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Reducing capital costs for surface preparation with modified air-blast cabinets

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Air blasting, or abrasive blasting, can be used by powder coaters for a number of surface preparation tasks, including cleaning, surface profiling, or both to improve coating adhesion; stripping of old coatings before recoating; and removing coatings for rework on defective parts. This article explains the air-blast process and operating principles. It then describes the types of equipment available, focusing on the role of modified air-blast cabinets for specialized surface treatment requirements.

Air-blasting equipment falls into four basic categories: portable blasters, blast rooms, blast cabinets, and automated blast systems. Sometimes, none of these equipment approaches are quite right. For example, a workpiece may not fit into a standard blast cabinet, and the alternative, a blast room, may not fit into the production plant or its budget. Along the same line, manual blasting may not deliver the required repeatability, but stepping up to an automated system could be cost-prohibitive.

For companies caught in between, a hybrid, the modified blast cabinet, opens opportunities to increase productivity without incurring burdensome capital costs.

Background of the air-blast process

As demonstrated by its many labels, the air-blast process—also known as abrasive blasting, bead blasting, blast finishing, blast stripping, sandblasting, shot peening—is used in a variety of production and maintenance tasks. These range from delicate jobs, such as deflashing plastic parts, to heavy-duty assignments, such as increasing the fatigue resistance of metal workpieces through controlled bombardment with shot.

In an integrated production plant, air blasting often performs multiple functions. The process may be used to clean molds at one end of the production line and put the finishing touches on a product at the other. The air-blasting jobs most frequently associated with powder coating operations fall into the general category of surface preparation, typically consisting of one or more of the following procedures:

- Cleaning, surface profiling, or both to improve coating adhesion
- Stripping of old coatings before recoating
- Removing coatings for rework on defective parts

Depending on the nature and extent of the production plant, blasting may also be used for peening parts or removing burrs before coating, as well as for touch-up subsequent to coating.

Although air blasting is a mature technology, selecting the best equipment mix and blast media can be complex—and therefore potentially profitable in the sense that many opportunities for substantial cost reductions and increased productivity still exist in the world of air blasting.

Operating principles of air-blast equipment

All four groups of air-blast equipment rely on essentially the same operating principle: They propel particles entrained in moving air toward a workpiece to alter its surface characteristics. The particles are put in motion under suction or with pressure.

Suction systems. These systems operate by siphoning media into a blast gun. They rely on compressed air being fed through the gun to create a partial vacuum that draws media from a storage hopper through a feed line. When the gun is triggered, escaping air carries media through a nozzle to the work surface.

Pressure systems. In this system, media are stored in a pressurized vessel operating at a pressure equal to that in the feed line. When the system is actuated, media are gravity-fed into the air line and then propelled onto the work surface through a nozzle.

The major difference between suction and pressure systems is that pressure uses compressed air much more efficiently than suction, often performing up to five times as much work with an equivalent amount of air. Beyond offering greater efficiency, pressure systems enable more precise control of media flow at both high and low operating pressures.

Nevertheless, suction systems aren't without their advantages. They're normally less expensive and easier to maintain than pressure systems. In addition, continuous operation and the use of multiple blast guns are simplified with suction.

Types of air-blast equipment

The first type mentioned in the introduction, portable blasters, or pots as they're commonly referred to in the industry, are available in small and large sizes for jobs ranging from do-it-yourself restoration of automobiles to stripping rust from girders supporting the world's longest bridges. Consumer models often use suction systems.

Equipment built for construction and industry universally rely on pressure systems. When outfitted with media-reclamation and dust-collection accessories, portable blasters are used in contained areas to strip aircraft and other large pieces of equipment. One such contained area is the blast room.

Blast rooms. Blast rooms (see Figure 1) prevent particulate matter from escaping to the environment while one or more operators, working within the room and wearing protective gear, air blast larger parts manually. Beyond having to accommodate the size of the operator and part, rooms are available in almost any size, ranging from smaller prefabricated units designed for quick assembly to custom enclosures constructed on site.

