A STUDY OF
SHOT PEENING INTENSITIES
USING
BALLOTINI IMPACT GLASS BEADS

PART I

BY
JAY R. MATTESON
POTTERS BROS. INC.
CARLSTADT, NEW JERSEY

FEBRUARY, 1968
"All data, statements and recommendations made herein are based upon information we believe to be reliable, allowing for experimental error, but are made without any representation or guarantee or warranty of accuracy. Also, statements regarding the use of our products or processes are not to be construed for their use in violation of any patent rights or in violation of any applicable laws or regulations."
INTRODUCTION

There has been a considerable amount written about shot peening and most of it refers to use of metallic shot. Because more and more use is being made of exotic and nonferrous metals, the need for a shot peening media other than ferrous shot has become increasingly important. Shot made from stainless steel and aluminum have been used for some of these nonferrous applications. They are expensive and are not satisfactory for all metals. Glass, which is essentially inert, appears to be the answer.

Glass Beads have been around for quite a number of years, but their use as an impact media for shot peening has been very limited. One of the reasons for this has been the lack of proper equipment which will classify, separate, and return for reuse a high percentage of spherical beads. In the past few years, equipment manufactures have made great strides along these lines and proper equipment is now available.

Recent testing has indicated that much of the published data regarding glass bead peening is out dated. Typical intensity curves are often contradictory. From this study, we expect to develop information which will aid the engineer in selecting glass beads as a peening media.

Part I of the study gives several intensity curves which we obtained with suction/induction equipment using a \( \frac{1}{2} \)" ID nozzle with \( \frac{1}{4} \)" air jet.
CONCLUSIONS

1. It appears that Ballotini Impact Glass Beads will peen to equivalent Almen test strip intensities in equivalent exposure time as steel shot of the corresponding size when using air blast peening equipment with induction guns.

2. Nozzle distances between 3" and 6" from the work surface will yield equivalent intensities.

3. Ballotini Impact Glass Beads can be maintained at a high percentage of spherical particles in dry blast peening equipment.
DISCUSSION

1. By comparing the intensity and saturation curves in this study, which were obtained with suction/induction equipment, with what can be expected from gravity feed equipment using steel shot, we find the intensities and required exposure times to be equivalent. A possible explanation for this is that the lighter weight glass beads accelerate to a greater velocity than steel shot and thereby represent an equivalent energy force.

2. Generally, it has been found that intensities are equivalent at nozzle distances from the work surface of 3" to 6". In this study, using Ballotini Size D, tests at all pressures were made at 3", 4½", and 6" distances. Intensities were equivalent.

3. For cast steel shot, specification Mil-S-13165B allows 2 percent above and 8 percent below the specified screen range with a percentage of acceptable deformed shot. After use: "Metallic shot shall be maintained in the machine so that not more than 20 percent of the particles, by weight, shall pass through the screen size specified in Table V for the shot size used". As an example: For shot size 230, which is 20 to 30 screen size, it is considered uniformity of shot in the machine if not more than 20 percent passes a 50 screen. This means that 20 percent can be less than one-half the required original size and an undetermined percentage can be below the original bottom screen of 30 but above 50. For this percentage of shot to be under-sized after use, it has to fracture -- to be broken. Therefore, metallic shot which is considerably more than 20 percent broken is considered to be uniform and satisfactory for peening purposes according to Mil-S-13165B.

Glass Beads in dry blast peening equipment can be maintained well above the requirements of Mil-S-13165B for steel shot. Dry blast peening equipment is available which will maintain glass beads with not more than 15 percent broken beads.

During the tests in this study, it was not necessary to change the charge of beads to maintain them above 15 percent broken beads. With the larger size beads, it was observed that they improved with use -- a higher percentage of spheres at the end of the tests than at the beginning.
ADVANTAGES

OF

BALLOTINI IMPACT GLASS BEADS

1. Ballotini Impact Glass Beads are essentially energetic and do not contaminate metal alloys.

2. Ballotini Impact Glass Beads produce an improved surface appearance over steel shot and leaves the surface clean.

3. Ballotini Impact Glass Beads are available in a wide range of sizes -- from .250" down through .0015".

4. Ballotini Impact Glass Beads are approximately one-third the weight of steel shot and therefore, there is approximately three times the number of glass beads per pound as there is of steel shot.
Typical Peening Intensities
Dry Peening with Ballotini Impact Beads

Size A 0.025
0.0331" - 0.0232"

Size D 0.06
0.0117" - 0.0083"

Size H 0.04
0.0059" - 0.0041"

Test Strip A 2
Suction Induction Equipment
1/4" ID Nozzle - 1/4" Air Jet
Nozzle Dist. 4½" - 90° Angle
TYPICAL PEENING INTENSITIES
DRY PEENING WITH BALLOTINI IMPACT GLASS BEADS

