



How to Reduce Compressed Air Consumption in Drying and Blow-Off Applications

Changing your approach can slash operating costs, increase efficiency and optimize performance

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A Quick Review of the Options for Drying and Blow-Off

BLOWER AIR

- Air knife packages that use blower air
 - No compressed air required
 - Low operating noise

COMPRESSED AIR

- Low flow air knives
 - Low air consumption – 89% to 92% less than open pipe
 - Comparable noise to air nozzles
- Air amplifiers
 - Low air consumption – 75% to 90% less than open pipe
 - Comparable noise to air nozzles
- Air nozzles that use compressed air
 - Medium air consumption – 25% to 35% less than open pipe
 - Lower noise – perceived noise reductions range from 28% to 60% less than open pipe
- Open pipes, pipes with holes or slits
 - High air consumption
 - High noise

Actual performance will vary depending on the operating parameters of the application, but this general information can help you start comparing the options.

You probably don't spend much time thinking about all the applications in your plant that require compressed air. But compressed air is a costly utility that can easily account for 1/3 of a plant's total electricity usage.

Yet, compressed air is often viewed as a fixed cost and overlooked when process improvements are considered. If that's the case in your plant, it may be time to revisit that approach. You may be able to save tens of thousands or even hundreds of thousands of dollars annually by significantly reducing compressed air consumption in your drying and blow-off operations.

In addition to dramatically reducing air consumption, other positive effects can result from making some changes:

- ✓ Reduced noise
- ✓ Improved worker safety
- ✓ More precise, repeatable drying and blow-off

So, what types of changes should you consider? If you're using open pipes, pipes with drilled holes or pipes with slits are for drying and blow-off, you should definitely consider air nozzles or air knife packages. While open pipe systems are fast, easy and inexpensive to manufacture, the drawbacks of using open pipes are many:

- Very high air and electrical consumption.
- High noise – compliance with OSHA noise level requirements can be a problem.
- Worker safety can be compromised. High noise can result in hearing loss and injury can result if a worker accidentally blocks the opening in the pipe.

In the pages that follow, you'll find information on various options including guidelines for usage, cost savings and other benefits.

Eliminating Compressed Air: A Viable Option for Many Applications

Air Knife Packages Powered by Blower Air Can Reduce Operating Costs By 95% or More

Some drying and blow-off operations are well suited to using regenerative blowers and air knives. Using blower air instead of compressed air can result in significant savings and return thousands of dollars annually to the bottom line.

In addition to reduced cost, air knife/blower packages offer:

- Clean, heated air.
- Low operating noise – no sound enclosures required.
- Easy installation and operation.

In general, the following applications are good candidates for air knife/blower systems:

- Velocity rather than impact is required.
- The oil in compressed air is causing quality problems.
- Large application areas – more than 2' (61 cm).
- Heated air is needed.
- Air knives can be placed close to the target surface – 4" (10.2 cm) or less.

Performance and efficiency gains are dependent on the individual components used in the air knife/blower system or package. There are many factors to consider including air knife length, air slot size, blower horsepower and a wide range of supplemental components. Working with a single supplier that provides a complete package will help ensure optimal performance. In the sections that follow, you'll find more information on both air knives and blowers and which features to watch for when specifying your system.

Air Stream Integrity: A "Must Have" in an Air Knife

Most air knives feature slim lines to facilitate placement into a wide range of manufacturing environments. But, that's where design similarities usually end.

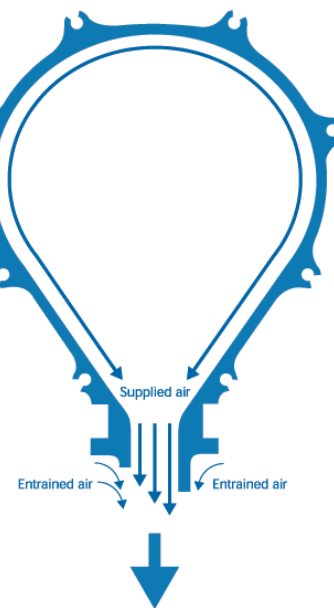
Some air knives feature a protruding leading edge design that directs the airflow out of the knife in a straight stream, producing an air stream that retains its integrity better than other air knives. This design also takes advantage of the Coanda effect and air entrainment to economically produce a uniform and constant air stream.

