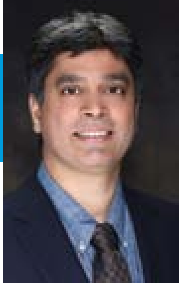

AN INSIDER'S PERSPECTIVE

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Testing Media Durability Using Airblast

INTRODUCTION

In the Fall 2017 issue of *The Shot Peener*, we discussed a similar topic, "The Critical Role of Metallic Shot in Achieving Consistent Shot Peening Results." Our focus then was to determine the durability and transmitted energy of blast media using the Ervin Test Machine. I used J445 as the guideline, specifically the procedure as described under 5.3: "100% Replacement Method." The topic involved using a centrifugal blast wheel type system to test durability and characterize critical media properties. Although a valid and time-tested procedure, it is limited to metallic media only.

Airblast nozzles are commonly used when cleaning or peening with non-metallic media. This type of propulsion generates greater momentum and is most effective for this media type. Additionally, velocity generated by using air-type media propulsion systems could be significantly higher than that with centrifugal blast wheels. For example, an 18" blast wheel running at 3600 RPM generates media velocity of about 360 feet per second, which is still a fairly high velocity for most cleaning and peening applications. In contrast, a long, wide-throat venturi nozzle at 90 PSI can develop a velocity of 535 feet per second (source: Abrasive Blast Cleaning Handbook, A.B. Williams). At this velocity, blast (and peen) media impact and failure characteristics are much different than when propelled from a blast wheel. Such high air pressures and velocities are quite common in manual airblast cleaning applications as well as when shot peening truck transmission components, mining bits, and railroad accessories.

Here, we will focus on developing a technique for testing media characteristics in an air-type propulsion system.

PURPOSE AND TEST CRITERIA

Media breakdown has several ramifications; the obvious one being the "nick" on the component caused by a sharp, fractured particle of metallic media. Incorrect size (i.e., broken media) of media can lead to improper transfer of impact energy. The breakdown of media may not be immediately visible and it can be disastrous. In general, media degradation, if gone unnoticed, can lead to catastrophic results. Shot peening machines are typically equipped with classifiers and spiral separators to keep media quality in check, but it's still critical to know the media's operating limits.

Media selection is generally not a luxury available in shot peening, but it is possible in blast cleaning and critical to the economics of the cleaning operation. Except for a few manual peening processes, the majority of shot peening applications using nozzles are automated. In contrast, in the world of contract blasting, the majority of cleaning projects are manual, with air pressures in the range of 90 to 120 PSI, or as high as can be generated by their compressed air system. Therefore, testing media durability under these circumstances becomes imperative.

Versatility in such a test machine is important and should ideally address key variables in an airblast process. Listed below are the common ones.

Enclosure. Despite that it is not easy to control the proliferation of a blast stream discharged from a nozzle, it is critical that almost all the media is re-captured within a controlled enclosure (commonly called the Blast Cabinet). For the purposes of our test, this cabinet could be a standard manual blast cabinet with enough distance between the two end walls to allow for alteration of the stand-off distance (distance between the nozzle and the target plate). A suggested cabinet size is between 48" (1219 mm) and 60" (1524 mm). Typical cross-sectional area (depth x width x height) of such cabinets will be around 48" x 48" x 36" or 60" x 60" x 74". Large cabinets pose challenges in media collection, but they will also provide the maximum flexibility when physically adjusting machine components during test parameter changes.

Target Plate. When shot peening a component, it is established practice that the peening media be harder than the component. On the other hand, hardness of the component determines the absorption of energy and also the media breakdown rate. Therefore, our test machine needs to have the flexibility to accept target plates of different materials and hardness. In order to establish a baseline, the media could be calibrated with commonly used metals such as Mild Steel (up to 50 HRc), Spring Steel (45 HRc), Aluminum and Titanium.

