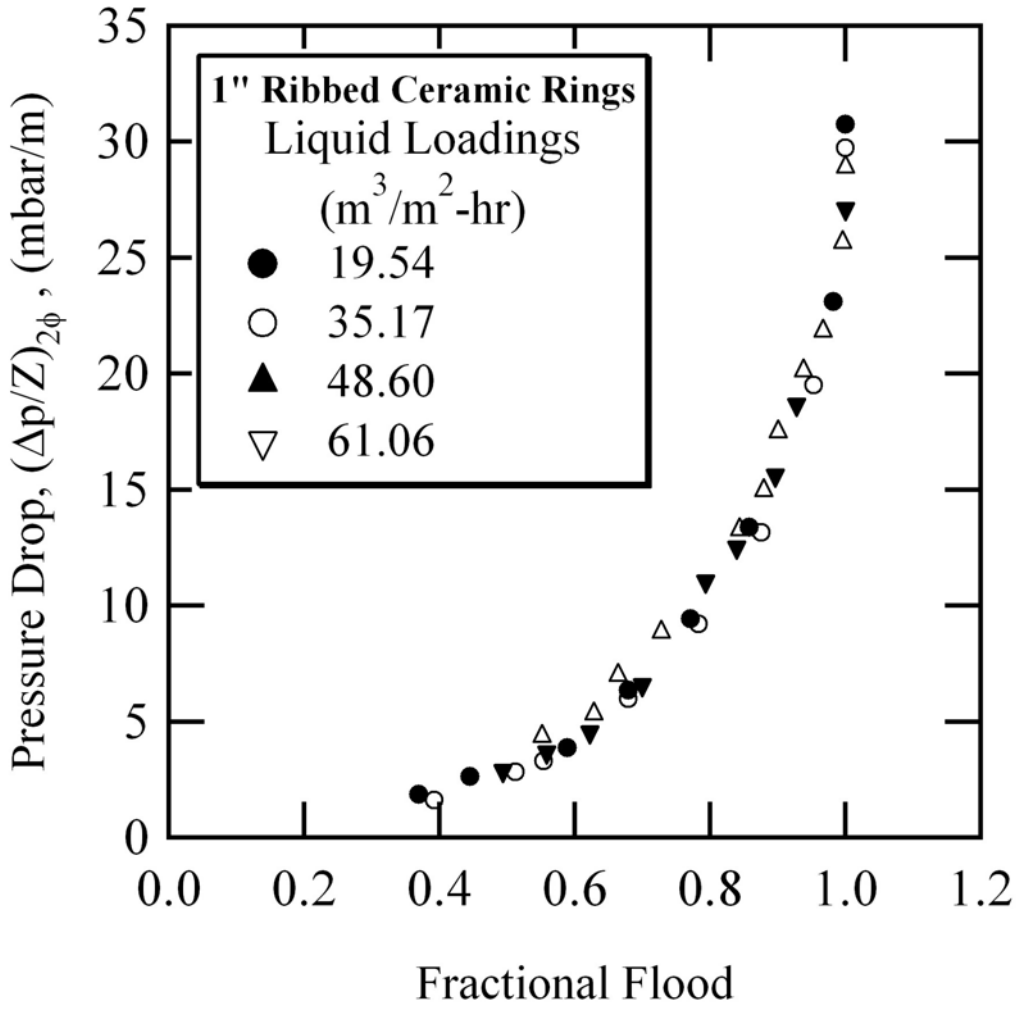
Superposition of Datasets

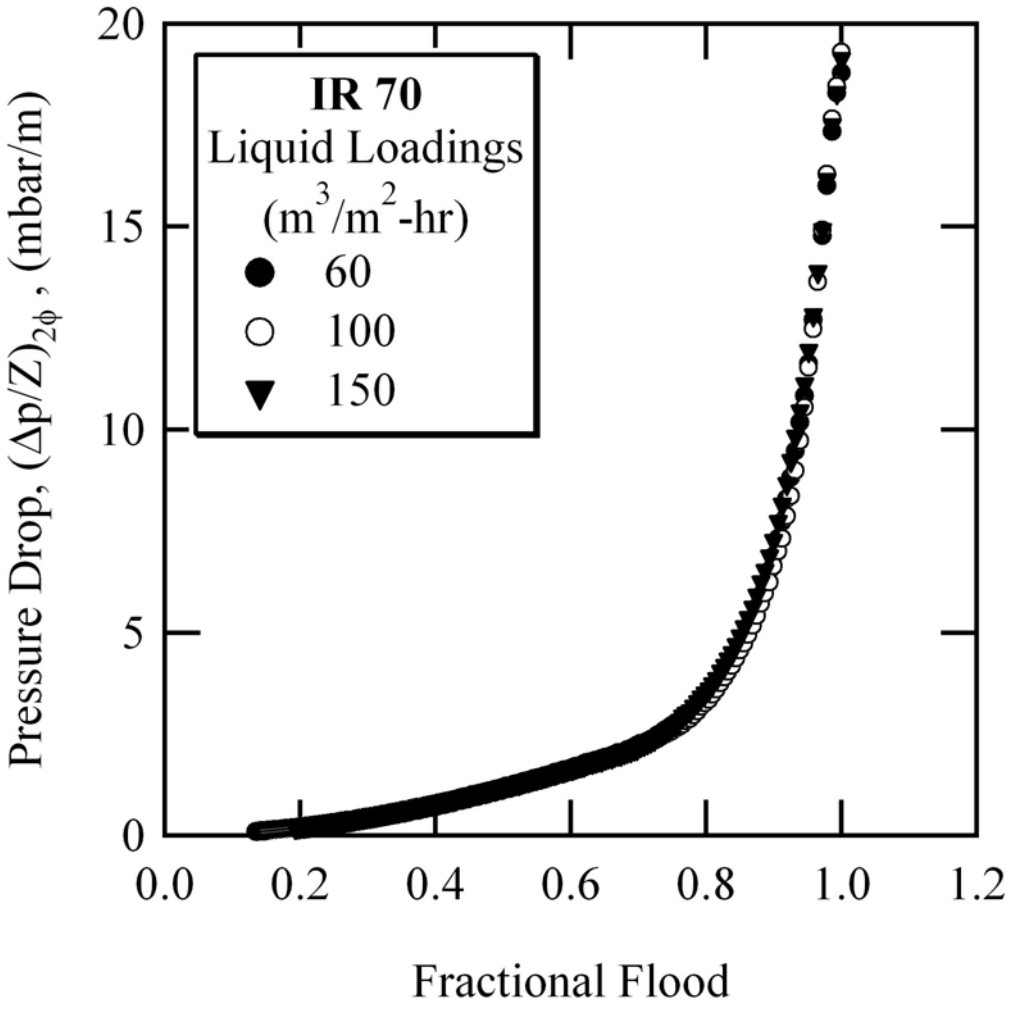


