VENTILATED ENCLOSURES

A wide variety of abrasive blasting enclosures are available to accommodate part sizes, cleaning or treatment requirements, production rates, and budgets. Blast enclosure methods include airless blasting (centrifugal wheels), water blasting, and dry air blasting. This article focuses on dry air blasting enclosures and equipment.

BLAST CABINETS

Air-blast enclosures start with simple, manually operated blast cabinets. These cabinets range in standard sizes from 24-in wide by 24-in long (600 x 600 mm) to 72-in wide by 72-in long (1,800 x 1,800 mm). Typically, they are equipped with one operator station, which includes a sealed pair of gloves, a wide viewing window, and lights. Inexpensive, light duty cabinets are equipped only with dust collectors. They do not have media cleaning or efficient screening components. Generally, light duty cabinets are used for infrequent blasting applications where cleaning the media after each blast cycle is not a necessity. Applications where a cabinet may be used more than an hour per day, and when reuse of contaminated media is not acceptable, require abrasive reclaiming and screening equipment.

Blast cabinets evolve from simple, manually operated units to much more sophisticated automated systems. Systems are designed around part shapes and production quantities to produce consistent, precise surface finishes. Parts are processed in and through cabinets as individual pieces or in bulk on motorized rubber belts, roller conveyors, hanger conveyors, single turntables, and indexing tables with integral satellite turntables. Computer programmable, multiple-nozzle carriages move over the parts in multi-axis motions to cover the entire shape of the part. Microprocessors control and monitor abrasive media flow, nozzle air pressure, and dust collector efficiency. For example, system computers precisely program nozzle distance, intensity, and dwell time in highly sensitive aircraft turbine blade shot peening applications. Blast systems are designed to feed and recycle accurately clean media ranging from very fine glass beads to coarse steel grit. Blast cabinets can be designed to accommodate an extremely wide variety of surface finishing and production requirements.

BLAST ROOMS

Blast rooms are designed and constructed to allow operators to blast within an enclosure. With few exceptions, high production, pressure blasting is performed inside this type of enclosure. Rooms must be engineered to withstand the powerful nozzle blast and rebounding abrasive from the parts being cleaned. Walls, ceilings and doors are usually built with heavy gauge steel, and sealed to prevent escape of abrasive and dust. Properly engineered lighting is essential for operators to see the results of their work clearly. Lighting is normally exterior mounted to avoid damage from abrasive impact.

There are many choices on abrasive recovery and recycling systems inside blast rooms. There are three basic recovery categories: floor hoppers, pneumatic, and mechanical. The choice is largely influenced by the type of abrasive, production demands, and budget limitations.

Floor hoppers are small collection hoppers measuring about 3 feet by 3 feet (900 x 900 mm), recessed in a floor pit conveniently located on one side of the room. The bottom of the hopper is attached to a bucket elevator installed outside of the room. The bucket elevator unloads into an abrasive cleaner/storage assembly, which is mounted over a pressure blast machine. In operation, abrasive is swept or shoveled into the grated floor hopper, carried up by the elevator, mechanically screened and air washed by the abrasive cleaning unit and stored above the blast machine for reuse. This economical type of recovery system is ideal for facilities where blasting takes place occasionally.

Pneumatic recovery systems are designed to recover and clean fine, lightweight media. Applications using glass bead, fine mesh aluminum oxide, plastic, and agricultural abrasive, such as walnut shell, are more effectively reclaimed by the pneumatic vacuum process. Pneumatic systems consist of a series of small 12-in by 12-in (300 x 300 mm) hoppers covering the entire room floor area. The bottom of the hoppers attach to parallel conveying ducts, which connect to a master duct leading up to the inlet of the media reclaimer. The reclaimer, mounted over the pressure blast machine, centrifugally cleans and screens media for reuse (see pneumatic reclaimer section for additional information). Partial floor-sized pneumatic systems are available where complete floor recovery is not required.

