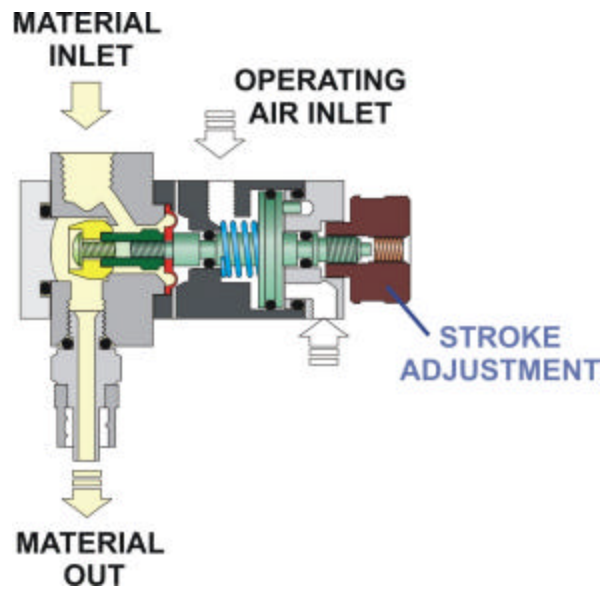


I&J Fisnar Inc. Dispensing Dynamics - Part 4 – Fluids, Valves



Most industrial valves used in dispensing liquids and pastes continue to be pneumatically operated. The overwhelming reasons are reliability and high cycle performance.

Selecting a Pneumatic Valve

Operation of a Pneumatic Valve

By actuating a timed air pulse originated from a controlled air source, an air solenoid in the valve opens a seal (gate), which allows material to flow unrestricted for the duration that the seal is opened. A return-spring returns the seal to its closed position, preventing fluid from flowing. For fast cycling, a 4-way action is recommended. This requires an initial air pulse to open the seal and a final pulse to snap the seal shut after a timed interval. The minimum operation time for any valve is 0.2 seconds and a minimum pressure of 65 psi.

Pinch-tube valves simply pinch a tube, in the normal or closed state. When an air pulse is received, the pinch is released when the solenoid is actuated.

Controllers can be stand-alone bench systems with timed pulse outputs, integrated robotic-timed pulses or PLC actuated air solenoids. In the case of spray valves, a controller ensures that the atomizer commences before fluid flow and stays on momentarily after the fluid shuts off.



The precision of the pulse-timed material deposit depends upon the construction and quality of the valve.

Considerations in Selecting a Pneumatic Valve

The two considerations in selecting a valve are: **Fluid and Purpose**

We will first consider the **Fluid** and later the **Purpose** (what action the valve will perform).

Fluid

All fluids have three groups of features that accurately describe the substance of the fluid:

Group 1 – Consistency
Group 2 – Character
Group 3 - Condition

Group 1 - Consistency:

- Watery
- Creamy
- Gel
- Treacle
- Paste

Group 2 - Character:

Terms that will further define the consistency of the fluid:

- Viscosity (The relationship of a liquid when compared with water at 1.002 measured in centipoise {cps})
- Thixotropy (The property of various gels becoming liquid when disturbed)

(Further examples of Viscosity)

| | |
|----------------|--|
| Water: | 1.002 cps |
| Vegetable oil: | 80 cps |
| Engine oil: | 1000 cps |
| Milk: | 8000 cps |
| Ketchup: | 30,000 cps (ketchup is also thixotropic) |
| Mustard paste: | 200,000 cps |

Group 3 - Condition:

- Corrosive
- Abrasive (fillers)
- Cure rate and conditions of cure
- Anaerobic

Fluid Examples

A combination of features from these three groups will accurately describe the material and assist in selecting the right valve.

Example FLUID-A: Describes a paste-like corrosive fluid of 200,000 cps that will require a valve with resistant seals. The valve will require regular maintenance due to the fluid's corrosive content.

Example FLUID-B: Describes a light fluid of 100 cps that cures quickly, such as cyanoacrylates. A suitable valve will separate the wetted parts from the air-actuated moving parts. A further issue in this case will be the likely necessity to purge or park the tip in a material that prevents clogging during dispense cycles.

