What Makes a Good Abrasive?

There are a wide variety of abrasives available on the market, and not all are good for every application. Remember this - it is not the particular machine that does the actual cleaning but rather the abrasive. The machine can have a very marked effect on the end result because that result will depend on how the abrasive is delivered and impinged on the surface to be cleaned or otherwise treated. Further, the overall economics of any abrasive blasting bears heavily on the equipment and its ability to provide sufficient impact to the abrasive to accomplish the job. In the case of durable abrasives, it’s also important to effectively and efficiently recover the reusable abrasive so that it can go back and do its job over and over again without being lost.

Years ago, the term sandblasting covered almost the entire field of blast cleaning. Now the list of abrasive media runs from steel shot to glass beads and plastic spheres that include a variety of metallic oxides, mineral products and organic materials such as crushed walnut shell. Even common baking soda is used as an abrasive for cleaning electronic components and teeth.

Jagged or Rough Edged Abrasives

For tough cleaning jobs where abrasives need to be capable of cleaning a surface of rust, scale, heavy corrosion, heat treat oxidation and hard scale, etc., there is available a group of rough edged abrasives. These include such abrasives as:

- Steel grit
- Chilled iron grit
- Metallic oxide
- Sand
- Garnet
- Silicon carbide

The above are generally referred to as “hard angular abrasives”. There is another class of rough edged abrasives available which are generally referred to as “soft angular abrasives”. These include such organic abrasives as walnut shell, cob, ground fruit pits, etc.

There are several spherical abrasives available which are usually hard and are generally referred to as “shot”. These include steel shot, chilled iron shot, aluminum or other metallic shot, glass beads, ceramic beads, and plastic spheres. The only shot that can be called “soft” is the plastic spheres or beads not presently in wide use but with interesting characteristics and possibilities for much broader application and use in the near future.

Principles of Accelerating Abrasive

Early man discovered the abrasive quality of sand as an excellent agent for removing scale, dirt, rust, etc. from metal surfaces. With the advent of the industrial age and the manufacture of more products from ferrous materials, including ships, the recognition of the fact that ordinary sand was a good abrasive agent was exploited.

Abrasives are selected generally to meet three basic requirements:

1. The economic factor of achieving the fastest cleaning, peening or etch at minimum cost.
2. To achieve the desired surface finish.
3. For compatibility with material to be cleaned, peened or etched.

The kinetic energy of each particle of abrasive is a measure of the work done by each particle since the energy is practically destroyed on impact. The impact energy is thus proportional to \( \frac{1}{2}MV^2 \) where \( M \) is the weight and \( V \) the velocity of the particle. This indicates that an increase in particle speed increases the amount of work done by each particle more than an increase in mass or weight.

There is an old adage in the impact cleaning field which says that for any given abrasive type; “The finer the abrasive, the faster the cleaning rate - provided the abrasive has the capacity to clean”. Some very light particles - or very small particles - simply will not clean certain heavy scale. A larger particle is needed to chisel a bigger indentation. But generally speaking the finer abrasive cleans faster. This is particularly true in the case of air blasting. There are two basic systems used for accelerating the abrasive particles to project them against the work surface:

1. The “wheel” unit is a mechanical throwing device operating on the principle of introducing the abrasive into the center of a high speed spinning wheel. The particles are thrown from the wheel blades by centrifugal force. Wheels throw all similar abrasives at the same speed irrespective of particle size. Limitations restrict wheel speeds and resultant particle speeds of 300 feet per second are the maximum obtainable. Therefore, the only way to get greater impact energy, to perform more work, is to go to larger particles.

2. The air blast machine is more versatile. With this system, the abrasive is introduced into an air stream and the particle is accelerated through a nozzle where the air speed is extremely high - above Mach 1 in many cases. Varying air speeds can be achieved by varying pressure over wide limits.

Since lighter particles are accelerated by the air stream more easily and more quickly than heavy ones, air blast systems achieve high velocities with smaller particles. It can be seen that with high particle velocities - up to something in the region of 600 feet per second in the case of fine abrasives - very high impact energy (\( \frac{1}{2}MV^2 \)) can be achieved.