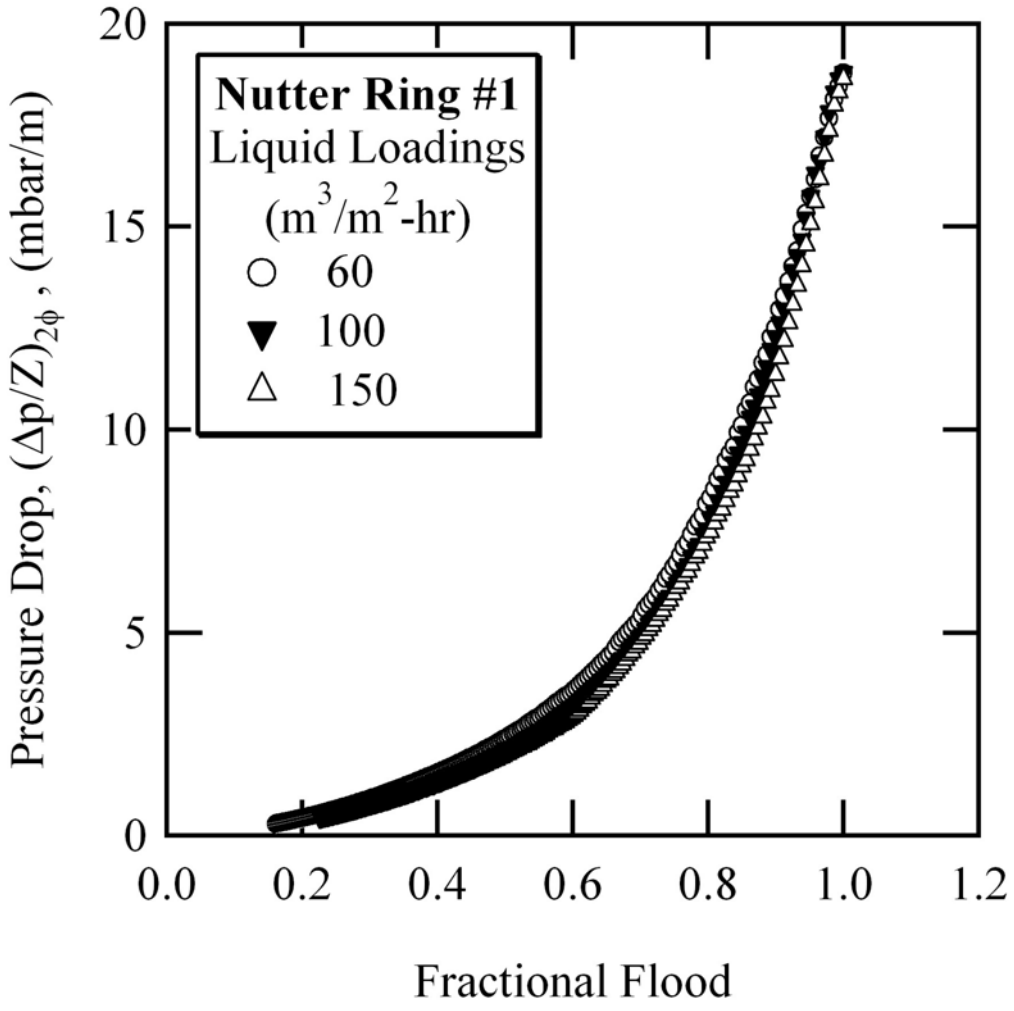
"Scaling" of Ordinate Leads to a Data Collapse

