Improving Productivity of Steel Grit Blasting
by Wallace P. Cathcart
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For environmental and health reasons, shops that line and paint railcars are moving away from sand and slag abrasives to metal abrasives. In these shops, some people have been slow to recognize important differences between non-metallic and metallic abrasives; thus, many contradictions arise and misinformation tends to become gospel. This Maintenance Tip is the result of an extensive review of the literature, together with the experiences of the several shops of Tank Lining and Railcar Repair Company that have been using steel abrasives for as long as 35 years. Although it is written for air abrasive blasting, most of the information is readily transferable to centrifugal blast operations.

Below is a list of recommendations, each followed by a rationale that is intended to justify the recommendation.

Use Only Cast Steel Grit
Cast steel grit is, in my opinion, the most cost-effective metallic abrasive to satisfy most current surface preparation specifications, although steel abrasive particles created by other means are claimed to be equally effective. Steel grit is more effective than iron grit because it is approximately four times longer lasting. Grit is more effective than shot because it produces the etched anchor pattern required rather than the peened or even polished surface produced by shot.

When Purchasing, Always Specify The Hardness Of Steel Grit
Grit is commonly supplied in a range of Rockwell C hardness from 30 to 66. Almost all industrial users, including the surface preparation industry, commonly use it in the range of 40 to 50. In this range, however, it tends to ball or round quickly and thus does not long provide the etched surface required by today's coating and lining specifications.

Rockwell C hardness in the range of 50 to 60 is best for interior lining and exterior coating work. The higher portion of that range seems better for lining and the lower portion better for exterior painting. Above 60 the grit is so hard it fractures quickly and therefore is consumed very rapidly and becomes expensive. Nevertheless, hardness in that range usually is necessary when the average anchor pattern needed or specified is above 4 mils, as is often the case when preparing surfaces for vinyl ester lining materials.

continued
Specifying the appropriate hardness for your particular work is of concern because the more times grit is used and reused, the less costly the total blasting operation becomes. As a rule of thumb in a given set of working conditions, grit in the range of 60 to 65 hardness will be used $x$ times before it is totally lost from breakdown. Reducing to 55 to 60 hardness in the same working conditions, the grit will last 4 times $x$. At 50 to 55 hardness, again in the same working conditions, the grit will last 6 times $x$ or 6 times as long as the hardest grit. These ratios should make it clear that the hardness of grit is important to cost effectiveness and deserves your attention and record keeping as you attempt to develop your best "working mix."

Lowest Cost And Highest Quality Blasting Are Attained And Maintained By The Understanding And Control Of Your Abrasive “Working Mix”

The larger the grit, the deeper the anchor pattern. The harder the grit, the deeper the anchor pattern. The higher the velocity of the grit at point of impact, the deeper the anchor pattern. If the object were to peen or to surface harden, then it would be easy to do more work simply by increasing the mass and the velocity of the abrasives. Unfortunately in surface preparation work, increasing the mass and velocity causes the abrasive to make a bigger hole, or in other words, it increases the anchor pattern. In surface preparation, we are attempting to do three things:

- knock off hard, tightly adhering contaminants, which requires big abrasive particles;
- cut or form the desired tooth or anchor pattern, which requires a smaller particle; and
- clean the bottoms of the anchor pattern as well as the pits and other intricacies of the surface, for which a quite small particle is needed.

Small particle grit is also desirable because it has more particles per pound or per unit volume and thus more impacts.

As the grit is used and reused, it constantly breaks into smaller bits, and some edges tend to round. If this were not so, if grit stayed always at its original size, the ideal grit would be as small as possible, yet heavy enough to clean and etch the surface. To do surface preparation work efficiently, there must be a balanced distribution of large, medium, and small particles. At this writing there is not yet a real science of how to develop such a working mix. It can be done only in your given circumstances by study, conclusions, and management.

Record keeping and careful analysis of data over a period of time will eventually indicate the size, the hardness, the frequency, and the amount of new abrasive that should be added to a system as the old grit is consumed. A managed routine of addition of new grit to a system must be developed to create your working mix. Adding small amounts of new grit as often as every hour is desirable but often bothersome. Adding new grit less than once each shift is too long a time, because adding too large an amount at one time causes an undesir-
able jump in anchor depth and a decrease in consistency of quality.

**Grit Size Is Important Only As It Affects Your Particular “Work Mix”**

As a hangover from sand blasting, where each batch of sand is used only once, there is a popular concept that profile size is controlled merely by specifying the grit size. When everything else is constant, then the larger the grit, the greater the profile. However, with recirculating steel grit blasting, everything is not constant, and therefore, the concept is just plain wrong. You cannot control profile solely by specifying size of grit. The hardness of the surface being blasted, the air pressure, the distance from the nozzle to surface, hardness of the grit itself, and the angle of attack of the abrasive are all significant in creating the profile.

As discussed above, the grit size in the recirculating system is always changing to smaller and rounder particles. Most often, charts show anchor pattern as related to grit size based on new grit, even though that fact is not always stated. With a conditioned, stabilized abrasive working mix made up of grit with a Rockwell C hardness of 55 to 60, and with 90 psi of blasting air, new steel receives maximum and average profiles as shown in Table 1.

