

The Ohmsett Gazette

The National Oil Spill Response Research & Renewable Energy Test Facility

Facility Refurbishment is Underway

Tank refurbishment activities have begun at Ohmsett. In preparation for the necessary maintenance, a crane service removed oil recovery tanks from the auxiliary bridge and will be used to remove the bridges during the project. The staff filtered the tank water through a granulated carbon treatment system and drained 2.6 million gallons of crystal clear salt water from the Ohmsett tank.

While drained, refurbishment tasks include

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Updating the Dispersant Effectiveness Test Protocol

Over the last two decades, Ohmsett and BSEE staff have played key roles in supporting important spill response research and have been instrumental in developing protocols for a variety of tests performed at the facility. One in particular, the Dispersant Effectiveness Test Protocol, was developed between 2000 and 2003 to standardize tests with dispersants at Ohmsett. It was recognized that important physical processes present at large scales were not being replicated by laboratory tests, and a reliable way to measure dispersant effectiveness at Ohmsett would assist regional response teams to make science-based decisions on the potential use of dispersants as a response tool.

Since then, several of the Ohmsett test tank components, and the monitoring

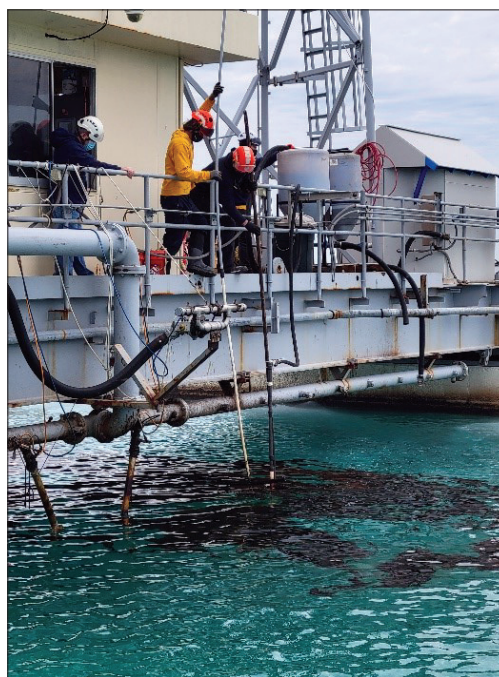
and analytical equipment have been replaced or upgraded, including the wave maker and controllers. Additionally, engineering studies to characterize tank performance and limitations were conducted after the protocol was designed. These various factors prompted a review and update of the protocol to align it with the current tank performance features.

Recently, SL Ross Environmental Research, Ltd. of Ottawa, Canada

conducted BSEE-funded multi-phased research to update the test protocol.

In October 2020 researchers conducted an evaluation of the ability to provide reproducible waves that would break at a predetermined location in the tank. They also established methods for isolating an area

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Dispersant Effectiveness Protocol Update

on the surface of the wave tank to contain an oil slick without the use of solid barriers, such as a boom. This was accomplished using subsurface turbines, along with sprayers on the auxiliary and vacuum bridges, and along the sides of the tank.

“We were very pleased at the ability of the jets to keep an oil slick inside the test area, even in high winds and waves, while still allowing it to spread and move naturally,” said James McCourt, environmental engineer at SL Ross.

To build on this effort, SL Ross returned in December 2020 to conduct tests with oil, dispersant, and waves to integrate the previously tested

techniques into a fully developed protocol. According to McCourt, during those two weeks, they measured the wave profiles and turbulent energy dissipation rates, evaluated options for distributing oils as slicks into a controlled containment area, developed a method for applying dispersant to the oil slick, verified the ability to target slicks with breaking waves and measure the characteristics of the resulting dispersed oil plume, and developed a method to recover and quantify residual (undispersed) oil.

