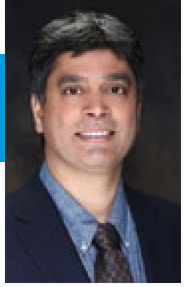

AN INSIDER'S PERSPECTIVE

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Media Choices for Grit Blasting

INTRODUCTION

Specialists in the Coatings industry stress that the effectiveness of a coating is greatly dependent on the component's pre-treatment process. This is a well-respected fact for some of us in the pre-treatment industry and it is what makes us tirelessly pursue the advancement of pre-treatment techniques. The two widely used types of pre-treatment techniques are mechanical and chemical. Though the manufacturing industry uses both, mechanical pre-treatment such as blast cleaning and grit blasting are preferred due to the environmental concerns associated with the use of chemicals. Pre-treatment requirements are also applicable for downstream processes such as thermal spraying and galvanizing.

In Automotive, Aerospace and Medical—industries of interest to us—users attach great emphasis on grit blasting when pre-treating their components. The desired outcome on a grit-blasted part is a surface profile that improves bond strength for a downstream thermal "spraying" process such as plasma, flame, and HVOF (High Velocity Oxy-Fuel). These spraying techniques restore a damaged surface or provide resistance to wear, corrosion, abrasion and heat. Fine metal particles, when sprayed on the surface of a grit-blasted component, rely on the condition of the substrate for their bonding strength. In addition to surface roughness, the cleanliness of the surface and pre-heating of the substrate determine the efficiency.

Given its criticality, most grit blasting machines, especially for aerospace applications, are designed and manufactured with the same sub-systems and controls for repeatability and accuracy as in a shot peening machine. The most commonly used grit blast media is Aluminum Oxide, commonly referred to as AlOx. In cleaning applications, AlOx is known for its aggressive nature and the rapid removal of paints and other contaminants while preparing the surface for coating. When blasted in a controlled fashion, it also imparts a profile (surface roughness) on the substrate. It is almost always propelled using compressed air through a blast nozzle. AlOx is available in several sizes to suit the application. With all its beneficial features, AlOx is also brittle and generates a fair amount of dust during blasting. The purpose of our discussion is two-fold: (1) to explore alternate media to AlOx that can be used in common applications for cleaning and (2) analyze this media for specific grit blasting processes that require precise and repeatable surface profiling.

CHARACTERISTICS OF ALOX

The blast industry is flooded with non-metallic abrasives for cleaning and surface profiling. These include different grades of garnet (mineral), slags (by-products of coal and other metal refining processes) and varieties of glass. Among these, AlOx is found to be most suitable in aerospace grit blasting applications. The suitability of AlOx for grit blasting is due to its physical characteristics such as angular shape and hardness of 9 on the Mohs scale. Talc powder is 1 and diamond is 10 on the Mohs scale. Plastic is 3 and steel shot/grit is 7-8. The bulk density of AlOx is 120 lb/cft. Steel shot/grit is about 280, glass bead is 100 and plastic is 45. Due to its low bulk density, AlOx is best propelled using compressed air so that sufficient momentum and impact energy can be generated. Unfortunately, with high hardness also comes greater brittleness that leads to reduced durability or life (measured in passes/cycles).

When grit blasting aerospace components, the process is almost always associated and defined by a specification that has been derived over the years. Some of these OEM specifications were drafted when media choices were limited. With the choices available today, users should evaluate alternate media choices.

One of the acknowledged advantages of AlOx is the maintenance of its angular profile upon repeated impacts, albeit at a reduced number. AlOx disintegrates into dust after a certain number of impacts but doesn't blunt into a rounded edge. This allows the substrate to continue receiving angular hits that contribute to its surface roughness. Most grit blasting applications for aerospace components require the use of AlOx for this reason. However, the type of downstream process also determines the surface finish requirement. Typical surface roughness required for thermal spray is between 80 and 100 microns. In order to achieve this surface, AlOx between 60 to 120 mesh screening is commonly used. The surface profile requirement for HVOF is not as demanding as, for example, plasma spray. This opens up the opportunity to try other media types that may have better durability than AlOx.

AN ALTERNATE MEDIA CHOICE – STAINLESS STEEL GRIT

Stainless steel grit is increasingly replacing AlOx in cleaning applications that had previously utilized mineral abrasive with low to no durability. The reasons are quite obvious when we evaluate its physical and operational characteristics. For this discussion, technical data has been obtained from publications for AMAGRIT manufactured by Ervin Industries. To provide a performance comparison, surface profile data was taken from publications by BlastOne. In both cases, the manufacturers caution us that end results are greatly dependent on the operating parameters. This information falls within the general range published by other manufacturers of these abrasives.