Size H
.0059" - .0041"

Size J
.0041" - .0029"

TEST STRIP N 2
SUCTION INDUCTION EQUIPMENT
\( \frac{3}{8} \)" ID NOZZLE - \( \frac{1}{4} \)" AIR JET
NOZZLE DIST. 4\( \frac{1}{2} \)" - 90° ANGLE

INTENSITY IN INCHES

AIR PRESSURE (PSI)
PEEN INTENSITIES AT DIFFERENT NOZZLE DISTANCES
DRY PEENING WITH BALLOTINI IMPACT GLASS BEADS

AIR PRESSURE (PSI)

INTENSITY IN INCHES

3" Nozzle Distance
4½" Nozzle Distance
6" Nozzle Distance

Size D
.0117" - .0083"

TEST STRIP A 2
SUCTION INDUCTION EQUIPMENT
¼" ID NOZZLE - ¼" AIR JET
90° ANGLE
TEST METHOD

GLASS BEAD PEENING INTENSITIES

A. EXPOSURE:

1. Angle of impact shall be 90°.

2. Nozzle distance shall be 4½".

3. Coverage shall be uniform and complete over 100 percent of the surface by visual inspection. (Further reference can be found in Mil-S-13165B, Mil-Std-852, and AMS 2430C.)

4. Intensity exposure coverage time shall be established by plotting a saturation intensity curve and by using that arc height which falls on the right side of the knee of the curve which cannot be increased by more than 10 percent by doubling the time of exposure. (Further reference can be found in Mil-S-13165B.)

B. PRESSURES:

1. Intensity pressure points shall be established for each bead size from pressures of 90 psi on down in increments of 10 psi per paragraph A.4.

C. INTENSITY:

1. After establishing exposure time for each pressure per paragraph A.4, a second test strip shall be exposed for the same period of time and the average of the two arc heights shall be the intensity point plotted.

2. An Almen Gage No. 2 shall be used to determine the arc height of the test strips.

3. Test strips and holding fixture shall be as specified in Mil-S-13165B and Mil-Std-852.

D. GLASS BEAD MAINTENANCE:

1. For each bead size samples from the nozzle shall be taken before starting tests and after completing tests. No more than 15 percent of the beads shall be broken or angular. When more than 15 percent of the beads are broken or angular, the entire bead charge shall be discarded. After completing tests for a given bead size and sample indicates more than 15 percent are broken or angular, the tests shall be rerun with more frequent sampling.

2. Samples from the nozzle shall be visually inspected with a magnifying glass of sufficient power to enable the inspector to make a proper observation.
BALLOTTINI SIZE - A 0.0331" - 0.0232"

TEST STRIP A 2
SUCTION INDUCTION EQUIPMENT
1/2" ID NOZZLE - 1/4" AIR JET
NOZZLE DIST. 4 1/2" - 90° ANGLE
TEST METHOD

GLASS BEAD PEENING INTENSITIES

A. EXPOSURE:

1. Angle of impact shall be 90°.
2. Nozzle distance shall be 4½".
3. Coverage shall be uniform and complete over 100 percent of the surface by visual inspection. (Further reference can be found in Mil-S-13165B, Mil-Std-852, and AMS 2430C.)
4. Intensity exposure coverage time shall be established by plotting a saturation intensity curve and by using that arc height which falls on the right side of the knee of the curve which cannot be increased by more than 10 percent by doubling the time of exposure. (Further reference can be found in Mil-S-13165B.)

B. PRESSURES:

1. Intensity pressure points shall be established for each bead size from pressures of 90 psi on down in increments of 10 psi per paragraph A.4.

C. INTENSITY:

1. After establishing exposure time for each pressure per paragraph A.4, a second test strip shall be exposed for the same period of time and the average of the two arc heights shall be the intensity point plotted.
2. An Almen Gage No. 2 shall be used to determine the arc height of the test strips.
3. Test strips and holding fixture shall be as specified in Mil-S-13165B and Mil-Std-852.

D. GLASS BEAD MAINTENANCE:

1. For each bead size samples from the nozzle shall be taken before starting tests and after completing tests. No more than 15 percent of the beads shall be broken or angular. When more than 15 percent of the beads are broken or angular, the entire bead charge shall be discarded. After completing tests for a given bead size and sample indicates more than 15 percent are broken or angular, the tests shall be rerun with more frequent sampling.
2. Samples from the nozzle shall be visually inspected with a magnifying glass of sufficient power to enable the inspector to make a proper observation.
TEST STRIP A 2
SUCTION INDUCTION EQUIPMENT
\( \frac{1}{4}'' \) ID NOZZLE - \( \frac{1}{4}'' \) AIR JET
NOZZLE DIST. \( 4\frac{1}{2}'' \) - 90° ANGLE

