

Taking Marine Biodegradable Mainstream

Eliminating Plastic Waste Afloat through Marine Biodegradable Plastic

THE NAVAL INVENTORY Control Point (NAVICP) through the Plastic Removal in the Marine Environment (PRIME) program is exploring marine biodegradable alternatives to replace traditional plastic packaging and disposable materials afloat. Teaming with the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC), NAVICP has identified and tested a new plastic that maintains the physical characteristics of petroleum-based plastic but safely biodegrades in the ocean. This testing has resulted in the development of a new American Society for Testing and Materials (ASTM) standard that could pave the way for incorporating marine biodegradable plastics into the supply chain. In turn, this could significantly decrease the effort needed to process plastic waste, free up valuable space and reduce cost associated with plastic disposal.

Background

Environmental regulations and laws prohibit the discharge of plastics into the ocean. The International Convention for the Prevention of Pollution from Ships (MARPOL) Treaty specifically prohibits discharges of all plastic waste at sea

and has since been adopted into U.S. public law. The Navy compresses plastic waste into disks using a Compress Melt Unit (CMU) and must store it aboard until the next opportunity to offload occurs. This can result in unpleasant and unsanitary working conditions if the plastic is not handled and treated properly. Additionally, space is at a premium aboard ships and plastic waste waiting for offload often takes up valuable space. Several Waste Characterization Studies conducted by NAVICP and the Naval Sea Systems Command (NAVSEA) indicate that a fully manned Carrier Vessel Nuclear (CVN) will generate approximately 1,200 pounds of plastic waste daily.

ASTM D7081

NAVICP, in conjunction with NSRDEC and the Woods Hole Oceanographic Institution, has performed studies to evaluate the biodegradability and toxicity of polymers and other potential plastic replacement materials in the marine environment. Analysis of these tests and studies indicate that some polymers show significant biodegradation in the marine environment and are non-toxic based

on U.S. Environmental Protection Agency (EPA) accepted testing procedures. This

research has resulted in the development of ASTM standard D7081, *Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment*. The specification outlines the criteria necessary to validate plastic biodegradability in the marine environment, which can be quite different than soil or compost biodegradability. The dynamic characteristics encountered in the ocean include a lack of microorganisms, low temperatures and high pressures. The rates of biodegradation in the ocean are generally slower in comparison to other environments.

ASTM D7081 will serve as the starting point for identifying additional marine biodegradable materials. This new ASTM standard can be used to develop new plastics that will not persist in a marine environment. These alternative bio-based or biodegradable plastics could provide replacements for a number of products manufactured using conven-





Plastic waste can accumulate quickly aboard an aircraft carrier.

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tional, petroleum-based plastics. Target applications include stretch film, plastic banding, foams, food containers and paper coatings. If marine biodegradable plastics are incorporated in sufficient quantity into mainstream manufacturing, this could ultimately halt and potentially reverse the level of plastic pollution already in the world's oceans.

Product Development

In an effort to address some of the issues associated with replacing conventional products with environmentally friendly alternatives, a pilot product development effort was completed that focused on the standard Navy paper drink cup. The paper cup replaced polystyrene foam cups in the 1990s, but while being environmentally friendly,



Plastic pucks produced by the CMU are placed in odor barrier bags to prevent unsanitary conditions.

the cup has performance issues that include leaking and poor heat insulation properties. Because of these issues, alternative configurations were being investigated. One potential alternative was to use a marine biodegradable polymeric coating, which could improve the performance of the cup while retaining its green environmental footprint. In early 2006, NAVICP, along with Concurrent Technologies Corporation (CTC), began to examine alternate configurations of the paper cup that would retain all of its beneficial environmental characteristics while offering improved performance.

This testing has resulted in the development of a new ASTM standard that could pave the way for incorporating marine biodegradable plastics into the supply chain.

