Oil Spill Response Research & Renewable Energy Test Facility

The Ohmsett Gazette

Leonardo, New Jersey | Testing · Training · Research | Spring/Summer 2017

High Volume, Low Speed Displacement Pump

Over the past three years, WindTrans Systems LTD of Canada has been working to optimize pump systems where large volumes of mixed mediums can be picked up at low speeds and separated quickly. The end result is the newly patented Zelda II HVLS (high volume, low speed) positive displacement pump.

"The pump technology provides the ability to truly self-prime and lift a full atmosphere within seconds of initial operation," explains Andrew Masse, general manager. "The low operational speed reduces wear, heat, possibility of cavitation, and emulsification. The ability to hand crank or power drive provides pumping service to many more environments than other technologies."

According to Masse, the Zelda II HVLS technology recently completed research and development stages and has been on the market for the past 11 months. In April of 2017, a team from WindTrans brought the pump to Ohmsett to demonstrate the performance of their system through a series of static lift tests with two standard

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What's Inside

Researching New Technology for the Mitigation of Oil in the Water Column

During oil spill recovery operations, without the proper technology it is difficult to determine the location of subsurface oil plumes; an important aspect in the decision making process for successful mitigation operations. Over the last several years, the U.S. Coast Guard Research & Development Center (USCG RDC) has worked to develop a solution for detecting oil in the water column in near-real time.

"The Coast Guard started this project in 2011 in order to stimulate research in detecting and recovering oil in the water column. Several oil spills have occurred in which no action was taken to mitigate the impacts of oil suspended in the water column due to lack of appropriate technologies or strategies at the time," said Alex Balsley, project manager at the USCG RDC.

While the detection phase of the project is completed with the development of the WET Labs optical tool and the Norbit sonar (see the Ohmsett Gazette Spring 2014 issue), the USCG RDC is now focusing on the development of a technology or technique that would prevent submerged oil from impact-

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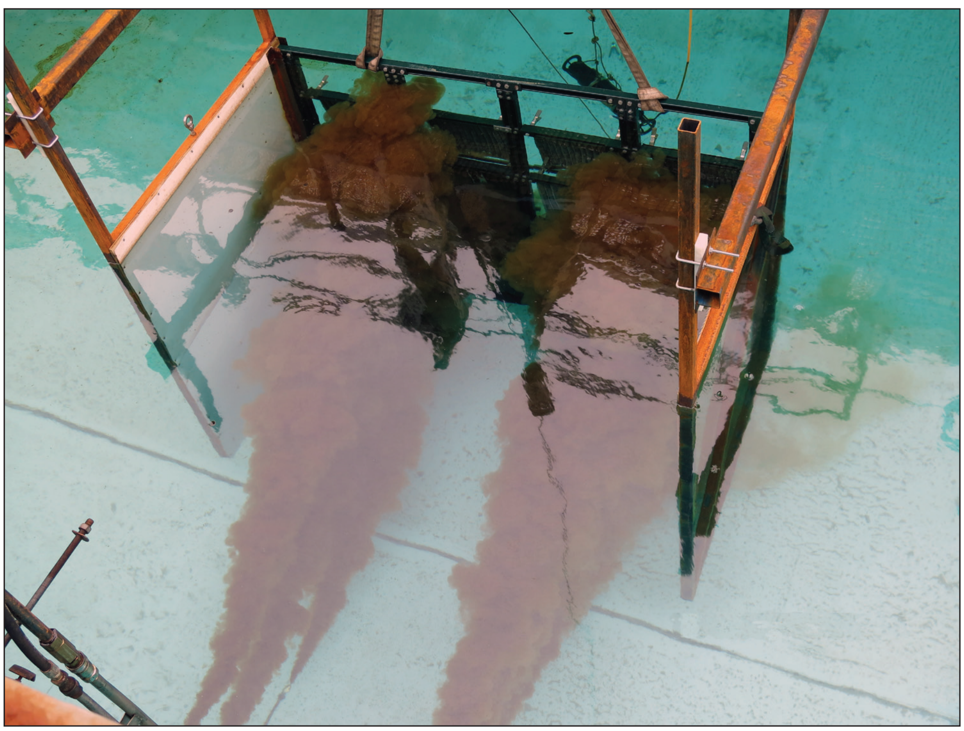