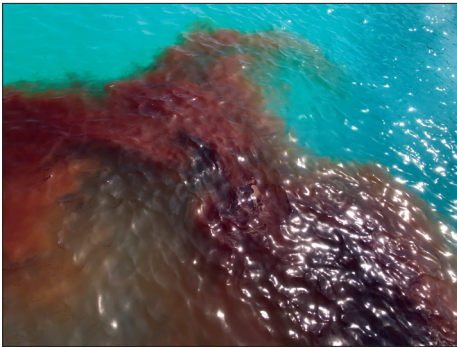
“The new oil containment system allowed us to use less oil per test compared to the original protocol,

which has several advantages, and significantly improved our ability to recover oil after a test and the accuracy of the mass balance.”

SL Ross returned in April 2021 to finalize the evaluation of the dispersant application method and made adjustments to the oil slick containment and recovery systems. Dispersant was applied to the test slicks from the main bridge using a hand-held pressurized nozzle system. The dispersant treated slick was then subjected to waves programmed to break at the slick location in the Ohmsett test tank.

“Undispersed oil was recovered using a J-shaped suction tube into conical-bottom tanks, where the oil was quantified and sampled,” McCourt explained. “Recovery efficiency for the control runs with no dispersant exceeded 95%, which is a significant accomplishment for tests at this scale. The waves were very consistent and were very effective at dispersing the treated slicks.”

The final report on the project is being prepared and will be available on the BSEE website in the fall of 2021.



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Ohmsett Welcomes Staff Scientist



We are pleased to announce the addition of Dr. Philip Sontag, staff scientist, to the Ohmsett team. Philip comes to us with more than 10 years of experience in analytical chemistry, electrochemical sensors, and field instrumentation and equipment. Most recently he held field director and laboratory manager positions in a multi-disciplinary research setting. Philip will be involved with a variety of technical activities at the Ohmsett facility, including support of laboratory functions, working with customers to develop test objectives, prepare final test reports, and provide peer review for other Ohmsett reports and proposals. Philip holds a Ph.D. in Environmental Science from Rutgers University and a Bachelor of Science in Biology from Lakeland University.

Ohmsett Has a New Web Address
<https://ohmsett.bsee.gov>

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Test Tank Offline

Reopens in Late October

structural concrete repairs, the interior of the tank restored to a smooth and flat surface, the three steel bridges painted, new drive cables installed, seals replaced, surfaces pressure washed and painted, as well as other maintenance tasks.

Work on the facility will take place into the fall, and the plan is to have the tank refilled and ready for testing and training in late October 2021.

Follow our progress on LinkedIn, www.linkedin.com/company/ohmsett, and on YouTube, <https://www.youtube.com/user/BSEEGov/playlists>.

Naturally Renewable Nanoparticles an Alternative to Chemical Herding Agents

When researchers at Louisiana State University's Cain Department of Chemical Engineering started looking at ecofriendly alternatives to chemical herding agents as a way to clean up oil spills, they studied reports on the renewable properties of lignin. A naturally occurring biopolymer, lignin is the main component of plants that provides rigidity and strength to the cell walls. It is the most abundant biopolymer in nature and is considered environmentally friendly, which makes it an inexpensive resource to produce oil herders.

"We chose lignin as a precursor to design an oil herding agent because there have been a vast number of studies reporting its strong affinity towards oil-water interface due to its amphiphilic characteristic," said LSU graduate research assistant Jin Lee. "Recently, the lignin nanoparticle has been recognized as a green alternative to petrochemical-based materials due to its ease of tuning surface characteristics, biocompatibility, and biodegradability."

In May, LSU conducted a series of scaled-up experiments at the Ohmsett facility to verify laboratory scale data related to the interaction of lignin nanoparticles with oil slicks on water. A test area with a 10-foot x 10-foot temporary tank was set up on the wash pad at the north end of the tank deck. This setup provided safe options for the researchers to clean and refill the tank in between test scenarios.

During testing, different salinity levels were used. This required freshwater and salt water, as well as measured amounts of added salt to reach the desired salinity levels. For each test, an oil slick was deposited on the surface of the tank. The herder, composed of heavy alcohol and a lignin polymeric solution, was sprayed around the periphery of the slick. "While the heavy alcohol confines the

oil slick by Marangoni effect, the lignin molecules form nanoparticles followed by nucleation and growth and adsorbed at oil-water interface, preventing re-spreading of confined oil resulting in long-term stability," said Lee.

