by Kumar Balan | B. Eng., MBA

Air or Wheel Peening?
An Application-Based Analysis


MANY ENGINEERING PROBLEMS have more than one solution. Application Engineers, however, are asked to find the one optimal solution given a list of variables and possibilities. In our industry, we are often called upon to recommend and validate our choice for the best media propulsion system—airblast or wheelblast—for the customer's application. Very often, either type will work for their application, and each has its own inherent advantages and shortcomings. While I've had the luxury of being able to offer both airblast and wheelblast solutions since the company I represented manufactured both systems, I still needed to recommend one or the other to my customers.

In this article, I'll review the basics of each option, categorize the applications, and define and validate the criteria that leads to the best solution.

THE BASICS

Wheelblast machines use a centrifugal blast wheel to propel media and airblast machines use compressed air. All other factors being equal, the productivity of the blast operation is directly proportional to the amount of abrasive propelled onto the part. In quantifiable terms, an airblast nozzle (3/8" or 9.5 mm diameter at 60 PSI or 4.1 bar) propelling metallic abrasive typically discharges only 10% of the blast media that can be propelled by a centrifugal blast wheel (15" or 381 mm diameter wheel powered by a 20 HP or 15 KW motor).

To get an even clearer perspective on operating efficiency, a single centrifugal wheel provides the same cleaning efficiency as eight (8) ½" or 12.7 mm diameter blast nozzles.

Centrifugal blast wheels are either direct driven or belt driven through a bearing system. The resulting line speed of the associated blast machine is directly proportional to the total connected wheel horsepower. Applications in wheelblast are wide and varied, and given that the first blast wheel was patented over a hundred years ago, wheelblast machines are prevalent in most automated cleaning applications.

The blast nozzle in an airblast system is powered by compressed air. The peening intensity is directly proportional to the air pressure level. There are two types of airblast systems—suction and pressure.

Suction-style propulsion systems are used for relatively lower intensity peening requirements with small ferrous and non-ferrous abrasives of all sizes. Pressurization of the blast media takes place inside the blast gun, eliminating the need for a separate blast tank. A suction gun is identified by two hoses, a red hose for compressed air and a black hose for the abrasive. A venturi or airjet inside the suction gun creates the suction and mixes compressed air and media prior to discharge from the gun.

Direct pressure systems are more commonly used than suction systems. As a rule of thumb, pressure blast systems are about two to three times as efficient as suction systems. Pressurization of the blast media takes place in a separate pressure vessel called the blast tank or blast pot. A single hose, carrying pressurized abrasive, is connected to the blast nozzle. Nozzles can be straight bore or venturi style, as suited to the application.

Suction blast uses less compressed air than direct pressure. A 3/8" or 9.5 mm suction nozzle with a 3/16" or 4.5 mm diameter air jet will consume 40 CFM or 68 cubic meter per hour at 80 PSI or 5.4 Bar. In comparison, a 3/8" direct pressure nozzle at 80 PSI will consume 175 CFM or 300 cubic meter per hour of compressed air.

CRITERIA FOR CHOOSING BETWEEN WHEELBLAST OR AIRBLAST EQUIPMENT

Criteria for Choosing Wheelblast Equipment

- Large production volumes with large runs of physically similar components
- Component needs to be completely treated with abrasive and there is no need for masking
- Treatment area is large
- User has several wheelblast machines and has an acceptable process for similar components
- Process specification calls for high-intensity values on large surface areas with large-size abrasive (common in automotive and railway applications)

Typical contenders for wheelblast peening are auto transmission components such as gears and shafts, connecting rods, coil and leaf springs and axle beams. In the

aerospace industry, landing gear, aircraft wheels and brakes are peened in a wheelblast machine.

Criteria for Choosing Airblast Equipment

- Only specific areas of the component need to be peened, with the other areas requiring protection from the abrasive
- Component is to be treated with non-ferrous abrasive
- Areas such as main bore, slots and other intricacies are to be peened
- Application requires significant manipulation of the blast stream in order to provide proper coverage
- Availability of compressed air

To recap, the same automotive and aerospace components that were good candidates for wheelblast should be peened in an airblast machine when only specific areas need to be peened and/or if the process requires non-ferrous media.

