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How automated air control valves can replace VFDs

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How AUTOMATED AIR CONTROL VALVES can replace VFDs

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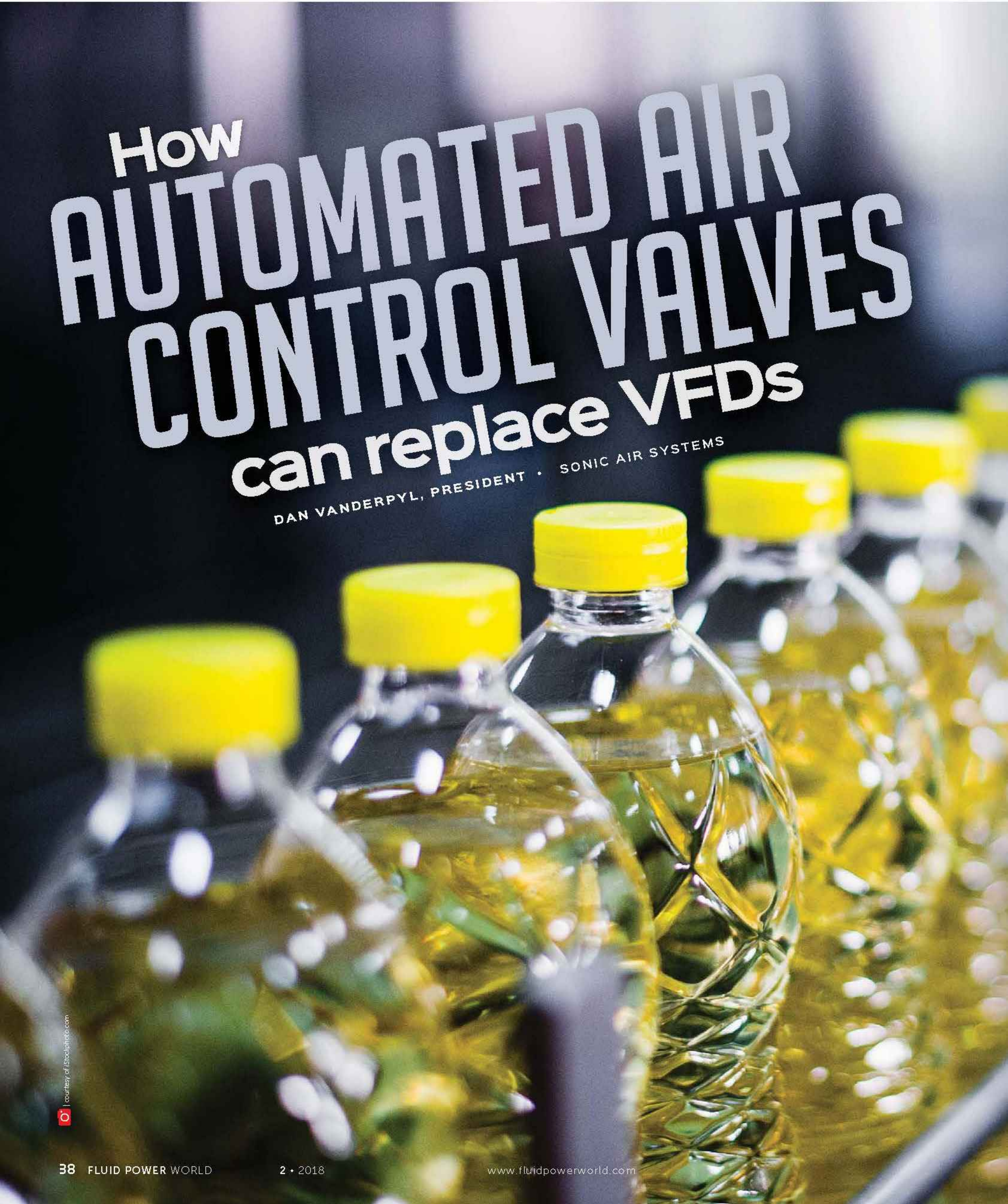

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Air knife systems controlled by automated valves offer significant benefits over complex and costly VFD motor controls.

Variable frequency drives for electric motors have become a welcome addition to a wide variety of machinery for a long list of 21st century applications, but they are no longer the only option when it comes to precise air velocity control for blower-powered air knife systems. Often, much simpler air control valves can offer comparable performance at a significantly lower cost.

VFD basics

Variable frequency drives are known by many names, among them: variable speed drives, variable frequency controllers, inverters, speed controllers and frequency inverters. Most people simply call them "VFDs." In a basic setup, a VFD connects in-line between the power supply and motor that, in turn, drives a rotating device like a pump or fan. A VFD's ultimate purpose is to adjust the motor speed to ensure the rotating device delivers optimum performance based on the required rpm, and at the lowest energy demand.