Features typically include powered floors. The floor transports media and debris to a reclamation device that extracts degraded media and debris before returning reusable media to the production cycle. Because a room must contain an operator as well as a workpiece, it's normally larger and more expensive than a system permitting the operator to work from the outside of the blast enclosure.

FIGURE 1

An operator works in a blast room where he manually strips large parts (doors are open for demonstration purposes only).

Standard blast cabinets. Rudimentary cabinets consist of a sealed enclosure with one operator station including a pair of sealed gloves and a viewing window. After parts have been loaded, the operator manipulates the parts and a blast gun or nozzle with the sealed gloves to strip, etch, and so on.

Cabinets can be equipped with either suction or pressure blast systems. Even the most basic cabinets should include a dust collector if operated in the presence of personnel unprotected by hood respirators connected to a clean air source. When used on a regular basis, cabinets should also include a media reclaimer for reasons of both work quality and economics. By removing dust, debris, and fines from the blast process before returning good media to the cycle, reclaimers improve the uniformity of results while reducing media-replacement and labor costs. Higher quality cabinet systems (see Figure 2) return recycled media to the blast process automatically without the operator wasting time on manual refills.

Automated blast systems. When first introduced, automated blast systems were generally dedicated,

FIGURE 2

This standard cabinet, designed for continuous production, includes ergonomic features and media recovery equipment.

meaning they could only process one type of part—albeit with a high degree of repeatability and speed. If a user wanted to blast different types of workpieces with a single machine, considerable time was required to reorient blast nozzles and fine tune other blasting parameters.

Through the use of programmable controllers, many automated blasting machines (see Figure 3) now have the versatility to finish a variety of workpieces with a simple program change. To set up a part for processing initially, operating guidelines involving nozzle movements, blast duration, blast pressures, conveyor speed, and part orientation are entered into the system via a control panel. In a multistation machine, the programmable controls enable precise information to be stored for each station. Once blasting instructions for a specific workpiece have been defined, they can be recalled and put into action with push-button ease.

Besides offering multipart capabilities, automated blast systems can be integrated into fully automated production processes. Examples include machines with in-line conveyors as well as turntable machines equipped with pick-and-place robotics.

Equipment limitations

The four groups of air-blast products discussed previously perform well within their own domains. Removing rust from water towers with portable blasters, etching jet-engine cowlings in blast rooms, peening turbine

FIGURE 3

A programmable controller, governing multiple functions, manages air-blasting parameters in an automated blast system.

blades in cabinets, and deburring hypodermic needles with an automated system are approaches that have proven to work successfully.

Putting portable blasters and the water tower aside (fitting a water tower into even the most severely modified cabinet would be a monumental feat indeed), the other three groups do have limitations.

Blast rooms, for example, are necessarily larger than cabinets. Because rooms contain not only the operator and workpiece, but also space to perform the work, they're normally more costly than cabinets. In addition, results largely depend on operator skill.

Repeatability also is limited by operator skill in standard blast cabinets because the blast stream and part are normally manipulated manually. In addition, standard blast cabinets restrict the types of parts that can be processed. Although they offer relatively large loading areas (64 inches by 58 inches) and working volumes of more than 200 cubic feet, even the largest standard cabinets aren't designed to accept parts with radically dissimilar dimensions.

Automated systems address the challenge of producing repeatable results and increasing productivity quite effectively, but they're normally the most expensive air-blast option and, as a consequence, unlikely to be cost-effective in smaller-scale operations.

The role of modified air-blast cabinets

Modified shouldn't be confused with custom when it comes to air-blast cabinets. A custom cabinet could be designed and built to handle almost any air-blast assignment, albeit at high cost. Modified cabinets, on the other hand, are built to perform specialized surface-treatment tasks with a minimum of custom engineering.

The concept revolves around configuring standard air-blast components to satisfy requirements particular to specific applications. By minimizing custom engineering, the modified approach has reduced capital costs for air-blast equipment as much as 70 percent in operations that might otherwise be performed with blast rooms or automated blast systems, while responding to requirements for fit, fixturing, parts handling, repeatability, and labor-cost reductions.

