Compressed Air or Blowers?

For an appropriate blow off in cleaning or drying, the choice for using a blower system over a compressed air is not always so clear cut. It is not just energy use as a great deal of other factors also impact the decision. There is also built in bias from both compressed air system providers and blower system providers so this must be accounted for in evaluating which would be the best choice. Blower sellers tend to compare the best aspects of a blower system in a best case scenario to the worst case scenario for compressed air, usually focusing entirely on energy cost to the exception of other factors, and even the actual pressure levels that need to be used in the application. Compressed air blow of providers tend to overstate the negative aspects of blowers, worst case for maintenance and noise, shutdown costs, and stretching the real limited shear force, such systems can obtain. Since most of all compressed air that is produced today (up to 70%) is still used for blow off applications, clearly there is a reason for using compressed air in many cases.

Blower or Compressed Air

Several factors should be considered for any blow-off application in choosing the best system. Each factor may have a greater or lesser weight over the other depending on the particular situation. They are as follows:

1. Availability of electricity and compressed air – if there is no electricity, the alternate choice is the only option unless the cost of electrical installation is justified.
2. Space and weight – compressed air blow off is compact and lightweight. Blower blow off equipment takes up much more space and more weight. . This can either be a major problem or irrelevant dependent upon the application
3. Noise level – as safety concerns tend to become increasingly important, and in fact demanded more by factory workers (which may even accelerate after the corona virus pandemic abates) this is can be a major factor. Blower system providers tend to downplay this basing their argument on the assumption that impact noise can outweigh exhaust noise. In fact, impact noise depends on a great deal of other things most notably on the environment where the blow off takes place and the nature of the target material being cleaned or dried. The total noise level is the combination of impact and exhaust. Properly engineered compressed air nozzles and air knives or other air flow amplifying designs reduce exhaust noise significantly.
4. Application particulars – Does the application require a small concentration of force lending itself more to compressed air engineered nozzles? Is it intermittent which would favor compressed air that can be provide on and off as needed while, if continuous, it would tend to favor a blower. Concentration of force, level of force or velocity and, whether use is intermittent or not, has an effect not only on overall energy use but also whether the choice can even perform the task.
5. Reliability – Often overlooked is the importance of reliability. Blower systems usually have one blower per task. If that blower goes down for any reason, that line goes down. Compressed air systems are usually off a central air compressor room supply with a backup compressor. Reliability should be factored into any choice. Some value for the cost of planned and unplanned shutdown should be an input into the final decision.
6. Energy cost – Important and often the major focus. It must be noted that for every 20% pressure reduction in compressed air supply needed reduces the energy use 10%. Many applications do not need a full 80 or 100 PSIG supply input pressure to do the job. Care should be taken in estimating energy cost to get true operating values for both types of systems. Many applications for blow off may need much less than line pressure.
7. System cost – Blower systems do cost more and a reasonable payback is needed. This should be compared to energy differences between systems (and maintenance cost) to evaluate a real cost comparison over an established period of time for any project.
8. Maintenance and operating cost – Compressed air systems tend to be much more rugged, longer lasting and with significantly less maintenance costs. This may or may not be important depending on the level of maintenance support that is available in a

