

#### TECHNICAL INFORMATION ON PULSE VALVES

ASCO Numatics has a comprehensive range of pulse valves for the dust control market with accessories to sense the pressure drop across the fabric and to control the pulse sequence.

Since the valve performance has great influence on the cleaning efficiency of the generated air pulse, this aspect in particular is highlighted in this section.

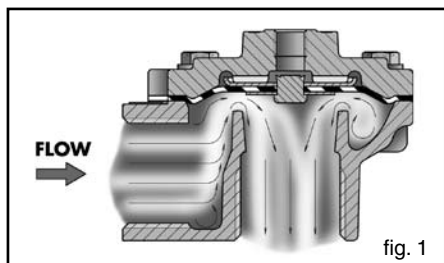
#### Diaphragm Pulse valves

The construction of the ASCO 2-way diaphragm pulse valves is based on the proven fact that fast opening and closing of the valve is of great importance for effective cleaning of the filter fabric and economical air consumption.

By keeping the weight of the moving parts in the valves as low as possible, the response times are, thanks to the low inertia, very short and result in opening times between 8 and 14 milliseconds. The diaphragm assembly used in the ASCO pulse valves is a low mass construction compared to what is normal practice in this industry. At the same time the strength and endurance of the used nylon reinforced Neoprene or Hytel sheet-material diaphragms are extremely good.

The main diaphragm is clamped between valve bonnet and body in a special patented way which forces the diaphragm to seal the valve seat without the use of strong closing springs, thus preventing the flutter phenomenon which is very common in other high flow diaphragm pulse valves.

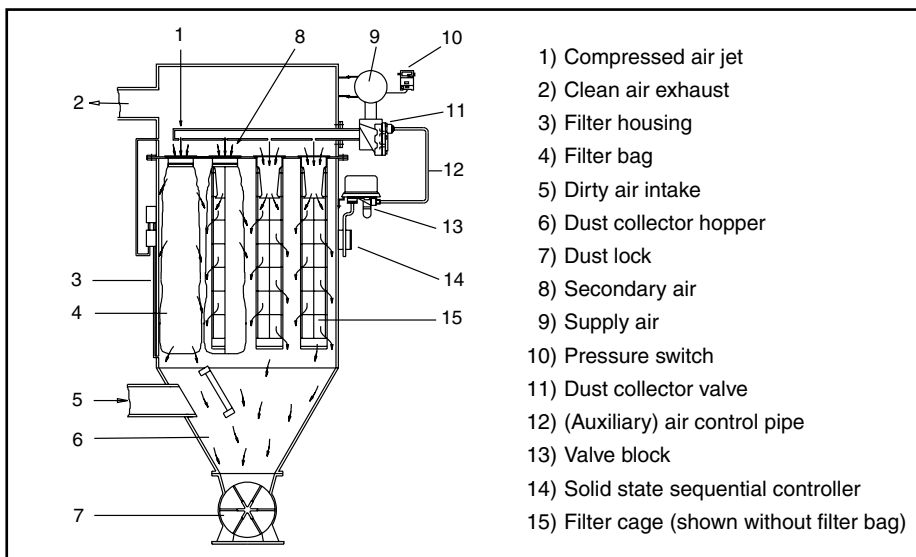
Fluttering of the diaphragm during opening and closing of the valve will affect the valve performance dramatically and increases air consumption.



The high flow, angle type aluminium bodied valves in combination with the special main diaphragm assemblies give the unique operating characteristics required for this application.

This higher flow is expressed in a very high Kv factor for each valve (fig. 1).

The maximum flow through the blow pipe(s)



in the filter is reached when the air velocity becomes sonic (344 m/s); this situation occurs at the critical pressure drop. For air this condition is reached when the absolute downstream pressure is 52,8% of the absolute upstream pressure.

The standard valve bodies have threaded pipe connections according to ISO 228/1. The valves are either integral solenoid pilot operated or remote pilot operated.

Solenoid pilot controlled types are standard equipped with epoxy moulded spade plug connection coils. Stainless steel waterproof enclosures (IP 67) and ATEX (CENELEC), IECEx, NEMA explosionproof solenoids are available as an option. Other options available are NPT or ISO 7/1 pipe threads, brass bodies for mining applications (sparkless) and epoxy coating for corrosive environments.

#### Piston Pulse valves

The main requirements of pulse valves for the dust collection market are low cost, superior operating characteristics, long life and ease of installation & maintenance.

In order to improve the present offer, a new piston concept, the power pulse valve was developed to meet these market requirements.