The target plate should be fitted on a mount that is also capable of being positioned at different angles since it is never recommended to blast (or peen) a component at right angles to it. The tilt will also allow us to study the effects of energy loss at angles shallower than 90 degrees.

Media propulsion: Suction and Pressure. While manual cleaning operations generally tend to be pressure blast systems, suction systems are common in automated peening machines, particularly those using non-metallic media such as glass bead and ceramic. It is generally known that suction systems are not capable of generating as much energy through media propulsion as pressure-type systems. However, this fact needs to be tested and validated. The test machine needs to be equipped with a mount that can accept a pressure blast nozzle as well as a suction gun. Like the target plate described earlier, this mount should also have a tilt feature to allow positioning it at different angles and stay fixed at that desired angle during blasting.

It might be obvious to the reader, but still important to mention, that different nozzle sizes and types will be used as part of the test procedure.

Media Reclaim. As in the 100% replacement method described in J445, the airblast test procedure will also start with a defined amount of media. This quantity will be dependent on the media type in order to accommodate their varying breakdown rates, and the need to conduct tests for the required length of time. For example, media with greater breakdown rates such as aluminum oxide and glass bead will be tested with a larger quantity than more durable media such as steel shot, cut wire and ceramic. Regardless of the quantity, the test machine should be designed with a reclaim system that closely simulates (or duplicates) an actual machine.

Given that we're discussing a test machine, the focus should be on providing every particle of media the opportunity to hit the target and be recycled at the quickest possible turnaround time. Therefore, the test machine should be equipped with a small capacity blast tank (1 CFT or smaller) depending on availability of associated valves and fittings without major customization due to being scaled down. Thus, the discharged media falls by gravity into a screener located below the hopper with separation of fines and unusable media through the different classifier screens. This arrangement eliminates the need for modifications to the reclaim system to operate with larger media sizes and limits it to simply changing screens. This arrangement allows efficient collection, separation and review of the generated dust without the need for a dust collector which could potentially retain dust within the cartridge and lead to incorrect measurement of broken media.

Media Size and Type Interchangeability. The test machine should be capable of (a) rapid change from one media type to another, and (b) complete evacuation of the previous media type to prevent cross-contamination. To address this requirement, the storage hopper and the blast tank should be provided with drains to empty out the media during changeover. The media in transit in the blast hose and nozzle should be flushed out as part of the changeover procedure. In the case of a pressure system, the tank inlet (pop-up valve) seals to prevent new media from entering the tank.

Consider the commonly used blast media listed in the following table. Media-holding capacities have been calculated using 80% utilization of tank volume. Flow rates vary quite widely depending on air pressure, media and nozzle size, whether suction or pressure, etc. However, for the purpose of our discussion, the flow rates below represent average values per nozzle.

Media	Specific weight (lb/cft)	Quantity in a 3 CFT Tank (lb)	Average flow (lb/min)	Blast capacity (mins) 3 CFT Tank	Blast capacity (mins) 1 CFT Tank
Aluminum Oxide	125	300	8	37	12
Glass Bead	100	240	6	40	13
Plastic	45 to 60	126	5	25	8
Ceramic	150	360	10	36	12
Steel Shot	280	672	15	45	15

The breakdown rate of the media listed above will vary with aluminum oxide disintegrating faster than the rest. In order to standardize on a test machine, it is suggested that a 1 CFT pressure vessel (tank), or smaller be used with the test quantity based on media type. This will allow the tank to blast itself empty within a reasonable amount of time.

Closed-Loop Feedback Systems. With air pressure being the primary determinant of impact energy, it is critical that constant pressure be maintained in the system during the test. Therefore, both suction and pressure systems should be equipped with the means to maintain the air pressure at a constant level and regulate it to that level during times of possible fluctuation. This feature is common in properly designed shot peening and grit blast systems.

WHAT ARE WE GOING TO TEST FOR?

Several hypotheses, beliefs, facts, "rules of thumb" and opinions exist in our industry. The proposed test machine can verify some of the common ones listed below.