The following examples of how modified cabinets address specialized surface-treatment requirements are by no means exhaustive. Instead, they're provided to spark ideas as to how air-blast operations can best be performed within the context of both physical and fiscal constraints.

Processing long workpieces. A dual-cabinet setup is one option. The modified assembly shown in Figure 4 joins two standard cabinets with a center expander. The expander is equipped with its own glove set and foot-treadle control, which operates one of the system's two blast guns. Blast controls work independently, enabling two operators to air-blast a single piece at the same time.

FIGURE 4

Connecting standard cabinets by a center expander, with its own operating station, processes long parts.

The modified cabinet shown in Figure 5 handles pipe or other long, cylindrical parts. Dual-baffle plates in the entrance and exit vestibules contain dust and debris as the operator air blasts the part in sections. With the addition of powered rollers and a feed device, the operator can work nonstop as the part spins and progresses through the cabinet.

These two approaches cost less and save space for short runs when compared with the alternatives of larger cabinets, blast rooms, or in the case of air-blasting pipe, an automated system. Nevertheless, neither approach would be suitable for high-speed production. They're spot players as are most modified cabinets.

Air-blasting large, flat workpieces. Figure 6 shows a cabinet modified to simplify the handling and blasting of

FIGURE 5

Pipe or other long, cylindrical parts are fed through this compact cabinet equipped with entrance and exit vestibules, and double-baffled to prevent dust release.

metal or glass plate. An entrance-exit slot between the cabinet's double doors, in addition to interior part guides, facilitates part handling while preventing dust from escaping into the work environment.

The two-story cabinet (shown in Figure 7) was modified specifically for blasting tall, flat parts. The tight-locking fixture on the loading turntable of the cabinet rotates so that parts can be flipped from front to back. Moving up and down on a scissor ladder, an operator accesses the over-and-under work stations, each of which is equipped with work gloves and a viewing window. An entire side of the workpiece can be blasted without opening the cabinet door. Work on the other side requires just opening the cabinet door and a quick 180-degree turn of the part.

One-time loading holds down labor costs, and because the cabinet's two work stations are supported by a single blast string, equipment costs are reduced as well.

All manual. The modified cabinet (interior shown in Figure 8) functions manually with the exception of the air compressor powering the blast stream. An operator slides the workpiece into the blast enclosure on a wheel-mounted cart, rotates it forward or backward while blasting, and then completes work on the end of the part through a side work station. Part manipulation is manual but much easier than blasting the part in a standard cabinet.

Adding automation. Modified cabinets automate loading and unloading, part movement, nozzle travel, oper-

FIGURE 6

A slot, surrounded by gaskets, in this modified cabinet holds metal or glass plates during blasting while simplifying loading and unloading.

FIGURE 7

Special fixtures, plus over-and-under work stations, speed up manual preparation of tall, flat workpieces.

FIGURE 8

Despite being all manual, this cabinet reduces labor with part rollers and a second blast station.

A quick note about media

FIGURE 1a

Air-blasting parts can be tested in a laboratory.

Media selection for air-blasting can be involved. When in doubt, send parts to media and blast equipment suppliers for testing. Most suppliers have test sites to handle an array of media and blasting equipment (see Figure 1a).

Many types of blast media are marketed today, ranging from less than 1 to more than 9 on the MOH hardness scale. Some are available in both spherical and angular shapes. All can be bought in a variety of mesh sizes. Each has its own particular characteristics and areas of application.

As an example, softer media, such as plastics, have made it possible to strip stubborn powder coatings from parts that are made of fragile substrates without damage, either for rework or for refurbishing. With plastics, added profits accrue when expensive, fragile parts are brought back to life rather than discarded, without relying on hazardous chemicals. (The most effective chemical strippers, containing methylene chloride or phenols, are banned from landfills, and costs for incinerating them can approach $1,000 for a 55-gallon drum. Plastic media are nonhazardous, thus limiting disposal concerns to the nature of the coating or substrate removed during the air-blast process. If neither the coating nor the substrate is hazardous, neither is the waste.)

