WHITE PAPER

THE TRUTH ABOUT PULSING COMPRESSED AIR SYSTEMS AND WHAT IS REALLY NEEDED TO MAKE THEM EFFECTIVELY

Energy savings are getting more and more a hot topic. There are worldwide initiatives, directives and agreements to stop climate change and limit the overall CO2 emissions. Consumers are becoming critical and demand products that are produced in a sustainable way. Furthermore, many production plants are becoming more aware of the huge cost reductions involved with energy savings. So, factories are looking to reduce steam, natural gas and electrical consumption by installing e.g. solar panels, investing in wind farms, turning to LED lighting and switching to heat recovery.

Unfortunately, there is one large savings opportunity that is often overlooked and that is compressed air! Even today, we see in the workplace that compressed is considered as “free”! This could not be any further away from the truth as it is one of the most expensive utilities. The workprice for compressed air is 8-10 times higher than for electricity.

Compressed air is used extensively to operate equipment as well as to cool, dry and clean despite high energy cost. In fact 70% of compressed air is used on blow off applications. Although there has been some movement to the use of blowers due to lower energy use they are still limited in use for many reasons, some being loud noise, lack of adequate space (too large a footprint), higher maintenance cost and sometimes just inadequate energy for the drying and cleaning.

Various technologies and techniques have been applied in an attempt to reduce the cost of the use of compressed air. One old technique is simply to reduce the pressure of the compressed air at the point of use in particular for blow off applications using open tube or pipe or drilled lengths of pipe. Every 10 PSIG reduction in compressed air pressure can save 5% energy use. This can work but the problem remains in that the exiting compressed air, being turbulent can still be quite noisy and still lose a great deal of energy from turbulence making the application less effective. This is similar to what happens when you switch to a blower system as the energy available is simply not adequate in many cases. Due to a large failure rate in applications for this technique it is not used very often.

To counteract this problem, the technology of air amplifying nozzles and compressed air operated air knives and other amplifiers were developed to operate at normal compressed air line pressure of 80 to 100 PSIG but at the exit of the air from the device, using aerodynamic shapes, convert the pressure normally lost as pressure drop and noise into flow. The pressure was still reduced at the target but a great deal of kinetic energy is maintained. In addition, the laminar flow allows for the exhaust air to work over a greater distance. Today there is extensive use of this technology.

Another technique to reduce the use of compressed air is the use of solenoid valves to pulse the compressed air. The idea behind this technique is simple. The on-off pulsing would reduce the overall amount of compressed air, theoretically up to 50%. This is because you only use the air half the time. However, the reality shows otherwise which can be explained momentarily. One nice advantage of the pulsing is that as the air goes on and off, you get a bit of a "kick" as the air turns on because the airline momentarily builds up a pressure that on the initial release provide this slight "kick". However, the air savings rarely end up anywhere close to 50%. As the air goes on and off, you get a jerking action with momentary higher than normal flow an faster than normal velocity working against an inside back pressure that also jumps. This causes a loss of pressure at the outlet is the airline is not upsized. For example, assume you have a blow off tube with a 1/8" opening. With no pulse the pressure at the exit can be 80 PSIG. With pulsing, due to the back pressure of the existing line size and length the outlet pressure easily can drop to 30 PSIG. You could have almost the same every saving by just reducing the pressure with a pressure regulator, or just by adding an amplifying air nozzle would use the same amount of energy and do the same work. What is quite interesting is that if an amplifying nozzle was added, the pulsing would most likely stop the solenoid valve from working as the hole size of any air outlet has to be large enough to avoid the pressure back onto the solenoid. In other words the hole size on the solenoid will effect if and how the pulsing system will work In addition to these issues there is the added cost and downtime to service solenoids, one basic problem with all solenoids.

In the past few years some valves have been developed which are basically modified solenoids and are promoted for pulsing to save on the use of compressed air. These systems are limited to about 15 hz in frequency and the same claims of almost 50% energy savings are made. However, as with solenoids the same problems exist. Both solenoids and these valves operate linearly and are highly sensitive to the back pressure in the airline from the valve to the air outlet. There is no doubt that pulsing save energy IF properly installed. As with solenoids, these new valves work almost the same, with maybe a little less maintenance. But either the savings are much less than 50% or the outlet force drops too low for most installations as it is generally not practical to replace existing piping, or the pulse generating valve may not be able to get close enough to where the air outlet is needed. And again, these valves require maintenance which means downtime and extra cost. As an examples, one new style pulse system incorporated into an air gun was hooked up and tested. The force from the air gun was 50% less when pulsed. The savings in energy using an air amplifying nozzle would have been greater. The supply like to the air gun was not changed so even the inlet airline negatively affected performance. This makes sense because energy is spent to intermittently tug onto the air supply. Just for fun, an air amplifying nozzle was attached to the end of the air gun and it actually slightly improved the performance. But savings overall were not significant. The slight, but present pulsing of the air gun was overtime somewhat irritating as well.

On a quick survey of installations where these new air saving systems were installed yielded results in savings of around 25% on the average and some where they did not work because the outlet force dropped below the level needed for the application. In short, these systems, like solenoid valves, are sensitive to back pressures and this has to be seriously considered for effective performance.