Air pressure influencing durability. This is likely the most obvious aspect of media breakdown, and the test machine should have enough flexibility to test at different pressures at constantly maintained values.

Media size influencing durability. Larger-sized media tends to breakdown rapidly, or in the case of steel grit, round-off to the extent that their loss of sharpness renders them unusable for the intended purpose. This takes place at a much faster rate with non-metallic grit as compared to steel grit. A spiral separator, in addition to a size classifier, incorporated in the test machine can separate out the rounds from the non-round particles.

Media flow influencing durability. When gradually increasing the media flow at the same air pressure, the capacity of each media particle to transfer energy reduces, which in turn could reduce breakdown, or show increased durability. This aspect is more important in shot peening applications since it adversely affects intensity. A calibrated flow control valve, in the case of a pressure system, or a calibrated (by catch test) orifice plate at the outlet of the hopper could help achieving a defined, constant media flow rate.

Nozzle stand-off influencing durability. A few years ago, when conducting a test to study the effect of stand-off distance using a blast wheel, we found that the impact energy started degrading at distance beyond 6' (1.8 M). The proposed airblast test machine should allow varying the stand-off and characterize the effect based on different media and nozzle types as well.

Nozzle angle (of impact) influencing durability. You have likely heard from several sources that the minimum accepted angle for shot peening is 45 degrees and the ideal tilt is closer to 90 degrees. The adjustable nozzle mount in the test machine will allow us to study the differences in blast patterns and resulting impact energy at different settings.

WHO IS THIS MACHINE GOING TO BENEFIT?

The simple answer to this question is: Anyone who blast cleans or shot peens! Specifically, the following users are expected to derive great benefits from the information gained in the process.

Process/design engineers that want to determine the optimum media for their peening or cleaning operations. They can learn the parameter limits of a media for their peening, grit blasting or cleaning process and possibly alter such parameters to increase or extend its effectiveness during use.

Media manufacturers could characterize their media quality in terms of general use parameters, since "it depends" is not an answer that is widely popular among users of peening and cleaning equipment when they question media durability! Such an arrangement will also help compare similar media types from different manufacturers, thereby establishing the basis for a competitive edge.

General users of airblast. The Ervin Test Machine is very popular among users of steel shot, grit and cut wire shot to test the quality of media. The proposed machine could gain the same popularity among users of non-metallic media, especially those that monitor their operating costs closely.

POTENTIAL LIMITATIONS

The above information presents certain limitations and possibilities for further thought and improvements.

Media capture: Industry colleagues that have conducted catch tests in their airblast machines will appreciate the challenges involved in conducting a true "capture" of discharged media. The blast cabinet must be designed to minimize flat spots to prevent media accumulation and facilitate close to 100% capture of media discharged from the nozzle within the cabinet.

Physical size: Though it is tempting to make this unit portable, a true test can be performed only with a proper recovery system that includes a classifier. In the process, this test machine will have a large footprint and likely be a skid-mounted design with reduced manual portability unlike the Ervin Test Machine. The miniaturization of certain components to achieve portability requires further thought.

SUMMARY

This discussion is an attempt to get us thinking about a test procedure for blast and peening media when used in an airblast machine. Blast media is the perishable tool of any cleaning, grit blasting or peening process and it will also be one of your largest operating expenses, especially with non-metallic abrasives. With new materials being introduced for machine components more frequently, your customers will want you to enforce checks in the finish quality and your primary source of quality assurance is the media. Knowing the characteristics of the media will not only help assure finish quality, but also potentially reduce operating costs associated with the process and disposal of fines and dust.

About Kumar Balan

Kumar Balan is a shot peening and blast cleaning technical specialist. He assists industry leaders achieve business growth in North American and overseas markets. His expertise is in centrifugal wheel- and air-blast cleaning and shot peening equipment. Kumar has published many technical papers on blast cleaning and shot peening and is a regular contributor to *The Shot Peener* magazine.

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