### Table 1: Maximum and Average Profiles Based on Grit Size

<table>
<thead>
<tr>
<th>Grit</th>
<th>Average Profile Mils (Microns)</th>
<th>Maximum Profile Mils (Microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G 50</td>
<td>1.6 ±0.3</td>
<td>2.2 ±0.3</td>
</tr>
<tr>
<td></td>
<td>(40 ±8)</td>
<td>(56 ±8)</td>
</tr>
<tr>
<td>G 40</td>
<td>2.2 ±0.5</td>
<td>3.4 ±0.4</td>
</tr>
<tr>
<td></td>
<td>(56 ±13)</td>
<td>(86 ±16)</td>
</tr>
<tr>
<td>G 25</td>
<td>3.1 ±0.7</td>
<td>4.6 ±0.5</td>
</tr>
<tr>
<td></td>
<td>(79 ±18)</td>
<td>(120 ±13)</td>
</tr>
</tbody>
</table>

Clean Grit Is A Major Essential

Cleanliness of grit affects the quality of performance of the applied coating or lining system, is essential to high production rates, and even materially affects the cost of the grit itself. "Clean grit" is not yet defined in any technical standards. If and when a strict definition is made, it will be difficult to attain and even harder to maintain in any circulating blast system. Nevertheless, the cleaner the grit, the better the quality of lining or coating performance because an abrasive blast is intended to remove “all” contaminants. If the abrasive itself contaminates the surface with old coating, grease, or salt, it obviously is counter-productive.

Further, the time between blasting and rerusting or bloom is directly related to the degree of “real cleanliness.” SSPC and NACE standards to date are entirely defined in visual terms. Non-visible contaminants, primarily soluble salts, also must be absent for a surface to be really clean. Thus, clean grit reduces the flash rusting caused by...
surface contamination, allows more tolerance in scheduling the application of the first coat, and reduces, even eliminates, reblasting.

To maintain clean grit, one should consider the following factors.

New grit should be specified and checked on arrival to be free of (or low in) out-of-specification fines, oil, and miscellaneous debris. Specification is easy to state, but inspection is both difficult and expensive. The most economical way is probably careful choice of a supplier. He should understand the criticality of your needs as compared with his customers who use grit to blast burrs from rough castings. Learn what precautions he takes or could take to assure that the abrasive he delivers to you is as you want it to be.

Your separators and/or dust collector systems should be operating correctly. If the system incorporates screens, they must be correctly sized. A blocked or plugged screen costs abrasive. As the abrasive falls through the separator, the air flow must be uniform. If the air flow is too strong, it will extract useable abrasive. If too weak, excessive fines and dirt will be recirculated back to the nozzles.

A dust collector should be equipped with a properly functioning expansion trap or other mechanism that allows the pressure to drop, assuring that useable abrasive will drop out. A dust collector should be equipped with a manometer, and it should be read and recorded regularly because any change in the air flow affects the efficiency and ability of the collector.

Additionally, inspect for warped vent piping and inspect the fan drive for loose belts and proper direction. Empty the hopper regularly; inspect the shaker mechanism routinely; and check for leakage between clean and dirty sides of the collector. Also, the supplier of your dust collector can provide additional maintenance tips. All of these are important because it is estimated in industry studies that the typical separator-dust collector operation loses between 15 and 25 percent of useable abrasive and wastes appreciable electricity.

The only materials that a separator should be required to remove are the abrasive fines and whatever is being removed from the surface in the act of abrasive blasting. It should not be required to remove mud or dirt from shoes, glass from blast hoods, tobacco juice, cigarette butts, and similar debris. Keep that area clean.

Clean the compressed air to remove oil. Obviously, the best oil removal technique is to keep oil out of the air in the first place. In older set-ups, however, this is often impossible and always difficult. The need for oil-free air is so obvious that quality painting or coating that usually it has been addressed, but it should be re-checked often and carefully. Filters and traps must be used. Precise testing for oil in air is difficult, but a satisfactory procedure is with a clean, white, absorbent cloth held directly in the air stream for a full 60 seconds at a point downstream from the last possible source of oil. Any visible discoloration is a test failure, and remedial action is necessary. Oil deposited on a surface conceivably can lessen or destroy adhesion. In addition, when it gets on the particles of abrasive, it

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102 / Journal of Protective Coatings & Linings
allows fines to adhere to the particles and intensifies the likelihood of picking up any chemical contamination that is being removed from the surface being blasted.

Compressed air should be dry as well as oil-free. Within any measurable amount, air cannot be too dry, and unless there is a properly sized and operating refrigerated dryer in the system, the air is virtually always too wet. Even miniscule amounts of water in blasting air do three things, all of which are bad. First, water causes or speeds rerusting or bloom of the surface being blasted. Second, it rusts the steel abrasive, materially shortening its service life. In the case of a fine grit such as G 40 or higher, a small amount of moisture can reduce service to only 20 percent to 25 percent of normal. This effect also prevails on the small particles of your working mix and has a similar but less detrimental effect on the larger particles. Third, moisture causes blockage in pots, lines, or nozzles, resulting in work stoppages and loss of production.

