

Improving Industrial Dispensing with Pneumatic Dispensing Valves

by Peter Swanson, MA (Cantab), Managing Director, INTERTRONICS

Introduction

The simple pneumatic dispensing machine has become almost ubiquitous. Often available for a fairly modest sum of money, they have improved the application of materials like single part adhesives, coatings, sealants and inks, by enhancing a process from a manual one to one which is less subjective, more controlled and repeatable. There are health and safety benefits as well, with less mess, less exposure to potentially hazardous chemicals and fewer RSI issues.



Figure 1 – Simple pneumatic dispensing

These systems work by filling an industrial syringe or barrel with the liquid material (*Figure 1*). A pulse of air, controlled by the dispensing machine, is applied to the back end. This pushes the liquid in the barrel out of the other end, usually through a dispensing needle or tip. The amount of liquid dispensed can be varied by the size of the needle orifice (they vary from as small as 0.1mm with specials as small as 0.06mm), the amount of pressure applied and the time of that pulse of air. The pulse of air is triggered by a footswitch, finger switch or by automation; as well as hand-held, it is quite common for these liquid dispensers to be mounted on positioning robots¹ or rotary tables.

These systems are reasonably accurate, with less than 1% variance easily achievable with many liquids, and 0.1% not uncommon. The latest dispensers have digital timers for improved accuracy, as well as alarms, auto-purges, counters, and other functionality.

Dispensing Valves

The next rung up the dispensing ladder is to use a pneumatically controlled dispensing valve. The four main reasons to step up to a valve are:

- 1) Increased accuracy – critical applications in areas such as microelectronics or medical device manufacturing may demand higher levels of accuracy and



- repeatability, especially where processes are validated and have fine tolerances². For instance, a dispensing valve can mitigate the effects that temperature induced viscosity changes have on material flow, and will remove the variable of air volume increase as the dispensing barrel empties, which can affect precision of deposits.
- 2) Challenging materials – liquids with characteristics at the extremes become more difficult to use with simple pressure dispensers. Cyanoacrylate adhesives (very low viscosity) and thermally conductive RTV silicone adhesives (very high viscosity) are examples of materials at either end of the rheology range which are more problematic to dispense.
 - 3) Volume – the largest dispensing barrels are typically 55ml in volume, and whilst there are dispensing cartridges available with a capacity of 400ml or more, these are not suitable for handheld use. Barrels and cartridges need to be filled off-line, and changed when empty. For higher daily volumes, then, some form of larger reservoir is needed.
 - 4) Automation – a valve can be fixtured to a robot and provide better stability than a dispensing barrel.

For industrial liquid dispensing, pneumatically controlled valves have been the leading choice for many years. They are robust, accurate, can be cycled quickly and in many cases can be implemented at relatively low cost.

Material Feed

The material to be dispensed is presented in some form of reservoir. Most are pressurised to provide the material flow. Sometimes, very low viscosity materials (e.g. solvent) can be gravity fed. At the other end of the scale, very high viscosity materials (e.g. grease) will require an extrusion pump to get flow. Dispensing barrels and cartridges can also be used to feed dispensing valves – RTV silicones are often sold in a 310ml cartridge, and these materials can be fed direct from their packaging. Other reservoirs take the form of pressure pots, starting in sizes of 500ml and increasing to 10 litres or more (*Figure 2*).

