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From: Commander, Naval Surface Warfare Center, Carderock Division, Philadelphia Site, Philadelphia, PA 19112-1403
To: Commander, Naval Inventory Control Point, 5450 Carlisle Pike, P.O. Box 2020, Mechanicsburg PA 17055-0788

Subj: **EVALUATION OF PROCESSING GREEN CELL STARCH-BASED ORGANIC PACKING MATERIAL IN THE NAVY LARGE PULPER**

Ref: (a) NAVICP Document MIPR #4GS6R00877

Encl: (1) TEST REPORT FOR THE EVALUATION OF PROCESSING GREEN CELL STARCH-BASED ORGANIC PACKING MATERIAL IN THE NAVY LARGE PULPER

1. As tasked by reference (a), Naval Surface Warfare Center, Carderock Division (NSWCCD), Code 635 was requested to support Naval Inventory Control Point-Mechanicsburg (NAVICP-M)) by performing process testing of Green Cell organic packaging foam using the Code 635 Environmental Quality test site Large Pulper.

2. Enclosure (1) is a test report for the evaluation of processing Green Cell starch-based organic packing material in the Navy Large Pulper. The objective of the evaluation was to determine whether or not the Large Pulper was capable of processing the material and, if capable, to note any differences with respect to processing paper waste.

Subj: **EVALUATION OF PROCESSING GREEN CELL STARCH-BASED ORGANIC PACKING MATERIAL IN THE NAVY LARGE PULPER**

3. Questions or comments may be directed to Mr. Paul Schwegler, Code 635, at Commercial (215) 897-8371 or Defense Secure Network (DSN) 443-8371.

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Survivability, Structures, and Materials Directorate

TECHNICAL REPORT FOR THE EVALUATION OF PROCESSING GREEN CELL STARCH-BASED ORGANIC PACKING MATERIAL IN THE NAVY LARGE PULPER

by

Paul J. Schwegler, Code 635

NSWCCD-63-TR-2004/42

ENCLOSURE (1)

TEST REPORT FOR THE EVALUATION OF PROCESSING GREEN CELL STARCH-BASED ORGANIC PACKING MATERIAL IN THE NAVY LARGE PULPER

BY

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July 2004

ENCLOSURE (1)

ABSTRACT

Biodegradable foams have been developed as possible alternatives to the plastic foams commonly used as cushioning in the packaging of Navy supplies and equipment. Since at-sea disposal of plastics is prohibited, alternate materials may relieve shipboard problems associated with segregating, treating and storing plastic waste. Currently biodegradable materials such as paper, cardboard, and food waste materials are processed onboard Navy ships using either a Large Pulper or a Small Pulper. The Pulper uses a combination of rotating and stationary pulverizing blades in a bath of seawater to break down materials until they are small enough to pass thru 0.25-inch holes in a security screen. After processing, the effluent is pumped directly overboard. The test consisted of feeding mixtures of paper and Green Cell foam into the Large Pulper at the test site of NSWCCD Philadelphia. While feeding the material thru the Pulper, effluent samples were taken from a sample port installed in the Pulper's waste discharge line for comparison purposes. After completion of all stages of testing it is apparent that the Green Cell material is capable of being processed by way of pulping. The effluent discharged from the Large Pulper during testing was similar to that of processed paper waste, with less visible solids left in solution.

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1.0 Introduction

Biodegradable foams have been developed as possible alternatives to the plastic foams commonly used as cushioning in the packaging of Navy supplies and equipment. Since at-sea disposal of plastics is prohibited, alternate materials may relieve shipboard problems associated with segregating, treating and storing of plastic waste. The item tested was Green Cell Biodegradable Foam. Green Cell packing foam is made from complex organic starches that are soluble in water and biodegradable. Green Cell foam packing comes in a wide variety of sizes and densities. A representative range of sizes and densities were provided for testing. Figure 1 shows a sample of the Green Cell foam packing material. Testing was performed at NSWCCD Philadelphia, and a Large Pulper was selected for testing. The Pulper uses a combination of rotating and stationary pulverizing blades in a bath of seawater to break down materials until they are small enough to pass thru 0.25-inch holes in a security screen. After processing, the effluent is pumped directly overboard. In this testing, a sampling tube was installed in the Pulper waste discharge line for capturing effluent after processing. Figure 2 shows some of the staging and preparation done for the testing including the Large Pulper, sampling port, and test material.

Figure 1. Green Cell Foam Packing Material

Figure 2. Large Pulper, Discharge Sample Port, Test Material

2.0 TEST OBJECTIVES

The objective of this test was to visually verify that it is possible to process the Green Cell foam packing material through the Large Pulper with results similar to that of processing paper waste. If the Green Cell material broke down or dissolved sufficiently enough to leave the Pulper through the security screen in approximately the same amount of time it would take for equal quantities of paper materials to process, then the test was deemed successful. Samples of effluent of both processed paper, Green Cell Foam, and a mixture of the two were compared for evaluation.

3.0 TEST DESCRIPTION

The Navy Large Pulper was selected for testing. The junk box and slurry chamber of the pulper were examined to ensure that it was clean and free of foreign objects. The pulper was put through normal startup procedures. Samples

of non-waste filled discharge water were taken as a control sample. A 100 lb. sample of waste paper was then fed to the pulper at a feed rate of approximately 10 lbs./minute. Several samples of the effluent from the pulper were collected and examined to verify that waste processing was typical, and to establish a normal baseline for the amount of paper solids in suspension in the fluid.