The Coanda effect induces the supplied air to attach itself to the surface of the air knife and helps maintain the integrity of the air stream further downstream. This effect also creates a condition conducive to entraining ambient air to increase the total volume of air. (See Figure 1.)



Another advantage of the leading edge design is that it provides a visual guide for positioning the air stream, pointing out the direction of the flow. This allows easy positioning of the knife to ensure maximum target coverage.

FIGURE 1.



Extended edge design improves air entrainment and ensures the integrity of the air stream.

The result of this leading edge design is a uniform, high volume, constant air stream along the entire length of the knife. The spotting and blotching problems associated with many air knives are eliminated.

Eliminating Compressed Air: A Viable Option for Many Applications

A Bit About Blowers

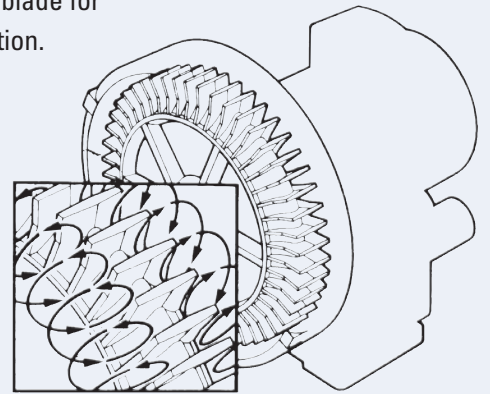
Similar to air knives, there are different types of blowers. Performance and maintenance requirements may vary considerably so be sure to research the alternatives carefully. Regenerative blowers are often recommended to supply air knives for these reasons:

- ✓ **Minimal maintenance:** Unlike other blower types, regenerative blowers are rugged, reliable and require infrequent, minimal maintenance.
- ✓ **Greater operating efficiency:** Dynamic operating principle recycles a certain amount of air, enabling regenerative blowers to provide performance comparable to many multi-stage or positive displacement blowers.



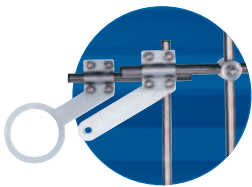
THE REGENERATIVE PRINCIPLE

In a regenerative blower, the compression space consists of a hollow circular ring between the tips of the impeller blades and the walls of the housing. In operation, the rotating impeller draws air from the inlet port into the compression space and moves it radially outward to the curved housing by centrifugal force. The action is called "regenerative" because a certain amount of air slips past each impeller blade during rotation and returns to the base of a succeeding blade for re-acceleration.

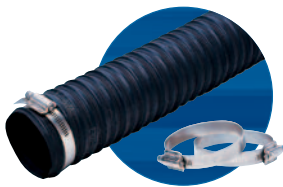


If you are considering an air knife/blower system, be sure to contact a manufacturer that offers a complete package to ensure optimal performance.

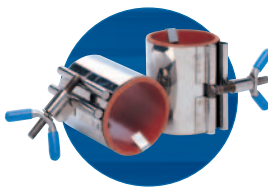
Air Knife Package Accessory Options



Mounting Brackets



Tubing



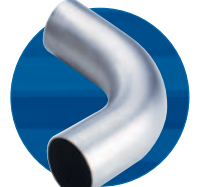
Couplings



Air Cannon



Manifolds



Elbows

A Comparison of Compressed Air Systems

Low Flow Air Knives: Maximum Efficiency in Small Areas

When space is limited and the process cannot tolerate any increase in temperature, low flow air knives that use compressed air are an excellent option.

This style air knife delivers a high velocity, uniform air flow across the entire length of the knife. (See Figure 2.) Drying and blow-off are fast and efficient and minimal air is used. Compared to a 3" (8 cm) pipe with three drilled holes, a 3" (8 cm) low flow air knife will use approximately 92% less air.

Another appealing attribute of low flow air knives is the noise level. Noise is under 70 dB(A) in many applications – lower than many compressed air options.