AMAGRIT is a contaminant-free inert metal abrasive with a martensite/chrome carbide microstructure. Its manufactured hardness is 57 HRc and chemistry is as follows: Carbon (2%), Silicon (4%), Manganese (2%) and Chromium (30%). The high percentage of chromium in this abrasive imparts its non-corrosive property. Tests conducted by the manufacturer have shown no trace of corrosion even after a 24-hour salt spray test. Joe McGreal, Ervin's Vice President, adds, "AMAGRIT's corrosion resistance was validated by one of our customers that manufactures trailers. They were looking for an alternative media to AlOx due to increasing operating costs and a dusty blast environment that resulted in a loss of productivity. The anti-corrosion property was paramount to them since residual media that lodged itself in the intricacies of the trailer could rust, giving the appearance of a coating failure. This same benefit works with Railroad Automobile Carriers where fugitive grains of grit could work themselves out of these intricacies and fall and rust on new automobiles. AMAGRIT works very well for our customer not only in terms of operating performance but has also resulted in significant cost savings." More on the economics in paragraphs that follow.

The surface profile that can be expected when blasting with AlOx ranges from 0.5 to 1.0 mil with 120 mesh (120 mesh is a screen with 120 openings per linear inch—a very fine media size). In contrast, 60 mesh (60 mesh is a screen with 60 openings per linear inch) AlOx will provide surface roughness in the 2.0 to 3.0 mil range. Larger mesh sizes of AlOx could increase the profile to as high as 6.0 mil (8 mesh AlOx). The area of reference is typically in the 60 to 120 mesh screening for aerospace coatings. For other grit blasting applications, the requirement could be potentially higher.

Surface profile values obtained using AMAGRIT were recorded at a relatively lower pressure than typically found with use of AlOx. The sample coupons were stainless steel and blasted at about 45 PSI and a blast angle of 45 degrees. Surface roughness for a similar particle size of AMAGRIT as AlOx was found to be at least 1 mil higher. As per the manufacturer, this is because of the stability of the work mix in AMAGRIT and a smaller percentage of very small particles. AlOx, due to its lower durability, tends to have a wider sieving range.

When considering replacing AlOx with stainless steel grit, Ervin recommends replacement with a smaller grain size of AMAGRIT. Also important to mention are the other process parameters that will need alteration during the switch, since size is not the only parameter that affects surface roughness.

ECONOMICS OF OPERATION

The question of media durability is one of the most difficult for a manufacturer to answer. "It depends" is not an answer that's accepted by users! However, that is unfortunately the reality when it comes to addressing this pressing issue. Among the factors that affect durability are media hardness, substrate hardness, blast pressure, media size, blast angle, stand-off distance and so on. Since this discussion will be incomplete without this topic, we will use field data obtained from multiple sources and compile the information using averages.

Let us assume an operation using two blast nozzles blasting identical components. Process data is tabulated as follows:

Airblast Operating Cost Analysis		
Operating Data 5/16" Nozzle (qty. 2) @ 60 PSI	AlOx	AMAGRIT
Media flow rate/hour	1920	2400
Field consumption data (cycles)	10	100
Consumption per hour (lb)	192.00	24.00
Abrasive cost per lb (USD)	$0.60	$3.00
Abrasive Cost Per Hour (USD)	$115.20	$72.00
Per 8 hour shift (60% Blasting)	$552.96	$345.60
Annual Cost (2000 Hours/USD)	$230,4000.00	$144,000.00
Abrasive Dust (Tons/2000 Hours)	192.00	24.00

Some noteworthy factors in this exercise include:

- The cleaning quality is assumed to be comparable with both abrasive types
- Loss of productivity and worker morale due to excessive dust generation using AlOx has not been quantified
- Savings in machine maintenance costs have not been quantified
- Dust disposal costs (transportation, landfill fees, etc.) have not been factored into the savings

Stainless steel grit has the potential to be a viable substitute to AlOx, glass bead and garnet due to some distinct advantages and resulting savings in operating cost.

AMAGRIT stainless steel grit from Ervin Industries.

The atmosphere inside a blast facility using AMAGRIT is cleaner due to its low breakdown rate, and this leads to increased productivity. The operating cost with stainless steel grit is lower not only due to the lower attrition, but also given the decreased frequency at which blast nozzles, hoses and blast tank parts need to be replaced. Users have reported around 85% savings in such costs. Stainless grit is also popular for contaminant-free cleaning of aluminum castings, stainless forgings, zinc pressure die-castings, corrosion-prone metal surfaces and stainless steel railroad cars. Dust disposal efforts and costs are quite significant when blasting with low-durability media such as AlOx. Some municipalities and local and state agencies offer incentives to factories to reduce material sent to landfills. This adds to the justification of using blast media of greater durability.