From these two examples we can begin to see the complexity that builds using the three groups.

We will refer to these examples later in this chapter.

Application of Fluid Groups

Let us again take the first group and apply the listings to an appropriate valve construction and type.

Group 1 - Consistency:

- Watery
- Creamy
- Gel
- Treacle
- Paste

- **Watery fluids** are always characterized as low-viscosity and require a valve construction that allows low material pressure, often gravity fed. The valves are either pinch-tube, needle or diaphragm operated.

- **Creamy fluids** are of medium- to high-viscosity. The pneumatically pressurized reservoirs that feed creamy materials to the valve can require de-gassing and agitation. The valve is usually of a spool or poppet variety integrating a suck-back or snuff-back feature to stop post-dispense oozing. Medium-viscosity fluids can be dispensed with pneumatically operated needle valves.

- **Gel fluids**, e.g. silicones, are mostly dispensed directly from their packaged container, such as a 1 gallon or 5 gallon pail or a 1/10th gallon cartridge. Pail fluid is extruded to the valve by pneumatic pumps using a follower-plate to mechanically force the material through a high-pressure braided hose to the valve. Cartridges are pneumatically pressurized and can suffer from tunneling if the package is not designed for automated dispensing. For these higher viscosity fluids, the valve design is again a spool and/or poppet type. Some gels can be described as thixotropic, an

example is ketchup. Thixotropic fluid is difficult to pour but moves easily against itself and becomes more of a creamy fluid when agitated.

- **Treacle type fluids** are subject to the same requirements as gels but are often supplied in small cans that have not been de-gassed. Therefore, careful consideration should be given to how the material is fed to the valve so as to deliver air-free fluid.

- **Paste fluids** are of very high viscosity and are dispensed directly from their packaged container, such as a 1 gallon or 5 gallon pail or 1/10th gallon cartridge. The material is supplied de-gassed but confirmation should be sought from the manufacturer. A quality supplier is essential when using these materials. Pneumatic valve types for pastes are spool, poppet or a high-pressure needle valve.

Note: Electrically operated auger/screw valves are also recommended for micro deposits of high-viscosity fluids.

Group 2 - Character:

- **Viscosity** – directly affects the valve type. Watery and creamy fluids having low viscosities can be dispensed with diaphragm, needle or pinch-tube valves, whereas high viscosity valves usually require a spool or poppet style. However, some needle valves are designed as high-pressure valves and rated for a high-pressure fluid supply.

- **Thixotropy** – although listed as a consideration, thixotropic materials are heavy creams or gel-like consistency substances and as such dictate the same requirements for a pneumatic valve as their viscosity rating at the time of delivery to the valve. As the material is also under pressure in the feed hose and the valve's wet-chamber, an alteration to its thixotropic nature will be experienced.

At this stage we have an idea of the type of pneumatic valve required for a fluid substance. Now we must look at the condition of these fluids that will further impact the decision to correctly specify the valve construction.

Group 3 - Condition:

3.1 Corrosive

3.2 Abrasive (fillers)

3.3 Cure rate and conditions of cure

3.4 Anaerobic

- **Corrosive fluids** affect most fluids and can contain acids, alkaline, methanol alcohol and solvents. Each of these conditioners will react upon the fluid wet-chamber and the seals ("O" rings) used in the valve's wet-chamber. Therefore, if a diaphragm or needle valve has been selected, the wetted parts used in the construction must be suitable for corrosive substances.

For acids, seals and “O” rings should be fabricated from Ultra High Molecular Weight (UHMW) material that is resistant to acids. UHMW is also suitable for alcohol and methanol. Other materials such as PEEK can be used depending upon the corrosive content. Pinch-tube valves are often used with acids and all types of solvents using polyethylene disposable tubing. Pinch-tube valves have no wet-chamber that can be corroded.

Since adhesive fluids, such as cyanoacrylates, are solvent based and highly corrosive, a diaphragm valve with either a polyethylene or stainless steel wet-chamber should be selected with UHMW seals/”O” rings. Alternatively, a pneumatic pinch-tube valve can be selected with polyethylene tubing.