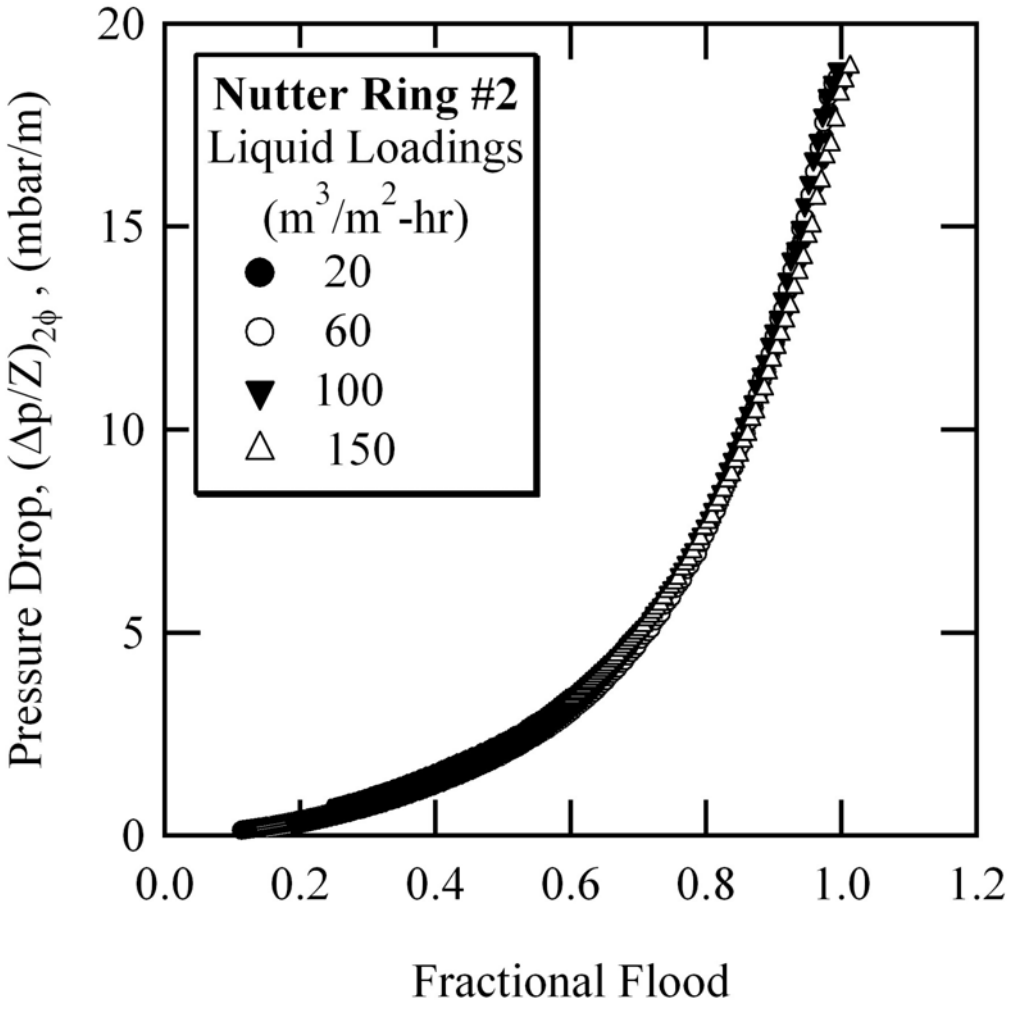


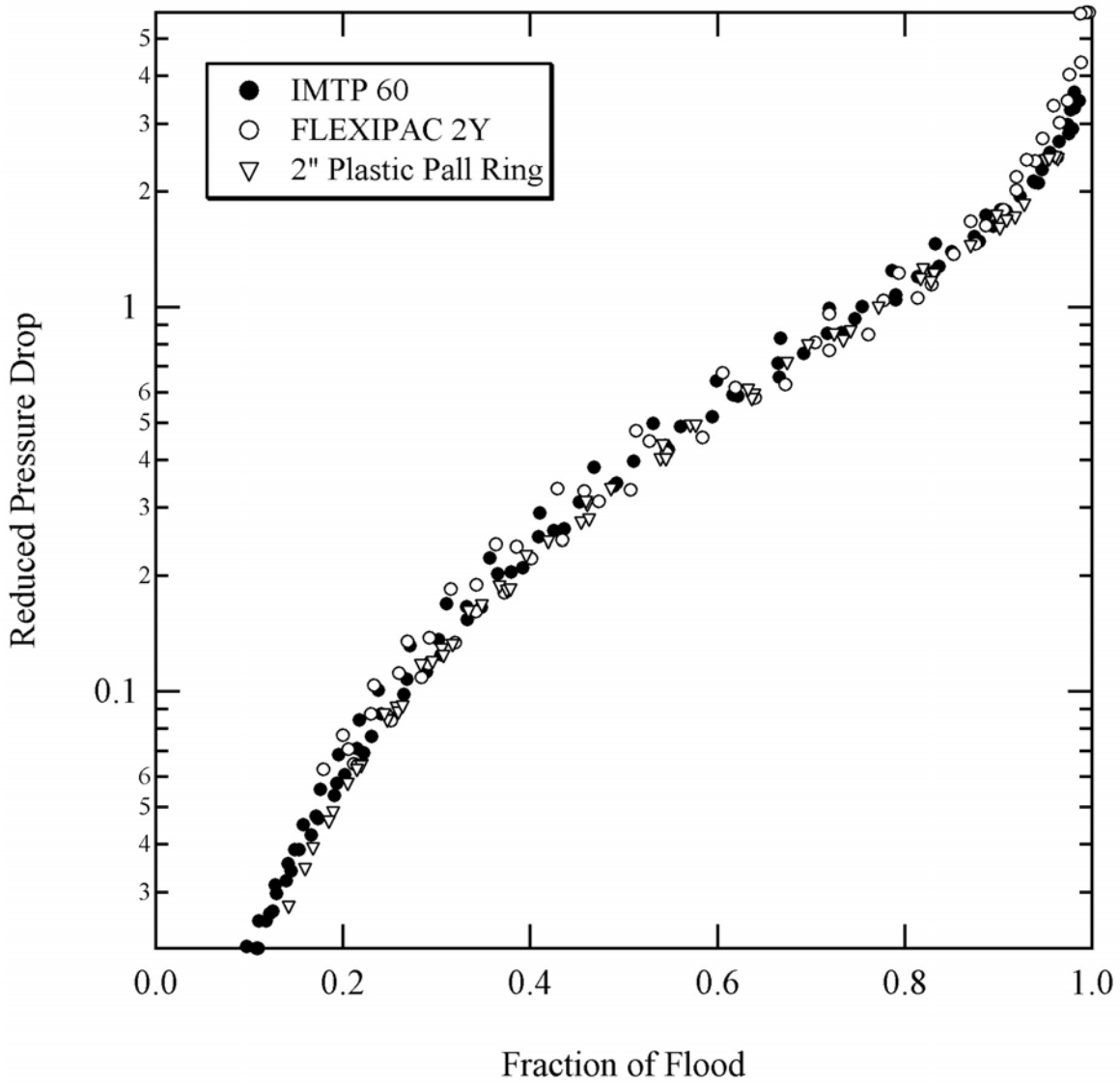

50mm Ceramic HiFlow Ring
Liquid Loadings
(m3/m2-hr)
10
20
40
Pressure Drop, (Δp/Z)2ϕ , (mbar/m)
Fractional Flood
0
2
4
6
8
10
12
14
0.0
0.2
0.4
0.6
0.8
1.0
1.2


1" Ribbed Ceramic Rings
Liquid Loadings
(m3/m2-hr)
19.54
35.17
48.60
61.06
Pressure Drop, (Δp/Z)2ϕ , (mbar/m)
Fractional Flood
0