The Ohmsett staff used a scissor lift to provide a platform for overhead time-lapse photography for the duration of each test. They assisted LSU in quantifying slick contraction using dynamic light scattering (DLS) to characterize the size of lignin nanoparticles, and optical tensiometry to observe the change of oil-water

interfacial tension over time.

"At Ohmsett, we observed that the thickness and stability of the oil slick increased as the concentration of lignin polymer in the herder increased. We believe that the lignin nanoparticles and molecules form a thin film at the air-water surface, as well as the oil-water interface which prevents the re-spreading of oil," said Lee. "With the test results, we will study the mechanism for the formation of this thin film and its property using analysis techniques in our lab."



LSU conducted a series of scaled-up experiments at the Ohmsett facility to verify laboratory scale data related to the interaction of lignin nanoparticles with oil slicks on water.

Engineering Student Interns at Ohmsett

We are pleased to have Mikaela Zurick intern with us this summer. She is a rising senior at the University of Texas-Austin in the Petroleum Engineering program, and will be working with the Ohmsett team on projects related to oil weathering and imaging data analysis.



Prototype Takes a Polar Plunge into an Icy and Oily Test Basin

The bitter-cold, snowy, and icy conditions in New Jersey during the last week in January and first week in February 2021 were not necessarily a welcome sight for the Ohmsett staff, but a definite plus for conducting a BSEE funded evaluation of the Bowhead Ice Deflection System. The test scenario was similar in appearance to the very first ice test that took place at Ohmsett in the winter of 2002 during the Joint Industry Project (JIP) and BSEE funded Mechanical Oil Recovery in Ice Infested Waters (MORICE) project, but with a modern twist. (Ohmsett Gazette, Spring 2002).

The development of the Bowhead prototype was initiated in September 2019 in response to recommendations from the final MORICE report. “The new ice deflection system, intended for potential deployment in an Arctic oil spill, will enhance the MORICE system and will focus on simplicity, scalability, ease of operation, and deployability,” said Kristi McKinney,

BSEE program manager for mechanical containment and recovery. “A couple of key differences include developing an unmanned system with operations occurring from the deployment vessel, and moving the oil recovery from directly under the system to behind the system. This increases flexibility in pairing the Bowhead with existing skimmer systems.”

The need for this type of specialized technology came about due to difficulties response organizations have experienced with mechanical recovery of oil in ice infested waters. Conventional booms and skimmers tend to push the ice out of the way along with the oil. Some people believe that in-situ burn is the best response method; however this approach relies on the oil being thick enough to ignite and burn, which may not be the case. Therefore, an alternative approach is necessary.

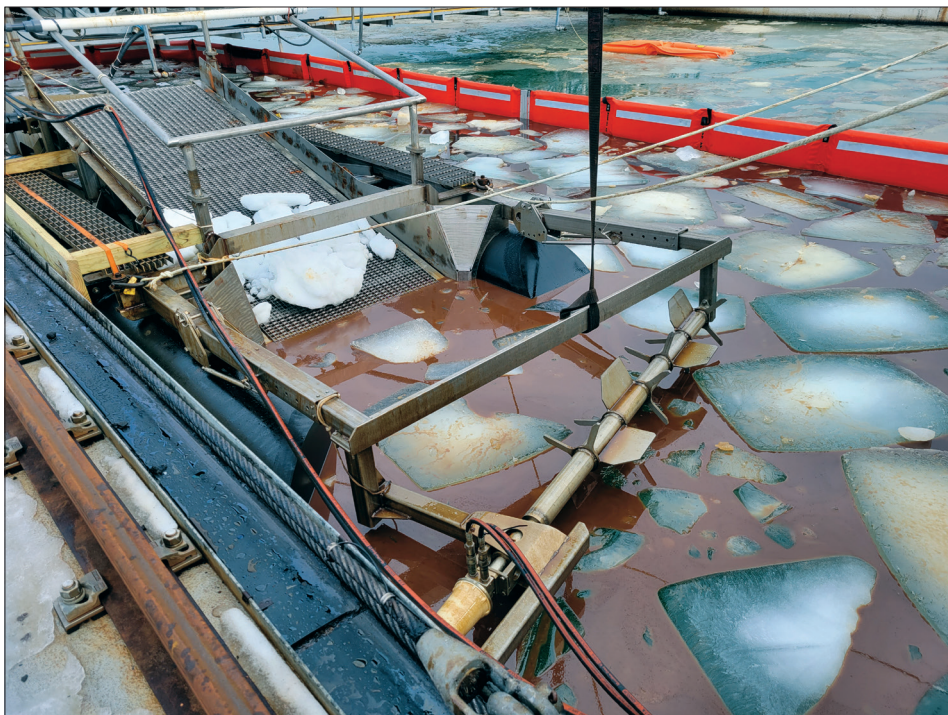
In preparation for the January 25 – February 5, 2021 test, work started

