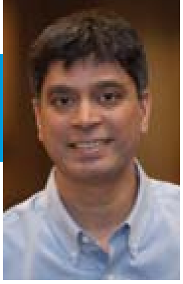

AN INSIDER'S PERSPECTIVE

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The Role of Wheelblast in Shot Peening – Part I

THE INTRODUCTORY CLASS at the EI Shot Peening Workshop covers the history of shot peening. The instructor explains that engine valve springs were blast cleaned in a tumble-type wheelblast machine (commonly known as the tumblast) to remove paint. As an unintended consequence of cleaning, the springs also received the fatigue strength benefits of shot peening, prompting further measurement and validation of the process. Therefore, apart from the blacksmith who inadvertently shot peened buggy springs manually with his hammer, the first known shot peening practice was in a wheelblast machine! However, when visualizing shot peening equipment today, the image of a blast nozzle held by a robot or an articulating arm processing an aerospace component is more common than multiple blast wheels shot peening connecting rods.

Though Aerospace has embraced shot peening in a large scale, shot peening was initially more widely used in Automotive as part of their production process. Production volumes being significantly higher in Automotive as compared to Aerospace, the Automotive industry has traditionally used wheel blast machines, and for obvious reasons.

Peening coverage is directly proportional to the amount of blast media targeted onto a component. This makes wheelblast machines a good choice to address the high productivity goals of the Automotive industry. Aerospace applications are typically low volume, but high precision, and more often use airblast peening machines.

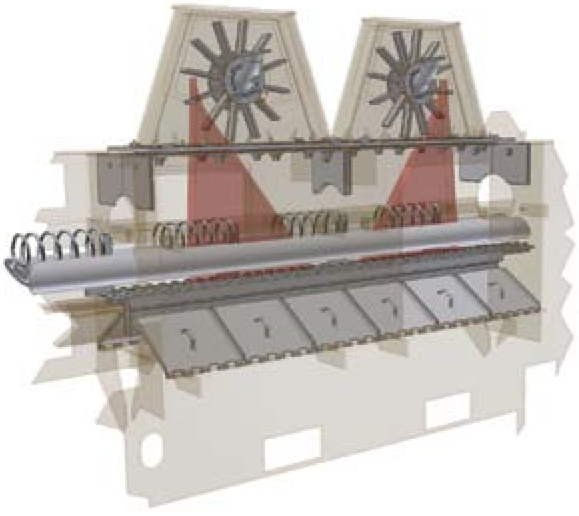
Our discussions here will be limited to shot peening applications only. Blast cleaning with wheel machines, though a very important discussion, will require in-depth reviews and may not necessarily interest our readers using only shot peening equipment.

Automotive and Aerospace - Wheelblast

Joe McGreal, Vice President of Sales and Marketing at Ervin Industries, a leading manufacturer of steel abrasives, explains that, "An understanding of impact/kinetic energy is paramount to appreciating blast cleaning and shot peening." Impact energy is calculated as the product of two parameters of the blast media—its mass and velocity. *Effective Use of Steel Shot and Grit for Blast Cleaning* by E.A. Borch, Ervin Industries, Inc. (found on ervinindustries.com) is an excellent resource to learn more about the impact of blast media. The second factor is velocity, which is directly proportional to the air pressure in an airblast machine, and wheel diameter and rotational speed in a wheelblast machine.

"Ervin supplies media to users of wheelblast and airblast equipment. As an example, we know our automotive customers that shot peen hundreds of coil springs per hour rely on their wheelblast machines with multiple wheels that collectively flow over 2,000 lb per minute. This is only possible with blast wheels driven by high horsepower motors," said Mr. McGreal.

An elaboration of the points made by Mr. McGreal will help us understand the choice of wheelblast over airblast. Shot peening large surface areas, such as the entire cross-section of coil springs, leaf springs, connecting rods, etc., at high throughputs common in automotive, requires a high flow rate of abrasive. Coverage is achieved faster with wheels capable of flowing large quantities of abrasive. The number of nozzles required to match a wheel's flow rate, and the corresponding compressed air requirement, make airblast an impractical solution. It is important to note that in the examples of parts



Inline Coil Spring Peening Machine
(Image is courtesy of Wheelabrator Group)

listed earlier, the surface is "open" and without geometric intricacies such as holes and slots, making it possible for a fixed, properly targeted wheel to always hit the exposed areas. Also, such automotive components are always shot peened with ferrous blast media, another factor that justifies the use of blast wheels for peening.

Several other Automotive components, such as crankshafts, valve springs, valve stems, transmission gears and shafts, are shot peened in wheelblast machines. Some of these components could also be processed in airblast machines, with the preference driven by local plant choices, commonality with existing machines, effort invested in process development with the existing wheelblast or airblast machine, and so on. Let's discuss one such application in a bit more detail—transmission gears.

Transmission gears are shot peened to prevent cracking at their root. It's common to see stacks of planetary gears being processed in wheelblast machines. Equally common are gears peened with airblast nozzles that reciprocate along the stack height. While the wheelblast argument is in favor of increased throughput, the airblast machine promises a more targeted blast impacting the root. Therefore, it won't do justice to generalize the effectiveness of one machine type over the other. Smaller gears with a tight space near the tooth could benefit from a lower flow rate possible with blast nozzles.