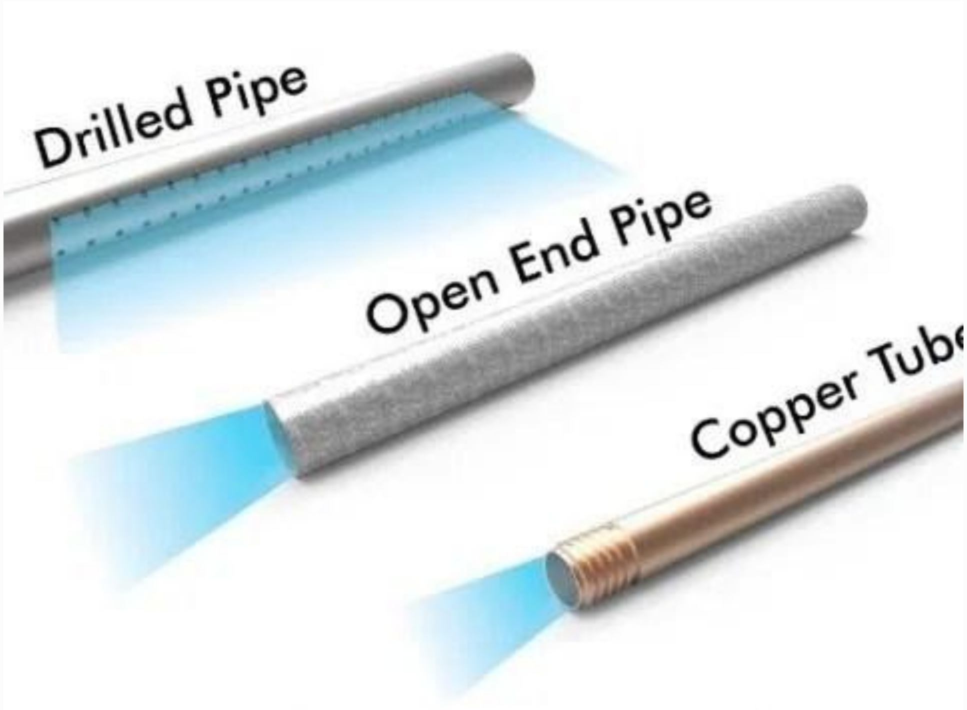
production operation, but it does have a cost to consider. The cost of doing maintenance involves downtime cost, cost of obtaining, training, and preparing and actual labor cost of personnel. These costs are not small and in fact are continually rising.

What Product Do I Choose For a Compressed Air Blow off?

Let's take the situation where compressed air is the choice. Some applications are best suited to air knives, some rows of flat jets, some rows of engineered nozzles, sometimes annular flow amplifiers. Certain applications are best served by a certain product type.

Air knives are best suited to replace drilled pipe, if the holes in the pipe are an inch apart or closer to each other. In those situations the energy savings with compressed air can be anywhere from a minimum of 10% to as much as 90% depending on the size of the holes and spacing that was on the original pipe. A huge advantage of properly designed air knives is the relatively even flow along its entire length and dramatic exhaust noise reduction.   There are two types of compressed air operated air knives, and older style where the air exist the air knife and bends 90 degrees while entraining surrounding air. The newer style (new for many years now of course) and where the air exists and goes straight. This design gives a much higher force/unit air consumption by as much as 25% above old style designs and has therefore become the most accepted type on the market.

Air knives can have their force and flow boosted by using larger gaps in the air knife. The majority of air knife designs use shims to maintain an air gap. So adding or subtracting shims changes the force flow. But there is a limit to how big the gap can be. If much higher forces are required, and option is a flat jet or flat nozzle. They normally are stronger than air knives per inch (but also use more energy of course). But when a heavy force is required, they can be installed close to each other on a manifold. Due to their design, larger gaps are possible with a resulting much higher force.



Energy is wasted when using compressed air this way

If the drilled pipe has holes placed far apart, and close spacing is not important to the application, it might be more appropriate to replace the drilled pipe with a manifold, or thread the pipe and use it as a manifold and install engineered nozzles where the holes are. Properly engineered air nozzles will reduce noise and energy consumption compared to the opening (hole) they replace by 30% to 40% depending on the nozzle design.   An important note for air nozzles (and in fact for air knives and any other compressed air amplifying product) is that the airflow produced is laminar over a long distance from the air exit. Replacing holes in a pipe will result in an airflow that will work much further away than before using compressed air amplifying technology.   This may offer some benefits in an installation by making more room for the blow off process.