in December 2020 with the Ohmsett technicians creating over 300 blocks of ice in refrigerated chiller units; that’s equivalent to 100,000 pounds of ice. They filled wooden box forms and plastic trays with fresh water. All of the trays were loaded on racks and placed in the chiller units set at and steadily chilled to 0°F over two to three weeks to freeze the water into solid blocks.

Despite the frigid temperatures that descended upon Ohmsett during testing, the basin water still needed help cooling down to better simulate ice infested waters. The staff ordered a 50-ton liquid chiller system to continuously recirculate the basin water, lowering the overall temperature to 30°F. The chiller system is similar to three units used in New York City’s Central Park ice skating rink. “The frigid waters served to preserve Ohmsett’s fabricated ice over longer durations than prior ice testing, and allowed for extended testing,” said McKinney. “A benefit to the snow storm that occurred prior to week two tests included the natural creation of frazil/slush ice which enhanced the realism of the test environment.”

The Ohmsett staff also had to develop an improved ice delivery system for depositing the ice into the test basin. The previous method paired a two-part slide system with a forklift. The new system was designed and fabricated to use the functionality of a telehandler, similar to a telescoping forklift, which could take a tray-load of ice from the parking lot, and deliver it directly to the surface of the basin water.

Once the fabricated ice was ready and the basin water chilled to 30°F, the technicians used the new ice handling system to place the ice blocks in the test basin. Then, the Bowhead paired with a skimmer, was lowered



The Bowhead Ice Deflection System intended for potential deployment in an Arctic oil spill was initiated in response to recommendations from the 2002 MORICE project.

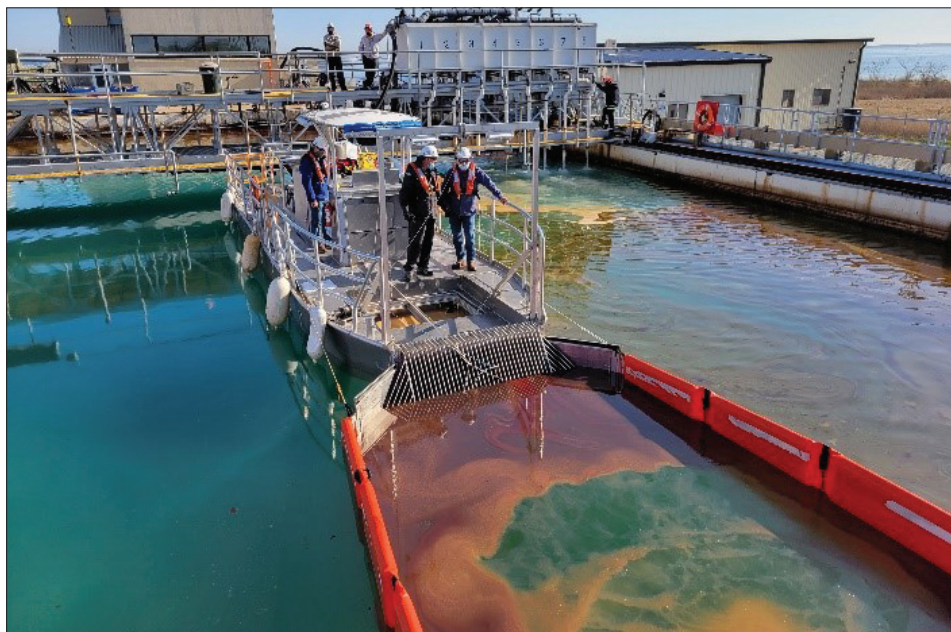
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Proof of Concept Testing of a Self-Propelled Oil Skimming Vessel