Therefore, the selection of abrasives for air blast systems can include a much wider range, including very small sizes, than can be used in wheel units.
Air systems are much more flexible in their design and application and lend themselves more easily to the concepts of portable or semi-portable abrasive blasting equipment, in wide use today, since they are generally less bulky, simpler in design, lighter in weight, more flexible in use and more finely controllable for many precise applications - and generally less costly.

As a reference, tabulated below are general areas of application and guide lines for selection of popular abrasives. While application studies may indicate some “grey” areas such as breakdown rates and abrasive use, it is felt that the following will provide general guide lines for evaluating abrasives in terms of end results to be accomplished.

**Steel Grit**
Steel grit is the most durable of the hard angular abrasives presenting millions of tiny cutting edges and will do the fastest cleaning job, commensurate with minimum abrasive breakdown and usage, of any abrasive. Steel grit is the most widely used coarse abrasive. Steel grit is ideal for removing contamination from any surface, but principally ferrous materials, such as rust, scale, paint and similar surface materials. It is most effective, and generally used, for cleaning decks of ships, like aircraft carriers, to “white metal”. Blast rooms used for general cleaning of castings, forgings and fabrications usually offer the greatest overall cost savings when using steel grit.

**Chilled Iron Grit**
Chilled iron grit generally achieves the same results and surface finish as steel grit. Chilled iron grit costs less than steel grit but breaks down faster, too. The rate of breakdown is related to blasting pressure. Therefore, in some cases where a lighter degree of etch is required, or desirable, and lower pressure are used, chilled iron grit may prove to be more economical than steel grit. Both chilled iron grit and steel grit provide an excellent etched surface as a “key” for good bond of paints, epoxy coatings, vinyl coatings or rubber bonding.

**Steel Shot**
Steel shot is used for a variety of cleaning jobs such as castings and other large fabricated parts. Steel shot is used extensively for shot peening in both wheel type and air blast type equipment. Shot is, however, used for cleaning primarily in wheel type machines because it flows more readily and minimizes wearing of the parts in wheel equipment for a given volume of abrasive thrown. As per formula given above, even though the energy contained in a similar sized particle of steel shot and steel grit hurled at the same speed is the same, the penetrating effect of the jagged particle is greater because its first point of contact is smaller.

**Aluminum Oxide**
Aluminum oxide is a very excellent abrasive in the angular or jagged abrasive class and is very widely used, particularly in the finer mesh sizes. Actually, as a first “go around” in an abrasive blasting system, aluminum oxide has perhaps the finest cutting ability of any abrasive, including steel grit. However, aluminum oxide “breaks up” or shatters on contact much more readily than does steel grit, for example, and therefore the increased rate of breakdown, and subsequent abrasive make-up, is considerably higher resulting in an overall abrasive cost well in excess of steel grit. Reclaiming systems and dust collector capacity must be proportionately sized for this higher abrasive breakdown rate and may necessitate having larger reclaiming system and dust collection capacity than an equivalent job being done with other abrasive. However, where the problem of possible surface contamination with a ferrous material and possible consequential oxidation and rusting may be a problem, aluminum oxide can well be the answer since ferrous abrasives have this disadvantage and cannot be used on certain parts where this is a problem. Aluminum oxide is also available in much smaller particle sizes (ie. 240 mesh) than is steel grit or shot.

**Garnet - Silicon Carbide - Sand**
The above mentioned abrasives are used for a wide variety of blasting applications. There are applications and economic reasons why certain of these abrasives are used and individual analysis of particular applications will indicate which abrasive is most economical and suitable for a particular job. There is one point that must be considered and that is hardness and long wearing qualities.

Hardness and long wear are not synonymous. All of the above named abrasives are “hard”. They also have one other quality in common and that is that they, to a greater or lesser extent, shatter and break up on cleavage planes, upon impact. The wear rate does not begin to compare with the so-called “durable” abrasives and all of these abrasives basically shatter on impact. Sand, generally, is good for only “once around” whereas garnet and silicon carbide may be reusable from two to five cycles depending upon surface to be cleaned, type of reclaiming equipment and blasting pressure used. All of these are generally in the category of hard, angular, jagged but high breakdown rate abrasives.

