**Cast Steel Shot and Grit**

**The Miracle Workers of Blast Cleaning, Profiling, Peening**

Part 2 of a 5 part series

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Sometimes even miracles need a helping hand to make them happen!

Before the user of cast steel shot or grit can be assured that he is achieving the most effective and efficient results from his blast-cleaning-profiling-or peening system, he should establish the order of priority to be assigned to these four factors common to all users of cast steel abrasives:

- Every user's #1 Priority, and the sole reason for using the blast-process, is the FINISH required. For some it is blast cleaning, or removal of surface contaminant, (the subject of this Ervin Technical Bulletin), for others it is providing an anchor pattern profile to assure optimum bonding, painting, or coating life. For yet others it may be to shot peen the workpiece to improve fatigue life and/or prevent stress corrosion cracking.

- The remaining factors that need to be prioritized (their ranking depends strictly on the individual user's circumstances) are: PRODUCTIVITY (how many units can be processed per shift or day); EQUIPMENT WEAR/TEAR (Cost of parts replacement and downtime for maintenance and repair); ABRASIVE COST TO USE (evaluating price vs. use life, and how the abrasive affects the factors of finish, productivity, and maintenance/repair).

And, before the user can intelligently do his prioritizing on these factors, he must be aware of the many choices he has with respect to the size, shape or hardness of the cast steel abrasive he uses. THE CHALLENGE: Understand how and why choices made in behalf of one priority may adversely affect one or more of the other priorities.

Choices? There are over twenty shot and grit sizes to consider: four basic hardness ranges, plus specials, and two shapes (round shot and angular grit). Because the universal #1 priority is Finish, this issue deals with the subject of blast cleaning, or contaminant removal, and how it is affected by choices made as to size of abrasive asked to do the work.

The Choice: Abrasive Size

The Effect: On Finish - Contaminant Removal

In order to make the best choice as to initial, or new size of shot or grit, these basic facts must be recognized and understood:

- Whatever steel shot or grit is purchased, it is just the raw material from which is developed the work mix that actually does the work.
- The work mix will develop naturally as the abrasive fatigues and gradually breaks down, from its original size to its eventual destination in the dust collector as spent abrasive, and is replenished each operating shift in small quantities, always maintaining the abrasive feed hopper level at least two-thirds full.

- For sizes 5-230 shot or G-25 grit and larger, a properly balanced and controlled work mix will contain roughly 40-45% large, original-size abrasive, with the balance fairly evenly split between medium-size fractured particles, and small-size fractured particles larger than the spent abrasive extracted by the separator system. A properly balanced work mix has the needed mix of impact power and blast stream particle population to clean effectively and efficiently.

Obviously, there are two sizing factors involved in our study: The size of the new cast steel shot or grit (purchased) and the size distribution maintained in the work mix (operations control).

How large should the new shot or grit be? The key determinant is how thick and heavy the contaminant is—how great an impact is required to loosen, break up, dislodge the contaminant? The blast equipment supplier recommends the type and size of cast steel abrasive he feels will perform in accordance with what the system was designed to do. However, the user should make certain that the choices of type and size also meet his specific priorities with respect to Finish, Productivity, Maintenance/Repair, and Abrasive Cost to Use while bearing in mind that those priorities may have changed since installation of the equipment.

To achieve complete contamination removal, the smallest particles in the work mix must have sufficient impact power, and yet be small enough to penetrate and dislodge rust, etc. from minute cracks and fissures in the work piece surface.

The lower fine size limit of the work mix is established by the air wash cut-off point that separates dislodged contaminant and spent abrasive from usable, effective abrasive. To determine just where that cut-off point should be usually requires some trial and error experimentation. While wasting usable abrasive when the cut-off point is too coarse is not acceptable, neither is it acceptable to set it so fine that the work mix retains useless, ineffective abrasive fines as well as dislodged contaminant that will very significantly increase wear of the blast wheel components.

