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SUPERIOR GLASS BEAD UNDER DEVELOPMENT

by Kelly Cook, Cataphote, Inc., Mississippi

Cataphote, Inc. the single largest glass bead manufacturing facility in the world, along with her sister companies, Sovitec France and Sovitec Belgium, have been engaged in developing a different type of glass bead. The purpose of this effort is to produce a glass bead which lasts longer in peening and blasting applications than the currently available soda-lime product. This development has proceeded for some time with the material having been tested and approved for production in Europe (SNECMA). Cataphote is currently in the process of correlating its internal test data as well as that from certain independent testing. This process will be completed during October and presented at the Shot Peening Workshop in November.

Even though the data is not in its final form we are in a position to offer several observations concerning the merits and characteristics of this new product. These vary from the general to the specific but all are relevant and supported by our test data and experience.

A word about the product and how it differs from standard glass beads is necessary at this point. The following data will define the physical and chemical properties of the two types of glass beads.

Chemical Composition (Typical)

	Standard Soda-Lime Composition % by Weight	Engineered Glass Spheres (E G S)
SiO_2	72.5	52.5
Na_2O	13.7	0.3
CaO	9.8	22.5
MgO	3.3	1.2
Al_2O_3	0.4	14.5
FeO/Fe_2O_3	0.2	0.2
K_2O	0.1	0.2
B_2O_3	0.0	8.6
Specific Gravity	2.5	2.54
Hardness (Moh)	6.0	6.5

LIFE CYCLE

How does the difference in composition and slight variations in physical properties translate to the actual beads and the peening process? First, the E G S has demonstrated a consistently longer life cycle when compared to soda-lime beads. This life cycle difference

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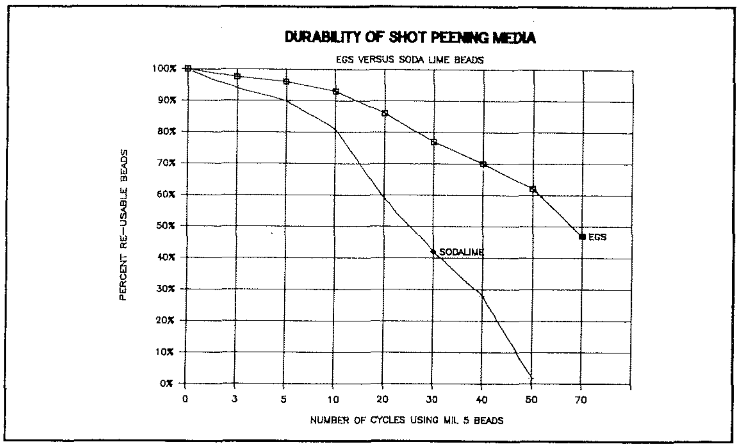
varies substantially with Almen intensity, target composition and method of propulsion. The smallest differential recorded resulted from a test to failure trial utilizing a dry blast procedure. A mild steel target was fixtured in a stationary position 5 inches from the blast nozzle. A MIL Spec (G-9954-A) bead, size #5, was utilized in the test with a suction/ venturi blast gun. Consistent pressure of 80 PSI was supplied to the blast gun producing a saturation arc height of 7A with E G S and 6A with soda-lime.

The test to failure consisted of cycling a closely measured quantity of beads through the test machine for 10 cycles. At this point all media was removed from the test unit and weighed. The material was then mechanically classified to remove fractured beads and dust. The materials were again weighed and examined under a 40x microscope to make sure the remaining beads were in fact clean and free of dust and other small particles. Then the remaining beads were re-introduced to the test machine and the entire cycle repeated.

The above procedure was followed for both the E G S and standard soda-lime beads. The graph below illustrates the results of this test.