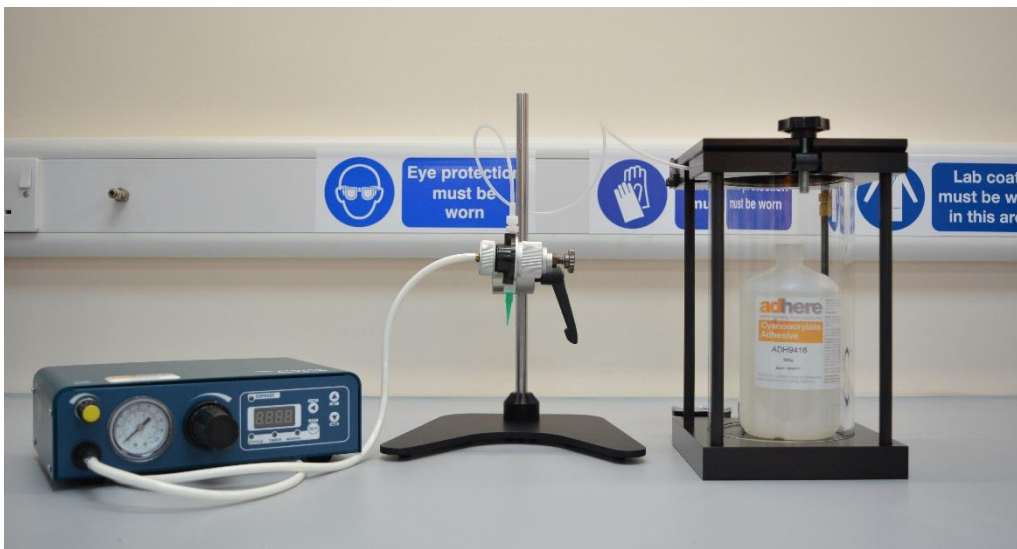


Figure 2 – A pneumatic dispensing valve is fed from a bottle in a glass pressure reservoir. The valve is controlled by a dispensing controller.

Valve Operation

The liquid is fed to the valve through a material hose. The valve is opened or actuated by a pulse of air pressure, allowing the material to flow through the valve. The controlling air pressure is provided by a dispensing controller, the same or similar to a pneumatic dispensing machine described above, or another form of pneumatic logic. When the pulse of air is turned off, the valve closes, usually by means of an integral spring, and the material flow is stopped. A dispensing needle or tip of variable size is attached to the material outlet of the valve. The amount of material dispensed can be varied by the size of the needle orifice, the amount of pressure applied to the material reservoir and the time of the pulse of air which opens the valve.

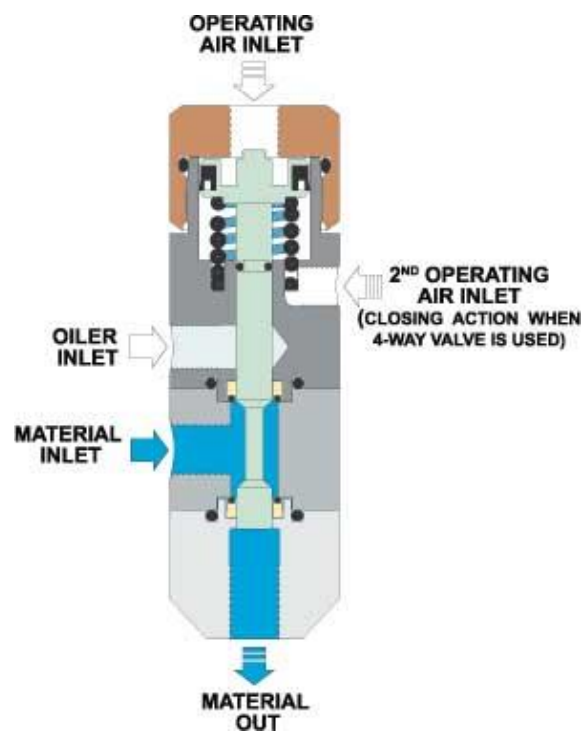


Figure 3 – A cutaway schematic of a poppet dispensing valve, showing material flow path and operating air inlet. There is a stroke adjustment screw, and a second air inlet for an optional closing function.

One of the main advantages of dispensing valves is that they snap close, with a positive cut off of material flow. Some designs inherently “suck-back” the material, improving the dispensing of materials that tend to string, for example. Some designs offer even more responsive closing by using a reciprocal air pulse to shut the valve, instead of the spring (Figure 3).

Valve Types and Selection

There are a number of different types of pneumatic dispensing valves available, including spool valves (Figure 4), diaphragm valves, needle valves, pinch tube valves, poppet valves and spray valves³. Correct selection will depend on both the type of application (coverage, accuracy, shot size, gaskets or beads, etc) and the type of material. Budgetary factors may also come into play.

