DEEP SPRINGS TECHNOLOGY

Case Study: Deep Springs Hollow Alumina Macro Sphere (HAMS)

Evaluate Deep Springs Technology's Hollow Alumina Macro Spheres for use in syntactic foam buoyancy.

Introduction

Deep Springs Technology (DST) has a patented technology for making hollow spheres from many different materials (Figure 1). The one of interest for use in syntactic foam buoyancy is made from alumina oxide. Alumina oxide is economical and has a very high compressive strengths and should result in high specific strength hollow spheres.

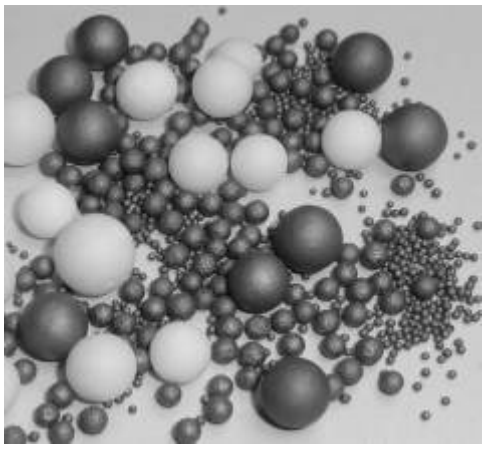

Figure 1 – Hollow shells of various size, density and, material produced by DST.

Sample Preparation

Small cylindrical samples having a diameter of 50mm and a length of 100mm of syntactic foam containing the HAMS were made with hollow glass micro spheres (HGMS). The HAMS were the coarse fraction (~60 vol%) of a binary with the small fraction (~20 vol%) being 3M's XLD 6000 HGMS. The density of the syntactic foam samples ranged from 24.0 pcf to 31.7 pcf. Prior to hydrostatic soak testing of the syntactic foam samples the outer radial skin was removed in a lathe.

Soak Testing

Hydrostatic soak testing of the syntactic foam larger samples was done starting at 3000 meters, and increasing 1000 meters at a time. The syntactic foam samples performed very well at 3,000 meters with no weight gains measured after 3 hours exposure. Weight gains at 4,000 meters for 18 hours appeared high but the samples had a very high surface area because of the exposed cavities of the machined through spheres. The exposed sphere cavities would be sealed with HGMS only foam in the final application. On the pressurizing to 5,000 meters, sample 2 imploded at around 7,800 psi. The remaining 2 samples, 3 and 4 had no implosions to 6,500 meters, 9,620 psi.

Hydrostatic Testing

After soak testing, small samples were cut from the cylindrical samples 3 and 4 cylinders for hydrostatic crush testing. by saw cutting . A block with dimensions 25mm x 25mm x 90mm was created as shown in Figure 2.

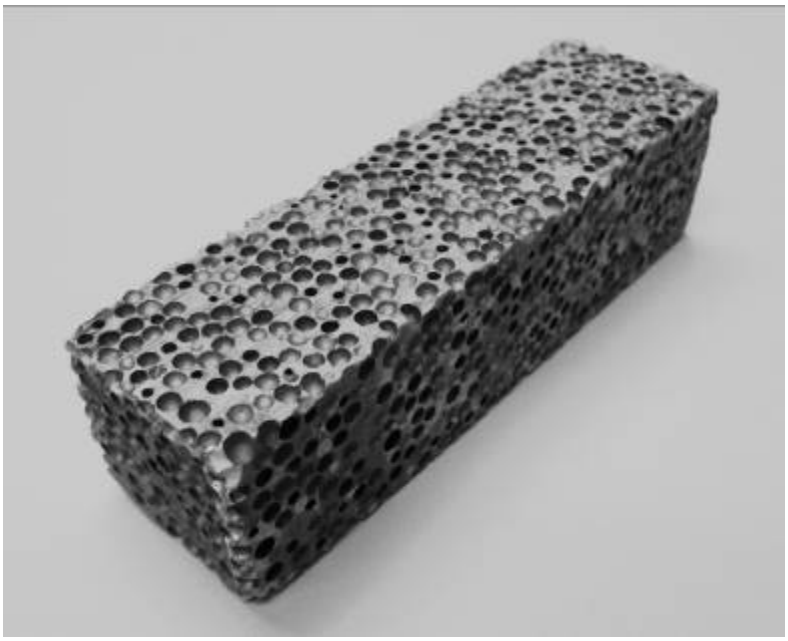

Figure 2 – Prepared Syntactic Foam Test Sample

Initial acoustic emissions were heard at 11,000 psi but pressure continually increased with some acoustic emissions up to 24,000 psi, the limit of our pressure chamber. The samples were still in 1 piece when removed from the test chamber.

Discussion of Results:

The performance of the supplied HAMS during the hydrostatic crush testing shows the potential for this technology to produce the 30.0 pcf foam for deep sea applications. Much of the foam within the test sample survived up to the 24,000 psi limit of the test chamber. Optimizing the fabrication, density and processing of these HAMS could yield a very large window of potential to reach the density and performance desired for this application.

Conclusions:

The HAMS supplied by DST performed to an extent that shows a great potential for achieving the 30.0 pcf, 6500 meter, man-rated performance. The HAMS provides a wider window of opportunity for achieving the desired foam performance, opening up the use of any commercially available HGMS as the fine fraction in the binary.