- **Abrasive (fillers)** are used for several reasons and mostly apply to pastes; examples are to increase conductivity or improve dielectric properties. Not all fillers are abrasive; therefore, the nature of the filler should be discussed with the manufacturer and supplier in order to avoid unnecessary expense in the selection of the valve.

Once it is confirmed that the fluid contains an abrasive, select a valve with a high-grade hardness stainless steel wet-chamber and resistant seals that will stand up to constant abrasion with the minimum of maintenance. However, it is good practice to have replacement valves at the ready while maintenance is carried out.

- **Cure rate and conditions of cure** – cure rate is particularly relevant in automated and robotic dispensing. A changing cure rate alters the process consistencies, such as the time to complete a bead. If the fluid cures quickly, continuous monitoring and Park-Purge is necessary. While this does not impact strongly on the type of pneumatic valve used, it will impact upon the ease of maintenance that will probably be required. Therefore, a valve should be selected with easily replaceable parts or parts that are disposable. It is often necessary to apply a constant temperature control system that includes the valve to maintain a constant fluid viscosity throughout the dispensing apparatus, thus ensuring consistent deposition and reduced down time.

- **Anaerobic** – these fluids cure in the absence of air, so the material feed and the valve’s wet-chamber need to be porous. Valves which handle anaerobic fluids are likely to be diaphragm or pinch-tube using plastic wetted materials, although there are also needle types available with plastic inserts.

At this stage we have carefully considered the material and have a good knowledge of how the fluid will dictate the pneumatic valve construction required, but a number of valve types will be suitable for the **Fluid** but not suitable for the **Purpose**, which brings us to the next important consideration: the purpose for which the valve will be used.

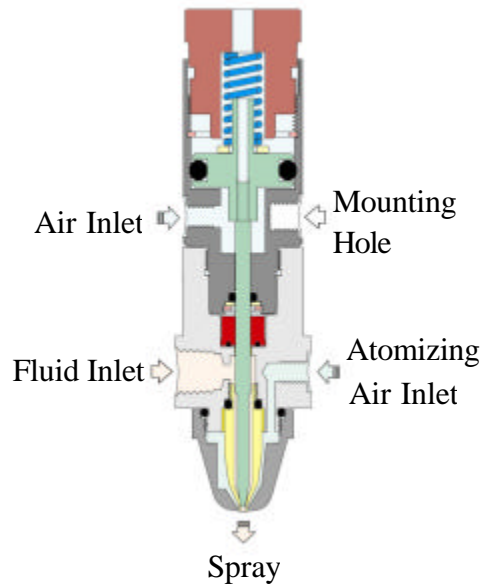
Selecting a Pneumatic Valve for a Dispensing Purpose

Pneumatic valves are available in the following configurations:

- Spray Valves
- Needle Valves
- Diaphragm Valves
- Spool Valves
- Poppet Valves
- Pinch-Tube Valves
- Positive Displacement Valves