Argonne National Lab's Oleo Sponge prototype is a reusable chemically treated polyurethane foam to adsorb submerged oil. Multiple Oleo Sponge panels were attached to a metal frame and mounted to the auxiliary bridge where it encountered suspended oil plumes.

High Volume Pump

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test oils, Hydrocal 300-200cP and Calsol 8240-2000cP.

"The objective of the Ohmsett testing was to confirm our in-house testing we have undergone during the last three years," says Masse. "We wanted to confirm our pump could do the following: Is the pump truly self-priming? Can the pump run at low rpm and provide high efficiency pumping with a consistent flow? When the lift requirement or load changes can the pump provide the same consistent flow? Can the pump provide service and operate when the pump medium or viscosity changes? Is it possible for the pump to save the user time?"

The Zelda II HVLS system test took place in the Ohmsett oil storage tank farm. The pump was placed between two 17-foot tall storage tanks on a base platform with a piping system the Ohmsett staff fabricated for the test. This setup allowed the system to be operated at starting lift heights up to 17 feet.

The Zelda system was powered by a hydraulic motor and was supplemented by a hydraulic power unit (HPU) on the catwalk just below the pumping system. An Ohmsett operator controlled the HPU, while the WindTrans staff operated the pump for the first nine tests. A tenth test was performed using the hand crank option to demonstrate the hand pump capability at a significant lift height.

The Zelda II HVLS pump can be powered by a hydraulic motor or by a hand crank. The low operational speed reduces wear, heat and the possibility of cavitation and emulsification.

"We quickly proved that our pump provides great support to the user, time savings, lift and volume capabilities," says Masse. "We feel that this third party testing was important for us to validate our technology so that oil recovery systems, floating devices, and filtrations systems can now be designed and tested to enhance the pump technologies use."

High Tech High School STEM Mentorship Program

Over the years, through MAR's participation in the BSEE Science, Technology, Engineering, and Mathematics (STEM) program, the Ohmsett staff has had the pleasure of mentoring talented students from High Tech High School who intend to major in science and engineering. High Tech High School is a pre-engineering career academy in Lincroft, New Jersey that emphasizes the interconnections among mathematics, science, technology, and the humanities.

For the spring 2017 semester, we hosted High Tech High student Mary Finnerty. Ms. Finnerty is a motivated student who plans to pursue a career as an environmental engineer focusing on water pollution and water treatment.

"I chose the mentorship opportunity at Ohmsett because I felt it was a good fit. It matches my interests in environmental engineering and water remediation," said Ms. Finnerty.

With many different testing programs conducted at Ohmsett over the months of her mentorship, she has learned how to test the density, interfacial tension, surface tension and salinity of the test basin water. "I like the work here and find it quite interesting," said Ms. Finnerty. This was a nice complement to her previous work with environmental

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High Tech High School pre-engineering student Mary Finnerty conducts analysis on fluid samples in the Ohmsett Lab during her mentorship at the facility.

ROVs and AUVs Collect Slick Thickness Measurements

Everywhere you look ROVs are being used in the marine environment; from ocean floor mapping, species and habitat reporting to performing site investigations and pipeline inspections. So it is no surprise to find a ROV taking acoustic measurements of an oil slick.

Looking to the future of this technology, BSEE has contracted Applied Research Associates, Inc. (ARA) to develop and test acoustic techniques and sensors to measure the slick thickness of oil on the surface of the water and to measure the droplet size of subsurface releases of crude oil and dispersants for potential use at the wellhead.

