WHITE PAPER

NEW EQUIPMENT DIGEST

Penton Manufacturing and Supply Chain

GET MORE VALUE FROM YOUR AIR COMPRESSOR WITH A MAINTENANCE-FREE PNEUMATIC VACUUM

Air-powered vacuums are safer, more powerful and more reliable than electric shop vacs.

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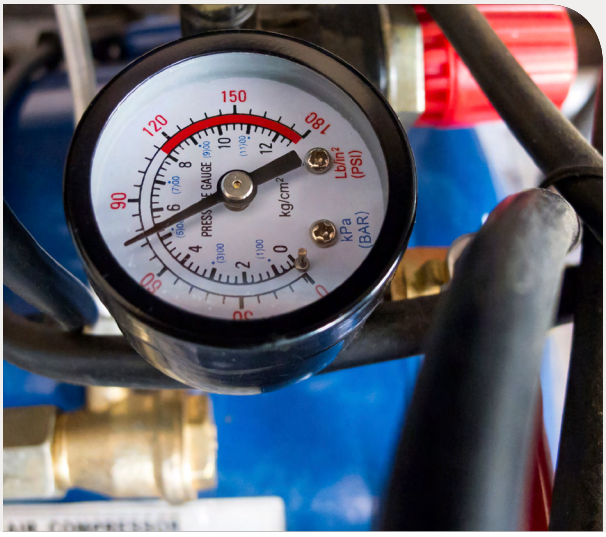
Compressed air is a staple of manufacturing operations around the world. Commonly known as "the fourth utility," compressed air provides power to pneumatic tools and equipment that perform thousands of industrial applications, from grinding to sandblasting, from material handling to plant maintenance. Among its many commercial uses, compressed air plays a key role in automobile and aircraft production, shipboard repair, food and beverage processing, pharmaceutical manufacturing, highway construction and maintenance, and vehicle servicing.

"Compressed air is used in virtually every phase of manufacturing," the Compressed Air & Gas Institute explains in its Compressed Air and Gas Handbook. "In one medium-sized plant, there may be a hundred different uses of air. Air from the same compressed-air system may actuate stamping presses, air wrenches, aerating equipment and pneumatic controls and, at the same time, be part of a chemical or manufacturing process. In addition to the well-known applications for air, individual manufacturers find many special uses tailored [to] their own techniques."

Perhaps one of the lesser-known applications for compressed air is its use as a power source for pneumatic vacuums. A pneumatic vacuum is a high-performance vacuum that uses compressed air – rather than electricity – to generate powerful suction. Pneumatic vacuums offer a number of advantages over electric vacuums:



- Because they have no electric motors or moving parts (which can clog or wear out), pneumatic vacuums excel in industrial environments – particularly in high-duty-cycle (on-off-on-off) applications that are prone to burning out electric vacs.
- With no electric motor, sparking from brushes or arcing at a power switch is eliminated, and no electric fields are present.
- They require no dangerous, high-voltage electrical cords, an important safety feature in wet and/or hazardous environments.
- Often, compressed air is more readily available than electric power, particularly at mobile or remote worksites and in many in-plant locations.

Because they're powered by compressed air, pneumatic vacuums offer another key advantage: They produce up to five times more suction power, or lift, than conventional electric-powered units.

The operation of pneumatic vacuums can be explained by a basic principle of fluid dynamics known as the Venturi Effect, named after the 18th century Italian physicist Giovanni Battista Venturi. The Venturi Effect is a phenomenon that occurs when fluid flowing through a pipe is forced through a restrictive section, causing an increase in velocity and a decrease in pressure.

Pneumatic vacuums harness this phenomenon when compressed air, via the air-supply hose, enters the unit and travels through the injector. As the air exiting the injector continues through a surrounding venturi, it accelerates, creating an area of low pressure that induces vacuum flow inside the adjacent canister, and in turn through the attached vacuum hose.

Electric Shop Vacs Create Explosion Hazards

In hazardous environments, such as locations with dangerous vapors or combustible dust, pneumatic vacuums offer a number of important safety advantages over electric-powered shop vacs.

"The motor and switch of an electric vacuum can produce arcs, or sparks, that can ignite an explosion in a dust-filled or vapor-filled hazardous location," explains Mark Yorns, Director of Engineering for the Vacuum Products Division of Chicopee, Mass.-based Guardair Corporation.