Media play an important role in controlling operating costs. General factors to consider include the following:

- Quality: Does the material produce desired results?
- Speed: How fast does the media strip or clean?
- Durability: Some media break down in a single cycle; others have breakdown rates of less than 5 percent per cycle.
- Operating pressure: Lower pressures reduce compressed air costs.
- Purchase and disposal costs: Although more expensive initially, durable media may prove to be a bargain when replacement, disposal, and handling are considered.

For example, a manufacturer of automotive components is now saving more than $100,000 per year in media costs alone on a single production line by having switched from a system using glass-bead media to one using a ferrous abrasive. Food for thought.

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ating sequences, and other functions with the inclusion of devices ranging in sophistication from timers and stroke counters to programmable controllers.

Figure 9 shows one of the most basic arrangements—a modified basket blaster with four oscillating blast guns focused on narrow compartments that corral small parts beneath the blast streams to assure consistent coverage. A reset timer and blow-off cycle enable automatic batch processing. An unloading chute simplifies part removal.

The modified pressure cabinet (see Figure 10) incorporates a manual shuttle mounted through the door so that the door doesn't have to be opened during loading and unloading. Blast nozzles are mounted on a ball-screw assembly tied into a controller, enabling the operator to program the range of nozzle movement as well as blast and blow-off sequences.

Figure 11 shows modifications aimed at the interior of hollow, cylindrical workpieces. This cabinet includes a powered lance with a boron-carbide nozzle, a rotating part fixture, and programmable controls. Via the control panel, the cabinet can be programmed to blast, blow-off, or stop during designated intervals in the lance stroke.

The modified cabinet in Figure 12 delivers consistent surface preparation on cylindrical parts by combining

FIGURE 9

A basket blaster, modified with oscillating nozzles focused on corrals (insert), automates batch processing.

FIGURE 11

A powered lance, blasting outward, prepares the interior of hollow, cylindrical parts.

FIGURE 10

A manual shuttle, running through the cabinet door, speeds part loading and positioning.

FIGURE 12

Powered rollers and an oscillating gun, synchronized by a programmable stroke counter, assure a high degree of repeatability.

powered rollers with an oscillating blast gun, driven by a ball screw, which traverses horizontally while the workpiece rotates. A programmable stroke counter synchronizes part rotation, gun oscillation, and blast duration.

Unlike a timer, the counter completes the desired number of strokes for a higher degree of repeatability.

Heavy parts-in and out. Figure 13 shows a heavyweight unit. This cabinet handles parts weighing up to 2,500 pounds. A powered work cart moves parts in and out when the palm buttons at the end of the loading track are pushed. The operator controls part rotation as well as on-off blast functions with foot-treadle controls.

Multipurpose modifieds. The modified cabinet shown in Figure 14 provides in excess of 125 cubic feet in volume for work on symmetrical parts, as well as separate entry-exit points and a work station for blasting cylindrical parts. The front work station is raised so that the operator blasts down on parts and the primary entry to the cabinet is closed by a piston-lift door to assure tight sealing. The work station on the side of the cabinet enables an operator to air-blast pipe or other cylindrical workpieces. Baffled entrance-exit vestibules, at front and rear, prevent the escape of dust and debris. To reduce equipment costs, the front and side work stations share the same air-blast operating system.

Unique assignments. The air-blast cabinet shown in Figure 15 was modified (that is, constructed in stainless steel—along with its accompanying pressure vessel, media storage hopper, and media reclaimer) to minimize the possibility of parts being contaminated by mild or carbon steels.

If the requirement seems unique, it's not alone. Air-blast operations are often one of a kind. Modified cabinets don't replace traditional air-blast options; instead, they draw on the appropriate strengths of each to satisfy specialized surface-treatment requirements at an attractive price. **PC**

FIGURE 14

With only one air-blast string, this modified cabinet handles large, symmetrical workpieces and pipe.

FIGURE 15

Stainless steel construction reduces chances of contamination from other types of steels.

FIGURE 13

Capable of handling heavy workpieces, this cabinet simplifies loading as well as part movement.

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