Mechanical recovery systems work best with medium and heavy abrasives, especially when steel grit and steel shot are used. Several design concepts are available on the market featuring wiper vanes, oscillating pans, and screw conveyors. All the systems are covered with steel grating to support weight loads. Each design has certain advantages depending on the abrasive and application.

Wiper vane systems offer the most versatility on abrasives due to the conveying method. Steel vanes are powered by pneumatic drive cylinders in forward and backward strokes. A series of vanes push abrasive on the forward stroke. On the back stroke, the vanes tilt up and ride over abrasive on the floor. Sequencing of the vanes pushes abrasive into a vane cross conveyor and on to a bucket elevator positioned at the end. Vanes can easily handle any type of angular abrasive that is not too fine. Wiper vane systems are only offered in full floor size of the room.

Oscillating pans are supplied at various lengths in 3-, 4-, or 5-foot (900, 1200 or 1500 mm) wide sections. The steel pan in each
section is hung by link chain and is oscillated back and forth by eccentric cams. A central screw conveyor collects and delivers abrasive from the pans to an outside bucket elevator. Abrasive is cleaned and stored in an abrasive cleaner as described in the wiper vane system. A single small electric motor operates all the cams in an average-size floor. This system is designed to handle coarse, angular abrasive. It is available for partial floor recovery areas at any combination of width sizes to accommodate economic limitations.

The screw conveyor system’s primary advantages are abrasive recovery volume, speed, and distance. On long length blast rooms [over 50 feet (15 meters)], a screw conveyor will move greater amounts of abrasive faster than by other methods. This system consists of rows of motor driven screw augers mounted in steel troughs, covered with steel grating. The floor augers connect to a cross collection auger, which takes abrasive to the inlet of a bucket elevator. The bucket elevator, abrasive cleaner, and blast machine are the same equipment as used with the other mechanical recovery systems previously described. The versatility of this system allows any number of screw conveyor sections to be placed anywhere in the floor area.

**BLAST ROOM PARTS HANDLING OPTIONS**

Materials may be brought into blast rooms by many different methods. Hand trucks and small wheeled carts are used to handle lightweight parts. Heavier parts are transported by forklift trucks. There are, however, several options available to reduce handling time and increase production. One common option is a monorail mounted on the blast room ceiling, using a pneumatic or electric hoist to lift, carry, and place parts.

Another popular option is steel-decked work cars riding on rubber tired wheels or steel shells. The steel wheels are often the flanged railroad type of wheel, which allows them to be used with rail tracks. Work car wheels may be driven by pneumatic or electric motors, although a more common method is to use motor-powered steel cables to pull the carts in and out of the room.

There are many other material handling methods designed of specific parts to be processed through the room. A few examples are steel roller conveyors, rubber belt conveyors, “cherry picker” hoists, cranes, and large turntables. The choice of parts handling is predicated on desired production speed and cost justification.

**PNEUMATIC RECLAIMERS**

Pneumatic abrasive reclaimers provide one of the best methods of removing dust and large contaminants from recycled media. Reclaimers, sometimes referred to as cyclone separators, work on the principle of centrifugal force to spin media at a rapid rate to separate heavy particles from light particles. Media are drawn up through vacuum hoses from the bottom of cabinets by means of electrically powered impellers. The media-spinning action begins as soon as the media enters the reclaimer. Heavyier particles and debris are thrown to the outer perimeter of the reclaimer while lightweight dust particles circle around the reclaimer center, where a suction tube connected to the dust collector pulls the dust out. Heavy reusable particles and debris swirl downward into a meshed screen. The screen captures debris and allows heavy media to pass through to a storage area for reuse.

There are two basic reclaimer designs - push through and pull through. On push through, the blower and motor are installed on top of the reclaimer. This design is primarily furnished on smaller, one-operator cabinets. On pull-through reclaimers, the blower and motor are assembled on the clean air side of the dust collector. This design draws air from the reclaimer through the vacuum hose and captures fine particles in the dust collector filters. Multi-operator cabinets, large cabinets, and blast room utilize the pull-through concept.