An integral component in producing this new flow concept is a unique one-piece patented Hytel piston/diaphragm construction. This combination allows the flow to travel under-

neath the piston instead of over a wall as in the conventional pulse valve. This creates less of a restriction to the flow (fig. 2). Another advantage is that the venturi shape of the valve outlet increases air speed. In addition to the flow, the peak pressure is positively influenced. Laboratory tests show a 20% improvement.

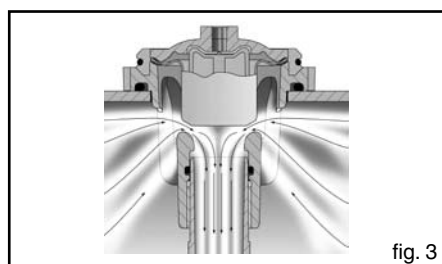
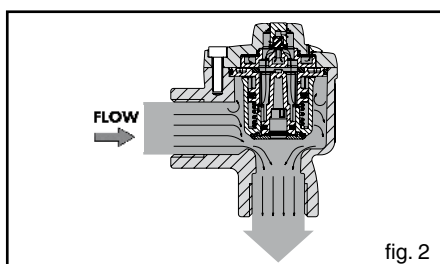
#### Fully immersed piston valves

Due to the Pressure Equipment Directive 97/23/EC, which contains pressure equipment operating above 0.5 bar and manufactured or traded within the European Union, filter builders more and more prefer to buy complete assembled pressure header tanks.

Besides this regulation also other factors enable true "one stop shopping":

- One supplier supplies and guarantees the complete system
- Simplified stocking and purchasing process
- Tank system with full-immersed valve has an increased flow performance

To meet these market demands, a revolutionary Power Pulse Tank System with fully immersed valves has been introduced, based on the proven Power Pulse valve technology. In the case of the full-immersed valves, the air enters the valve from all directions (see fig. 3).



In the adapter the flow is optimal guided by the patented venturi concept, resulting in a higher peak pressure.

### ACCESSORIES FOR PULSE VALVE CONTROL

Pulse valves are vital parts in dust collector systems but only one of the many components necessary to build a complete system.

turer, the tank type and the size of the pipe connection. Below the heading of the graph the following data is provided:

The sine wave is the electrical signal and further two pressure signals are shown. The upper signal shows the pressure in the supply tank and the lower signal shows the pressure of the shock wave generated by the pulse valve which is registered at the end of the blow pipe.

- **Opening time to 50% Pp [ms]:**  
This is the elapsed time from zero until 50% of the peak pressure has been reached. The quicker the opening time, the higher the acceleration of air for better cleaning.
- **Closing time from 50% Pp [ms]:**  
This is the elapsed time from 50% of the peak pressure measured on the down stream slope until the valve is completely closed.