This slick thickness measuring technology will help the industry direct cleanup operations to areas were the majority of the oil is located and determine if the oil is thick enough to sustain burning. By measuring the droplet size and gas bubble size distribution at the wellhead, responders will be able to better determine the fate and transport of oil and optimize the efficiency of a dispersant application.

The project started in September 2015 with ARA developing the acoustic technology and sensors. A team of researchers from ARA and the Virginia Institute of Marine Science conducted a feasibility test of the technology in March 2016 at Ohmsett. A second test was conducted in June 2016 to refine the measurements of oil slicks and subsurface oil releases using a commercial ROV platform and a commercial AUV glider platform equipped with the ARA acoustic technology.

"The main goal of this work is to begin transitioning the high fidelity acoustic measurements for slick thickness and oil droplet size, to free swimming ROV and glider platforms for eventual deployment during oil spills in the open ocean," explains Dr. Paul Panetta of ARA. "Acoustics offer several advantages for measuring oil properties, including the ease of deployment, large number of existing marine acoustic instruments, and its ability to penetrate high concentrated plumes of oil."

The project has now moved into the next step of incorporating the acoustic sensors on an ROV and an AUV glider platform.

An ROV, just visible under the oil slick, is fitted with ARA's acoustic technology to collect measurements of the slick.

According to Dr. Panetta, they returned to Ohmsett in February 2017 to study the effects waves can have on measurements of the slicks in various sea states using Ohmsett's wave making capabilities.

For the first series of tests, a large volume oil slick was placed in a 15-foot by 20-foot channel. The ROV and AUV glider moved freely along the length of the channel collecting measurements of the slick. These test runs were performed using various wavelengths and wave heights to study the sensors performance while mounted on the free swimming ROV and AUV platforms.

Throughout the final test series, a mounting stand outfitted with discharge nozzles was suspended from the Ohmsett bridge to create subsurface oil, dispersant, and methane releases to simulate a subsurface release. Prior to the release, Alaska North Slope (ANS) crude oil was premixed with COREXIT 9500 dispersant. The ROV and AUV moved freely through the water column while collecting acoustic data from the plume of oil and gas.

"Once the data has been analyzed, we will identify key advancements needed for integration of measurements of slick thickness, dispersant effectiveness, gas bubble size distribution, and oil droplet size distribution onto free swimming ROV and AUV platforms," said Panetta.

As part of the project, the acoustic ROV will be delivered to Ohmsett and will become new tool for researchers to use during testing at the facility.

High Tech High STEM Mentorship

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groups where she tested for bacteria in the waterways and beaches around the Bayshore area. "For my volunteer work last summer with the Bayshore Watershed Regional Council, we partnered on a Baykeepers project. The project was to test the water at non-swimming beaches for E. coli. One of the areas we tested, I had sailed in many times," she commented.

Besides learning about the environment, Ms. Finnerty loves being outdoors. She sails with the Keyport Yacht Club competitively and recreationally for which she has won several awards.

Next year, she will be attending Rensselaer Polytechnic Institute in Troy, New York. "I hope to earn a master's degree in environmental engineering and work at a place like Ohmsett in the future."

Mitigation of Oil in the Water Column

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ing the marine environment or man-made structures.

According to Balsley, the U.S. Department of Energy Argonne National Laboratory (ANL) and Dynaflow, Inc. proposed different approaches to meet the Coast Guard's need and that would mitigate the impacts of oil in the water column. During December 2016 and January 2017, each prototype was demonstrated at Ohmsett to address capabilities that the RDC designated as being crucial to the prototype's success.