Although OSHA has not yet promulgated a combustible-dust standard (as of October 2015, the standard was in the pre-rule stage), combustible dust has been in focus over the past decade, due to a spate of dust-related explosions and fires. According to the U.S. Chemical Safety Board, 50 combustible-dust accidents – resulting in 29 fatalities and 161 injuries –occurred between 2008 and 2012 in the United States.

Related OSHA standards as well as voluntary standards such as NFPA 654 (Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids) point to the need to use safety-certified vacuum equipment for combustible-dust cleaning.

Section 8.2.3 of NFPA 654 provides specific requirements that a vacuum must meet to be safe for combustible-dust cleaning. A typical electric shop vac fails to meet a number of those requirements. Among them:

- Hoses shall be conductive or static-dissipative.
- Conductive components shall be grounded.
- Dust-laden air shall not pass through the fan or blower.
- Electrical motors shall not be in the dust-laden air stream.

Hughes Environmental, a Louisville, Ky.-based dust-remediation firm, asserts that typical electric-powered shop vacs are unsafe in hazardous environments because:

- Their canisters, components and plastic hoses are not grounded, creating a risk of static electricity exploding inside the vacuum body or in the dust-laden air around it.
- Where powered by DC motors, they can spark, creating an ideal ignition source for a combustible-dust explosion.
- The exhaust air from electric shop vacuums can be strong enough to stir up existing dust in work areas, potentially creating a combustible-dust cloud.
- Most electric shop vacs lack the suction power and filters needed to handle fine particles that compose dust clouds. [1]

Also, because shop vacs are prone to clogging and overheating in dust-heavy environments, they require more frequent maintenance (emptying the vacuum and cleaning the filter, for example), making the cleaning process more arduous – and less efficient.

[1] Hughes Environmental, "6 Reasons a Shop Vac Creates an Explosion Hazard," Feb. 17, 2015

Pneumatic Vacuums Are Safer

To safely clean combustible and fugitive dust, facilities should use an explosion-proof vacuum certified by a nationally recognized test laboratory for use in hazardous environments. Explosion-proof certification indicates where the vacuum can be used and with which types of material the vacuum can be used. The onus is on the facility to make sure that the vacuum has the correct certification for the particular work environment, and that the unit is properly grounded. [2]

Because there are no U.S. standards to certify pneumatic vacuums for use in hazardous locations, Guardair engages a U.K.-based, nationally recognized testing laboratory to certify its Guardair hazardous-location pneumatic vacuums to certain requirements of Europe's ATEX Directives for controlling explosive atmospheres. Guardair's ATEX certification is the equivalent of NFPA 70 (National Electrical Code) ratings for some Class I, Division I environments; some Class II, Division I environments; and Class III environments (for definitions, see sidebar).

Yorns notes that Guardair's hazardous-location pneumatic vacuums "eliminate the threat from static electricity by combining static-conductive design with inherently safe, pneumatic vacuum technology."

"Static-conductive attachments, electrically bonded components and multiple grounding options eliminate static electricity at the source," Yorns explains. "Pneumatic vacuums have no electric motor to spark or burn out and no wires to create a potential hazard in wet environments."

Another way that pneumatic vacuums can make the workplace safer is by eliminating the use of compressed air for self-cleaning (blowing off clothing and hair) at the end of the workday. OSHA forbids this practice because loose debris and particles can be blown into workers' skin, clothing and eyes. A safer and acceptable alternative is the use of a personal cleaning station – such as the Guardair CS3000 – which vacuums up debris instead of blowing it into the air.

"This product also features a thumb-switch-activated air agitator, which loosens and lifts up debris for the vacuum to suck away, safely and effectively," Yorns explains.

[2] "Explosion-Proof Vacuums: An Investment in Safety," *Industrial Maintenance & Plant Operation*, August 2013

Pneumatic Vacuums: Some Helpful Definitions

If you're new to the concept of compressed-air vacuums, here are some terms and definitions that will help you gain a better understanding of their benefits and applications.

Terms for Vacuum Performance

Vacuum flow – The volume of air that passes through a vacuum hose during a given period of time. Vacuum flow is expressed in cubic feet per minute (cfm).