Reclaimers are carefully sized to accommodate the cabinet and blast room dimensions, number and size of the blast nozzles, and the type of media. Blowers and motors are also sized to correspond with the reclaimer requirements. Reclaimers and blowers are air-flow rated in cubic feet per minute (cfm) with the smallest rating beginning at 300 cfm (8.5 m³/min).

**DUST COLLECTORS**

Efficient dust collectors are vitally important for all blasting enclosures. In addition to capturing dust, they must effectively prevent any unacceptable emission into the surrounding atmosphere. Proper dust control eliminates the danger of respiratory injury to personnel and avoids contaminating nearby machinery. It is an absolute necessity to use high quality dust collectors specifically engineered for abrasive blasting applications.

Some of the major considerations for choosing a dust collector are the dust particles that will be generated from the abrasive and the material to be removed from the surface, air flow and air volume requirements, and the amount of dust loading the collector must handle. The composition and construction of the unit’s filters must be designed to accommodate wide variations found in different blasting processes.

Dust collector filters are available in a variety of types and materials. The selection of types is generally on envelope, tubular, or cartridge. Envelope filters are flat, rectangular, cloth segments, which are assembled side by side in a collector housing. Tubular filters are cylindrical, attach to collector housing tube plates at each end, and come in many different lengths. Cartridge filters are round and compact with evenly spaced pleats of cellulose fiber material. Each segment, tube, and cartridge provides a specified amount of square feet of filtering materials. Engineering specifications on the blasting system determine the required number of square feet of filter materials, which, in turn, gives the number of segments, tubes, or cartridges required in the dust collector.

Another factor in filter specifications is the “air-to-cloth ratio” requirements. “Cloth” is used as a generic term, whether or not the filter material is cloth. Blasting applications, which include the number of blast guns, type of abrasive, composition of removed substance, and so on, dictate the proper ratios. There are also federal, state, and/or local regulations with which to comply. In abrasive blasting applications, ratios usually range from 5 cfm of air to 1 foot of cloth (designated as 5:1) to 2 cfm of air to 1 foot of cloth (2:1). The lower the number of cfm, the more filter material is required. As a simple example, on a standard blast cabinet requiring 600 cfm of ventilation air, and where an air-to-cloth ratio of 5:1 is acceptable, the dust collector will be furnished with 120 or more square feet of filter material.
**COMPRESSED AIR**

A standard abrasive blasting system is totally powered by compressed air, whether it is a cabinet or blast room. There are exceptions where some accessory items are run by electricity, but for most systems, compressed air operates valves, pressurizes blast machines, conveys abrasive to nozzles, provides operator breathing air, and runs additional ancillary equipment. Compressed air is a critical component of blast systems because its energy generation dictates the amount of work that will be done on any given surface.

**PRESSURE AND VOLUME**

So many times we hear the statement, “I have plenty of air... I have 100 pounds of pressure.” High pressure is great, but it is only one-half of the energy equation. Along with pressure, there has to be air volume. A 100-hp (75 kw) compressor can produce 100 psi (700 kPa), but so can a small 1-hp (0.75 kw) electric compressor. A 1-hp (0.75 kw) compressor will develop between 4 and 4.5 cfm of air (0.11-0.12 m³/min); a 100-hp (75 kw) unit will generate between 400 and 450 cfm of air (11.3-12.7 m³/min). Obviously, the difference between the two compressors is the air volume they are capable of producing.

Pressure and volume work hand in hand. In abrasive blasting operations, the higher the pressure, the higher the volume consumed. If the volume of air is not available to accommodate the pressure, the desired pressure will not be attained. To illustrate this point in pressure blast systems, a 3/8 in. (9.5 mm) nozzle requires approximately 200 cfm at 100 psi (5.6 m³/min at 700 kPa). If a 150 cfm (4.2 m³/min) compressor is hooked up to a blast system using a 3/8-in (9.5 mm) nozzle, the maximum amount of pressure the compressor can produce is about 70 psi (490 kPa). The 150 cfm (4.2 m³/min) compressor simply does not have the volume capacity to supply 100 psi (700 KPa) to a 3/8-in (9.5 mm) nozzle.