Compressed air is also used for cooling with engineered nozzles and larger annual air flow amplifiers. The advantage is that they do cool quite effectively because there is no heat that would be added to a blower system. But they do use a significant amount of energy. One aspect of a compressed air flow annular amplifier is that the larger you make the unit, the more efficient it becomes as a flow amplifier. (It is probably important to clarify here that an air flow amplifier does not create energy – it simply converts energy that would normally be lost as pressure drop and turbulence and noise, into additional mass flow through atmospheric entrainment. Hence the term air movers which is also, often used to describe the technology). Because they are more efficient in larger sizes, it is NOT recommended to use air nozzles or even air jets (small annular air amplifiers) for cooling as they will produce less flow per unit energy consumed. Larger annular air flow amplifiers (often just called Air Amplifiers) entrain a significant amount of volume and produce very high velocity and have excellent performance in cooling. In fact, a row of large Air Amplifiers, will use approximately the same amount of energy as a row of smaller engineered nozzles but cool better and faster because of the higher air entrainment. For cooling, high mass flow and velocity is important. For cooling, it is best to consider annular Air Amplifiers. Of course, these annular Air Amplifiers or Air Movers (and smaller annular versions called Air Jets) are also used for blow off especially for more complex shapes. One common application for these Air Amplifiers and Air jets is the drying of the top and bottom of cans, the size dependent upon the diameter of the can. A linear air knife would push the liquid into a corner on the lip of a can but the annular shape of the Amplifier or Jet will scoop out the liquid.

For cleaning or drying, the force is important. While air knives tend to be the preferred choice for most applications and rows of flat nozzles or flat jets for more difficult blow off applications, engineered nozzles are also possible if the flow does not have to be even along the length of an assembly. In these applications the flow profile is very important. The performance figures of an air nozzle are usually at a particular distance (and actually does not vary very much over any distance up to the point where turbulence sets in) but the force does spread out over a larger area the further you move away from the nozzle. You need to look at the flow profile for blow off coverage, recognizing the force spreads out with distance.

You need to do the following when using engineered nozzles:

1. Know the height range you need or choose the height range you can work with from the target of the blow off.
2. Know the force required per unit area on the target for the pressure you will be using
3. Space the nozzles on the manifold according to the chosen height.

You need to have a minimum force value or range that is acceptable as the end pressure and force will rarely be exactly what is calculated because you have no idea until installed what pressure loses or peculiarities you maybe have to deal with in your compressed air system. Moving the manifold up or down to get the full coverage for blow off can be done after installation. You want full coverage but you also do not want flows from one nozzle to interfere with another as that will cause turbulence at the target and it will not perform as expected. Too far from the target will leave gaps in the blow off on the target.

One special application for compressed air has been its use to dry extrusion processes, from extruded profiles to rope, wire and cable. These compressed air operated “air wipes” are still used, especially in very high speed extrusions. Special designs have been available for many years which tend to be application specific and at a relatively high cost. A “split” annual version of old style air knives was introduced over ten years ago that has become increasingly accepted due to both reduced cost from economy of scale production but also because it works very well for most applications due to the full circle coverage in blow off. The compressed air in these air wipe designs impinge the surface at a 30 degree angle for blow off and because of the angle and full circular coverage, gets into most corners and crevices for excellent drying. The outside dimensions of the extruded part (whether round, square or some complex shape need to be close to the inside diameter of the air wipe for best performance. In many processes more than one may be needed for complete drying but generally a smaller number is needed than with the older, more costly designs.

What Do You Look For in a Compressed Air Blow Off?

Two things are very important in choosing a compressed air blow off product. First is obviously the specifications (air consumption, force, velocity especially) but also the material used in construction. Even air nozzles which may even look alike on the outside, may not be the same on the inside. It is important to confirm that the specifications provided are accurate. Unfortunately, there are some knockoffs of various primary manufacturers of this technology that manipulate the figures. Be wary of product look-a-likes and what appears to be copied and manipulated data. It is usually easy to tell because the web sites will tend to be less detailed and provide only basic information (which is also a clue to potentially a lack of knowledge and maybe even lack of support). It should always be buyer beware. Also be wary of suppliers asking to test what you have against their own product at their premises. You do not have control over their testing and how they get results. It is always prudent to test “yourself”. Most legitimate companies will offer materials to test if necessary on a trial basis once the application is assessed. But even without testing, published data (if deemed reliable) should be studied and assessed “if it makes sense”. Material of construction is important. If the product is made of aluminum it is wise to get assurances that it is anodized aluminum. Bare aluminum will not look too good after a year of use in a factory environment. Material protection is important. The materials of construction are another way to assess quality to be sure you are getting value for the product.