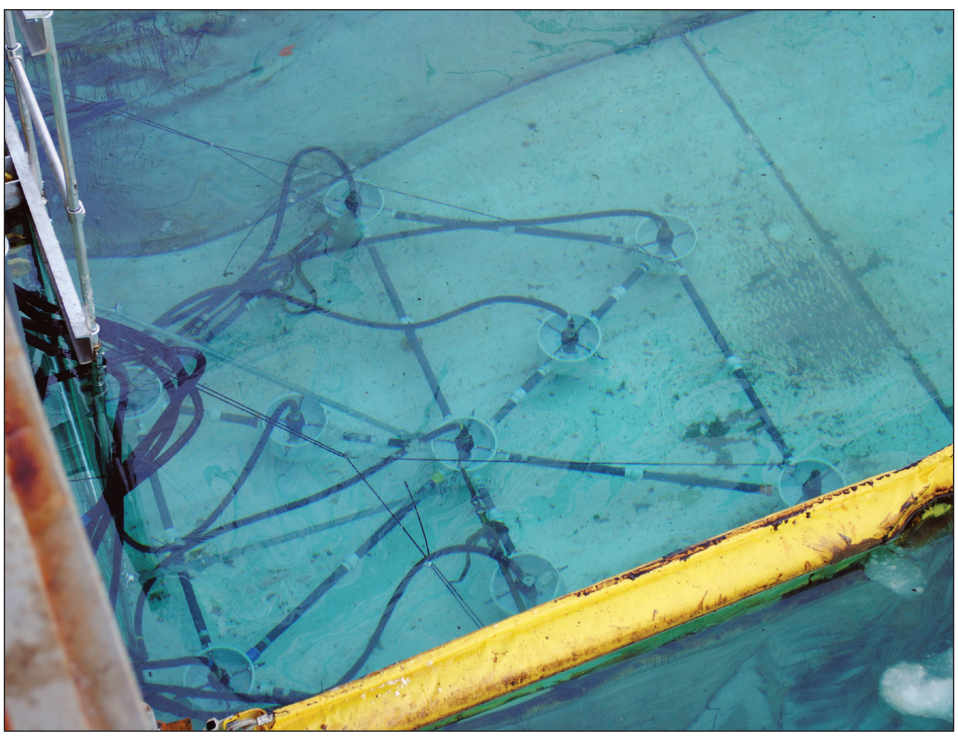
A major challenge for carrying out these demonstrations was replicating a submerged oil plume encountered at sea in Ohmsett's test tank. To do so, the Ohmsett staff custom-built an oil distribution manifold system with atomizing nozzles that provided a consistent and controlled flow rate, droplet size distribution and concentration to create the plume. The oil distribution system was attached to the main bridge during testing.

The first series of demonstrations was the ANL prototype. Their approach uses reusable, chemically treated polyurethane foam called Oleo Sponge to adsorb submerged oil. Multiple Oleo Sponge panels were attached to a metal frame, which was mounted to the auxiliary bridge. HOOPS crude, Alaska North Slope (ANS) crude, and diesel were used during the tests and dispensed at a predetermined rate through the oil distribution manifold system. As the foam array encountered the oil plume, a LISST was used to confirm the particle size and concentration of the submerged fuel/oil plume, while an underwater video recorder and digital camera captured the mitigation effort in the test area. After each sweep through the oil plume, the foam panels were squeezed through a manual wringer system where the amount of oil and water recovered was recorded. The collected oil was further analyzed by Ohmsett to determine the amount of pure oil recovered by the foam.

The second prototype tested was Dynaflow's system of microbubble generators (DynaSwirl®). When placed beneath a submerged oil plume, the air bubbles adhere to and lift oil droplets and dissolved oil to the surface where they can be removed by traditional oil recovery methods.