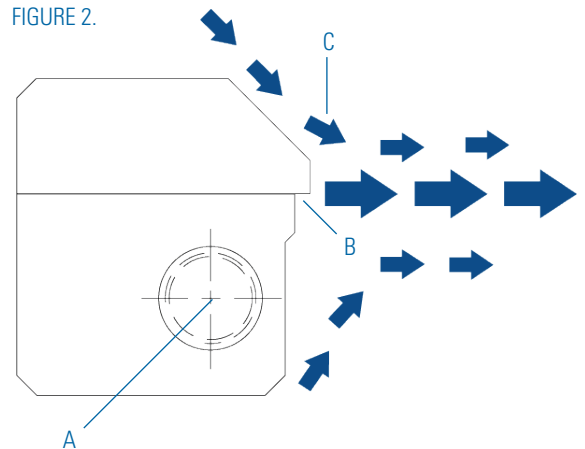
Designed for small areas, low flow air knives are typically mounted close to the target. Maximum knife length (or combined length of all knives) is limited to less than 2' (61 cm). Applications that only require one or two air knives can experience significant operating cost reductions by using low flow models.

Benefits of low flow air knives include:

- High velocity, uniform air flow.
- Low noise level.
- Low profile for ease of mounting.
- Efficient – minimal air use.



FIGURE 2.



Compressed air flows through an inlet (A) and is directed to the orifice. The air flow exits the nozzle orifice across the length of the knife (B), creating a uniform sheet of air. Secondary air is entrained along the edge of the knife (C) for added force.

Air Amplifiers Increase Intensity and Efficiency

A variable air amplifier is another option when using compressed air. Air amplifiers produce a constant, high velocity air stream for very targeted drying and blow-off applications. Efficiency is maximized because additional free air is pulled through the unit along with the compressed air. (See Figure 3.)

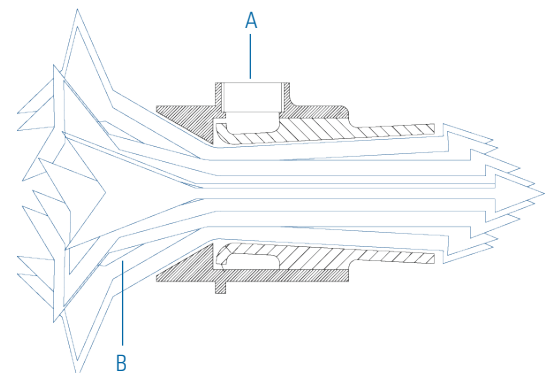
Variable air amplifiers typically provide coverage in the ¾ to 4" (19.1 to 101.6 mm) range at a distance of 6" (152.4 mm). Commonly used for spot drying, blow-off and exhaust operations, variable air amplifiers are ideally suited to robotic applications as well.

Benefits of using variable air amplifiers include:

- Extremely efficient use of compressed air – up to 90% less than open pipes and 60% less than air nozzles.
- Delivers higher volumes of air and operates at higher pressures than air nozzles for fast drying and blow-off.
- Low noise.



FIGURE 3.



Variable air amplifiers use both compressed air (A) and additional free air (B) to maximize air amplification.

A Comparison of Compressed Air Systems

Air Nozzles: A Better Direction

Air nozzles convert a low-pressure volume of compressed air into a targeted high-velocity concentrated air stream, flat fan or curtain of high-impact air. Ideal for use in many applications, air nozzles come in a variety of types, capacities, sizes and materials.

Air nozzles are widely used for moving materials and cleaning, drying and cooling parts. The high impact provided by these nozzles ensures effective drying and blow-off even for round or oddly shaped products.

The benefits air nozzles bring to every operation include:

- A significant reduction in compressed air consumption compared to open pipes. (See Figure 4.)
- Up to 60% reduction in perceived noise level, depending on the initial air pressure. At 100 psig (7 bar), for example, an open pipe would produce a noise level of 98 dB(A) while an air nozzle would produce 85 dB(A), a reduction of 13 dB(A) and a perceived noise reduction of 60%. (See Figure 5.)

- Improved safety. The design of many air nozzles prevents dead-ending should the nozzle accidentally be placed against a flat surface.
- The targeted air stream delivered by the nozzles can improve the effectiveness and efficiency of drying and blow-off. More complete drying, even in cracks and crevices is commonly achieved.