Let’s consider each type of compressed air operated amplification product:

1. air knives and air wipes
2. air amplifiers
3. air jets – annular and flat
4. air nozzles

1. Compressed air operated air knives seem simple but not very easy to produce. They have to be very flat over their length for even flow. The most common are units machined from aluminum. The best air knives would be well made (flat), fully tested and anodized for better protection in a factory environment. There are variations in performance from one size to the next so be dubious of any claims that claim all sizes perform the same. They cannot because different lengths of essentially the same shape have an internal volume that will affect performance at different lengths and as more and more compressed air enters the unit when it gets longer in length. Published data per size is more reliable. Similarly with air wipes. These units usually utilize shims. Some use plastic and some use stainless steel. Stainless steel shims do tend to last much longer since they do not wear out like plastic shims can with even small particulate and dirt from a compressed air system. Units without shims may not be easily taken apart to clean if necessary depending on their design.

Cooling with compressed Air Amplifiers

2. Air Amplifiers are normally specified on air amplification ratio which is the ratio of the airflow at the exit divided by the compressed air consumption at standard conditions. In reality this ratio will vary with the inlet pressure and even the density of the ambient air entrained. So any figure provided is a weighted average. Be wary of extremely high ratios for this one logical reason; it is “still” ambient air which is entrained with

the “moving” compressed air. This means that it slows down the more you entrain. If you entrain too much, you will get a much lower velocity and also less force and the unit will not perform so well for most applications. Amplification ratios do go up as the size of an Air Amplifier increases but if the figure provided by a manufacturer is over 20 for large diameter units, it should be suspect and actual test results demanded. As with air knives, any aluminum units should be anodized. Typically in the industry there are two types of air amplifiers. There are adjustable units made of aluminum and stainless versions. And then there are more popular fixed versions that are either machined or cast in aluminum or zinc or some alloy of these materials and which have their gaps maintained with shims (either plastic or stainless steel) as is done with air knives.

3. Annular air jets or flat jet/nozzles are made of various materials, aluminum, brass, stainless steel. Some annular air jets are fixed, some adjustable and fixed flat jets usually maintained with a stainless steel shim. There are also many plastic flat jets on the market that are basically materials glued together. And there are also metal jets that are fixed with no shims, just pre-machined air exit holes. Plastic flat jets are generally lower in cost but subject to breakage. Breakage can cause a potential factory accident in an application (and there have been accidents as a result of broken blow off product), so plastic should be avoided at least in potentially dangerous areas. Another problem with units that cannot be taken apart is that they may not be easily cleaned (such as fixed flat jets and plastic versions) resulting in replacement cost. That replacement cost can add up over time and offset any higher initial cost if a metal material was used in the first place.