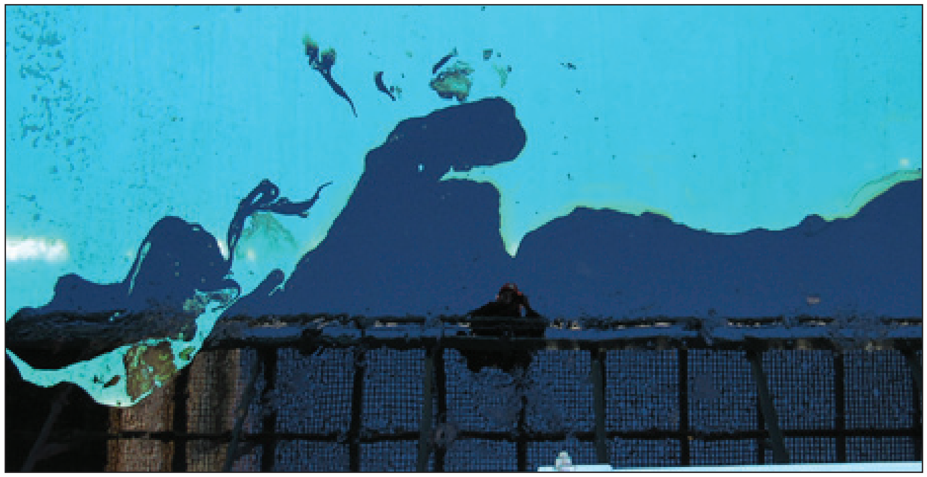
During Dynaflow's demonstrations, a boomed test area was set up within the main tank where the system could freely traverse along the tank floor to distribute bubbles the length of the test area. The main bridge was then moved slowly over the test area while the oil distribution manifold established a plume of a predetermined concentration of ANS crude oil. As Dynaflow's prototype moved along the tank floor, underwater cameras, placed in strategic locations for the best view of the mitigation technology, captured photographic and video data. At timed intervals, the surfaced oil was collected for measurement and compared with results obtained during unassisted surfaced oil tests.

"The demonstrations gave us valuable insights about their current capabilities. As we analyze the oil recovery data in the upcoming months, we should have a better understanding of the technologies' full capabilities and what improvements should be made for a more successful outcome in the future," states Balsley. "Our goal with this project and prototype demonstrations is not to achieve commercialization of the technologies, but to assist the vendors in the development of their technologies. Hopefully our findings will allow them to continue building on their successes, lead to collaborations with other partners for further research and commercialization, or inspire similar research efforts among academia or industry."



Dynaflow tested a system of microbubble generators (DynaSwirl®) placed beneath a submerged oil plume. The air bubbles adhere to and lift oil droplets and dissolved oil to the surface where they can be removed by traditional oil recovery methods.

A Floating Gel to Prevent an Oil Slick From Spreading



The combined oil and i-Petrogel adduct was left on the tank surface overnight. The treated oil became a piece of black gel ready to be recovered mechanically.

When Dr. Mike Chung of Pennsylvania State University's Department of Materials Science and Engineering came to Ohmsett in October of 2015, he was on a quest to determine whether an absorbency material he called Petrogel could effectively clean up oil spills. During scale testing in a small tank on the basin deck, the answer was a resounding yes. When spread on an oil slick it formed a floating gel material that could be recovered from the water's surface.

A year later, Dr. Chung was back at Ohmsett in December 2016 with an improved product, i-Petrogel, developed through funding by BSEE. This time he wanted to evaluate the ability of i-Petrogel to contain an oil slick and prevent it from spreading in cold weather; under calm surface conditions and gentle waves. He also wanted to test the ability of an oleophilic skimmer to collect i-Petrogel treated oil.

In the test basin, control runs were conducted with fresh Alaskan North Slope (ANS) crude oil was allowed to spread on the surface of the tank. "The oil diffused quickly from the spill site with light hydrocarbons leading the spreading edge to form a thin (brown) layer. Within 15-20 minutes, the two gallons of oil almost covered most of the confined area in the main tank," observed Chung.

Subsequent tests were conducted where oil slicks were dispensed within a containment ring treated with i-Petrogel. The tests were conducted over various durations after which the oil was released from the ring and allowed to spread on the water's surface. "Some oil did spread out with increasing surface area over time, but to a lesser extent (without light hydrocarbon leading edge) when compared to the control run," commented Chung. "However, after keeping the treated oil in the main tank overnight, the treated oil became a continuous piece of homogeneous shiny black gel, which was clearly separated from water. This phenomenon strongly indicates the fact that due to the larger size of i-Petrogel flakes, the self-diffusion of ANS oil into i-Petrogel matrix takes more time to achieve the saturation level. In other words, the absorption process requires longer time to capture all the spilled oil." The spreading footprint of each slick was recorded for analysis using the Ohmsett TRACS thermal imaging system. The test series was conducted in calm and gentle wave conditions.