Vacuum lift – The height that a vacuum unit can raise a given material or liquid. Vacuum lift (sometimes referred to as vacuum head) is expressed in inches of mercury (in Hg), or inches of water (in H_2O).

Vacuum suction – A non-scientific term referring to the general cleaning power of a vacuum unit. Vacuum suction is an off-hand way to describe a vacuum unit's ability to generate vacuum flow, vacuum lift and its overall effectiveness.

Related Compressed-Air Terms

Pressure – The measure of potential energy stored within compressed air. Pressure is measured in pounds per square inch (psi). In general, most industrial compressed-air systems operate at

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Pneumatic Vacuums Are More Reliable

Because of their durability and reliability, many pneumatic vacuum manufacturers – including Guardair – offer extended or even lifetime warranties for their vacuums.

"The simple fact is that with no motors to burn out or no moving parts, pneumatic vacuums are hands-down, 100% more reliable than electric shop vacs," Yorns concludes.

Good Housekeeping: The Pneumatic Advantage

OSHA has established statutory requirements for housekeeping in general industry and construction (1910.22 and 1926.25, respectively). But there are other compelling reasons to invest in a robust housekeeping and maintenance program: Among them, good housekeeping contributes to a safe work environment as well as improved production, quality and efficiency.[3] Powerful, safe and versatile pneumatic vacuums can support those housekeeping and maintenance efforts.

Users of Guardair compressed-air vacuums report that the vacuums can handle a wide range of applications, including:

- Vacuuming excess product, debris and water from the inside of railroad tank cars.
- Cleaning up powder coatings in spray booths.
- Picking up fiberglass dust generated during a trimming process.
- Vacuuming up weld dust, spatter and slag.
- Housekeeping around bark-conveying equipment.
- Vacuuming paint chips and steel grit on lead-abatement jobs.
- Sucking up water, coolant and oil spills off plant floors.
- Vacuuming magnesium chips and coolant inside machining centers.
- Cleaning up plastic pellets around injection-molding machines.

[3] Cary Gray, Ohio Bureau of Workers Compensation, "Housekeeping and Safety" brochure, 2013

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pressures between 80 and 120 psi. The electrical equivalent of pressure is voltage.

Flow – The volume of air traveling through an air-supply line, or through a vacuum line, during a given period of time. Flow is measured in cubic feet per minute (cfm). The electrical equivalent of flow is current.

Definitions of Hazardous Environments

Classes

Class I – A location made hazardous by the presence of flammable gases or vapors that may be present in the air in quantities sufficient to produce an explosive or ignitable mixture

Class II – A location made hazardous by the presence of combustible or electrically conductive dust

Class III – A location made hazardous by the presence of easily ignitable fibers or flyings in the air, but not likely to be in suspension in quantities sufficient to produce ignitable mixtures

Divisions

Division 1 – A location where a classified hazard exists or is likely to exist under normal conditions

Division 2 – A location where a classified hazard does not normally exist but is possible to appear under abnormal conditions

Sources: Guardair Corp. and the National

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About Guardair

Guardair Vacuum Products is a division of Guardair Corporation, the world's largest manufacturer of safety air guns and pneumatic accessories used for industrial cleaning. Guardair pneumatic vacuums are used in a wide range of industries around the world, including:

- Metalworking
- Chemical processing
- Food processing
- Pulp and paper
- Mining and processing
- Pharmaceutical
- Transportation
- Electric power generation
- Power coating
- Foundries and die casting
- Steel production and processing
- Hazmat cleanup

"Guardair offers more than 30 models in a variety of sizes and with a wide array of hoses, filters and accessories – all unmatched in durability and dependability," Yorns says. "Designed to handle the toughest of cleaning jobs, Guardair vacuums are ideal for vacuuming up chips, dust, debris, liquids or sludge. Powered by compressed air, always dependable and trouble-free with no motors or moving parts to wear out, Guardair drum vacuums generate exceptional vacuum lift and vacuum flow while operating quietly and efficiently."

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WHERE OSHA STANDS ON PNEUMATIC VACUUMS AND COMBUSTIBLE DUST

While NFPA 654 and NFPA 484 (NFPA Standard for Combustible Metals) are considered to be definitive recommendations for preventing fires and explosions in combustible-dust environments, they are not enforceable by law. However, inspectors have used the standards to determine if safety risks are present, and then have referenced tangentially related OSHA standards to cite employers for using vacuum equipment that isn't rated for hazardous environments.