Air nozzles come in two main designs, a cone shaped design and a bullet shaped design. Cone shaped versions are not as efficient as the bullet shaped units but generally much less costly to produce. If nozzles must be used for cooling a very small area, the cone shaped units have better flow entrainment for mass flow output (better for cooling) while the bullet shaped designs provide a higher force/unit air consumption and therefor better for actual blow off in cleaning and drying. As mentioned earlier, it is not just the look of the air nozzle on the outside, it is the design on the inside. With air nozzles careful consideration should be on the air consumption at a particular pressure and the force produced. Published data should be reviewed carefully to make sure it is realistic. Once a particular style and brand of air nozzle is used, it can be hard to change. This is because air nozzles are typically picked based on the air supply line size. For example, a ¼” nozzle is typically added to a ¼” supply line. Smaller nozzles attach to smaller airlines, larger to larger air lines, etc.   If you were to compare any two air nozzles, assuming the published data is correct, and they happen to have the same force at the same pressure, but one uses even a small amount of compressed air more – even if only 1 SCFM more – it will NOT perform the same as the nozzle with the lower air consumption, This is because of pressure loss on the supply line. That extra air consumption can lower the real pressure at the nozzle and even that small amount can produce a lower force. So if replacing an air nozzle, always replace it with a nozzle that gives the same or more force at the same pressure but, with the same or less air consumption rating at that pressure. Only this will insure that it will work for your application.   Engineered air nozzles always perform better at a greater distance than an open tube because of the laminar flow they produce. To meet proper OSHA standards, the dead end pressure must be less than 30 PSIG and are designed to meet those standards. So if a higher pressure is needed for an application, engineered nozzles may not work. However, there are many application where open pipe is used at high pressure but the target is several inches away. Because of turbulence, the actual pressure at the target may have already dropped significantly below 30 PSIG. In these cases, engineered nozzles can indeed work, and work well providing both energy reduction, reduced noise levels and much improved safety to personnel.

Why Do Some Companies hesitate in using More Efficient Compressed Air Blow Off?

The following three reasons are often given against the use more efficient compressed air blow off technology:

1. Bias to energy use instead of the whole picture
2. Fear of clogging
3. Not enough pressure
4. In some cases, the focus becomes only to “eliminate the use of compressed air”. There are definitely some applications and situations where alternatives to compressed air is possible and feasible. However, some applications, just by their nature are better suited to using compressed air – but use it wisely. One example is a company that produces a food product requiring breading added to meat on a moving conveyor. They had used blower systems to blow off access material. The problem was very high maintenance on the blower units because of a very cold but humid environment. They replaced each blower with stainless steel, compressed air operated air knives. The pressure needed to operate the air knives was only around 20 PSIG and it was enough to blow off the excess material. In addition, the air was turned off with a sensor when not needed. The stainless steel air knives had virtually zero maintenance except for normal wash down. The problems of high blower maintenance was eliminated, and noise level was greatly reduced creating a much better environment. The energy consumed was less than that of a blower system and without the noise and maintenance headaches. While energy cost was certainly a consideration, the other advantages in the saving in maintenance cost, reliability and improved working environment were even more important.
5. Fear of clogging of nozzles air knives, etc. are not an unreasonable concern. All engineered air nozzles and air flow amplifying technology does require filtration to prevent clogging. The solution is to address the quality of the compressed air, and there has been enough developments in filtration to accomplish this. I know of one factory that literally spends a million dollars a year on compressed air with up to 80% used for compressed air blow off. Engineered nozzles would save a lot of money and it’s all being held back because of a fear of clogging. Having said that, if the environment “around” the engineered nozzle or amplifier is very dirty, it is a valid concern and sometimes only a redesign of the application setup to correct the quality of air can open up the possibility to use air saving technology with confidence and with significant saving.

6. The concern of “not enough pressure” comes up often when considering the use of engineered nozzles. As described earlier, there are indeed applications where pressure is important and in those situations you would not use amplification technology. However, there are applications where open ended pipe is used for blow off “at a distance” where engineered nozzles will work very well. One bias against the use of engineered nozzles is that “if it’s not loud it does not work.” This is like the same bias car manufacturers had to deal with in offering quiet electric cars – with no engine running, how do you know the car is running? But, like an electric car, it can work. It is worthwhile to look at a particular application to check the distance from an open tube or pipe to the target. Testing an engineered nozzle might provide the needed pressure at that distance from the air source due to its laminar flow and increased distance of effectiveness.

White Paper by Les Rapchak

President of Nex Flow Air Products Corp. based in Richmond Hill, ON Canada

Manufacturer of compressed air products for blow off, conveying and cooling.

Offering online consultation for cooling, cleaning, drying and conveying applications with compressed air.