The two factors that make cast steel shot and grit qualify as "MIRACLE WORKERS" are: (a) the tremendous impact power of shot or grit at a velocity of 245 fps or more, with all the energy expended on an almost infinitesimal point of contact; (b) the high particle count in the abrasive blast stream, affording optimum blast pattern coverage with literally thousands/millions of impacts per minute.
It is the particle size that determines the relative impact power and the particle population. The larger the size, the greater the impact power per particle, but the fewer the particles per unit of weight. The smaller the size, the lower the impact power, but the higher the particle count.

At a given velocity, kinetic energy, or the impact power of steel shot, varies as the cube of the difference in diameter. For example, a steel shot particle 0.044" in diameter is twice the diameter of a particle 0.02" in diameter, but delivers eight times the impact power! The other side of the coin is this: While the 0.02" particle has only one-eighth the impact power, it has eight times the particle count per pound thrown. With a properly balanced work mix size distribution, the user has both high impact-energy and high particle count—IMPACT AND COVERAGE, the two ingredients necessary for effective and efficient contaminant removal.

Shown below is a visual comparison of both relative size and particle count, and the effect on area coverage. Consider these assumptions: Average particle size of the original-size portion (40%) in the work mix is 0.044". Average particle size of the medium-size portion (30%) is 0.030". Average particle size of the small-size portion (30%) is 0.018".

Now, further assume that in a given instant, and in a given small area within the blast-stream striking the work piece, that ten (10) pellets of the 0.044" shot would impact in that given small area.

What is depicted below is the relative coverage, or the number of impacts that would strike that same small area if the 0.030" shot, or the 0.018" shot, was thrown instead of the larger 0.044" shot:

- **0.044" shot**: Simulated 10 Pellets
- **0.030" shot**: Simulated 30 Pellets
- **0.018" shot**: Simulated 150 Pellets

Note the open pattern of the 0.044" shot. Obviously, a work mix consisting mostly of this coarse shot would leave much of the contaminant untouched, with the result the finish would not pass inspection, and re-blast would be required. It can readily be understood how a balanced work mix removes contaminant better and faster than a too coarse mix—the large pellets break and loosen heavy scale so the medium and smaller pellets, with many more pellets at work, can finish the job, effectively and quickly.

There are many applications where steel shot or grit as large as 0.044" would succeed in removing contaminant but would produce an unacceptable finish appearance (i.e., indentations that are too deep and would induce warping or cracking, etc.).

Again, for visual comparison, and using the same frame of reference, a work mix with average 0.018" shot as original size, and average 0.012" shot as the medium/small size portion is shown to reflect the difference in impact coverage.

Obviously, this work mix has a tremendous “coverage” factor—all areas where contamination exists will be impacted, and the most minute crevices and fissures will be thoroughly scoured—and fast!

Will shot or grit this small have sufficient impact power to do the job? That depends on the nature of the contaminant. For many applications... no. But, for others, indeed. Consider this: Shot equal in size to the very small 0.012" size is being used by steel mills to remove thin, tough, tenacious oxide scale from hot-rolled stainless steel strip. The shot may be small, but it’s mighty. It’s a true miracle worker!

Control of the work mix sizing is the single most important challenge in the blast cleaning operation. The problem most frequently encountered is having too much large, original size material (70-80% or more) in the work mix. This is not necessarily due to selecting the wrong size to start with, but occurs mostly because operations have gotten out of control (for example: excess air velocity pulling out and discarding the small and medium sizes, causing the percentage of original size material to become excessive). This can occur, even when using material as small as the 0.018" material in the example above. Consider what happens to coverage if all the 0.012" material is inadvertently pulled out of the system. And, it does happen! Think of all the impacts that have been lost.

Part three of this series about Cast Steel Shot and Grit as Miracle Workers (in the next issue of Abrasive Cleaning News) will once again deal with the choice of cast steel shot or grit, but with emphasis on the effect of that choice on the finish as it relates to the profile attained, and how, in turn, that can affect subsequent operations such as bonding, painting, or coating.

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