AN INSIDER'S PERSPECTIVE

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Tribal Knowledge in the Blast Industry

Part Three

THE ARROGANCE OF EXPERIENCE

When speaking to past colleagues for this series, I kept recalling an incident I was involved in a few years ago. In my anxiety to make it to a meeting on time, I kept directing the cab driver in my past hometown of Bombay, India to take routes presumably not known to him. After enduring me for a while, he abruptly stopped his car and displayed his driver's license to my face with an arrogant remark that even his credential was older than me and asked me to pipe down. He then proceeded to get me to my destination without delay! Similarly, I have often heard my seasoned colleagues complain that the new engineers were re-engineering proven designs and messing them up in the process! Would you call it arrogance, impudence or them simply knowing what has worked and will work again? So, why is it important to acknowledge the past in our industry?

Our industry suffers from extremes—there are only a few books on blast cleaning that are written to educate the everyday blaster, and then there are those that will require a graduate degree in surface engineering to assimilate. There is no middle ground. The middle ground is covered in this undocumented and almost latent repository of "tribal knowledge." My goal is to continue unearthing as much of it as I can through interviews with these experts that have hung up their well-worn hats, but still eager to transmit their experience to the eager listener. Fortunately, I was not met with any experience-accorded arrogance from those I spoke to!

In case you are just joining us in Part 3, in Part 1 we have discussed the significance of media velocity, fallacies of needing high velocity, wheel diameter and evolution of blast wheel speeds. In Part 2, we talked about the loss of velocity due to deflector tips in nozzles, fixturing, PVTs and MVTs, angle of impact resulting from different wheel locations, and tips on Tumblast style machines. I concluded with a discussion on a blast pattern verification technique for wheel machines. The focus in Part 3 is on airblast cleaning/peening/gritblasting. (Part 1 and 2 are available in the 2020 Fall and 2021 Winter issues of *The Shot Peener* magazine and are available for download at www.theshotpeenermagazine.com.)

ACHIEVING SURFACE PROFILE

My first contact for this article is Dennis Denyer, who started in this industry in 1973 and continues to serve in an active capacity with GMA Industries in Romulus, Michigan. Dennis is a wealth of information through his journey with Wheelabrator-Allevard and Metaltec in the past. "Though perceived as a low-tech operation with the newbies starting in the cleaning room, the final quality of finish matters to whether the product can be made to look attractive enough for a sale," explained Dennis. Those of us that assist end-users develop their surface finish process often get asked, "What size of media will give me a particular surface roughness (mil. Microinch etc.)." The application engineers at Ervin Industries, a global steel abrasive manufacturer, provided me with the following table data, with a caveat that I use this for reference since the result depends on a combination of several other process variables. Dennis explained to me, "There is no magic formula to obtain a particular surface profile. More so with non-metallic media such as AlOx that degrades relatively faster than metallic abrasives. To maintain consistency of finish, grit blast applications in the aerospace sector rely on process control components such as classifiers to maintain constant abrasive size, and not an operating mix as in general blast cleaning."

Surface Profile		
SAE Grit Size	SAE Shot Size	Estimated Mil Profile
G-14	S-460	4.0 to 6.0+
G-16	S-390	4.0 to 6.0+
G-18	S-330	3.0 to 6.0+
G-25	S-280	2.5 to 5.0+
G-40	S-230	2.5 to 5.0+
G-50	S-170	2.0 to 4.5
G-80	S-110	1.5 to 3.0
G-120	S-70	1.0 to 2.5

Table data is courtesy of Ervin Industries

When chatting with Dennis, he confirmed a myth that continues to haunt the blast industry—higher pressure leads to faster cycles. Most cleaning operations (as mentioned in Part 1 of this series) crank up their operating pressure to 120 PSI, or whatever their source would allow. "At 120 PSI, all you are doing is wearing out the operator and blast accessories. The media gets pulverized (Dennis is referring to non-metallic abrasive), leading to a cloudy and unproductive environment to work in. This leads to re-work, larger amounts of dust generation and higher operating costs," explained Dennis.