There is rarely too much air volume, but air pressure is another story. Pressure blast machines and their related components and accessories are built to operate within specific pressure ratings. Standard blast machines are fabricated for working pressures up to 125 psi (880 kPa). Although some of the blast components have higher pressure ratings (i.e. blast hose), pressure to the entire system should not exceed the approved pressure rating of the blast machine. (Note: Some European machines are built for 180 psi (1200 kPa) as standard; therefore, air compressors and ancillary equipment are rated accordingly.)

A common question is what pressure is needed for high-production pressure blasting. For most applications, 90-100 psi (630-700 kPa) works well when hard, sharp abrasives in standard mesh sizes are used. The 100 psi (700 kPa) level was established long ago as the maximum pressure. Using a coarse, extremely sharp abrasive, such as aluminum oxide, it is often better to set pressures in the 70-80 psi (490-560 kPa) range because of deep surface penetration by the abrasive’s sharpness. Proper pressure is a determination based on surface condition, required surface finish, and selection of abrasive.

In cabinets using the suction principle, the normal maximum pressure is 80 psi (560 kPa) due to the use of fine, soft blasting media, and the close proximity of the nozzle to the part. When blasting on delicate materials, the pressure may be reduced to as low as 30 psi (210 kPa) to avoid damage to the parts. Even in suction blasting, however, air volume is equally important.

**COMPRESSOR AIR LINES**

The majority of applications for metal air lines are stationary, in-plant blasting systems where lines are permanently placed. Although there are flow advantages, metal line air requires similar filtering care as any other method of conveying air. Condensation builds up rapidly in the pipe during the conversion of hot compressor air to cold expansion in pipe lines. Drainage valves should be installed in piping, just before entering blast system filters, to bleed accumulated line water. As steel pipe lines age, rust and scale particles are carried in the air flow to blast machines. Consequently, high-efficiency filters are needed to remove moisture, oil mists, and particulate matter.

The only drawbacks to permanent piping are distance and turns. Many plants install compressors far from blasting sites so air must travel several hundred feet before entering blast systems. There is pressure loss even through smooth piping and, if the distance is very long, substantial pressure drops occur. To overcome this problem, larger-than-normal pipe should be installed. The turns and bends in the pipe cause pressure loss, as well. Arrange piping to avoid as many sharp turns as possible and, when turns must be made, try to install two 45° elbows rather than one 90° elbow. Gradual bending of air flow is less detrimental to pressure than are radical turns.

Sizing air lines is critical to utilizing compressor power fully, which ultimately affects blast equipment performance. Air line sizes must be consistent with compressor fittings to allow a smooth transition of flow at pressures and volumes required to support nozzles. Determining air line size follows the same rule as calculating compressor air outlets... *hose inner diameter should be a minimum of four times the nozzle orifice size.* This rule applies to applications where air lines are no longer than 100 feet (30 meters) between compressors and blast machines. Use Table I to ascertain air line inner diameters.

<table>
<thead>
<tr>
<th>Nozzle Orifice Size, in. (mm)</th>
<th>Minimum Hose Diameter, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16 (5)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td>1/4 (6.5)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>5/16 (8)</td>
<td>1-1/4 (32)</td>
</tr>
<tr>
<td>3/8 (9.5)</td>
<td>1-1/2 (38)</td>
</tr>
<tr>
<td>7/16 (11)</td>
<td>2 (50)</td>
</tr>
<tr>
<td>1/2 (12.5)</td>
<td>2 (50)</td>
</tr>
<tr>
<td>5/8 (16)</td>
<td>2-1/2 (64)</td>
</tr>
<tr>
<td>3/4 (19)</td>
<td>3 (76)</td>
</tr>
</tbody>
</table>

We will start with Pressure Blast Machines in the next issue of Abrasive Blast Cleaning News.

A Abrasive Blast Cleaning News Winter, 1998