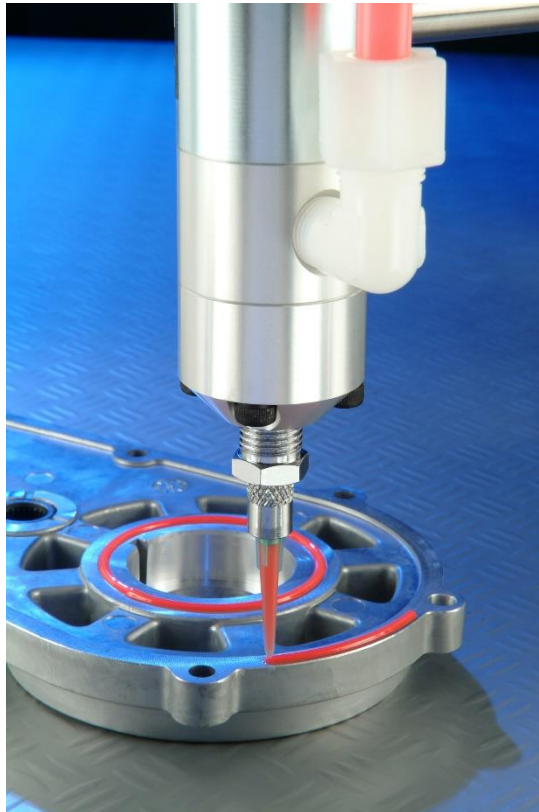


Figure 4 – A high pressure spool valve dispensing a gasket.

The main material characteristics which influence valve selection are:

- 1) Viscosity – liquids with very low viscosity, like water or solvent, might be dispensed with a diaphragm valve or a needle valve. Toothpaste-like materials with very high viscosity like temporary solder mask would dispense better from a spool valve or a poppet valve.
- 2) Cure – adhesives have many different cure mechanisms and a wide range of “pot life” or usable timeframes within which they remain dispensable. For example, the presence of metals and metal ions can prematurely initiate the curing of anaerobic adhesives, or cause them to gel. Similar unwanted reactions can occur with cyanoacrylate or UV curing acrylic adhesives. With adhesives or materials which cure quickly or are easily catalysed, consider using a valve with a disposable fluid path (pinch tube valve) or a fluid path which is both chemically inert and very low wetting (diaphragm valve). Light sensitive materials (e.g. UV curable adhesives) will require light-tight valves, fittings and material hoses.
- 3) Reactivity – materials may have a very high solvency power or be corrosive. Care needs to be taken to select valves where the wetted parts can withstand the reaction with the material to be dispensed. Metal parts might need to be stainless steel. Polymer parts like seals, valve seats and O-rings might need to be an ultra high molecular weight (UHMW) plastic, synthetic rubber or fluoropolymer elastomer like Viton.
- 4) Abrasiveness – materials can have fillers added to them to give properties like conductivity (thermal and/or electrical), chemical resistance, physical robustness or a wide range of other properties including simple bulk. These fillers may be abrasive, which will inevitably cause wear on the valve parts. The valve selected must be durable to this, and thought should be given to how easy it is to replace the worn parts with new ones, should this be necessary.

Summary

There are quite a few options when it comes to choosing a dispensing valve. There is a plethora of materials which might be dispensed through them. Finding the optimal match is quite complicated - material rheology and reactivity needs to be understood, valve capability identified and proven, and the final outcome defined. Consult with your dispensing supplier, who should have a comprehensive range of valves to pick from, and the experience to help you make the correct choice.

References

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- 3) *Pneumatic Valves: Their Selection and Use in Industrial Dispensing*, James Dornan, US Tech, October 2006
- 4) [An Introduction to Time/Pressure Dispensing](#)
- 5) [25 Top Dispensing Tips](#)

Contact

intertronics

adhesives, coatings, sealants & equipment
for your manufacturing and technology applications

INTERTRONICS
Station Field Industrial Estate
KIDLINGTON
Oxfordshire
OX5 1JD
England
t 01865 842842
e info@intertronics.co.uk
www.intertronics.co.uk

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