During the week of April 12, 2021, Oversea, LLC of Orange, Texas brought the Balaena prototype skimming vessel to Ohmsett to evaluate the performance of the novel oil collection technology. Using the near real-world conditions of the Ohmsett test tank, the team was able to use significant volumes of actual oil to collect data on the recovery rate and efficiency of the system.

The Balaena Express vessel has been in development for about 10 years. The concept for the design came from technical gaps identified during the team's involvement while responding to previous oil spill events. "During my personal experience as Command Post Coordinator on the Alvenus oil spill in 1984, and then observing the Macondo spill in 2010, it became clear the need for significant improvements in the mitigation of these potentially catastrophic events," said Russell Covington, Oversea president.

What makes the Balaena Express different from other skimming vessels is that it utilizes ambient water to transfer the floating oil. It can operate both as a stationary skimmer and as a self-



The Balaena Express skimming vessel uses ambient water to transfer oil. It can operate as both a stationary skimmer and as a self-propelled recovery vessel.

propelled recovery vessel. "Since it does not rely on oleophilic technology, it is effective with light to heavy viscosity fluids, and with oils in various stages of emulsification," said Covington. "It can store and transport the oil collected, to the extent of recovered oil tank capacity, or discharge the recovered oil to transport barges with no interruption

to the spill collection process."

The objective of the week-long test at Ohmsett was to evaluate the proof of concept, to identify opportunities for optimization, and evaluate the clean water discharge. With the skimming vessel moored in the test tank to ensure stability and proper operations in the stationary mode, a boomed area was deployed in front of the skimmer mouth to act as a controlled oil slick. A total of 12 tests were performed while recording recovery rate and efficiency as the skimmer recovered oil in calm water. "After testing was complete, we made some observations of the vessel's reaction in various wave heights," commented Covington.

"The test vessel is currently undergoing some minor modifications/improvements resulting from our test experience," Covington said. "And with proof of concept, we're initiating Front End Engineering Design (FEED) of Generation II, which will focus on improved performance, operator efficiency, and the option for full remote control function."

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Bowhead Prototype Plunge

into an oil and ice field to demonstrate the recovery of rinsed oil.

The Bowhead system is designed to travel alongside a ship. To simulate that during testing the staff rigged the system between the main and auxiliary bridges so it could glide along the basin wall. "As the system was towed forward, the approaching ice engaged the inclined conveyor belt. In order to better grip the ice and pull it up out of the water, the conveyor belt is equipped with various spike-like implements to capture and convey ice through the system," explained Grant Coolbaugh, Ohmsett senior mechanical

engineer. "As the ice traveled up the conveyor belt, it was exposed to water sprayers positioned above and below the conveyor to remove oil from the ice. Oil removed from the ice, as well as oil passing under the system during travel, was collected behind the system and directed to a skimmer for collection."