The next test series assessed the ability of an oleophilic drum skimmer to recover i-Petrogel treated crude oil. Using treated oil from the previous tests, the oil was gathered in an area at the north end of the Ohmsett test tank. Some of the mixture had been exposed and weathered on the cold water surface, with wind and waves, for up to 50 hours. The oil was herded into a corner formed by the wall of the tank and a boom fixed at 90 degrees to the wall. A smooth drum, oleophilic skimmer was used to collect the oil slick from the water's surface.

"It is very exciting to see the completely clear water and the cohesiveness of the treated oil (without any detectable emulsification)," said Chung. "The recovery of the oil/i-Petrogel adduct by a skimmer was very effective and efficient. The recovered oil/i-Petrogel adduct can also be pumped to the storage vessel."

Marine Salvage Training

August 8-10, 2017

Ohmsett, in partnership with T&T Salvage offers the hands-on training course you can't afford to miss! You will learn effective operational planning and equipment deployment for successful Marine Salvage Response Operations. Classroom and Tank exercises include:

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When:
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8:00 a.m. - 4:30 p.m.
Where:
Ohmsett
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Cost:
$1650 per student
Registration:
Phone: 301-230-4565 or
732-866-7286
*Note: Maximum 16 students to facilitate hands-on training.

Study of Ocean Wave Spray and Foam

Researchers from the Applied Physics Laboratory of the University of Washington used remote sensing to detect the foam and spray of breaking waves.

The awesome power of ocean waves with frothy spray and massive swells is a stunning sight to behold, almost ethereal. They attract surfers, swimmers, and even scientific researchers from the Applied Physics Laboratory (APL) of the University of Washington. For the university researchers, their attraction is from the scientific standpoint of how that beautiful spray produced by breaking waves is detected using remote sensing. This research could also lead to an enhanced understanding of how foam and spray affect oil spill detection in the open ocean.

Researchers have found that the spray and foam can easily interfere with the microwave, infrared and visible modes of remote sensing equipment, while also limiting visibility and distorting signals. To study the presence of turbulence, surface spray and surface foam that result from breaking ocean waves, Principal Oceanographer Chris Chickadel, and his team from APL conducted an Office of Naval Research funded study to understand this aspect of waves in the Ohmsett test basin.

"The overall objective is to understand and quantify the spray production and longevity of surface foam produced by deep-water whitecaps and depth-limited breaking in surf zones," says Chickadel. "Specifically, we wanted to quantify the spray distribution and flux from field scale saltwater breaking waves, and determine the role of turbulence in regulating sea foam longevity at the surface."

Various oceanographic instrumentation was mounted above and below the main bridge and the crow's nest, as well as cameras at and below the surface of the water. The wave generator was then programed to create breaking waves at specific locations in the tank for data collection. "Observations were made over repeated waves using the wave focusing technique," says Chickadel. "This produced repeatable breaking waves at our measurement location which is needed to build up a robust estimate of the spray distribution."

Over the course of the week, 88 test runs were conducted. According to Chickadel, the data collection proceeded as they had anticipated, with all instruments collecting data over 90% of the data runs. "We were able to refine the breaking wave generation to increase the frequency of the repeatable and energetic breaking waves, [this was] crucial for our analysis techniques," he explains. "From here we'll work on processing our data to compile the spray distribution function to correlate to the foam and bubble generation and ultimately the breaking wave generated turbulence."