This could also reduce possibilities of "flooding" with abrasive, and the risk of "abrasive on abrasive" impact instead of "abrasive on part." However, with proper wheel positioning and managing flow rates, this issue could be mitigated in a wheelblast machine even when peening a small gear. This is less of a concern in larger gears, found in differential and truck transmissions, with more open tooth areas. The industry has a rich history of both types of media propulsion systems effectively peening transmission gears and shafts.

Almost all metallic parts in an automobile pass through a blast cleaning process prior to downstream coating. Greater volumes of Automotive parts and part types are blast cleaned compared to Automotive components that are shot peened.

The Aerospace industry shot peens its aircraft components, landing gear, structures and wheels with both wheelblast and airblast machines. When an application calls for shot peening with non-ferrous blast media such as glass bead or ceramic, it is always an airblast machine that fits the bill. Most Aerospace components, particularly in engines, have holes, slots, and bores, and areas that need to be protected (masked). This dismisses the suitability of a wheelblast machine. Therefore, an airblast machine is almost always used for peening engine components.

Landing gear peening applications could be served by wheelblast or airblast equipment; the process details being the deciding factor. New landing gear components when peened in their entirety offer a large enough surface area to justify peening with a wheelblast machine. One such example of a suitable machine is a vertical spinner hanger that spins the main gear about its own axis in the vertical plane, which is an ideal way to peen the cylindrical shape of the forging.

MROs that service and refurbish landing gear as part of an authorized maintenance procedure rely on airblast machines to "spot" peen specific areas on the gear. This is because nozzles allow better targeting of smaller areas on the gear as compared to blast wheels that cover all exposed areas with abrasive impact. New landing gear could also be peened in an airblast machine with a single or multiple nozzles. However, as discussed earlier, the relatively slower pace could be a limiting factor.

Aircraft structures, like landing gear components, can be processed in wheelblast or airblast peening machines. The latter is preferred when the structure has complicated geometry making it a challenge to locate wheels at angles to achieve the minimum required 45-degree angle of impingement. Nozzles mounted on articulating, robotic arms make that task more practical and manageable.

Abrasive Type and Media Propulsion

Steel shot with a weight of around 280 lb/cubic feet generates greater impact energy than glass bead with a weight of around 100 lb/cubic feet. Though both media types have their relevance in shot peening applications, non-ferrous media is not usually propelled by blast wheels. This is largely due to the potentially lower momentum created by a blast wheel propelling non-ferrous abrasive as compared to a blast nozzle that fluidizes and creates a better blast pattern at higher momentum. Ferrous abrasives such as steel shot and conditioned cut wire, commonly used in shot peening, can be propelled using airblast nozzles as well as blast wheels, with selection criteria as discussed earlier and in paragraphs that follow.

High-Intensity Peening

The shot peening industry presents us with some special applications such as peening Heavy-Duty Transmission Gears and Mining Bits to intensities in the C scale. Though these components could be peened in wheelblast machines, some of these high ranges (> 0.012" C) are better served by an airblast machine. The limitations posed by the wheel diameter and speed (velocity in a wheelblast machine is calculated by diameter x speed/180) are non-existent in an airblast machine where the combination of nozzle bore and air pressure could develop considerably high velocities as compared to a wheelblast machine.

Impact energy is directly proportional to the intensity, and high energy values are achieved using a combination of high velocity and large blast media size. Blast wheels flow large abrasive sizes with minor adjustments to the internal

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Continued

wheel parts. In an airblast machine, blast nozzles and interconnecting hoses will need to be upsized to handle large media sizes. The high flow rate experienced in wheelblast machines also leads to a very different style of reclaim system as compared to airblast machines. In general, all blast machines are characterized by their five essential elements:

(1) media delivery (nozzles, hoses, blast wheels),

(2) media reclaim (mechanical or vacuum),

(3) work handling (rollers, hangers etc.),

(4) ventilation and dust collection, and

(5) controls to automatically sequence all earlier activities and achieve desired and consistent results.

(For more information on this topic, see "Machine Profiling: A Guide," *The Shot Peener*, Fall 2016).

Since a common size of blast wheel (say 15" diameter driven by a 15 HP motor) flows more abrasive than a common size nozzle (say 3/8" diameter at 60 PSI) by at least 10 times, the next step is to understand the needs of the reclaim system in a wheelblast machine. The media reclaim system in a wheelblast machine is always of a mechanical type, with a bucket elevator and airwash separator to clean the media prior to re-use. A majority of airblast machines employ vacuum reclaim systems with a cyclonic reclaimer and downstream dust collector with exhaust fan for media reclaim and ventilation. Vacuum reclaim systems are less maintenance prone since they lack mechanical moving elements as in a bucket elevator. However, vacuum reclaim systems are limited by the abrasive size and volume that they can recover.

Our discussions until now were intended to provide an application-based background in the use of wheelblast machines for shot peening. Since a large part of the industry's revenue is from the sale of wheelblast machines, it's important for us to educate ourselves on such machines and ask those relevant shot peening related questions:

- What are the critical process parameters in wheelblast machines, and how can they be controlled?
- How does wear affect peening results?
- What are the comparable parameters between both systems?

Let us continue our discussions in Part II in the summer issue of *The Shot Peener*.