The VFD receives alternating current (ac) incoming power at a 50 or 60 Hz frequency, converts the ac power to dc, then modulates the dc voltage in accordance with an external command signal to change the speed of the driven motor. It then converts the modulated dc voltage back to ac at a different voltage and Hz to make the driven motor operate at the required rpm.

The devices routinely control motors from 1 to 500 hp and adjust the performance of blowers, fans, pumps, compressors, mixers, conveyors, machining centers and many other rotating devices.

VFDs for blower-powered air knives

Air knives are devices that direct a tightly controlled flow of pressurized air to clean, dry or cool products that often are moving along a conveyor. A common benefit of blower air knife systems is their 75% lower electrical consumption versus most compressor powered blow-off devices.

Most systems today use 3 to 50 hp compact, high-rpm centrifugal blowers with air flows of 200 to 3,000 cfm at 1 to 3 psig air-knife pressures. These are available with either high speed belt-and-pulley drives powered by two-pole, 60 Hz, 3,600 rpm motors; or with direct-drive blower motor assemblies using ultra-high frequency VFD systems to operate ac motors at speeds up to 20,000 rpm.

Although air knives are now used in virtually every industry, high-volume food and beverage filling and packaging facilities represent the largest market for these systems. Most food and beverage plants have computer-based systems to monitor, control and adjust every aspect of each production line, with multiple VFDs serving several key roles for a wide range of motor-driven machinery. However, the VFDs with the highest power demand are often those operating

Engineered air-knife systems are often used on high-speed beverage conveyors to remove moisture prior to labeling or ink-jet coding.

blower driven air knife systems used after washing, cooling or warming processes; or prior to labeling, ink jet coding and packaging.

Some production lines permit changeovers for handling multiple types of products. They usually have a PLC which interfaces directly with the blower VFD to automatically deliver real-time air knife velocity control, based on production rates and specific package sizes, while optimizing the drive motor's electrical operating cost. When VFDs combine with blower powered air knife systems in such cases, exit air velocity can be adjusted to use only the precise amount of air force needed for blow off while maximizing the total system efficiency for every condition on each production line. These are considered a proper use of VFD controllers.

Potential misapplications

A VFD can be the most-efficient method for air knife velocity control, but there are many situations where the VFD is misapplied or, at the very least, serves only as an expensive motor starter. The results can be a host of unintended consequences or just a much longer return on investment than was used to justify its original purchase. This is particularly true if the VFD is chosen simply as an alternative to a magnetic motor starter even though the production line runs almost steady state and the driven motor operates at ≥80% of full speed most of the time.

Thus, experts always recommend that an electrical engineer review the entire job site before committing to the integration of a VFD, particularly to power a blower with a 10-hp motor or larger, or with multiple blowers and VFDs. This includes installation, cabling, operating plan and electrical power supply to ensure the compatibility and highest reliability of each VFD, motor, and all other associated plant equipment.

Although there are many successful installations where the VFD and motor are from different manufacturers, having the VFD manufacturer supply—or at least recommend the specific motor for each installation—can eliminate any questions of compatibility if problems arise.

Even with a "matched" VFD and motor, however, faults can occur. For example:

Electrostatic discharge (ESD) primarily affects the internal surfaces of motor bearings as electrical energy in the rotor travels through the bearings to the motor's grounded casing. This high-frequency electrical arc across bearing surfaces causes "frosting" and "fluting" which significantly decrease the normal operating

Blower and air knife combinations controlled by automated valves are much simpler and significantly less expensive than those with VFD motor controls.

A brief history of air knife systems

PRIOR to the historic 1987 Montreal Protocol, wherein nearly 200 countries ratified an agreement for the worldwide phase-out of chlorofluorocarbons (CFCs) and other volatile organic compounds commonly found in refrigerants, aerosols, cleaning agents, inks, coatings, adhesives and others, the term air knife was almost completely unknown. Only a small number of liquid blow-off applications in just a few manufacturing sectors had any need to use air to blow water or debris from their production lines.

The printed circuit board (PCB) manufacturing industry in the 1980s was trying to keep up with explosive growth at the start of the new personal computer age. The standard for cleaning boards after automatic soldering machines was liquid Freon, a CFC compound that was an effective and instantly evaporating cleaning agent. Scientists soon realized that the massive amounts of Freon being used for cleaning were inflicting enormous damage onto the earth's protective upper atmospheric ozone layer.

The Montreal Protocol addressed this urgent problem head on and water-based, non-CFC cleaning alternatives were implemented throughout PCB fabs and other industries during the late 1980s. As the need for ways to blow water-based cleaning solutions off manufactured products grew, most industries initially chose the lowest cost and easiest-to-install water blow-off devices they could find. Many of these early users bought or made air knives and air nozzle designs powered by their factory's existing high-pressure compressed air systems. Subsequently, the high electricity demands of most compressed air blow-off equipment became more widely understood, and the search for energy efficient alternatives began.

It wasn't long before most engineers realized that a 1 to 3 psi air knife could dry as good or better than a 100 psi compressed air system, which in turn created the demand for what is today's blower-powered air knife systems industry.

