IMPACT BLASTING WITH GLASS BEADS
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Glass beads were originally used for decorative applications. Their use as a medium in impact blasting came about largely as a result of the aerospace buildup of the 1950s. At that time, a need developed for multipurpose media that combined the advantages of coarse, organic, metallic, and fine angular abrasives. Table 1 shows a comparison of glass beads with other impact abrasives for cleaning, finishing, peening, and deburring applications.

Impact blasting with glass beads is well placed to satisfy demands of the 1990s for an energy-efficient and environmentally acceptable method of metal finishing. When properly controlled, the system is safe for workers and spent media presents no disposal problems.

PROCESS BENEFITS

Glass beads are virtually chemically inert. This factor, combined with their spherical shape, provides several key benefits. Media consumption is minimized; Table II compares consumption data of impacting media on different metal surfaces of varying hardnesses. On both metals tested, glass beads offer the lowest consumption per cycle. In addition, close tolerances are maintained and glass beads remove a minimal (if any) amount of surface metal.

Impacted surfaces are free of smears, contaminants, and media embedments; high points are blended and pores sealed. A wide range of finishes from matte to bright satin are achievable. The peening action of the media further acts to impart a layer of compressive stresses on the surface of the part. This increases fatigue life, decreases susceptibility of the part to stress corrosion, and enhances surface strength.

PROCESS ENGINEERING

Proper design of impact blasting equipment is essential for each application to achieve the full benefits of high productivity and low costs. Most important, the system should be easily controllable to produce consistent results.

Key to this control is determination and maintenance of the "arc height peening intensity" of the operation. To measure the peening intensity in a particular application, special steel strips are bombarded on one side only by the blasting media. The compressive stress induced by the peening action causes the strip to bow in the direction of the blast. A series of values of arc height versus blasting time are obtained, and when plotted on a graph, yield a saturation curve. From this curve, the arc height peening intensity can be obtained.

Environmental factors, operator skill, OSHA standards, and equipment capabilities are the process parameters involved in all glass bead blasting operations—whether they are cleaning, finishing, peening, or deburring. Once all the variables are optimized and the arc height peening intensity determined, process control is achieved by maintaining that arc height peening intensity. Any change indicates some modification in the system operation, away from optimum performance.

System control via arc height peening intensity is applicable to all cleaning, finishing, peening, and deburring operations. In cleaning, the arc height technique can be used to maintain process speed. In finishing, profilometer measurements of root mean square (rms) microinch finish can be correlated to peening intensity, thereby eliminating any subjective evaluation of performance. In peening, the degree of compressive stress induced is directly
Table I. Impact Media Comparison Chart

<table>
<thead>
<tr>
<th>Applications:</th>
<th>Glass Beads</th>
<th>Coarse Abrasives (e.g., sand)</th>
<th>Metallic Abrasives (e.g., steel and iron shot/grit)</th>
<th>Fine Angular Abrasives (e.g., aluminum oxide)</th>
<th>Organic Abrasives (e.g., walnut shells)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cleaning, finishing, peening—light—medium, and deburring</td>
<td>General cleaning where metal removal and surface contamination are not considered</td>
<td>Rough general cleaning and high intensity peening</td>
<td>Cleaning where smooth finish and surface contamination are not important</td>
<td>Light deburring and cleaning of fragile items</td>
</tr>
</tbody>
</table>

**Physical Properties:**

<table>
<thead>
<tr>
<th>Shape</th>
<th>Spherical</th>
<th>Granular</th>
<th>Spherical/irregular</th>
<th>Angular</th>
<th>Irregular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Clear</td>
<td>Tan</td>
<td>Gray</td>
<td>Brown/white</td>
<td>Brown/tan</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>2.45–2.50</td>
<td>2.4–2.7</td>
<td>7.6–7.8</td>
<td>2.4–4.0</td>
<td>1.3–1.4</td>
</tr>
<tr>
<td>Free silica content, %</td>
<td>None</td>
<td>100</td>
<td>None</td>
<td>&lt;1</td>
<td>None</td>
</tr>
<tr>
<td>Free iron content, %</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>95–100</td>
<td>&lt;1</td>
<td>None</td>
</tr>
<tr>
<td>Hardness (Moh)</td>
<td>5.5</td>
<td>7.5</td>
<td>7.5</td>
<td>9.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Media Comparisons:**

| Toxicity | None | High | None | Low | Low/noise |
| Metal removal | Low/noise | High | High/medium | High | None |
| Cleaning rate | High | Fast | Medium/high | Fast | Slow |
| Peening ability | High | None | High | None | None |
| Finish achieved | Range (various matte) | Rough anchor | Peened (shot): rough anchor (grit) | Various matte | Smooth |
| Surface contamination | None | High | High/medium | High | Medium/high |
| Suitability for wet blasting | High | Low | Low | Low | Low |
| Suitability for dry blasting | High | High | High | High | High |
| Consumption rate | Low | High | Low | Low | High |
| Cost comparison | Medium | Low | High | High/medium | Medium/low |
related to the arc height peening intensity. By such control, significant benefits are achieved in terms of labor productivity, reduced supervision requirements, and decline in the number of rejected parts.

