Basic Valve Sizing:

Air valves are sized for flow capacity (Cv) based upon a given cylinder piston size, stroke and travel time requirements. Cv is actually a flow coefficient that measures the amount of air a device can pass. The following formula can be used for air valve sizing:

$$Cv = \frac{\text{Area (in}^2\text{) x Length (ins) x Compression Factor}}{\text{Pressure Drop Factor x Time (secs) x 29}}$$

- Area = Effective cylinder piston area in square inches (A = 3.1416 x radius^2…. or…. A = diameter^2 x .7854)

Note: For the rod or annulus end of the cylinder, the same area formula applies, but to calculate rod end area accurately, one must take the piston cylinder area (in^2) and subtract that from the rod end area (in^2). This is the correct way to use the valve sizing formula for calculating the *return stroke* Cv rating.

- Length = Simply the total cylinder stroke distance in inches
- Compression Factor = Taken from the table based upon supply pressure rating
- Pressure Drop Factor = Taken from the table

(10 or 15 psi drop is a good guideline for using in this formula)

- Time = Required cylinder total stroke time in seconds

Supply	Compression	Pressure Drop Factor for Various Pressure Drops				
Pressure	Factor	2	5	10	15	20
40	3.7	9.9	15.3	20.5	23.6	N/A
50	4.4	10.8	16.7	22.6	26.4	29.0
60	5.1	11.7	18.1	24.6	29.0	32.0
70	5.8	12.5	19.3	26.5	31.3	34.8
80	6.4	13.2	20.5	28.2	33.5	37.4
90	7.1	13.9	21.6	29.8	35.5	39.9
100	7.8	14.5	22.7	31.3	37.4	42.1
110	8.5	15.2	23.7	32.8	39.3	44.3
120	9.2	15.8	24.7	34.2	41.0	46.4
130	9.8	16.4	25.6	35.5	42.7	48.4
140	10.5	16.9	26.5	36.8	44.3	50.3
150	11.2	17.5	27.4	38.1	45.9	52.1

Sizing Example:

- 6 inch bore cylinder / 2-inch rod thickness / 15-inch total stroke
- 2 second total travel time / 100 psi supply pressure
- We will use a 15-psi pressure drop factor

Calculate the 6" diameter piston bore area in square inches for extend calculations

$A = d^2 \times .7854 \ldots\ldots 6^2 \times .7854 \ldots\ldots 36 \times .7854 = 28.27\ (in^2)$ piston area

Note that this is for the cylinder extend area. To determine the cylinder

return area, the rod area must be calculated in square inches and then

this value must be subtracted from the piston bore area in square inches.

- Calculate the 2" diameter rod end area in square inches

$A = d^2 \times .7854 \ldots 2^2 \times .7854 \ldots 4 \times .7854 = 3.1416\ (in^2)$ rod are

- Calculate the annulus or rod end area of the cylinder for retract calculations

Cylinder return area = $28.27\ (in^2) - 3.1416\ (in^2) = 25.12\ (in^2)$

- Now apply all of these "givens" and calculations to the Cv sizing formula

Extend: $\frac{28.27\ (in^2) \times 15" \times 7.8}{37.4 \times 2 \text{ secs} \times 29} = \frac{3307}{2169} = 1.52$ Cv to extend

Extend: $\frac{25.12\ (in^2) \times 15" \times 7.8}{37.4 \times 2 \text{ secs} \times 29} = \frac{2939}{2169} = 1.52$ Cv to extend

- Select a valve that meets the higher 1.52 Cv rating.

Note: Many fluid power engineering and data resources have flow charts to simplify this process, but in the absence of those charts, this information should help with sizing pneumatic valve requirements.

Air Flow Rates:

- Standard Cubic Feet Per Minute (SCFM) = One cubic foot of gas (air) per minute at standard conditions of 68°F, 14.69 psi and a relative humidity of 36%.
- Cubic Feet Per Minute (CFM) = One cubic foot of gas (air) per minute at actual conditions…. i.e.: at actual temperature and compressed or expanded pressure.

- Free Air Flow = The volume of air at normal atmospheric conditions which enters a vacuum system due to the lower pressure caused by the pump or vacuum in a tank.
- Expanded Air Flow = Air flow inside a vacuum system, same as CFM.
- SCFM and Compressor Horsepower Requirements = To calculate pneumatic cylinder air consumption in SCFM and convert it to required air compressor horsepower.

Quick Reference Formulas:

- Area (sq ins) = $\pi \times r^2$ where π (pi) = 3.1416 and r = radius in inches squared
- Area (sq ins) = $\pi \times d^2 / 4$ where π (pi) = 3.1416 and d = diameter in inches
- Circumference (ins) = $2 \times \pi \times r$ where π (pi) = 3.1416 and r is radius in inches
- Circumference (ins) = $\pi \times d$ where π (pi) = 3.1416 and d = diameter in inches
- Pressure (psi) = force (lbs) / area (in^2)
- Force (lbs) = area (in^2) x pressure (psi)
- Area (in^2) = force (lbs) / pressure (psi)
- Cylinder Volume (head end) = piston area (in^2) x stroke (ins)
- Cylinder Volume (rod end) = (piston area (in^2) - rod area (in^2)) x stroke (ins)
- Compression Ratio = (psig + 14.7) / 14.7
- Consumption (cu ft) = Area (in^2) x Stroke (ins) x compression ratio / 1,728
- Air Demand (scfm) = 60 x Area (in^2) x piston speed x compression ratio / 1,728
- Peak Air Flow (Q) = volume / time x compression ratio
- Torque = force x perpendicular distance from the shaft
- Water Weight (lbs) = gallons x 8.3453

Note: This information is provided as a quick reference resource and is not intended to serve as a substitute for qualified engineering assistance. While every effort has been made to ensure the accuracy of this information, errors can occur. As such, neither IFP, any of its affiliated companies nor its employees will assume any liability for damage, injury or misapplication as result of using this reference guide.