5
10
15
20
25
30
35
0.0
0.2
0.4
0.6
0.8
1.0
1.2


IR 70
Liquid Loadings
(m3/m2-hr)
60
100
150
Pressure Drop, (Δp/Z)2ϕ , (mbar/m)
Fractional Flood
0
5
10
15
20
0.0
0.2
0.4
0.6
0.8
1.0
1.2

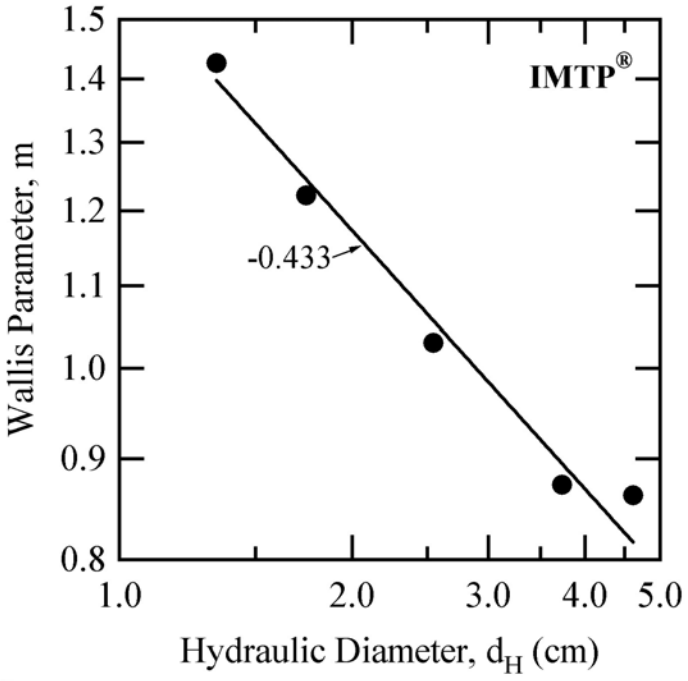

Nutter Ring #1
Liquid Loadings
(m3/m2-hr)
60
100
150
Pressure Drop, (Δp/Z)2φ , (mbar/m)
Fractional Flood
0
5
10
15
20
0.0
0.2
0.4
0.6
0.8
1.0
1.2