The air nozzle on the left produces a flat fan air pattern and the nozzle on the right produces a directed round pattern.

FIGURE 4.

Air Consumption: Open Pipe vs. Air Nozzles

Open Pipe		Equivalent Impact Using Flat Fan or Round Spray Pattern Air Nozzles	Air Consumption Reduction %	Annual Air Cost Savings *
Size in. (mm)	Air Consumption SCFM (NI/min)			
5/32 (4)	19 (538)	1	25%	\$593
1/4 (6)	41 (1161)	2	28%	\$1,432
5/16 (8)	94 (2662)	4	33%	\$3,872
1/2 (12)	177 (5012)	7	35%	\$7,731
5/8 (16)	309 (8750)	12	36%	\$13,833

*Data provided by Spraying Systems Co. and is based on AA727 and AA707 WindJet® air nozzles. Assumes a 16 hour work day, 5 days a week and an operating cost of \$0.50 per 1000 cubic feet of air.

FIGURE 5.

Noise Comparison: Open Pipe vs. Air Nozzles

Air Pressure psig (bar)	Noise Level		Noise Reduction	Perceived Noise Reduction
	5/32" (4 mm) open pipe at a distance of 5 ft. (1.5 m)	Flat Fan or Round Spray Pattern Air Nozzles		
15 (1)	70 dB(A)	63 dB(A)	7 dB(A)	38%
30 (2)	80 dB(A)	70 dB(A)	10 dB(A)	50%
60 (4)	88 dB(A)	76 dB(A)	12 dB(A)	56%
70 (5)	92 dB(A)	80 dB(A)	12 dB(A)	56%
100 (7)	98 dB(A)	85 dB(A)	13 dB(A)	60%

Note: Data provided by Spraying Systems Co. and is based on AA727 and AA707 WindJet air nozzles.

A Comparison of Compressed Air Systems

Air Nozzles, continued

Key Selection Considerations

Most drying and blow-off operations can benefit from the use of air nozzles. But before you can select the nozzle best suited to your operation, you need to understand the following terms.

✓ Sound Level

Capacity, air pressure and how the nozzle is positioned all impact noise.

Guidelines:

- Higher flow rates and higher pressures generally increase noise levels.
- Obstructions in the nozzle's path or spraying against objects will also increase sound levels.

✓ Effective Spray Coverage

Spray coverage is the width of the spray pattern for a flat fan air nozzle. Effective spray coverage is the width of the fan, which comprises a minimum spray force measurement. This coverage can be used as a guide for spacing nozzles. Effective spray coverage varies for different types of air nozzles.

Guideline:

- Effective coverage generally increases as distance from the nozzle increases.

✓ Lineal and Specific Impact Force

There are two types of impact to consider when selecting air nozzles: lineal impact and maximum specific impact.

Lineal impact indicates relative force per unit distance across the spray width. Flat spray patterns have fairly uniform impact distribution across the effective spray coverage. Spacing of nozzles in a header according to the effective spray coverage will provide consistent lineal impact across the entire target surface.

Maximum specific impact is a direct indication of spray intensity applied to a surface. It provides maximum force per unit area information, which can be used to compare spray effectiveness under various conditions.

Guidelines:

- Both lineal and specific impact increase with pressure.
- When capacities are the same, a nozzle with a narrower coverage will have greater impact than one with a wider coverage.