After a series of explosions and fires at a New England Wood Pellet factory in Jaffrey, N.H., in October 2011, OSHA issued $147,000 in fines (later reduced to $100,000) for fire and explosion hazards, including a $7,000 repeat citation for using unapproved electrical equipment to vacuum combustible dust. The agency referenced 1910.307(c), which states that: "Equipment, wiring methods, and installations of equipment in hazardous (classified) locations shall be intrinsically safe, approved for the hazardous (classified) location, or safe for the hazardous (classified) location."

"Employees used three ordinary shop-vac vacuums to collect fugitive dust from the floor and machinery," OSHA explained in its citation notice to the company. "These machines were not rated for use with combustible dust."

In a 2003 letter of interpretation, former OSHA Director of Enforcement Programs (now Deputy Assistant Secretary of Labor) Richard Fairfax referenced OSHA standards 1910.399 and 1910.307 in response to a question about whether it's acceptable to use portable wet/dry vacuum cleaners to pick up wood and aluminum dust and shavings. Fairfax noted that 1910.399, which provides definitions for hazardous-location classifications, would classify an area as a Class II, Division 1 location if it contained electrically conductive combustible dusts.

"Aluminum dust is an electrically conductive, particularly hazardous combustible dust, requiring any equipment used in that location would need to be approved for use in a Class II, Division 1 location," Fairfax wrote. "Therefore, if an unapproved vacuum-cleaning device is used to clean up aluminum dust, this is in violation of the provisions of 29 CFR 1910.307(b)(2), which require that equipment be approved for use in the hazardous location."

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Likewise, any vacuum equipment used to clean up combustible wood dust would need to be approved for a Class II or Class III hazardous location (depending on the particular conditions).

"It is the employer's responsibility to evaluate the area, determine, if necessary, the appropriate hazardous-location classification, and ensure that only equipment approved for that location classification is used in that area," Fairfax wrote.

OSHA also has leveraged the General-Duty Clause (Section 5(a)[1]) to cite employers for failing to address combustible-dust hazards.

The U.S. Chemical Safety Board, in a report triggered by a spate of dust explosions that killed 14 workers in 2003, lamented that OSHA's oversight of combustible-dust locations – in the absence of a national standard – has not had "a preventive focus."

The CSB noted that NFPA 654 and NFPA 484 "are widely recognized by experts as effective and authoritative" standards for preventing and mitigating combustible-dust explosions. The NFPA standards are incorporated into the International Fire Code and referenced in OSHA citations "and by authoritative publications on combustible-dust hazards," and are used directly by safety professionals and engineers as guidance to prevent dust explosions. [1]

"Indeed, the CSB concluded that if the three facilities that experienced catastrophic explosions in 2003 had complied with relevant NFPA standards, the explosions would have been prevented or their impact significantly reduced," the agency said in the report. "Although these NFPA combustible dust standards are generally incorporated directly or by reference into fire regulations of state and local jurisdictions, the CSB found that their adoption and enforcement is inconsistent and largely ineffective."

In an Aug. 22, 2014, *New York Times* op-ed, former CSB Chairman Rafael Moure-Eraso reiterated the agency's position, noting that the CSB considers an OSHA combustible-dust standard its "most wanted safety improvement." According to the agency, industries that process metals, food, wood, rubber, plastics and pharmaceuticals are at risk of combustible-dust explosions.

In August, the National Fire Protection Association issued a new, overarching combustible-dust standard: NFPA 652, Standard on the Fundamentals of Combustible Dust, 2016 Edition. Some have speculated that OSHA had been waiting on NFPA 652 to be finalized before moving forward with its own combustible-dust standard.

For collecting combustible particulate solids in nonhazardous locations, NFPA 652 (much like NFPA 654) specifies that portable vacuum cleaners must have hoses that are conductive or static-dissipative; all conductive components must be bonded and grounded; and dust-laden air cannot pass through the fan or blower. Unless they're listed for Class II, Division 1 locations, vacuum cleaners powered by electric motors cannot be used in dust-laden environments.

U.S. Chemical Safety and Hazard Investigation Board, "Investigation Report: Combustible Dust Hazard Study," November 2006