The bottom line: before adding VFDs to any blower/motor for air knife systems, the user must be aware of a wide range of factors which could result in unintended consequences, higher repair and maintenance expenses, and a corresponding increase in the total cost of ownership over the long term.

Automated flow control valves

An alternative to VFDs is using flow control valves in air knife designs. An automated air flow control valve on the outlet of a blower powered air knife system responds to PLC signals much like a VFD. However, that is where the similarities end, as air valves can offer some significant benefits over VFD motor controls.

First, the production line manager must define all the air knife system's performance objectives, along with variables in the product mix and conveyor speeds. This lets the system designer size the air knife performance to minimize horsepower requirements and cost, but at the same time achieve the desired blow-off results to handle the highest production rates and the most-complex product geometries.

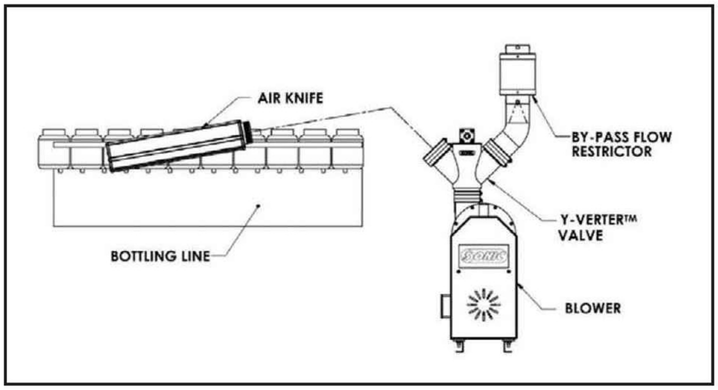
The second requirement is to have an effective and repeatable method for air knife velocity control. This is necessary when production line variables require either a reduced air knife velocity; or for the air to be shut off completely, such as during planned or unplanned production stops common in many food and beverage conveyor lines.

Whenever the product flow is interrupted and the air knife needs to shut off, regardless if it's only three or as many as 20 times per hour, the automatic air flow control valve can immediately divert all of the air completely from the air knife. In the air-divert mode, the blower continues to run at normal speed while total blower flow reduces to only 25% and air discharges through the bypass outlet to atmosphere. This cuts the motor amp load by 50%. There is no VFD "lag time," so the line sensor signal instantly shuts off the air knife, and then immediately resumes full air knife velocity the moment a restart signal is received.

Another condition that is better suited to an air flow control valve, instead of a VFD, is when the production line requires only two air knife velocity settings. In such cases, high air velocity is needed for the largest products or fastest line speeds, and a lower velocity setting for smaller, simpler or more delicate products passing through the air knife zone.

Likewise, the high air velocity point doesn't have to be the maximum possible, but can be set only as high as needed. This allows the blower volume and corresponding motor amperage draw to be reduced for peak efficiency at the upper operating point, similar to the benefits of a VFD set at 80 to 95% of maximum Hz.

There is no dispute about a VFD being the most-efficient motor control system. But with the air control valve being only a few percentage points less efficient for most operating conditions, the low cost, ease of installation, rapid response and much lower long term cost of ownership all



Valves for air knife velocity control can instantly reduce or shut off flow to the production line. They're nearly as efficient as VFDs under most operating conditions.

make for a strong justification for the air control valve option.

The air control valve has no delay in response time and can cycle on and off without limiting the number of cycles per hour or per shift. The motor runs at a constant 50 or 60 Hz and 3,000 or 3,600 rpm while the amps cycle up or down in response to the blower air demand signals from the production line. Although it is true that a VFD can reduce power demand by up to 75% in the "turn down" mode, these low flow/no flow air knife modes represent a small percentage of normal production cycles for most factories, and the true operating cost savings are therefore much less.

Cost comparison

As an example, consider a 20 hp, 60 Hz, 460 V motor at full air knife velocity running at 28 A. When the air diverter valve shuts off air knife flow, the motor amp load drops by 50% to about 14 A. By comparison, a 20 hp motor with VFD control would be turned down to approximately 30 Hz,

The automated Sonic Y-Verter flow control valve mounts on the outlet of a blower powered air knife system and responds to PLC signals much like a VFD.

which reduces motor current to approximately 7 A. Assuming that this low flow air operating condition represents 10% of a typical production day, the approximate electric savings of 4.2 kW/hr for each 8-hou shift, 5 days a week would take 10,000 to 15,000 total operating ays to pay for the extra $5,000 purchase price for the VFD rather han air control valves.

Even if the ow flow/by-pass condition were 90% of the air knife system's aily operating time, the 37 kW/hr savings per 8-hour shift would still require more than three years to recoup the purchase price (material and installation) of the VFD.

At the end of the application review, and before purchasing equipment, have the blower/air knife system supplier do an ROI analysis for each system, and then proceed accordingly.

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