Another issue with these new pulse systems and solenoids is that you can set the pulsing frequency but you need a separate system to turn the system off when not needed. There can be possible issue between that second system and the pulse system in operation. This on-off operation to use when the sir is not needed since using compressed air while not operating is wasteful. In fact, despite the general myth that compressed air systems cost more than blowers, it is not true in situation where a production line has significant periods where the compressed air can be turned off when the product being dried or cleaned is not there. If the actual blowing time is less than the time the air is not needed, quite often the overall cost (including maintenance cost) to the blower can be quite close to each other even without pulsing.

The other issue with pulsing systems is the frequency. Extremely fast moving production lines that need to be cleaned or dried cannot be cleaned nor dried if parts are missed because the pulsing is too slow.

In summary the limits to current pulse systems are:

1. High maintenance
2. High sensitivity to back pressure
3. No integrated means to turn off when not needed
4. Limited frequency

A recent process valve was developed that works stochastically that addressed all of the above limits. It is a solid, extremely low maintenance design (elaborate). While it is sensitive to back pressure as well, it is significantly less sensitive and firm guidelines are provide in installation. The frequency can be as high a 40 hz but is set to three levels for easy use by personnel (slow, medium and fast settings). It is integrated with an on-off setting as well to turn off when not needed quickly. Different sensors are offered depending on the environment and frequency needed so reaction time is fast. In one installation the customer reduced compressed air by 90%.

Putting that result into perspective…..

A blower replacement can reduce the energy cost of an open tube compressed air system by 90%

A blower replacement can reduce the energy cost of a compressed air blow off with air knives by 25%

THE NEW PULSE SYSTEM WAS ABLE TO MATCH THE ENERGY COST OF A BLOWER WITHOUT THE NOISE, WITHOUT THE HIGH MAINTENANCE, WITHOUT THE ADDED SPACE AND WITHOUT THE HIGH CAPITAL COST OF A BLOWER.

When tested against previous pulse systems described, the force produced was either maintained, or had a small loss. In fact, if the back pressure is kept low, due to the stochastic operation of the valve, the pulse instance force is amplified significantly. This means a much better scrubbing action for cleaning power as well as improved drying. Where other systems lost energy and the force dropped below workable levels, the new system performed well and recoded a MINIUM of 50% energy savings.

All the limits of previous pulse systems are addressed……

1. Low maintenance
2. Less sensitivity to back pressure
3. Integrated system to turn off when not needed
4. Low to higher frequencies

ANY pulse system MUST have these qualities. Low maintenance is a must because you do not want to replace saved energy with maintenance cost. Time is even MORE of a premium than energy cost! Less sensitivity to back pressure is of utmost importance to realize true savings and appropriate guidelines for installation are provided. The integrated on-off system with a separate setting, with the pulse system is of extreme importance to obtain real savings in energy cost. Having three frequency settings simplifies operation for maintenance personnel.

One benefit alluded to earlier was the high instantaneous force “amplification” obtained with the new pulse system. This also increases the average force when the air delivery piping is kept within parameters. With a higher average force, you can also cut back pressure further saving energy. Or, using this additional power can often improve cleaning and drying due to the high force scrubbing action.

This pulse system is also combined with air amplifying nozzles and air knives. It is important that these nozzles or other attachments NOT be made of plastic. When tested with plastic nozzles or flat jets, the amplified force and high frequency pulse racks the plastic over time. Similarly, attached air amplifying nozzles should be of one piece design and have enough thickness to withstand the constant pulsing. Two piece nozzles will not last. Air knives work quite well and have been tested up to 30 lengths. The optimum however appears to be 24” for the currently available unit, although larger valve capacities are being developed. The air knives do have a dampening effect on the force amplification due to the inside plenum chamber but hold up well. With these attachments the systems work better because of the laminar flow produced and further saves energy.

Cleanliness of parts prior to further production such as printing or paining or other clean room processing is continually seeking improvement. Currently rotating air nozzles are popular for some cleaning applications, in particular when combined with static removal when cleaning plastic parts prior to painting or in high tech equipment cleaning. Again, the rotation causes pulsing and gives a cleaning action. The problem with using rotating nozzles is that any residue is thrown all around the nozzle needs to be removed before it deposits back onto the part. This is difficult to do. Utilizing nozzles, flat jets and air knives would provide the pulsing action but easily creates the separation of the clean side from the still dirty side.

Specific applications where this new pulse system shows tremendous promise:

1. Drying packaged products esp. as often they are discretely on moving conveying lines and spaced apart so the on-off system is of great benefit
2. Cleaning and drying of parts with oily residue where the scrubbing action can remove the sticky material or cleaning rough surfaces like wood where pulsing can help to remove stuck debris
3. Part ejection if heaver parts on conveying systems using the amplified force action.
4. Combining the pulse system with air knives and static eliminators with enhanced scrubbing action to produce cleaner parts in the semiconductor industry and in plastic painting operations in particular plastic auto bumpers, door panels and instrument clusters.

Pulse systems using solenoid valves and other linear operating valves can when used properly provide savings but their intrinsic limits makes for many ineffective installations with sometimes no real benefit. Either they do not really save energy or improve operation overall or even if they do, with high maintenance can become ineffective over time.

A stochastic valve operated pulse system with proper installation guidelines and appropriate nozzles or air knives are much less trouble and more effective to be able in many cases, to reduce the energy level to that of a blower system without the added high capital cost, noise level, extra maintenance and space they need.