A marine biodegradable plastic coating was identified that would potentially improve the performance of the cup while retaining all of the environmentally friendly aspects of the pure paper cup. The material selected was a Polyhydroxyalkanoate (PHA), with a trade name of Mirel™, produced by the Telles Corporation. PHAs are a family of biobased, biodegradable natural plastics that have the potential to functionally replace over 50 percent of the plastics used today. PHA-coated items are candidates for broad replacement of current plastic packaging materials due to their durability in use and wide spectrum of properties. PHAs range in properties from



NAVICP has patented the "Happy Dolphin" symbol to assist in identifying items that will degrade in the ocean.

strong, moldable thermoplastics to highly elastic materials to soft, sticky compositions, and can be made as resins or as latex with excellent film-forming characteristics. PHAs are biodegradable in aquatic (ocean, river, wetland), soil and municipal waste treatment environments, and they can be both hot and cold composted. PHAs also meet the requirements for Biobased Products established by the U.S. Department of Agriculture (USDA) under the Farm Bill of 2002.

The PHA-coated paper cups were subjected to a full series of marine biodegradation and toxicity tests,

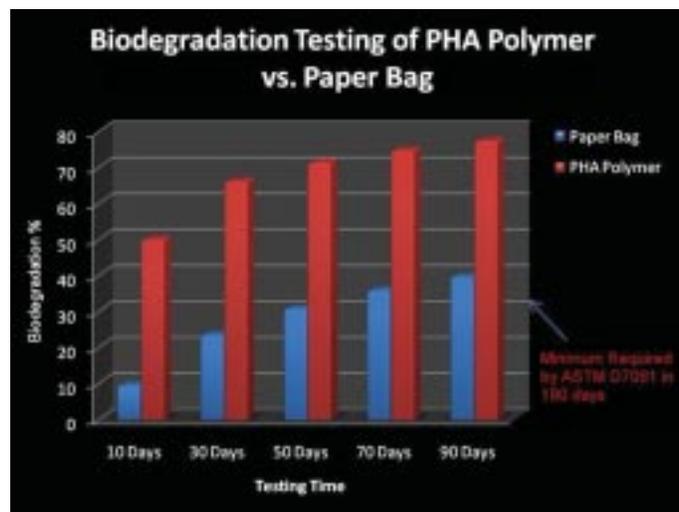
pulping trials, and CMU trials. Based on the results of the CTC evaluation, the National Defense Center for Environmental Excellence recommended in a 2008 report that the implementation of the PHA-coated cups be further pursued.

The Path Forward

Despite successful testing, several issues remain involving the implementation of the PHA-coated cup and further development of PHA products. Additional testing may be needed to satisfy EPA and/or USDA regulatory concerns

before moving forward to create a new category of biobased or biodegradable plastics. At this time, international and U.S. laws do not differentiate between marine biodegradable plastic and conventional petroleum-based plastic. Thus, the benefits of marine biodegradable plastics cannot be realized as they are not treated differently than their environmentally unfriendly counterparts.

Additionally, replacing materials with marine biodegradable alternatives may result in extra cost as the current cost of marine biodegradable plastic resin is greater than petroleum based counterparts. This disparity will change over time as more marine biodegradable products enter the commercial market, allowing for a decrease in manufacturing cost. However, this process can be helped by



PHA biodegrades significantly quicker than a paper bag in marine conditions.



A Sailor using the CMU to compress plastic waste.

ensuring that preference is given to purchasing products that meet Executive Order 13423, Strengthening Federal Environmental, Energy and Transportation Management. This will provide an impetus to manufacturers to develop more applications, increase volumes and help to drive costs out of the system.

NAVICP and NSRDEC are continuing to raise awareness and educate the U.S. Navy about marine biodegradable plastics, and garner the support necessary to create legal provisions that address the differences and benefits of new families of marine biodegradable plastics as they become more common in the commercial marketplace. NAVICP continues to investigate new technologies and products to improve solid waste management afloat.

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NAVICP, a field activity of the Naval Supply Systems Command, procures, manages and supplies spare parts of naval aircraft, submarines and ships worldwide. NAVICP has two locations, one in the Lawncrest section of North-east Philadelphia and the other in Mechanicsburg, PA. [📍](#)

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