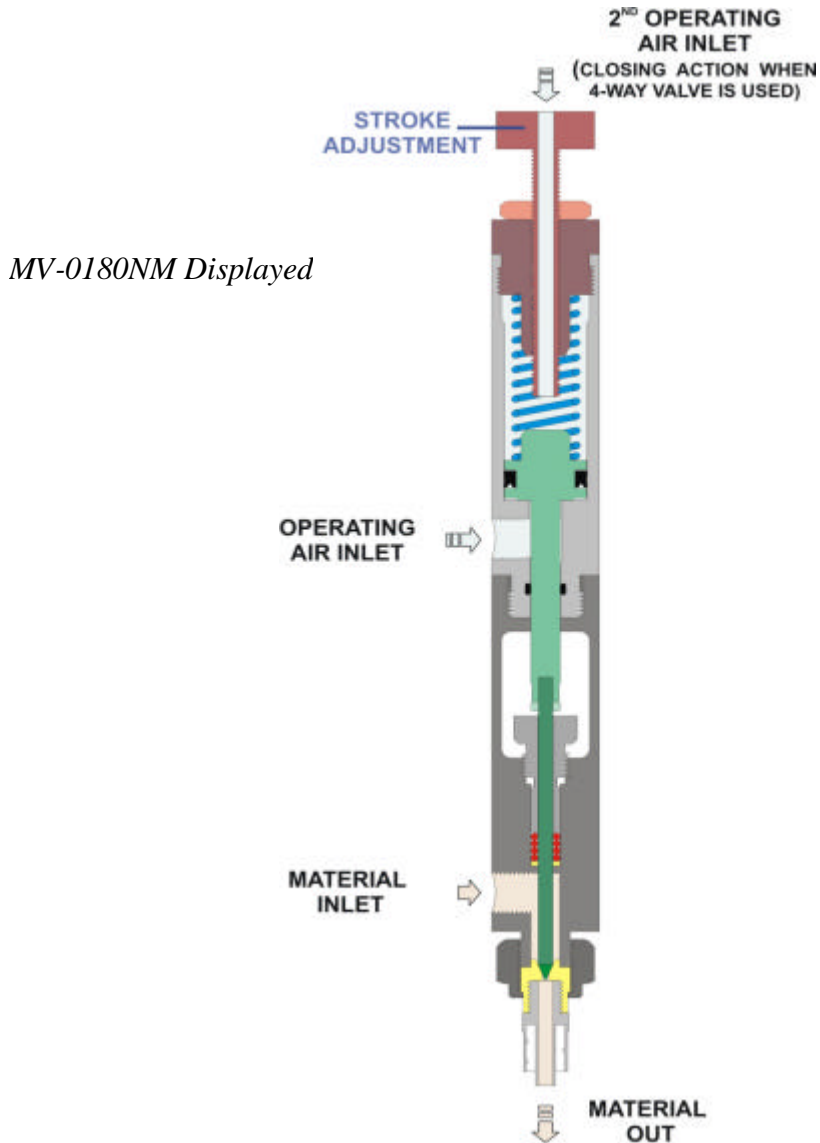
Note: Pneumatic valves can be Adjustable or Fixed.

Spray Valve Models SV1217 and SV1000SS



Obviously if the application is spraying, only a spray valve will be suitable. The material must be low viscosity, typically less than 1000cps. The criteria to ensure proper selection are the angle of spray permitted by the valve and the control module, ensuring that atomization takes place prior to material flow and then remains momentarily after the fluid has ceased to flow, thus preventing clogging common with conformal coating products.

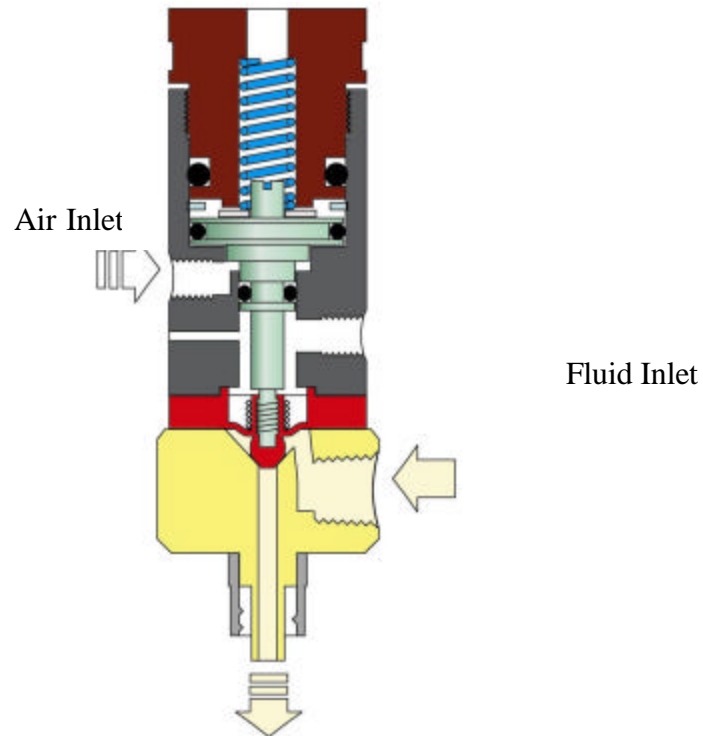
Needle Valve Models MV-0180NM, LV-0126NM and Cartridge Valve CV629