Wheelblast versus Airblast for Automotive Transmission

Gears and shafts can be peened in either machine type. In both cases, the machines are rotary indexing tables with multiple satellite fixtures on top that expose individual stacks of gears or a single shaft to the blast wheel, multiple blast wheels or reciprocating nozzles.

Wheelblast machines are used in high production environments and when the gear tooth geometry permits unimpeded access to the abrasive. The root section of the gear is the most critical area to be shot peened since this is where cracks tend to originate. Therefore, blast wheel location and part fixturing are important design parameters in this machine type. Using a more sophisticated arrangement, some wheelblast machine types also offer vertical wheel movement/oscillation to ensure proper coverage is achieved when peening a tall stack of gears or a shaft.

Arguments can be made about the efficacy of air-type machines over wheel, and there are clear lines of demarcation. Though production specifics will depend on several other factors, the production rate of airblast peening machines for gears is lower than its wheelblast counterpart. However, airblast provides precision or targeted blasting, resulting in lower abrasive consumption and breakdown. The direct tangible benefit is a more efficient use of available power and the elimination of unnecessary wear on machine components.

Wheelblast versus Airblast for Landing Gear

When the entire landing gear needs to be peened, as is typical in new gear manufacturing, a spinner hanger wheelblast machine provides efficient coverage. The blast chamber is fitted with multiple wheels in strategic locations to access all areas of the landing gear. When the specification calls for spot peening, typically in MRO and refurbishing operations, the applications are best addressed with an airblast machine. Also, an airblast lance is the only means of peening the ID of the gear, whether in specific areas or along the entire length.

PROCESS PARAMETERS FOR BOTH WHEEL AND AIR MACHINES

- **Media flow rate** monitored with a MagnaValve, or comparable valve, and validated through drop tests.
- **Media classification** (size and shape) using a vibratory classifier to maintain a consistent size and spiral separator to separate rounds from non-rounds. Due to high flow rates in a wheelblast machine, it is acceptable to sample the flow by diverting a percentage (usually 20%) of the total flow through a vibratory classifier on a continuous basis.
- **Exposure time monitoring** by controlling the speed of work handling arrangement such as rotary table, inline conveyor or speed of nozzle movement in an airblast machine.
- **Consistent pressure delivery** in airblast machines. The air pressure in an airblast machine determines the peening intensity so it is critical to monitor and maintain consistent pressure delivery in order to get consistent peening intensity results.
- **The wheel speed,** if all other parameters are stable, determines the intensity in a wheelblast machine. Blast wheels in a wheelblast peening machine are fitted with a variable frequency drive in order to monitor and alter the wheel speed as required.

A NOTE ON HYBRID BLAST MACHINES

A hybrid blast machine capitalizes on the advantage of the wheelblast propulsion technique to peen the majority of the part surface and relies on blast nozzles to complete the process by targeting specific areas insufficiently covered by the blast wheels —all in a common enclosure and sharing reclaim and control system components.

The decision between airblast and wheelblast takes a different dimension with hybrid machines. These machines offer distinct advantages over dedicated air or wheel machines:

- Cycle time savings due to reduced handling
- Commonality of fixtures
- Labor savings (operator required for one machine only)
- Machine certification simplified because only one machine needs to be certified

Hybrid machines are ideally suited to 'complete' the process in a high-production environment with the majority of the area already processed by a single or multiple blast wheels. (For more information on hybrids, download "Hybrid Cleaning/Peening Machines" by Mr. Balan, *The Shot Peener*, Fall 2007 from the Library at www.shotpeener.com.)

CONCLUSION

As we have read, there are multiple equipment solutions for applications such as transmission components and landing gear. Application engineers must assess each individual process and the site constraints, keeping in view that the final goal remains unaltered—an accurate and repeatable peening operation.