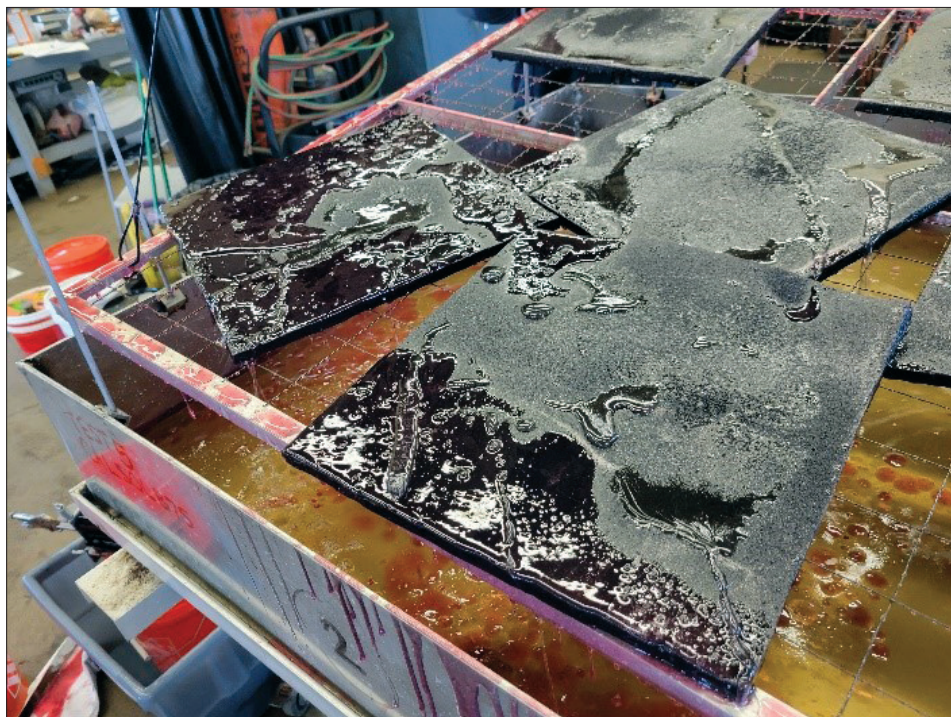
According to McKinney, the tests were conducted successfully, and several areas of improvements were identified. "Since operation at Arctic temperatures was not able to be conducted, the next steps would include further testing at low temperatures."

An Ecofriendly Approach to Cleaning up Oil

Sometimes the most innovative technology comes from unexpected places. For the last several years, Prof. Vinayak Dravid and his group at Northwestern University have worked on multifunctional nanostructures (MFNS) for a variety of biomedical imaging and therapeutic applications. Three years ago, Dravid and Dr. Vikas Nandwana, a senior member of his group, developed a cost-effective, scalable flow reactor to produce MFNS with low-cost environmentally friendly raw materials. One day, a few drops from the dispersion of the MFNS nanocomposite fell on their work bench, creating a smooth coating on the surface. Upon further research, they observed that the coating was repelling water, but had a high affinity for oil.

The result of this newly-discovered coating led to the development of the Oleophilic, Hydrophobic, and Multifunctional (OHM) Sponge, that not only removes oil, but recovers oil from oil-water mixtures in an economical, efficient, and ecofriendly approach. “This has been achieved by coating commercially available sponges with our patent pending MFNS coating that has been tuned to exhibit oleophilicity and hydrophobicity,” said Girish Bhatia, chief executive officer of MFNS Tech, a startup co-founded by Dravid and Nandwana to commercialize their invention.

In March 2021, the OHM-Sponge was evaluated for oil adsorption capacity/rates, hydrophobicity and durability with three different oils. “The objective was to validate our observations in the laboratory about key characteristics of OHM-Sponge,” said Bhatia. “Specifically: OHM-Sponge’s ability to absorb/adsorb oil up to 30 times its weight; its effectiveness across a spectrum of oil types, from low viscosity oils such as diesel to very high viscosity of crude oil; and its reusability to reduce the overall cost of sorbent, as the same sponge can be used 30-50 times reducing hazardous



The OHM sponge was evaluated for oil adsorption capacity, hydrophobicity and durability using ASTM F726 and the Ohmsett field scale test protocol.

waste associated with use of single use sorbent.” As part of the evaluation, a total of 14 field-scale tests were performed using the BSEE-Ohmsett developed Field Scale Test Protocol for Type I Sorbents Recovering Oil on Water, in addition to nine ASTM F726 Standard Test Method for Sorbent Performance for use on Crude Oil and Related Spills.

An initial series of absorption tests were performed in the Ohmsett laboratory using the ASTM F726 standard. The samples of the OHM-Sponge were placed into aluminum pans with sufficient oil coverage as required by ASTM F726. The maximum oil capacity data was collected and used as a baseline value for field-scale testing.