Once the samples had been taken, the pulper was run for another 15 minutes to allow the waste to clear out and the effluent to become clear again. After clearing the Pulper of paper waste, 50 pounds of Green Cell foam packing material was processed at a feed rate of approximately 10 lbs./minute and samples of the effluent were taken during the cycle for use as a comparison to examine the similarities/differences to samples taken from processing paper alone. Once again after the samples had been taken, the pulper was run for another 15 minutes to allow the waste to clear out and the effluent to become clear again.

After clearing the Pulper and discharge lines for another 15 minutes, a mixture of 50 pounds of waste paper intermixed with 50 pounds of Green Cell foam was fed to the pulper at a feed rate of approximately 10 lbs./minute. The effluent from the pulper was sampled and examined for comparison to all other samples and to note any anomalies.

All samples were taken at one-minute intervals for a total of five samples for each processing change. After all the material was put into the pulper, the pulper went through normal shutdown procedures. The junk box and slurry chamber were again examined and any remaining material noted. Photographs of the test samples and pulper operations were taken as well as Pulper discharge effluent samples from each processing cycle. Observations from the test were documented and are provided in this report.

Figure 3. Feeding Green Cell Foam and Paper Into Large Pulper, and Taking Sample from Discharge Port

4.0 RESULTS

4.1 The first step during testing involved taking samples of discharge water from the Large Pulper absent of any process materials. These are used as control samples for purposes of comparison. Figure 4 shows graphics of the water samples taken. The water used for testing in the Large Pulper is drawn from brackish river water drawn by pumps from the Delaware River adjacent to the test facilities.

Figure 4. Uncontaminated Control-Water Samples Taken from Discharge Port

4.2 The second step involved processing paper waste in the Large Pulper at a rate of 10 lbs./minute. Just as with the control water, samples of the discharge effluent were taken from the discharge port at one-minute intervals for a total of five samples. The samples with paper waste effluent were visibly inspected and photographed. The paper samples contained large amounts of visible solids in suspension as well as a very cloudy, almost milky white effluent. Samples of the processed paper effluent are shown in Figure 5.

Figure 5. Processed Paper Effluent Samples

4.3 Step number three in the testing involved processing only the Green Cell foam packing material in the Large Pulper. As before, the material was processed at a rate of 10 lbs./minute with five samples taken at one-minute intervals. The Green Cell effluent was not as cloudy, and did not have as many solids visible in suspension. The starch had almost completely dissolved in the water causing cloudiness, but solids were not very apparent as with the paper samples. Figure 6 shows discharge samples taken during the foam-processing phase.

Figure 6. Processed Green Cell Foam Effluent Samples

4.4 Step four intermixed both paper and Green Cell foam materials into one batch for processing. Feed rate remained at 10 lbs./minute with 5 effluent samples taken at one-minute intervals. This last batch of processed samples had no visible difference between the samples taken with paper alone. The effluent clarity and amount of solids in suspension was visibly identical to the paper tests. The Green Cell foam, when introduced into the Large Pulper, begins to dissolve into the water almost immediately. With the starches and sugars dissolved in solution, there were almost no solid particles left behind. The foam/paper

mixture was indistinguishable to the paper only sample. Figure 7 shows samples from the mixed testing portion.

Figure 7. Paper and Green Cell Foam Effluent Samples

5.0 DISCUSSION

The results from all of the process testing showed a distinct difference between the Green Cell foam and typical paper waste. The effluent collected from the processed foam was much clearer and contained very little solid particulates in suspension. This suggests that almost all of the Green Cell material dissolves into the water at a

rapid rate before discharge from the Pulper, and the remaining portion continues to dissolve the longer it is in solution. The paper waste breaks down to a point, but there is always a substantial amount of solids present. The addition of the Green Cell foam to the paper mixture does not make a noticeable difference in the discharge, and is visually identical to paper waste alone. Figure 8 shows a comparison of a processed paper waste effluent sample and a processed Green Cell foam effluent sample when placed into buckets for inspection. The difference in the amount of solids in suspension can easily be seen when the two are compared.

Figure 8. Paper Discharge Sample vs. Green Cell Foam Sample

6.0 CONCLUSION

The results of this test show that the Green Cell packaging foam material dissolves extremely well when submersed in water, and is easily processed by the Pulper in a short amount of time. The overall process rate for the foam is equal to that of waste paper, and can be intermingled with other waste streams going to the Pulper. Green Cell foam seems to be a good replacement for standard Styrofoam type packing material in that it feels like standard packing material. It provides the same type of cushioning as standard packing foam, and it also comes in many shapes, forms, and sizes. Additionally, it is biodegradable in water and is easily processed in currently available Solid Waste Processing Equipment.

7.0 RECOMMENDATIONS

A drawback to the use of this product is the fact that it resembles standard packing foam so well that it may cause shipboard confusion. If used properly, Green Cell can be used for packing and then pulped. However, if standard packing foam is misconstrued as Green Cell, it could lead to unlikely, but possible clogging or damage to the Pulper or an illegal overboard discharge of plastic. In order to avoid any possible confusion, the Green Cell material should have some type of embedded color striping or surface markings noting that it is Green Cell material and that it is biodegradable. These points are some suggestions as to how Green Cell may be adapted for use, but they are for discussion at higher Navy levels. The purpose of this test was verified, in that, it was proven that Green Cell foam is pulpable.