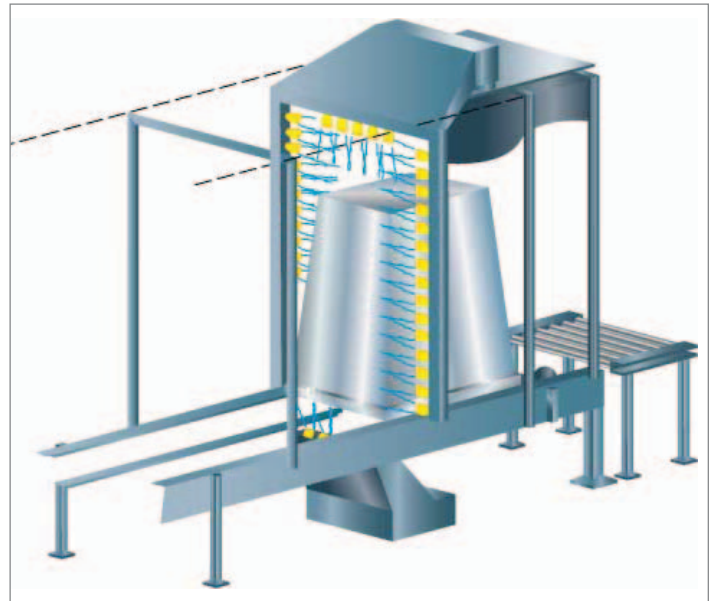
There are many other factors to evaluate during the selection process:

- To minimize air consumption and reduce noise, specify the lowest-flow nozzle.

- To reduce noise caused by air impacting its target, increase the distance between the nozzle and the target when possible.
- To reduce the number of nozzles required, position nozzles to swipe sideways across a moving target at a comparatively shallow angle. (See Figure 6.)
- When creating an air curtain, place nozzles up to 12" (305 mm) apart.
- When using air nozzles for cleaning, angle the nozzles 15° to 45° to ensure contaminant removal.

These guidelines will help you with the specification process, but you should consult the experts for additional information.

FIGURE 6.



Placing nozzles to wipe sideways can minimize the number of nozzles required.

Any plant with a drying or blow-off operation can benefit from an evaluation to determine the potential savings and efficiency gains of making changes to its systems. Certainly, if open pipes are currently used, reductions in compressed air consumption are possible and quickly offset the cost of any new equipment. If air nozzles are already in use, evaluating alternatives such as variable air amplifiers, low flow air knives or air knife/blower packages is a good idea to see if further savings can be realized. The magnitude of your savings will be application dependent but savings like those described in Figure 7 are common.

Find a manufacturer of air products willing to work with you to provide an objective assessment of your operations. The vendor should offer a broad product line, have a proven track record with applications similar to yours and be willing to provide references. This will help ensure you are partnering with a company that has a full range of solutions and the expertise to guide you through small or big changes to your drying and blow-off applications.

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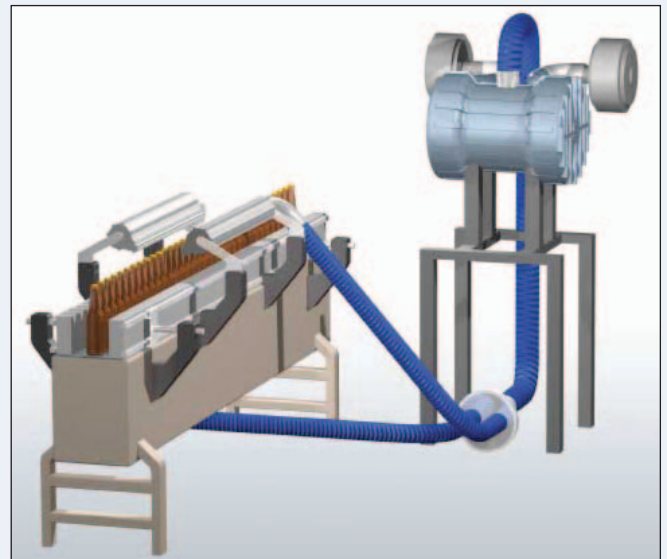
FIGURE 7.

Bottling up Savings: \$30,000 Annually

A change from compressed air to air knife/blower package yields significant savings

A bottling plant was using 24 flat-fan type compressed air nozzles to dry soft drink bottles after washing. The plant was operating 250 days per year, 16 hours per day. The cost of operating the drying system was estimated at more than \$35,000 annually.

A change to high-impact blower-fed air knives yielded dramatic cost savings. Four 24" air knives fed by a 30 horsepower blower use little energy. Operating costs for the system dropped to \$5,900 annually. The savings offset the cost of the new air knife/blower system in just a few months and the bottler continues to enjoy a \$29,100 savings on an annual basis.



An 83% reduction in operating cost was the benefit to one bottler who switched to an air knife/blower system.



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