Commonly Used Equations and Relationships for Compressed Air Systems

There are 7.48 gallons to the cubic foot.
Convert gallons to cubic feet: Gallons/7.48

Cubic feet of free air required to raise a receiver from some pressure greater than 0 gage to a final higher pressure:

$$\text{Receiver volume in cu. ft.} \times \frac{\text{final psig} - \text{initial psig}}{\text{Atm. pressure}}$$

***Usable cubic feet of stored air:**

$$\text{Receiver volume } (ft^3) \times \frac{\text{final psig} - \text{required operating psig}}{\text{Atm. pressure}}$$

*Assumes no compressor supply during demand event.

Fill time for an air receiver:

$$\frac{\text{Receiver volume in cu. ft.} \times (\text{final psig} - \text{initial psig})}{\text{Atm. pressure} \times \text{compressor cfm}}$$

If the demand in cfm is known, the size of an air receiver can be calculated as follows:

$$V = T \times \frac{C \times Pa}{p1 - p2}$$

Where:
V = Receiver volume, in cubic feet.
T = Time allowed (minutes) for pressure drop to occur.
C = Air demand, cfm of free air
Pa = Absolute atmospheric pressure, psia
p1= Initial receiver pressure, psig
p2= Final receiver pressure, psig

3-phase Electric Power:

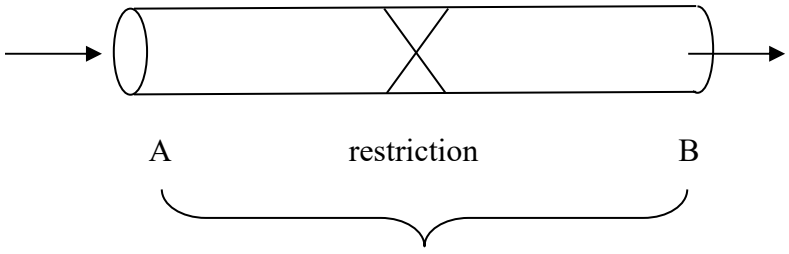
$$P_{kW} = \frac{V_{avg} \times A_{avg} \times \sqrt{3} \times p.f.}{1,000}$$

Air Velocity in a Pipe:

$$V = \frac{cfm \times P_a}{60 \times a \times \left(P_2 + P_a\right)}$$

Where:
V = velocity in ft/sec
cfm= air flow, free air, in ft^3/min
P_a = local barometric pressure in psia
P_2 = gauge pressure in header or pipe
Air temperature in the pipe is presumed to be ambient.
a = cross sectional area of the pipe bore in ft^2 $\quad a = \frac{\Pi \times d^2}{4 \times 144}$

Pressure Drop:



Δp = pressure drop

$$\Delta p_2 = \Delta p_1 \times \left(\frac{v_2}{v_1}\right)^2$$

Where: V = velocity.
Note: with the same pressure and pipe diameter, V can be replaced with Flow (cfm)

Calculate Flow or Leakage from Cycle Time on a Load/Noload compressor:

$$\text{Leakage (\%)} = \left(\frac{T}{T+t}\right)\times 100$$

Where: T = loaded time (seconds)
t = unloaded time (seconds)

Note: In general, this formula only applies to a trim compressor which operates in load/unload or start/stop mode. This formula can also be used to determine the average airflow contribution of the trim (cycling) compressor. To do so, omit the base loaded compressor contributions