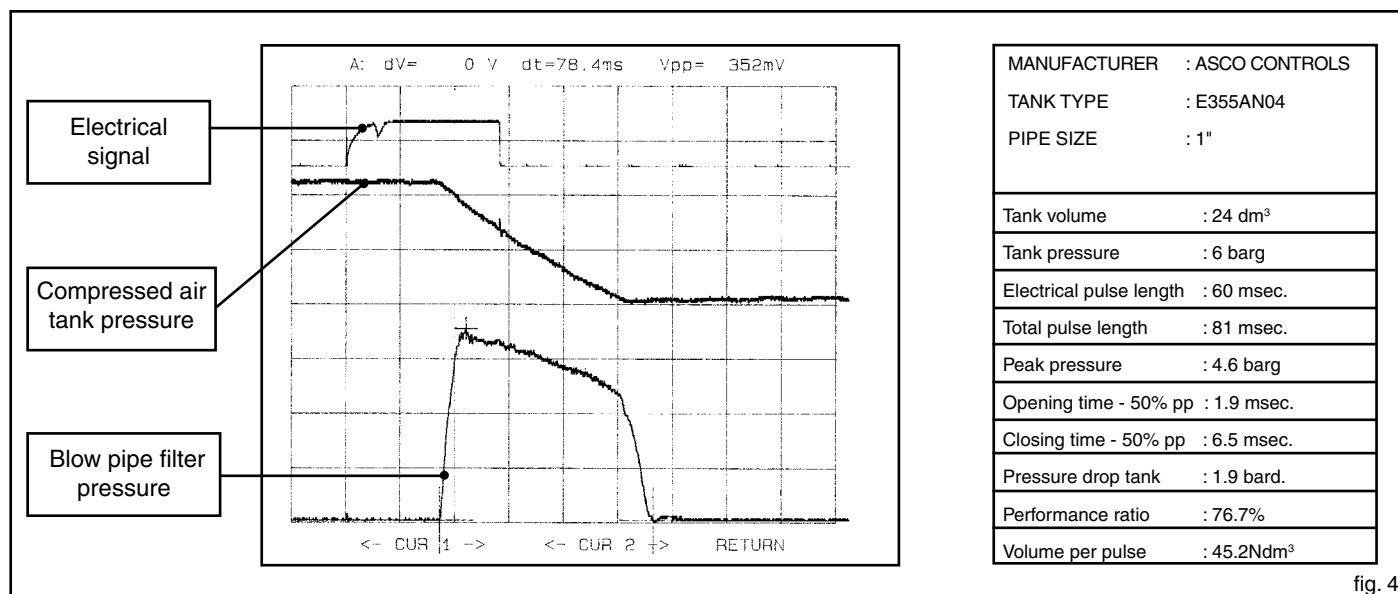


fig. 4

Additional accessories available from ASCO Numatics are solenoid pilot valves for remote control, both as single valve or grouped in pilot boxes for large filter units, electronic timers to control the solenoid operators and pressure switches to sense the air tank pressure or the pressure differential across the filters. The pilot valve boxes can house 2 up to 12 solenoid valves protected by a dust and waterproof aluminium enclosure (IEC 144, IP 65) and are available with a heating device for low ambient temperature conditions (down to -40°C).

To fulfill the timer function in the filter cleaning process, ASCO has a solid state sequential controller with adjustable impulses and interval signals to control the solenoid operators.

### INTERPRETATION OF THE FIGURES

The data sheet of ASCO pulse valves is divided into two parts; the left side shows the graphical presentation of the test data and on the right all the numeric data can be found (fig. 4).

The graph shows the following information: The x-axis represents the elapsed time and the y-axis represents the electrical and the pressure signals.

The table states the name of the manufac-

### DEFINITIONS

- **Tank volume [dm<sup>3</sup>]:**  
This is the amount of air volume stored in the supply tank. (Tank volume depends on valve size).
- **Tank pressure [barg]:**  
This is the air pressure in the supply tank which is given in gauge pressure. This is also the pressure to which the valve is subjected.
- **Max. allowable pressure (PS)[barg]:**  
The line or system pressure to which the equipment may be subjected without being damaged.
- **Electrical pulse length [ms]:**  
This is the energized time of the valve. (The wave length of a 50 Hz alternating current is 20ms for a full wave).
- **Total pulse length [ms]:**  
This is the time from the moment the valve opens until the valve is fully closed.
- **Peak pressure [barg]:**  
This is the maximum pressure which is measured at the end of the blow pipe usually scaled at the end of the first slope of the graph (after the valve has opened completely). This creates the shock wave down the filter bags for cleaning.

- **Pressure drop tank [bar]:**  
This is the difference between the tank pressure before and after the shot. With this value it is possible to calculate the air consumption of the valve per pulse (volume per pulse).
- **Performance ratio [%]:**  
This is the ratio between tank pressure and peak pressure multiplied by 100%.
- **Volume per pulse [Ndm<sup>3</sup>]:**  
This is the amount of air at atmospheric pressure passing through the valve for a given pulse time. The greater the volume per pulse the better the filter bags are cleaned and more bags could be cleaned per valve.

### Using figures for comparison and selection

To compare graphs of different valve makes and/or types of pulse valves the following is essential: it is preferable to have the graphs made by identical electronic measurement equipment since a slight difference in sensitivity and accuracy of the components can make a fair difference in the results.

The other basic test conditions and set up must be equal too. The most important parameters which have to be exactly identical are:

- **Tank volume and pressure**
- **Electrical pulse length/Total pulse length**
- **Fittings from supply tank to valve and from valve to the blow pipe**
- **Size of the blow pipe and the number and location of the blow pipe holes**
- **Location and position of the pressure transducer(s)  
(distance from the valve and radial or axial mounted on the air stream)**

Since there are so many parameters to take into account, the most reliable method to compare the test results is when they are made under the same test conditions, so with the same equipment.

Besides the performance and price level of the pulse valve, several other important parameters are essential, such as:

- **Installation dimensions**
- **Minimum and maximum operation pressure**
- **Service life time**
- **Internal and external leakage**
- **Installation possibility of silencers in vent port(s)**

### Calculation and determination of the parameters

First we have to divide the different parameters into those we can fix or influence and those which are depending on the settings of the equipment.