**Glass Beads**
Glass beads, as the name implies, are spheres of glass and are not a jagged or angular abrasive as referred to above. Glass beads are ideal for cleaning and other surface preparation, particularly in the finer mesh sizes. Glass beads, in addition to many cleaning applications, are also used extensively in shot peening. Within a reasonable range of blasting pressures, and thus impact energies, glass beads have a relatively good breakdown rate and are very effective for cleaning oxides, all types of corrosion, carbon residue and other surface contamination with air blasting equipment.

**Walnut Shell and Other Organic Abrasives**
As stated earlier, walnut shell and other similar types of ground or crushed organic abrasives are in the category of “soft” angular abrasives. Such abrasives are widely used for a variety of applications where the cleaning job is not a “tough” one and where the basic quality of an angular abrasive is applicable but where it is essential and imperative that the base material is basically not etched at all and where any base metal removal is prohibited. It is interesting to note that glass beads, for example, can and are being used for a number of applications such as corrosion removal from aircraft skins where previously only walnut shell or similar organic abrasives were considered satisfactory. The walnut shell, and similar organic abrasives, do afford a much larger “margin for error”.

*Continued on next page*
than do glass beads, for example, under the same conditions. It can generally be stated that misuse of any abrasive can result in damage to the equipment or part being cleaned. However, it must be recognized that this possibility is minimized even with misuse or incompetent personnel, where "soft" abrasives such as walnut shell are used.

**Plastic Spheres or Beads**

A great deal of experimentation is being carried on at the present time using this abrasive. Many promising results in character of surface, non-injury or etching of basic part and good durability of abrasive is being experienced. Applications involving plastic beads have been somewhat limited due to cost of the media and "hanging up" or clinging of plastic beads to the side of blasting cabinet and other parts of the blasting system due to buildup of static electricity charge. Plastic beads have the unique quality of being durable, yet soft, and contain some of the good qualities of both very durable and very strong abrasives not having some of the real objectionable disadvantages of both. For such applications as deflashing plastic parts, plastic beads are ideally suited and very economical, even at today's cost, considering breakdown rate and results obtained.

To follow in the next issue will be part three of this technical bulletin discussing "What Makes A Good Abrasive?".

Unfortunately, we don't know who wrote this article and therefore cannot give credit for this practical and enlightening series. However, we can thank Ken Dykstra of Precision Automation Inc. for submitting it to us for publication.

---

**News Release**

*Boride Products, Inc. Announces New Ergonomic Blast Gun for Suction Blast and Direct Pressure Abrasive Blasting*

Boride Products, Inc. announces a new, ergonomically-designed abrasive blasting gun, the RS-2000. The RS-2000 features an oversized, rounded thumb opening and extra-thick palm grip to more easily accommodate heavy protective gloves while requiring a minimum amount of holding pressure. Air/abrasive hose inlets are positioned closely together at the gun’s back to keep hoses away from the operator’s arm. The RS-2000’s grip is made from durable, high-density polyurethane and weighs just 14 ounces. These design features are intended to increase ease of handling for greater blast cleaning accuracy and reduce operator fatigue.

A unique boron carbide nozzle/tungsten carbide air jet cartridge has been designed to increase service life and make replacing wear parts simpler and faster with less chance for misalignment that can cause premature part wear and distort spray patterns. The tungsten carbide air jet provides superior service life to common steel alternatives. Boron carbide nozzles have been proven to provide many times the service life of nozzles made from common ceramics. Tungsten carbide nozzles are also available for lower wear applications (e.g., when using glass bead media).

The RS-2000 comes with fittings to adapt to any blasting system and is available in right and left-handed models. Boride offers a large selection of nozzle sizes as well as flexible hose options to further enhance ease of handling. For more information contact Boride Products at 1-800-662-2131 or fax to 1-800-662-2132.