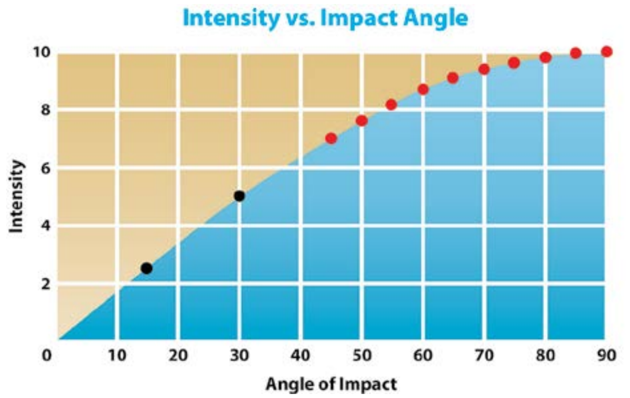
SO, WHAT IS THE IDEAL BLAST PRESSURE TO ACHIEVE A PARTICULAR ROUGHNESS?

A cursory search of abrasive supplier websites will provide you with several surface roughness estimates given different media sizes and types. Robert Heaton recently retired after 45 long years at Empire Abrasive Equipment in Langhorne, Pennsylvania. Empire Abrasive Equipment is a quality manufacturer of manual and automated airblast equipment. Robert remarked, "I wish it were that easy to publish a chart that shows roughness! The list of variables is endless with some having a greater impact than the others. For example, is it suction or pressure blast that you are using to generate your profile? Are you trying to clean and develop a surface at the same time, or are you starting off with a clean part? The efficiency of a suction gun starts diminishing after about 70 PSI." Robert adds a tip at this point if you are stuck with suction equipment and still battling a target surface finish. "Back down on the size of the airjet, keeping your nozzle insert the same size, and this will give you a potential boost in efficiency."

Process Characteristic	Impact
Flow rate	High
Air pressure	High
Media size	High
Nozzle and hose wear	Medium to high
Quality of media (durability and uniformity of size)	High
Stand-off distance	Medium to high
Nozzle type (venturi/straight bore/deflector tip)	High
Impact angle*	High

Effect of different process characteristics on profile

*Those of us that have gone through an EI Shot Peening Workshop will likely remember the following graph. The ideal impact angle to shot peening is 90 degrees (practical: 70 degrees). We profess that a part should not be peened at angles less than 45 degrees. Dropping from 90 to 45 degrees already reduces the impact by almost 30%. Similarly, when attempting a particular surface finish, the impact angle affects the magnitude of energy transferred by the abrasive on to the substrate. The converse is also true, wherein reducing the impact angle will allow easing of the surface roughness value, making it smoother.



Graph used with permission of EI Shot Peening Training

Though absolute answers are difficult to pin down, speaking to Robert and Dennis allowed me to formulate certain universal ground rules to achieve consistent surface finish:

1. A work ***mix*** is critical when attempting to achieve uniform **cleaning**. This holds true for metallic as well as non-metallic abrasive.
2. When **grit blasting** to a specific surface roughness, uniformity of size or a tight tolerance within a range of close sizes is essential. This can be maintained with a vibratory classifier.
3. Following along the lines of an ideal operating mix, 100% ***new*** media will not give consistent results. Allow the operating mix to develop over a few cycles, and when adding new media to replenish the system, add frequently but in low quantities.
4. Air pressure is a major determinant in maintaining consistent surface finish. High air pressures (greater than 60 PSI in suction and 90 PSI in pressure blast) need to be evaluated for their efficacy. Your process may not need such high pressures.
5. High air pressures will pulverize your non-metallic media at exponential rates, in addition to wearing out blast nozzles and hoses. Though hose wear does not directly impact surface finish, nozzle wear will change its blast pattern, decrease the intensity of blast, and could mis-direct the media to unintended areas inside the cabinet.
6. In shot peening applications, nozzle wear will reduce intensity (air pressure remaining unchanged).
7. If surface profile is your goal, it is important to maintain a tight tolerance with nozzle wear. It is time to replace your nozzle when a 1/16" change in nozzle bore is observed. Check with a calibrated dowel pin.
8. Air pressure loss will be experienced after a threshold hose length of 20'. A practical rule of thumb identifies a 5 PSI drop for every 50' of hose length. This rate of drop is exponential with hoses that are longer than 75'.
9. Threshold for nozzle sizes: a ¼" nozzle works with optimum efficiency for media sizes up to S110, 5/16" diameter for S230

and 3/8" for S280 and S330. Larger media sizes may require larger bores (and hose diameters), subject to media flow rate and air pressures.