The cloth test described for presence of oil is an indicator of moisture also. If at the end of sixty seconds there is any perceptible moisture on the cloth, it is a test failure.

Avoid using steel grit to blast surfaces that will contaminate the grit with oil or soluble salts. Contaminants should be removed prior to blasting. For instance, remove visible oil or grease by scraping heavy deposits and then follow with a washing/scrubbing with emulsion or alkaline cleaners followed by water or steam rinse. Spray, or wipe or scrub with rags or brushes wetted with a suitably safe solvent. Be careful to use a clean solvent and clean rags or brushes for the final wiping. Alternatively, use steam cleaning with or without detergents or cleaners as necessary, but if chemicals are used, follow with pure steam or fresh water to rinse away residues.

Prior to abrasive blasting, remove residual chemical products, particularly salts such as sodium chloride, sodium chlorate, and ferrous or ferric sulfate, by washing with steam; flushing, flooding, or soaking with water; or pre-blasting with high or ultra-high pressure water.

Probably the most used technique for keeping steel grit away from heavily contaminated surfaces is to pre-blast with a mineral grit or sand, but when doing this, you should take great care to comply with safety requirements and all local, state, and federal codes.

Maintenance Of Maximum Air Pressure Is Essential For Cost-Efficient Abrasive Blasting
With steel grit as with all other abrasives, recommended air pressure has been in the range of 80 psi to 100 psi. More recently, however, recommendations have focused on higher pressures of 100 psi or above. How high is limited only by the safety limit of air receivers and blast pots, and the fatigue factor of employees. The fatigue factor is not solely related to air pressure; it also involves where or what is being blasted, the workers' sense of security, and their continued...
the higher the air pressure, the better; and the recoil effect on fatigue is fairly minor as compared to increased productivity. As the pressure increases from 60 pounds up to even 120, the recoil pressure goes up, but at lower pressure, a great deal of work is lost. If 100 psi is used as a norm, each one-pound decrease in pressure costs approximately 1.5 percent production loss, and each pound increase above a hundred adds 1.5 percent production increase. Considerable attention, therefore, should be given to the factors that affect air pressure.

Compressors should be well maintained to reliably provide the design volume and design pressure maximums. Obviously, exceeding the compressor's rating will shorten bearing life and increase seal failures to an intolerable rate. Friction loss in hose is considerably higher than in relatively clean pipe, so air should be conveyed as much as possible in large diameter pipe as free of turns and restrictions as is possible. However, rusty, corroded pipe is less efficient than good hose. Hose must be used from pot to nozzle, but it, too, should be large, at least four times the nozzle diameter.

Hose should be kept as straight as possible. When turns are necessary, make them gradual, not right angle turns. Be sure all fittings are properly sized and that the system is free of reducers. Couplings should be externally mounted because internal stems create turbulence and a loss of pressure.

A "pigtail" or "whip" blast hose, a smaller diameter hose at the nozzle end that is easier for the worker to handle, is an expensive gadget. It is better to stay with full diameter hose to the nozzle. For accessibility to work in a confined area, or for a decrease in fatigue, try the newer super flexible, thinner-walled hose for the last few feet. But even with this, use it in as short a length as possible to accomplish your intentions.

Also, remember that cooler air has less pressure loss due to friction than hotter air.

The Nozzle Selection Is Significant In Controlling Your Costs
Steel grit erodes, even chews up, nozzles more rapidly than most other abrasives, and thus significantly increases the importance of nozzle selection. The cost of nozzles varies substantially, but the more expensive is usually the best. Some facts to consider when selecting nozzles follow.

Venturi nozzles as a family more than double the velocity of the abrasive when compared to straight barrelled nozzles, and simultaneously, they provide a larger blast pattern. Thus, a new Venturi does half again or more work than a similar, new straight barrel. Unfortunately, as a Venturi wears, its effectiveness decreases; if the wear is not uniform, the decrease can be disproportionately bad.

Short nozzles (about 3 in.) are most efficient when used within 1 ft of the surface to be blasted. Long nozzles are more effective as distance from work increases. For example, a nine-inch nozzle appears best at 2 to 3 ft from the surface to be blasted.

Nozzle liner material should be studied...
for given working conditions. Cast iron and ceramic wear so fast that their low purchase price results in the highest cost because of low productivity, constant replacement, and wasted air. Silicon carbide costs 30 percent more than tungsten carbide but lasts 60 percent to 70 percent longer. Boron carbide lasts about twice as long as silicon carbide but may be impractical due to its high purchase price. Loss of nozzle life by fracture of the liner can be materially reduced by worker training (a nozzle is not a hammer) and by using the newer flexible urethane light weight jacketing.

If and when you consistently attain pressures at or above 95 Ibs at the nozzle, you can experiment with the newer "double Venturi" and "bazooka" configurations. Each is designed to decrease recoil or back pressure and ease worker fatigue. These nozzles also create a larger area of impact of the abrasive while maintaining a relatively consistent number of impacts over the entire area. The first lab and field test work with these nozzles indicates productivity increases of 10 percent to 50 percent.

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