**Note that the calculation examples are based on sonic flow conditions (air flow velocity = 344 m/s) without friction losses and under isothermal conditions.**

- **Tank volume:**  
The determination of the tank volume depends on several conditions:
  1. The required volume air per pulse to clean the dust filter(s) (depends on type, size and construction of the filter unit)
  2. The tank pressure and the desired peak pressure
  3. The size of the valve (Kv value)
  4. The size of the blow pipe and the size and number of the blow holes
  5. The number of pulses per time unit
  6. The duration of the electrical pulse and the total pulse time

7. The number of valves on the tank
8. The capacity of the compressor

The most common method to determine the tank volume is to experiment at which minimum tank volume at a certain pulse time you achieve a square shock wave and the best cleaning effect.

To make a rough calculation of the capacity of the supply tank, the below mentioned method can be used:

To maintain sonic flow conditions in the blow pipe(s) it is necessary to choose the product of the tank volume and the absolute tank pressure (= gauge pressure + 1 bar) at least twice the required volume per pulse, this will also allow a maximum pressure tank pressure.

$$\text{In a formula: } V_t \geq \frac{2 \cdot V_p}{P_u}$$

- $V_t$  = Tank volume [dm<sup>3</sup>]
- $V_p$  = Volume per pulse [Ndm<sup>3</sup>]
- $P_u$  = Absolute upstream pressure [bara]  
(Absolute tank pressure)

- **Tank pressure:**

The tank pressure is usually set at 0,5 to 8 barg and depends on the type and construction of the filter units.

The system is often connected to an existing line pressure of 6 or 8 bar and reduced to the required pressure.

For direct pulse valve systems the tank pressure usually is 0,5 to 3 barg.

For reverse air-jet systems the pressure mostly is 6 to 8 barg.

The tank pressure is also proportional responsible for the height of the peak pressure.

- **Electrical pulse length:**

The electrical pulse length is usually set at 40 to 200 ms and is also mainly responsible for the total pulse length and thus the amount of air passing through the valve.

A minimum electrical pulse length is required to operate the pulse valve correctly and depends on the type, construction and size of the valve. The tank pressure can also influence the required electrical pulse length.

For remote controlled pulse valves, the length and size of the tubing is of great influence too because opening and closing

response times of the valve increase with the length and size of the tubing of the pilot valve (the opening response time is the time elapsed after the begin of the electrical signal and the moment the valve starts to open, the closing response time is the time elapsed after the end of the electrical signal until the valve is fully closed). The best way to estimate the electrical pulse length is to experiment since there is no other practical method. An electrical pulse time of 60 ms (for direct operated valves) in most cases is sufficient for correct operation that is: achieve maximum opening of the valve and reach the best possible peak pressure

- **Total pulse length:**

The total pulse length depends on the electrical pulse length as described earlier and the opening and closing times. Together they are responsible for the air consumption or volume per pulse of the valve.

- **Peak pressure:**

The peak pressure is an important figure to improve cleaning efficiency at minimum air consumption.

It depends in the first place on the tank pressure but also on the construction of the valve; a short opening time provides high peak pressures. Of course the valve must also have sufficient flow capacity (Kv) to allow pressure build up in the blow pipe.

- **Opening time:**

The opening time of the pulse valve must be as short as possible to achieve best performance.

To achieve quick opening times, air must be exhausted very quickly to allow line pressure to act against the bottomside of the diaphragm, opening the main orifice. Keeping the moving parts as light as possible (low inertia) will result in short opening times.

- **Closing time:**

It is preferable that the closing time of the valve is as short as possible, since a long closing time of the valve increases air consumption.

The extra flow air has a negligible contribution to the cleaning effect of the total air pulse and is therefore not efficient.

- **Pressure drop tank:**

The pressure drop in the supply tank is the result of the amount of air which has passed through the valve after one pulse and depends on the following parameters:

- Kv value of the valve
- Electrical pulse time and total pulse length
- Tank volume and tank pressure
- KV value blowpipe

As stated before, to maintain sonic flow in the blow pipe(s) it is necessary to limit the pressure drop to maximum 50% of the absolute tank pressure.

In a given installation it is the easiest way to reduce the electrical pulse time if the pressure drop is too high.

**• Performance ratio:**

The performance ratio is a figure to compare pulse valves under the same test conditions.

The size of the percentage depends on the Kv value of the valve and the opening time, both are responsible for the peak pressure.

$$P_r = \frac{P_p \cdot 100\%}{P_t}$$

- $P_r$  = Performance ratio
- $P_p$  = Peak pressure
- $P_t$  = Tank pressure

**• Volume per pulse:**

The volume per pulse can be determined as follows:

multiply the tank volume by the differential of the tank pressure before and after the shot; this is the (atmospheric) amount of air which has passed through the valve.