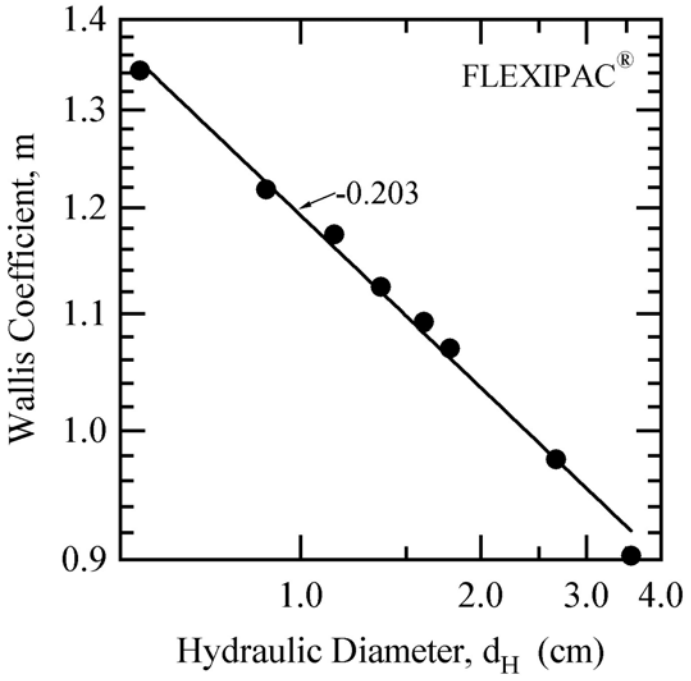

Nutter Ring #2
Liquid Loadings
(m3/m2-hr)
20
60
100
150
Pressure Drop, (Δp/Z)2ϕ , (mbar/m)
Fractional Flood
0
5
10
15
20
0.0
0.2
0.4
0.6
0.8
1.0
1.2


IMTP 60
FLEXIPAC 2Y
2" Plastic Pall Ring
Reduced Pressure Drop
Fraction of Flood
0.0
0.2
0.4
0.6
0.8
1.0
0.1
1