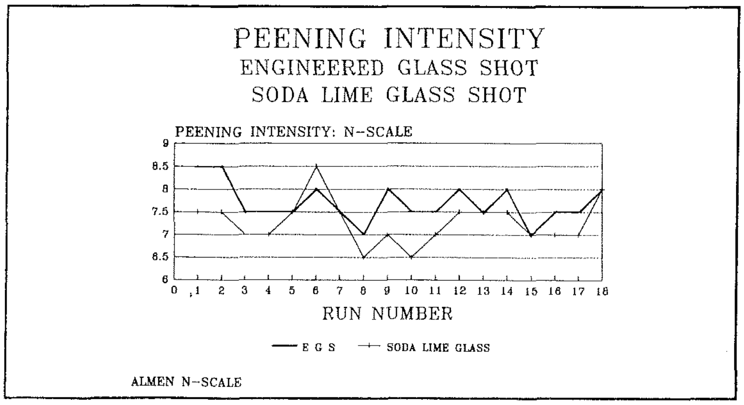
The E G S material demonstrates a very consistent breakdown rate averaging 7.7% loss per cycle over 70 cycles. The loss rate for the standard soda-lime beads was 19.3% for the first 30 cycles and by 40 cycles the soda-lime product had for all practical purpose collapsed.

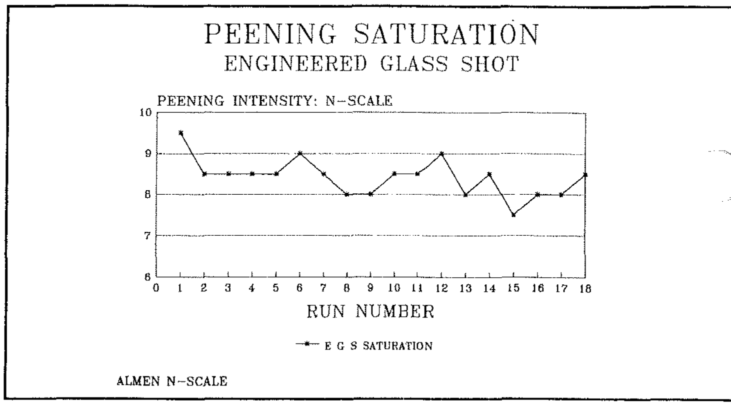
If one were to look only at the first 30 cycles one would conclude the E G S has an effective life of 2.57 times that of soda-lime. But at 50 cycles the E G S still has 60% useable beads while the soda-lime is at 3%. Can one conclude from this that E G S has a 20 times longer life? As mentioned earlier the actual increase in life cycle will depend on several factors including intensity, type of workpiece, sophistication of the media reclamation system on the peening machine and the type of machine - wet or dry.

This test represents the worst case performance (experienced to date in our testing) of the E G S as compared to soda-lime. The best performance was in testing done in a wet blast unit by our Sovitec counterpart in France. This test produced a 10 fold life cycle increase utilizing an aluminum alloy as the target. Cataphote has recently conducted tests with non-ferrous targets but as of this writing those results have not been correlated.

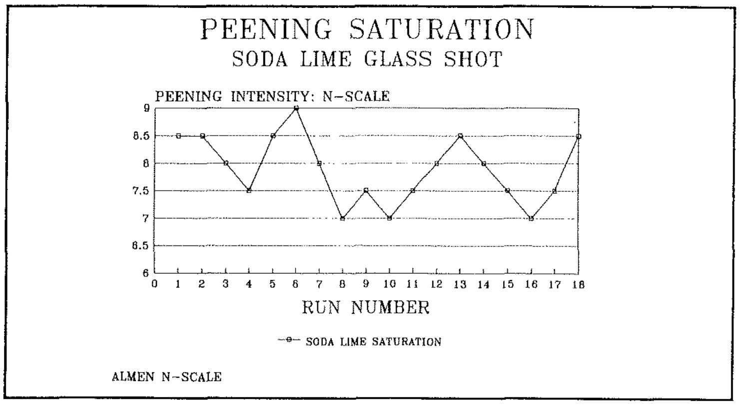
CONSISTENCY

Along with the consistent breakdown rates of the E G S we found it to produce more consistent arc heights. In an exhaustive in-house study, run by a major aerospace manufacturer, a multiple cycle test produced the following results:





Perhaps just as revealing are the saturation graphs plotted for the test.