10. Air pressure should always be verified as close as possible to the nozzle, using a needle gage.
11. In a pressure blast system, air and media consumption increase with nozzle wear. In a suction blast system, since the airjet determines the compressed air requirement, nozzle wear does not directly impact air consumption.
12. Depending on the nozzle design (straight bore and venturi) in a pressure blast system, the drop in impact is noticed at stand-off distances exceeding 8".

MEDIA HARDNESS AFFECTING SURFACE FINISH

Silicon carbide (SiC) and Aluminum oxide (AlOx) are two of the most aggressive and hard media used in our industry. They are rated 9 on Mohs scale where diamond gets a 10 and steel shot is at 7. Hard materials also tend to be brittle in structure. In aerospace, the durability of AlOx is accepted and accommodated for with process control. In other industries, users commonly experiment with alternate metallic abrasives such as stainless steel grit (in addition to conventional steel grit). Though brittle, particles of AlOx and SiC do create the intended roughness on the substrate before eventual disintegration.

Media hardness does have an impact on the roughness in equal proportion to the hardness of the substrate. A combination of all factors listed earlier will ultimately lead to the target profile/roughness. The article titled "Media Choices for Grit Blasting" in Spring 2019 of *The Shot Peener* has more details.

COMPRESSED AIR CONSUMPTION AND QUALITY

This is one of the first operating cost elements to be evaluated when considering a compressed air-type blasting or peening equipment. Compressed air is expensive to generate and, in a dynamic environment such as a blast machine, its requirement varies with component wear. Let us take the example of a 3/8" diameter nozzle blasting 80 PSI. This will require about 160 CFM of compressed air. Four CFM of compressed air requires about 1 HP to generate. In other words, this nozzle will require a 40 HP compressor. Consider the following with respect to this example:

- Though you will not always have the luxury of knowing the air pressure required for your application, you will need to plan for a compressor (or compressed air source) well in advance of process development. Therefore, fix the nozzle size and plan for compressed air requirement based on the next nozzle size (at 80 PSI). In other words, if your process requires a 3/8" (No. 6) nozzle, plan for compressed air requirement with use of a 7/16" (No. 7) nozzle. This will account for progressive wear of your 3/8" nozzle and resulting increase in compressed air consumption.
- If your plan involves diverting/sharing compressed air from an existing source, and if you are certain about the blast pressure requirement being no more than 50 PSI, for example, settle at that value, but still plan for the next size nozzle. A 3/8" nozzle will consume only 110 CFM at 50 PSI, a 50 CFM drop from that at 80 PSI. Most OEMs will be able to estimate the range of peening or blast pressure required for your specific application.
- In both cases, unless the compressor and dryer are located right next to the machine, always install a reservoir next to the machine to separate moisture (condensate) prior to feeding the blast tank, and ensure constant supply for an uninterrupted clean/peen cycle. Water in your compressed air line will wreak havoc on your media, both metallic and non-metallic. Surface rust on metallic media, due to this moisture, will transfer on to the part, leading to its discoloration. On this topic, the engineers at Ervin Industries provided me with suggested storage guidelines for AMASTEEL, Ervin's manufactured cast metallic shot and grit.

  * AMASTEEL should always be stored indoors in a covered shed without exposure to direct moisture or extreme humidity. Storage temperature should be stable with atmospheric temperature. Steel media stored in an air-conditioned environment, when introduced to a warm/humid environment for shipping or transportation, could cause moisture condensation. Therefore, temperature stability is important.
  * If a bag or drum of AMASTEEL is opened, it is advisable to store it in an atmosphere where the relative humidity is between 35 and 55. For unopened (sealed) bags and drums, standard humidity conditions indoors will be acceptable to prevent any material damage.
  * For opened drums, place a bag of desiccant on top and close the lid.
  * If the machine is scheduled to be taken out of service for any extended time (more than a week), empty the abrasive from the machine and store it in airtight drums. Before emptying the machine, it is advisable to run it for about two hours in the machine to remove any flash rust from the abrasive particles.

WHEN WE MEET AGAIN

What started as a single article has gained great momentum thanks to industry colleagues willing to share their knowledge. So, we will continue to Part 4 in Summer issue of *The Shot Peener* where I will share information specific to wheelblast equipment and process to benefit anybody working with a blast machine. I look forward to connecting with you again.