Model for Pressure Drop
-The Wallis Equation-

$$\sqrt{C_S^*} + m\sqrt{C_L^*} = c$$



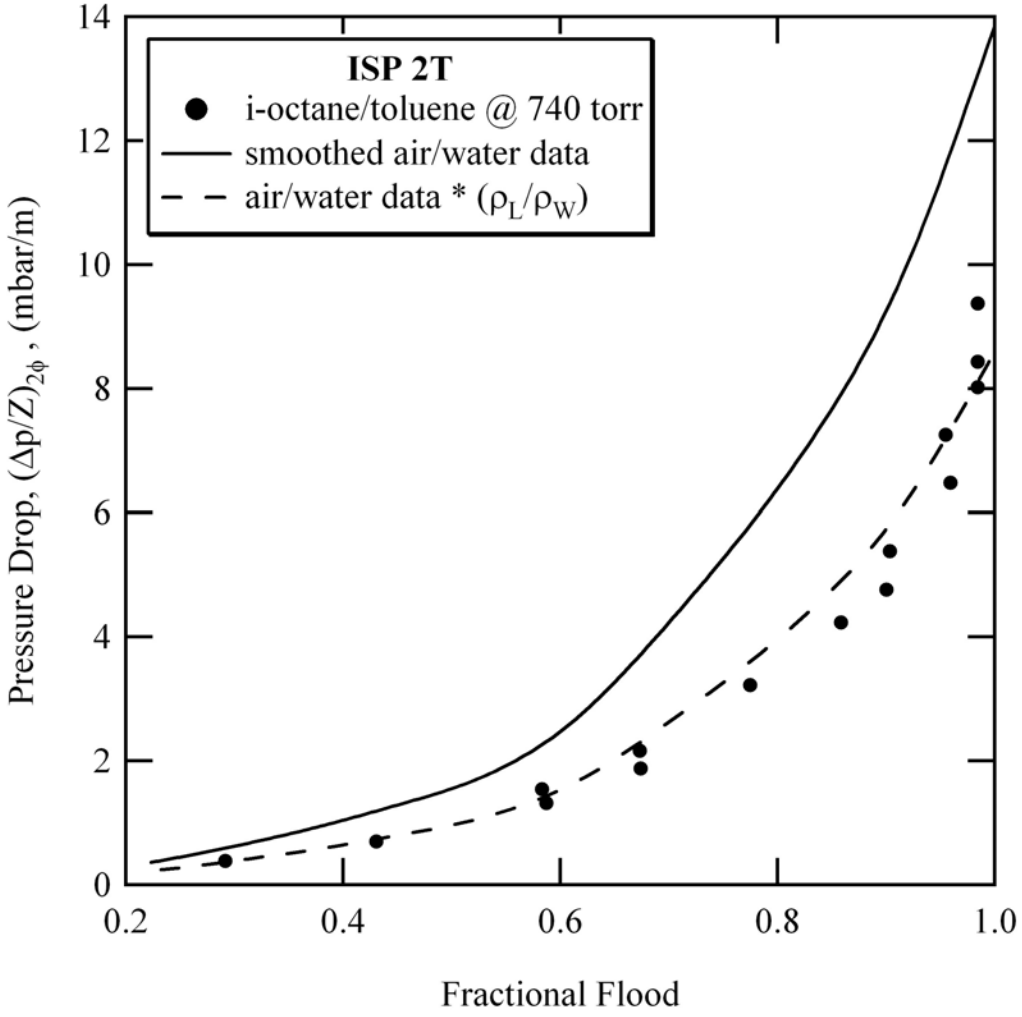


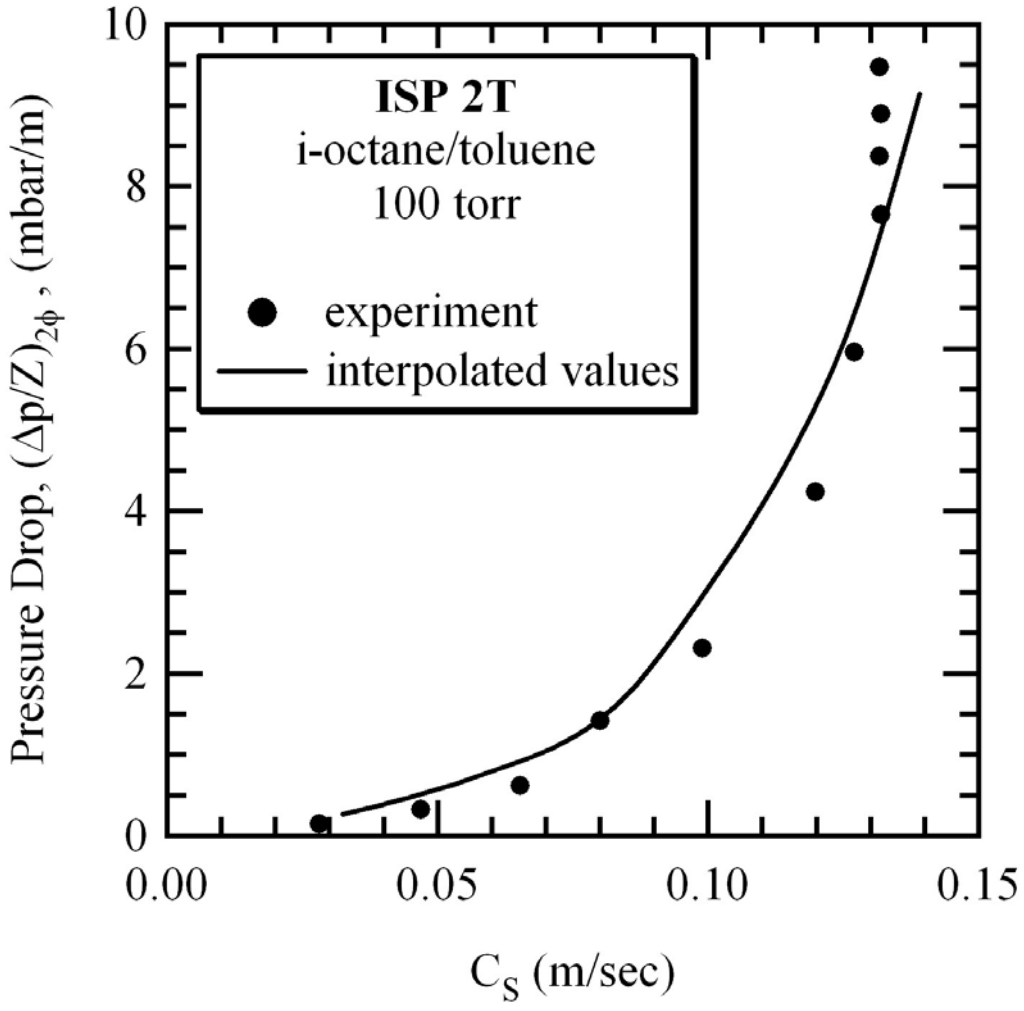
Dimensional Similitude and Experiment Imply That the Wallis Parameters Scale As

$$m \propto \left(\frac{d_H^2 \rho_L \, g}{\sigma_L} \right)^{b'}$$

$$c \propto \left(g \, d_H \varepsilon^2 \right)^{1/4} \left(\frac{d_H^2 \rho_L \, g}{\sigma_L} \right)^{y}$$