After the ASTM F726 test series, the Ohmsett staff performed field scale evaluations on more than 60 samples for efficacy under static and mixing energy scenarios. The tests focused on functional characteristics that would be important for field use including: volume of oil absorbed by the sorbent;

volume of oil recoverable by the sorbent; rate at which the sorbent will adsorb; amount of water the sorbent may adsorb; buoyancy; and the ability for the sorbent to be retrieved when fully saturated.

To evaluate OHM-Sponge’s ability to be reused, a single sample was run through the full test cycle 10 times. After each test cycle, the samples were squeezed through a wringer to recover and measure a portion of the oil adsorbed. “OHM sponge is expected to withstand many dozens of such squeeze/release cycles, thereby significantly reducing hazardous waste and the need to carry excess inventory,” said Dravid.

“With the data collected during these evaluations, we intend to reach out to oil spill cleanup companies to test drive our product, and reach out to skimmer manufacturers to explore a joint development to improve efficiency of skimmers,” said Bhatia. “Another related use case for OHM-Sponge, is to use it as a filtration media to remove minority oil from industrial processes.”

USN Looks to Modify Class V Skimmer Vessel

On an overcast day in March, a U.S. Navy (USN) truck towing a large flatbed trailer entered the Ohmsett compound to deliver a wide-load consisting of a 36-foot USN Class V skimmer vessel and ancillary equipment. The Navy's Supervisor of Salvage and Diving (SUPSALV), which operates large inventories of pollution response and salvage equipment, brought the vessel to perform full-scale oil recovery tests using two skimmers for a test scheduled the week of March 15, 2021.

The skimming vessel is currently equipped with a Marco Class V inclined belt fitted into the hull for oil recovery. In the oil skimming mode, the incline belt is lowered to lift the oil from the water's surface. The rotation of the oleophilic belt transports the oil and water up to a scraper bar and squeeze rollers where the recovered fluid drops into a recovery tank.

With an eye towards modifying the current skimming systems within the Navy fleet and a specific goal of increasing SUPSALV's recovery capability with light oil, SUPSALV's contractor, GPC, partnered with Elastec, Inc. of Carmi, Illinois to mount a specially designed version of their Elastec X150 oleophilic grooved disc skimmer system into the well of

the modified USN Class V skimmer. The skimmer vessel, one of the largest tested at Ohmsett, required a 75-ton crane to place it in the tank. With the vessel tethered between Ohmsett's main and auxiliary bridges, Navy SUPSALV personnel tested the skimming system with the Marco Class V inclined belt and Elastec skimmer.

During testing, diesel fuel and Hydrocal 300 were used with and without natural debris to simulate conditions encountered in the field. Each system was towed at various speeds to determine optimal vessel speed as well as optimal skimmer and belt rotational speed, while in calm and wave conditions.

"The tests were intended to quantify the maximum performance capabilities of the two skimmer systems and therefore all testing provided the maximum amount of oil to the skimmer during distribution," said Craig Moffatt, SUPSALV's Emergency Ship Salvage Material (ESSM) Oil Pollution Division manager.

"Our goal was to obtain test data and use the findings to make informed decisions about improving the Navy's spill response capability," said Moffatt. "It was well worth the effort, funding and time."



The USN Class V skimmer vessel was tested for the maximum performance capabilities of two skimmer systems.



The Ohmsett Gazette is published biannually to update our readers on testing, training, and research activities at the facility.

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Ohmsett Joins the TEAMER Marine Energy Testing Facility Network



Ohmsett has joined the U.S. Department of Energy-supported Testing Expertise and Access for Marine Energy Research (TEAMER) Program. The TEAMER program is dedicated to facilitating marine energy technology innovation and drive commercialization through research, funding, and providing access to U.S.-based testing facilities.

As a member of the TEAMER Facility Network, Ohmsett collaborates with marine energy developers through testing and evaluation of surface wave energy converters, subsurface wave energy converters (surge and ballast plate), surface current converters and near-shore tidal wash converters at-scale, as well as technology used for the Blue Economy.

Learn more about the TEAMER program at teamer-us.org.



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