BALLOTINI SIZE - A .0331'' - .0232''
BALLOTINI SIZE - D .0117" - .0083"

ARC HEIGHTS IN INCHES

EXPOSURE TIME IN SECONDS

TEST STRIP A 2
SUCTION INDUCTION EQUIPMENT
\( \frac{1}{4} \)" ID NOZZLE - \( \frac{1}{4} \)" AIR JET
NOZZLE DIST. 4\( \frac{1}{4} \)" - 90° ANGLE
BALLOTINI SIZE - H .0059" - .0041"

TEST STRIP A 2
SUCTION INDUCTION EQUIPMENT
1/2" ID NOZZLE - 1/4" AIR JET
NOZZLE DIST. 4 1/2" - 90° ANGLE

ARC HEIGHT IN INCHES

10 20 30 40 50 60 0 10 20 30 40 50 60
EXPOSURE TIME IN SECONDS
BALLOTINI SIZE - H .0059" - .0041"

TEST STRIP N 2
SUCTION INDUCTION EQUIPMENT
1/4" ID NOZZLE - 1/4" AIR JET
NOZZLE DIST. 4 1/2" - 90° ANGLE

ARC HEIGHT IN INCHES

EXPOSURE TIME IN SECONDS
BALLOTINI SIZE - J .0041" - .0029"

80 PSI

90 PSI

60 PSI

70 PSI

50 PSI

40 PSI

30 PSI

20 PSI

ARC HEIGHT IN INCHES

EXPOSURE TIME IN SECONDS

TEST STRIP N 2
SUCTION INDUCTION EQUIPMENT
\(\frac{1}{4}\)" ID NOZZLE - \(\frac{1}{4}\)" AIR JET
NOZZLE DIST. 4\(\frac{1}{4}\)" - 90° ANGLE
The performance results presented in this slide chart should be used as estimates only. Actual performance results will vary depending on the variables of each application.

### Particle Count Comparison Chart

<table>
<thead>
<tr>
<th>Pattern Sieve Range</th>
<th>U.S. Sieve</th>
<th>Sieve Opening in Inches</th>
<th>Sieve Opening in Microns</th>
<th>Particle Count Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20-30</td>
<td>0.0236-0.0324</td>
<td>650-600</td>
<td>960,000</td>
</tr>
<tr>
<td>AAM</td>
<td>24-45</td>
<td>0.0279-0.0394</td>
<td>710-350</td>
<td>2,000,000</td>
</tr>
<tr>
<td>AM</td>
<td>30-40</td>
<td>0.0335-0.0416</td>
<td>770-315</td>
<td>2,000,000</td>
</tr>
<tr>
<td>BB</td>
<td>40-60</td>
<td>0.0466-0.0617</td>
<td>820-500</td>
<td>18,000,000</td>
</tr>
<tr>
<td>C</td>
<td>40-60</td>
<td>0.0466-0.0617</td>
<td>820-500</td>
<td>18,000,000</td>
</tr>
<tr>
<td>D</td>
<td>60-70</td>
<td>0.0605-0.0806</td>
<td>200-100</td>
<td>17,000,000</td>
</tr>
<tr>
<td>AE</td>
<td>60-80</td>
<td>0.0605-0.0806</td>
<td>200-100</td>
<td>22,000,000</td>
</tr>
<tr>
<td>BE</td>
<td>80-100</td>
<td>0.0806-0.1099</td>
<td>250-150</td>
<td>27,000,000</td>
</tr>
<tr>
<td>AE</td>
<td>80-100</td>
<td>0.0806-0.1099</td>
<td>250-150</td>
<td>27,000,000</td>
</tr>
<tr>
<td>AE</td>
<td>100-120</td>
<td>0.1012-0.1333</td>
<td>300-200</td>
<td>32,000,000</td>
</tr>
<tr>
<td>AE</td>
<td>120-140</td>
<td>0.1333-0.1833</td>
<td>325-250</td>
<td>37,000,000</td>
</tr>
<tr>
<td>ME</td>
<td>140-160</td>
<td>0.1667-0.2133</td>
<td>350-300</td>
<td>37,000,000</td>
</tr>
<tr>
<td>ME</td>
<td>160-200</td>
<td>0.2083-0.2700</td>
<td>400-375</td>
<td>66,000,000</td>
</tr>
<tr>
<td>ME</td>
<td>200-250</td>
<td>0.2700-0.3500</td>
<td>450-500</td>
<td>66,000,000</td>
</tr>
<tr>
<td>ME</td>
<td>250-300</td>
<td>0.3500-0.4375</td>
<td>500-600</td>
<td>1,140,000,000</td>
</tr>
</tbody>
</table>

Printed in U.S.A. SR964SM