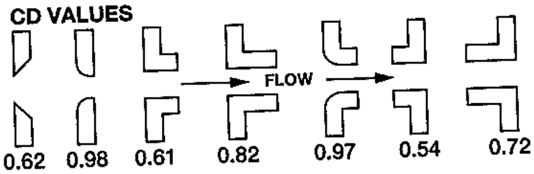
Orifice Calculations

Fluid flow through fixed openings is readily predictable by calculation. The formulae may be used to approximate the pressure drop (PSIG) in the basic circuit shown. No allowance has been made for passages on either side of the orifice.

CD VALUES



Q = Flow Rate (GPM)
SG = Specific Gravity
cd = Orifice Coefficient
ΔP = Pressure Drop (PSIG)
d = Orifice Diameter (inches)

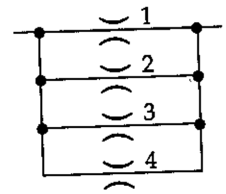
PARALLEL CIRCUIT:

$$\Delta P = SG*\left[\frac{1}{\frac{29.81}{GPM}*\left[cd_1*d_1^2+cd_2*d_2^2+cd_3*d_3^2+cd_4*d_4^2\right]}\right]^2$$

$$Q=\left[29.81*\sqrt{\frac{\Delta P}{SG}}\right]*\left[cd_1*d_1^2+cd_2*d_2^2+cd_3*d_3^2+cd_4*d_4^2\right]$$

EXAMPLE: Find the flow rate (GPM) that passes (4) orifices of different sizes with a system pressure of 1,000 PSIG @ 0.85 SG. All have an orifice coefficient of 0.62. d_1= 0.2, d_2= 0.1, d_3= 0.3 and d_4= 0.25

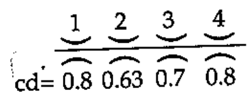
Use the single orifice formulae to establish flows across individual orifices, if desired.



$$Q=\left[29.81*\sqrt{\frac{1{,}000}{0.85}}\right]*\left[0.62*0.2^2+0.62*0.1^2+0.62*0.3^2+0.62*0.25^2\right]=128.37\ GPM$$

SERIES CIRCUIT:

NOTE: For additional orifices, add terms $cd_5\ d_5$, $cd_6\ d_6$, etc.For less orifices, eliminate terms $cd_n\ d_n$ as desired.



$$\Delta P=\frac{SG*GPM^2}{29.81^2}*\left[\left[\frac{1}{cd_1*d_1^2}\right]^2+\left[\frac{1}{cd_2*d_2^2}\right]^2+\left[\frac{1}{cd_3*d_3^2}\right]^2+\left[\frac{1}{cd_4*d_4^2}\right]^2\right]$$

EXAMPLE: Find the ΔP (PSIG) across (4) orifices @ 15 GPM. Each 0.156 diameter, SG = 1.0 and cd_n varies as noted in the example.

$$Q=\sqrt{\frac{\Delta P*29.81^2}{\left[\left[\frac{1}{cd_1*d_1^2}\right]^2+\left[\frac{1}{cd_2*d_2^2}\right]^2+\left[\frac{1}{cd_3*d_3^2}\right]^2+\left[\frac{1}{cd_4*d_4^2}\right]^2\right]*SG}}$$

$$\Delta P=\frac{1.0*15^2}{29.81^2}*\left[\left[\frac{1}{0.8*0.156^2}\right]^2+\left[\frac{1}{0.63*0.156^2}\right]^2+\left[\frac{1}{0.7*0.156^2}\right]^2+\left[\frac{1}{0.8*0.156^2}\right]^2\right]=3286\ PSIG$$

Use the single orifice formulae to establish individual pressure drop across each orifice if desired.

SERIES/PARALLEL CIRCUIT:

Solve for P_1, P_x, x or Qx for first orifice "X" using single orifice calculations:

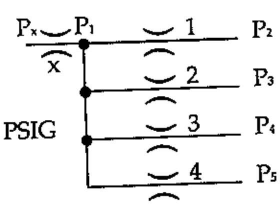
$$Q_x=29.81*cd_x*d_x^2*\sqrt{\frac{\Delta P}{SG}} \qquad \Delta P=SG*\left[\frac{Q_x}{29.81*cd_x*d_x^2}\right]^2$$

$$d_x=\sqrt{\frac{Q*\sqrt{\frac{SG}{\Delta P}}}{29.81*cd_x}}$$

EXAMPLE: Find the ΔP (PSIG) across orifice X, if Q = 10 GPM, cd_x = 0.62, d_x = 0.19, SG = 1.0 and P_x = 1,500

$$\Delta P=1.0*\left[\frac{10}{29.81*0.62*0.19^2}\right]^2=224.635\ PSIG$$

P_1 = 1,500 - 224.635 = 1,275.365 PSIG



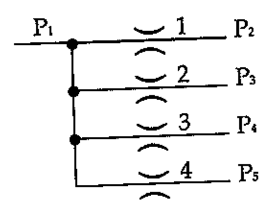
THEN USE

PARTIAL PARALLEL CIRCUIT:

$$Q=\frac{29.81}{\sqrt{SG}}*\left[cd_1*d_1^2*\sqrt{P_1-P_2}+cd_2*d_2^2*\sqrt{P_1-P_3}+cd_3*d_3^2*\sqrt{P_1-P_4}+cd_4*d_4^2*\sqrt{P_1-P_5}\right]$$

If cd is constant:

$$Q=\frac{29.81}{\sqrt{SG}}*cd\left[d_1^2*\sqrt{P_1-P_2}+d_2^2*\sqrt{P_1-P_3}+d_3^2*\sqrt{P_1-P_4}+d_4^2*\sqrt{P_1-P_5}\right]$$



EXAMPLE: The input flow of 10 GPM must equal the sum of the flow at orifices 1, 2, 3 & 4. One of several methods may be used. The simplest is to apply the single orifice formulae to orifices 1, 2, 3 & 4, assuring the $Q_1 + Q_2 + Q_3 + Q_4$ = 10 GPM and that $P_1 > P_2$, P_3, P_4 or P_5. Alternately the formulae to the left may be rearranged manually or by computer to solve for any one unknown. The solutions are left to the user.