A needle valve is ideal for single micro-shot deposits of all types of fluids, providing its construction is suitably configured to handle the condition of the fluid. They are often adjustable and, if rated for high-pressure work, will handle high-viscosity (unfilled) material. As they can be opened for any determined time, needle valves are often also suitable for applying beads of low to medium viscosities. They are not recommended for abrasive materials which can clog.

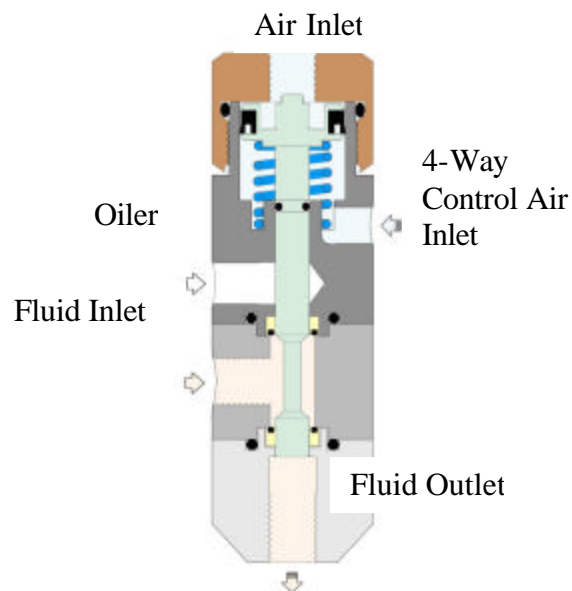
The CV629 has a replaceable cartridge seal between the wet-chamber and moving parts. This enables a set maintenance schedule to be implemented based on cycling of the valve.

Diaphragm Valve Models DV509 and VD510



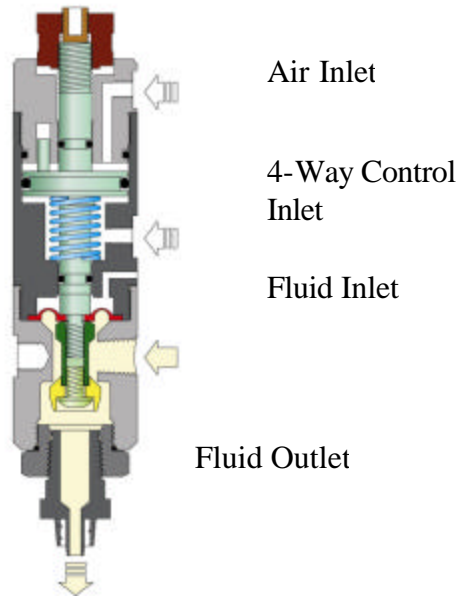
A diaphragm valve is chosen for adjustable high-cycling dispensing of many low - to medium - viscosity fluids including glues, solvents and corrosive agents, providing the valve is configured. They are lightweight and easily maintained.

Spool Valve Models 790HPNM and VMS400



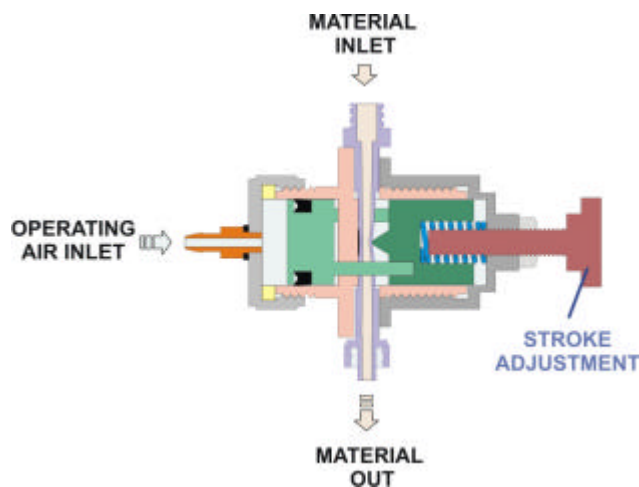
A spool valve is suitable for high-viscosity pastes, treacle and gel type fluids. Spool valves can operate at high material feed pressures necessary for high-viscosity fluids, and they also include a suck-back or snuff-back feature inherent in their design. Ideal for applying beads and with proper automated control they can seamlessly complete a beaded path of fluid as in a gasket. The 790HPNM has an oil gland which is lubricated to protect the valve from silicone vulcanization.