As indicated in Table 1, both steel shot and glass beads are available for peening applications. Steel shot with its heavier density offers a deeper depth of compression, but requires more energy to propel while leaving dissimilar metallic smears (i.e., various forms of contamination) on the part’s surface. Glass beads are often used as a secondary peening medium, removing contamination while improving surface texture and finish (lower rms) of the part.

Glass beads are also used extensively as a peening medium, achieving a wide range of arc height peening intensities in a variety of applications and industries (see Fig. 1).

Typical glass bead peening applications take place before plating and after grinding and welding on aerospace, automotive, and machine tool components.

**KEY FACTORS IN USE OF GLASS BEADS**

There are a few key considerations that will help the user to enjoy the benefits of glass bead impact media to the fullest.

Whether for cleaning, finishing, peening, or deburring, the work actually done depends upon the amount or weight of abrasive thrown against the target surface in a given time. It also depends upon the speed with which the material is thrown against the target. The formula:

$$I = \frac{1}{2} MV^2$$

indicates that impact energy (I) equals one half the mass or weight (M) times the square of the velocity (V) at a 90° nozzle angle. Correction factors should be used for other angles.

As a general rule, the smallest particle that will provide the desired effect on the surface is the most efficient one to use, as this gives the greatest number of impacts per pound of glass spheres.
When the nozzle is at a 90° angle to the surface being treated, the bounceback of beads has a “blinding” effect. This interferes with the effectiveness of the blast stream and tends to increase the rate of bead consumption through breakage. Generally, an angle between 45 and 60° will give the most effective performance. In some cleaning applications, still lower angles may help speed the work.

The work energy of the flying particles is also affected by the distance from the nozzle to the work surface. It is usually best to keep this between 4 and 8 in. to avoid loss of velocity, and to gain maximum acceleration and proper diffusion of particles into the most desirable pattern.

BEAD CONSUMPTION

Because beads can become broken after repeated impacts on the work surface, controlling bead consumption is of critical importance. It is affected by five key factors:

1. Bead size—the larger the bead, the more durable and resistant to breakage it is at a given impact intensity. This preference for larger beads must be balanced against the greater efficiency of smaller size beads, which are capable of the work required.

2. Uniformity of size—proper sizing also affects efficiency of operations. The wider the range of bead sizes in a particular “charge,” the higher the rate of consumption at given conditions.

3. Roundness or sphericity of beads—the more spherical the individual beads, and the freer the “charge” from nonspherical particles, the lower the rate of bead consumption.

4. Surface hardness of material being treated—the harder the surface being treated, the higher the rate of bead consumption.

5. Angle of impingement—the closer to 90° the stream of beads is to the work surface at a given arc height peening intensity, the greater the rate of bead consumption.

APPLICATION NOTES

Cleaning

Because of the wide variety of different materials that must be removed in cleaning operations—including mill scale, rust, carbon buildup, and the like—it is often best to
experiment with different nozzle angles to find which works most efficiently. Where there are
internal recesses and other difficult areas, the use of the smaller bead sizes may be particularly
helpful. Because a high cleaning speed usually minimizes labor cost, bead size and nozzle
angle are the key considerations. Normally, a velocity that optimizes cleaning speed with a
given size of bead will optimize consumption, to give the lowest total cost.

Finishing
Where appearance is of prime importance, bead size is normally the key consideration.
Velocity, nozzle angle, and other factors should be adjusted, first to give maximum finishing
speed, and second, to minimize consumption. This will provide the lowest total labor and
material cost per unit of production. As a general rule, large beads at high intensities provide
a deep matte; at low intensities large beads give a smooth, bright surface; small beads at high
intensity give a dull matte, and at low intensities a bright satin. Selective masking of surfaces,
the use of multiple nozzles, and a “painting” motion may be employed for highly specialized
decorative effects. Automated machines are generally used for finishing.

Peening
Peening to increase fatigue resistance or to increase stress corrosion resistance is
essentially a uniform “hammering” operation. Uniformity of bead size and control of the
number of nonround and angular particles included is critical to process performance. The key
consideration is impact intensity, which must be specified as minimum and maximum. Nozzle
angles should be as close to a right angle as possible without excess bead consumption. In
general, the larger bead sizes, because of their resistance to breakdown, will prove most cost
effective. In peening fillet areas, it is a standard rule that beads no larger than one half the
radius should be used.

Deburring
The key considerations in deburring are usually a combination of programming surface
finish, while achieving sufficient impact intensity to remove or depress the burr. Bead size,
which governs finish, must be adjusted to an adequate peening intensity with velocity. Proper
nozzle angle will optimize consumption.

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