MACHINE RETROFITS

Since the majority of our discussions revolve around "conversions" to stainless steel grit, the obvious question in a reader's mind is the cost involved in modifying the blast equipment. Let us consider all possible scenarios:

1. If your blast operation currently uses minimally recyclable or non-recyclable abrasive, you will need to incorporate some kind of recovery system. A few choices are:
   a. If your blast operation is manual and involves a single operator, you could install a stand-alone vacuum recovery system that will include a recovery hopper in one corner of your room (into which the operator will sweep-in the abrasive), a media reclaim duct leading to a cyclone reclaimer, storage hopper and likely your existing blast tank. Approximate investment: $25,000.00 to $ 30,000.00.
   b. If your blast operation involves two operators, the above retrofit could still work as long as the operators take precautions to not overload the reclaim system with a "media dump." In other words, your operators should meter the amount of media discharged into the reclaim hopper to prevent it from choking.
   c. If metering the media discharged into the reclaim system is not possible or practical, consider "locking" the media flow rate from the blast nozzle so that the risk of choking the reclaim is stemmed at the source. This will of course require regular diversion of media into the reclaim system, too.
   d. Incorporate a mechanical reclaim system with a single or multiple screw conveyors (augers) leading to a bucket elevator and airwash separator.
2. If your blast operation is built with a vacuum recovery system:
   a. Check with your blast equipment manufacturer to confirm that the reclaim system can handle metallic abrasive. A well-designed system should be able to handle this switch, as long as you don't exceed the media flow rate generated by a single nozzle.
   b. Any modification to the reclaim system might entail a new reclaim duct and exhaust fan with a higher static pressure capability and a suitable motor drive.

In general, any resulting equipment modification will be justified in less than a year by cost savings from the use of stainless steel grit.

AMAGRIT is cleaner due to its low breakdown rate. AMAGRIT was used in the top blasting operation and AlOx in the bottom operation.

SUMMARY

All engineering cases and problems have multiple solutions with a handful of optimal ones. Use of abrasive in surface pre-treatment is no different. I have seen many blast operations that operate with a particular type and size of abrasive because "that is how it has always been done." Change is seldom openly embraced. It takes considerable effort from both the supplier and end-user to initiate and effect change. Cost and process justifications have to be considered carefully and in conjunction with the other.

Ultimately, the DFT (dry film thickness) of a coating, and its uniformity and life validate the quality of the pre-treatment process. Similarly, the thickness and bonding strength of the thermal spray will be determined by the effectiveness of the grit blasting process in presenting a suitable surface profile for the process. Since no single abrasive can provide a universal solution for all coating applications, explore to find the one that will result in the most suitable fit in cost and effectiveness.

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.

Kumar is a speaker at industry conferences and training seminars worldwide. He is also a Lead Instructor for EI Shot Peening Training at their international seminars and workshops. Please email him at kbalan13@gmail.com.

4th International Symposium on Fatigue Design and Material Defects

May 26-28, 2020 in Potsdam, Germany

FOLLOWING the successful symposia in Trondheim in 2011, in Paris in 2014 and in Lecco in 2017, the conference chairpersons announce the 4th International Symposium on Fatigue Design and Material Defects from May 26-28, 2020 in Potsdam, Germany.

Material defects such as non-metallic inclusions, pores, micro-shrinkages etc., play a crucial role in fatigue crack initiation and propagation which in turn has significant consequences for structural integrity in terms of lifetime, fatigue strength and other characteristics of cyclically loaded components.

The main objectives of the symposium are to improve the understanding of the mechanisms and the impact of defects on structural integrity, and to work out measures to improve the fatigue properties of materials and components.

To that purpose presentations are welcome which address the following topics:

- Defects and manufacturing processes
- Defect detection and monitoring
- Statistical considerations
- Defects and fatigue strength
- Short fatigue crack propagation starting at defects
- Critical defect sizes
- Defects as root causes of structural failure
- Modelling fatigue life and strength taking into account defects

All materials are concerned, particularly:

- High-strength steels
- Cast aluminium alloys
- Nodular cast iron
- Sinter materials
- Weldments
- Materials generated by Additive Manufacturing

To submit your abstract, go to https://fdmd2020.inventum.de/registration/registration. The deadline is October 31, 2019.

The symposium will be chaired by Prof. Dr. Uwe Zerbst and Dr. Mauro Madia with BAM (Bundesanstalt für Materialforschung und -prüfung). BAM is a senior scientific and technical federal institute with responsibility to the Federal Ministry for Economic Affairs and Energy. BAM is located in Berlin, Germany.