Air/Water Collapse Doesn't Predict Pressure Drop For Another Liquid Directly





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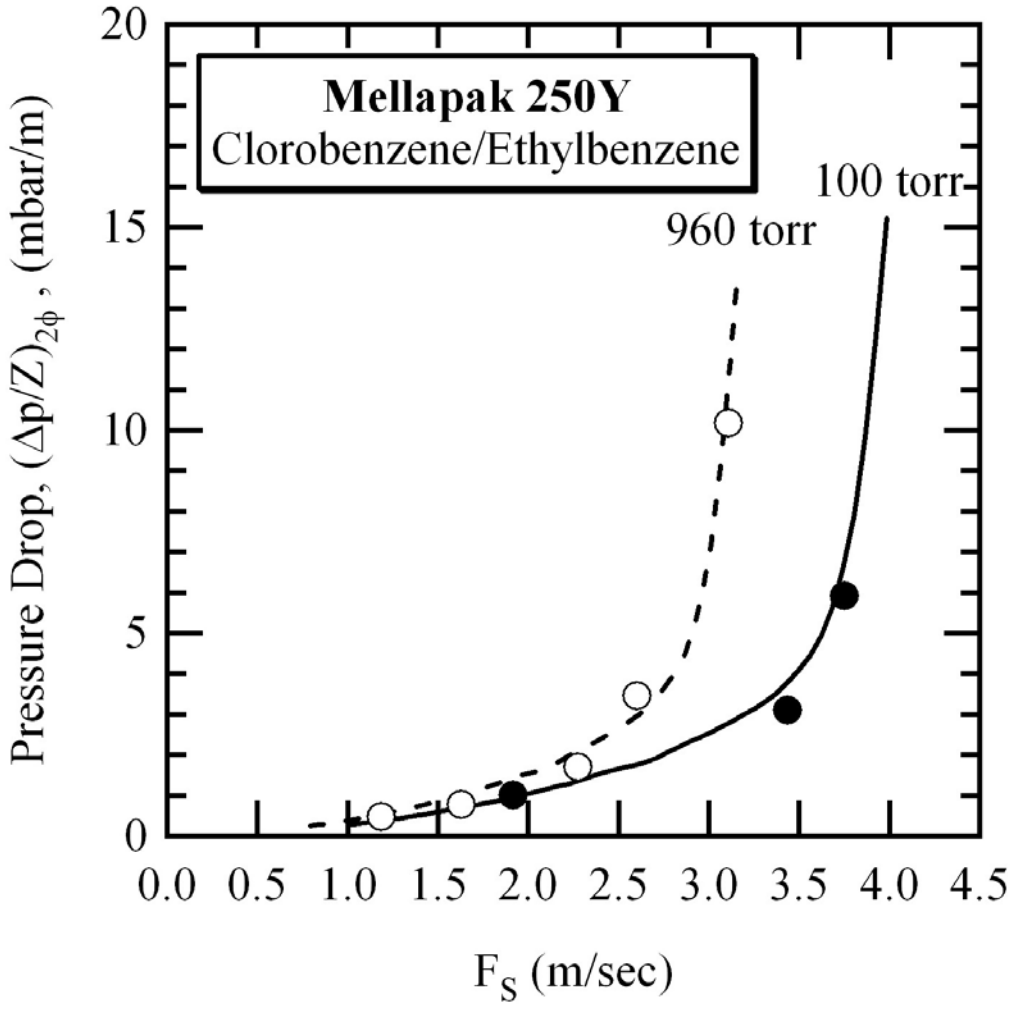
Mellapak 250Y
Clorobenzene/Ethylbenzene
100 torr
960 torr
Pressure Drop, $(\Delta p/Z)_{2\phi}$, (mbar/m)
F_S (m/sec)
0
5
10
15
20
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

Final Model Formulation
Values Can Be Obtained from Interpolation

$$\frac{(\Delta p/Z)_{2\phi}}{\rho_L g} = \Pi(\Im) \; and \; \Im = C_S/C_{S,F} = F_S/F_{S,F}$$

$$\Im = \frac{C_S}{C_{S,F}} = \frac{C_S}{\left(c_W \left[\frac{\rho_L \sigma_W}{\rho_W \sigma_L} \right]^{(\gamma - 1/4)/2} - m_W \left[\frac{\rho_L \sigma_W}{\rho_W \sigma_L} \right]^{\beta/2} \sqrt{C_L} \right)^2}$$