[1]<https://www.cedengineering.com/userfiles/Control%20Valves%20Basics%20-%20Sizing%20&%20Selection.pdf>

Ball Valves

* high recovery valves, having a low pressure drop and relatively high flow capacity.
* Usually open or closed, limited throttling
  + Not what we want

Butterfly Valves

* Minimal pressure drop when fully open (good for us)
* Limited throttling

**Globe Valves**

* Precise flow regulation, but design introduces lots of turbulence to flow even when fully open
  + This means an open valve would still have a decent amount of resistance
* Wide throttling
* **Needle valves are in this category**

Gate Valves

* Best for open/closed
* Best for infrequent operation, good sealing

Types of actuators:

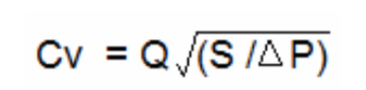
Pneumatic, **electronic**, manual

* Electronic has superior precision, fastest response time
* Mechanical has same range of regulation but with much longer timescale of adjustment (also much cheaper)

Types of regulators:

* Fixed orifice flow regulators
  + needle/globe valve, select a constant orifice size
* Pressure compensating flow regulators
  + Include a spring to retain constant flow rate despite pressure changes

**General guidelines: Valves should be sized so that maximum flow is obtained at about 90% valve open. Valves should be able to provide normal flow conditions at around 60% to 70% of the travel. Valve should provide minimum flow when about 10% open [1].**

**Flow Coefficient Cv:**

* Cv = amount of flow in gpm that will flow through the valve when it is **100% open** with a pressure differential of 1 psi (S is specific gravity, which is 1 for our purposes)
  + Our max pressure differential across the valve is going to be 180mmhg (3.5psi) according to our requirements, but typically it will be 120 (2.3psi)
  + Our max flow will be around 5L/min = 1.32gpm
  + So we want at a pressure difference of 2.3psi across an open regulator to allow 1.32gpm of flow
    - Cv = 1.32gpm / sqrt(2.3psi) = **0.87**
  + But really pulmonary pressures are the limiting case. Cv of 0.87 → no way we will get 5L/min at a pressure drop of 20mmHg across the regulator.
    - We need 5 L/min with 20mmHg (.38psi) drop across the valve
    - Cv = 1.32gpm / sqrt(.38psi) = **2.14**
    - We want normal flow (5L/min) when the valve is ~60% open, so a Cv closer to 3 would probably be fine

<https://www.globalspec.com/industrial-directory/electronic_air_flow_control_valve#articles>

|  |  |
| --- | --- |
| Viable Options | |
| Mechanical | <https://www.mcmaster.com/45585k78> (Cv = 2.67)   * can connect to tubing of ¾” OD   <https://www.mcmaster.com/1042k21> (Cv = 2.47)  [1042K36](https://www.mcmaster.com/1042K36) |
| Electronic | <https://www.omega.com/en-us/valves-pumps-and-mixers/valves/proportional-valves/pv14/p/PV12-B> (Cv = 3.5) |

**How necessary is an automatic valve?**

* Main purpose: augment the function of the pump to have finer control over pressure waveform
  + It would primarily augment the pressure curve *after* the pump “contraction” is finished, assuming the pump is capable of generating the initial curve