Poppet Valves Models VP300 and VMP30H



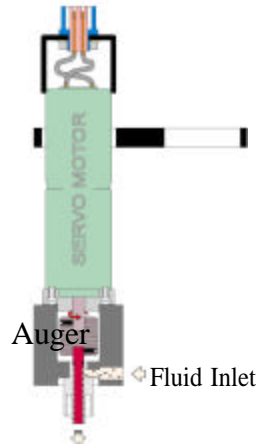
A poppet valve is similar to a spool valve in features; for example, it features suck-back, but is for use with low to mid-high viscosities. It can apply a smaller shot size than a spool valve.

Pinch-Tube Valve Model 710PTNM



Having fully disposable wetted parts, a pinch-tube valve is an economical solution for aggressive solvent-based fluids. It can be used with moderate precision and repeatability within the confines of a pinch-tube design. Take care before using polyurethane tube, as solvent can permeate through. A pinch-tube valve is often used for two-part, meter & mixed applications where the material will cure and disposing of the tube is a low-cost solution.

Positive Displacement (Volumetric) Valves VDP150 and Auger Type PDV-1000



VDP150

For many dispensing applications, particularly in the medical and electronic sectors, the use of a volumetric valve is advisable. These valves operate on the principle of dispensing a determined volume of product instead of the principle of time/pressure dispensing. The amount of product that can be dispensed using a time/pressure solution is affected by the fluid's temperature. As the temperature increases, viscosity decreases. Consequently, the amount dispensed will vary independent of the set pressure and time. A volumetric valve eliminates this issue.

The VDP150 positive displacement valve includes an adjustable chamber that is filled with material and dispensed. The fluid chamber can be adjusted to dispense between 0.005cc and 0.15cc. This valve can operate with lower- to mid- range viscosity materials.

PDV-1000

The PDV-1000 valve contains an auger or Archimedean screw. A small servo motor is connected to the metering screw by means of a flexible joint; the rotation of the motor, and consequently of the metering screw, advances the fluid toward the valve outlet.

The constant supply of fluid to the valve inlet is controlled by low-pressure



compressed air during the valve operation. Typically, the material supply is prepackaged in 30, 10 and 5cc syringes.

The valve is controlled by a dedicated controller PDC-2000, which programs time and rotation speed of the valve motor. Reverse rotation may also be programmed, providing a snuff-back effect at the valve outlet. This type of valve is suitable for products having mid-high (minimum 35,000 cps) and high viscosity, such as adhesives for SMT components or solder pastes.

The choice of a positive displacement or volumetric valve is determined by viscosity and shot size. Pneumatic valves can positively displace lower viscosities than auger valves and their shot size is less in range with a higher minimum deposit. Pneumatic positive displacement valves are less expensive than electronically controlled auger systems.

Finally, let us return to the two examples and add “Purpose” into the decision as to which valve to select:

Example FLUID-A: Describes a corrosive paste-like material of 200,000 cps that will require a valve of heavy-duty construction with resistant seals. The valve will require regular maintenance due to the fluid's corrosive content.

A spool valve is recommended for this example.

In the next example there is a choice, so there are two recommendations:

Example FLUID-B: Describes a light fluid of 100 cps that cures quickly, such as cyanoacrylates. A suitable valve will separate the wetted parts from the air-actuated moving parts. A further issue in this case will be the likely necessity to purge or park the tip in a material that prevents clogging during dispense cycles.

A diaphragm or pinch-tube valve is recommended for this example