As you will note the E G S graphs indicate much greater consistency in the test results. One concludes from the intensity and saturation graphs that the media mix was consistently more uniform with the E G S. Thus, while not eliminating the blast media as a vari in the peening process E G S can lower its variability, producing much more consistent peening results with less monitoring.

SURFACE FINISH

Testing to date strongly indicates that the E G S consistently produces lower surface finishes than soda-lime when all other parameters are equal, particularly in dry blasting applications. E G S commonly produces finishes 5-10 points (Ra) lower than soda- lime on inconel. Results on titanium depend on the alloy but vary from 1-4 points (Ra) to as much as 5-8 points (Ra) lower for E G S.

We feel the improved surface finishes are due in significant measure to the lower breakdown rate of the E G S. The subsequent larger quantity of spherical particles in the work mix tends to produce a smoother surface than the higher concentration of angular particles using soda-lime beads.Adding to this improvement in media mix is the tendency of E G S to shatter into small pieces at its fatigue point. Soda-lime characteristically fractures into a few large particles. As many of these particles are too large for a cyclone separator/dust collector to handle, they remain in the mix until they finally fracture to a size the collector can pull off. In the interim they are impacting the workpiece producing a rougher finish than a mix of true spheres. E G S does not display this tendency to fracture in large particles to the degree soda-lime does. When it does finally fracture, E G S tends to pulverize into a particle size easily handled by cyclone-separator/dust collector reclamation systems. Thus, we are peening with a higher percentage of spheres, producing an improved surface finish.

PARTICLE EMBEDMENT

Particle embedment has become of concern, particularly in the aircraft industry, in recent years. While both E G S and soda-lime be produce this condition, our results to date indicate that E G S beads not have as high an embedment rate; in fact, in many cases (titanium) it can be dramatically lower. In one SEM analysis of 14 locations the

E G S had a lower embedded particle count in 12 locations. Frequently the differences were 30% lower for the E G S and in many cases exceeded 50%. It was further observed that the embedded E G S particles tended to be smaller than the soda-lime.

Again we attribute a large part of this differential to the difference in breakdown rates and the manner in which the beads degrade. The larger, sharper soda-lime particles tend to cut into the workpiece and embed themselves; the smaller, less sharp E G S particles do not. Couple this with the smaller percentage of fractured particles in the operating mix due to the more efficient reclaiming of the E G S previously discussed and it is understandable why the embedment rate is lower

A potential further advantage of the E G S over standard soda-lime regarding embedment is the difference in chemical compositions. Standard soda-lime glass has a pH of 11-12 at 25°C while the pH of E G S is 8-9 at 25°C. Thus the soda-lime is potentially more corrosive. Leachate tests confirm this with boiling de-ionized water producing 25.7 mg/cc total alkali with soda-lime and only 3.6 mg/cc with E G S. Further, a one hour boil test in water produces an 11.1% weight loss with soda-lime compared to 1.7% for E G S. While we have not done any studies to date on the actual effect of this composition difference on various metals, we feel confident the preceding information provides a strong basis for a valid assumption. That is, E G S are less corrosive than soda-lime glass beads.

DISPOSAL/ENVIRONMENT

While both soda-lime beads and E G S by themselves are not environmentally hazardous or a disposal problem, they can be following use. Depending on the composition of the workpiece, the blast media, spent abrasive and dust can acquire sufficient quantities of metal or other contaminants to be classified as a hazardous waste. While this is not the problem in peening as it is in general cleaning operations it still must be addressed. Where it is a defined problem, E G S can be a partial solution due to its lower breakdown rate. With known hazardous materials disposal rates varying from 33 cents/lb to over $2.50/lb (chromate contamination) for spent glass beads, the initial cost of glass bead peening media can become almost irrelevant. If you can reduce the quantity of spent beads by 2/3 or more, this often becomes the pertinent portion of the equation.

SUMMARY

In summary Engineered Glass Spheres are in the final stages of test and development. All indications are they will produce significant benefits in the glass bead peening process. While higher in initial cost a case by case determination will have to be made whether the longer life cycle, more consistent peening operation, lower surface finish, less particle embedment, lower corrosion potential and less waste to dispose of, offset the initial cost.

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