In a formula:

$$V_p = P_d \cdot V_t$$

$P_d$  = Differential pressure [bar]

To calculate the volume per pulse at a certain valve and at a certain pulse length, the equation mentioned below can be used. You have to take into account that the calculated value is only the amount of air which is supplied by the tank.

The air that will clean the dust filter depends on several other things e.g. the distance from the blow holes to the filters and the use and shape of venturies which will draw secondary air into the filter increasing the amount of cleaning air.

$$V_p \leq \frac{C \cdot 0,528 \cdot P_u \cdot T_{pl}}{1000}$$

- C = Flow factor [dm³/s.bar]
- 0,528 = Critical pressure ratio to obtain sonic or choked flow
- $T_{pl}$  = Total pulse length [ms]
- $P_u$  = absolute upstream pressure [bar]
- C = 3,97.Kv
- C = 3,39.Cv

**• Kv value:**

With the same equation we can calculate the required Kv value:

$$K_v \geq \frac{1000 \cdot V_p}{2,1 \cdot P_u \cdot T_{pl}}$$

- $K_v$  = Flow factor [m³/h]
- 2,1 = Dimension factor (3,97.0,528)

Instead of using the volume per pulse you can also use the volume per second value  $V_s$ , this is more accurate since opening and closing effects of the valve have been eliminated.

$$K_v \geq \frac{V_s}{2,1 \cdot P_u}$$

$V_s$  = Volume per second [dm³/s]

**• Average volume per s:**

The average volume per second at a certain upstream pressure (tank pressure) can be calculated by taking the quotient of the volume per pulse and the total pulse length.

In a formula:

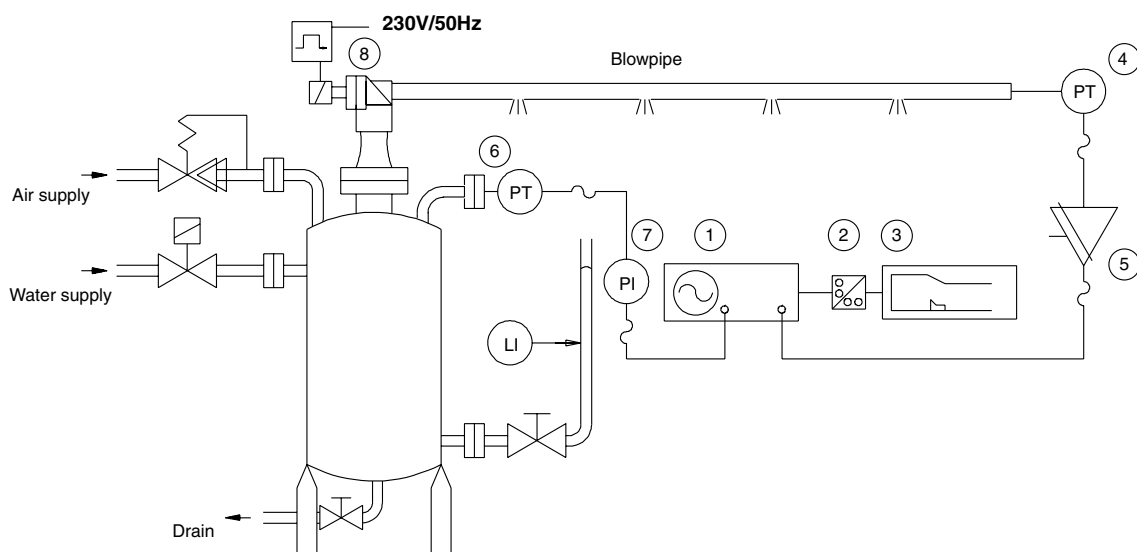
$$A_{vs} = \frac{V_p}{T_{pl}}$$

$A_{vs}$  = Average volume per s [Nm³/s]

This figure indicates the flow capacity in relation with the opening and closing times of the valve. In other words, a valve with a high flow capacity has a relatively high  $A_{vs}$  value.

However, long closing and/or opening times will reduce the  $A_{vs}$  value, especially at shorter total pulse length. On the other hand, short opening and closing times can compensate a lower flow capacity.

### TEST SET-UP



- Equipment used:
- Digital memo oscilloscope
  - Busconverter parallel
  - Digital plotter
  - Pressure transducer

- Demodulator/carrier/transmitter/amplifier
- Pressure transducer
- Pressure indicator
- Adjustable time triggering device