University of Houston Strikes Gold

Early detection of a pipeline leak or an oil spill is worth its weight in gold – literally. A team of researchers from the University of Houston created surface coatings using gold nanoparticles and incorporated them into sensors for subsea oil detection. The coatings have the demonstrated ability to detect certain molecules that are present in crude oil, in very low concentrations using substrates which can be easily cleaned and reused.

Using this new technology, the research team led by Dr. Wei-Chuan Shih, developed two sensing devices and data acquisition systems for real-time pipeline leak detection. The devices use Surface-enhanced Raman Scattering (SERS) to capture and detect Polycyclic Aromatic Hydrocarbons (PAHs), and a Surface-enhanced Near-infrared Absorption (SENIRA) to identify hydrocarbons.

BSEE funded the team to further develop the systems to advance the scientific principles of the new oil spill sensing techniques. As part of this development, lab experiments were conducted at Ohmsett to collect data using several crude oils in various concentrations in temporary test tanks. The two sensor devices were tested over the course of four days, for a total of six tests, with oil being released to simulate a pipeline leak. With the sensors suspended within the temporary test tank, readings were recorded with each instrument before each oil release. Instrument data and logs were collected and documented by the University of Houston research team.

The Ohmsett Gazette is published biannually by Ohmsett -The National Oil Spill Response Research & Renewable Energy Test Facility to update our readers on activities at the facility.

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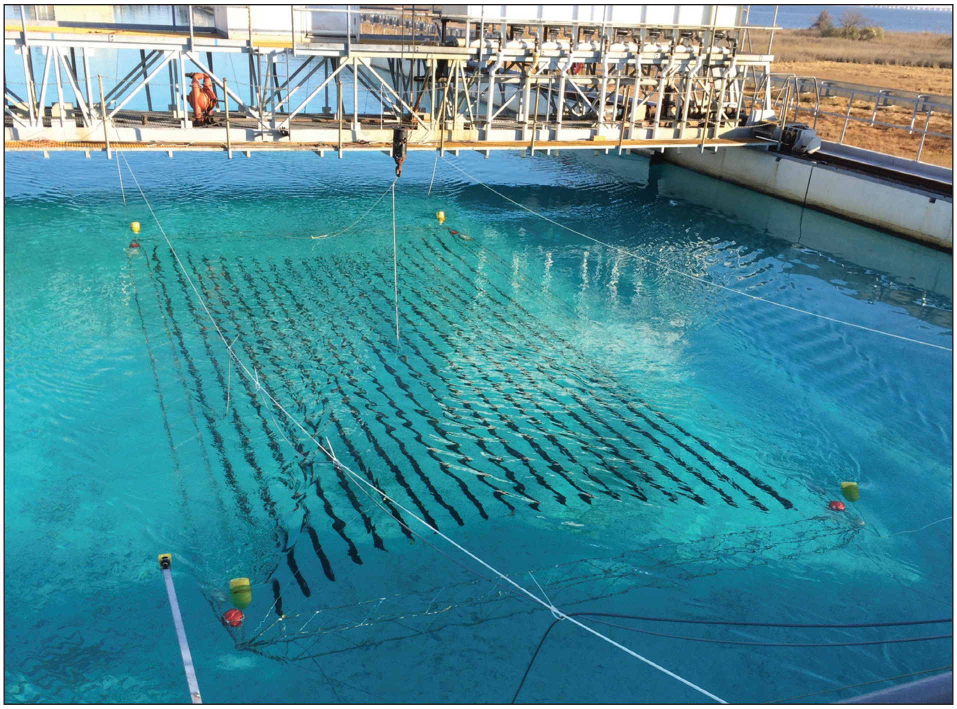
Cultivating Kelp to Improve the Ocean Ecosystem

C.A. Goudey & Associates was awarded a Small Business Innovation Research contract from National Oceanic & Atmospheric Administration (NOAA) for Phase I development of systems for the commercial scale cultivation of macroalgae on the open ocean. Macroalgae, or seaweed, is one type of aquaculture that can generate economic value while improving the ocean ecosystem by absorbing CO_2 and excess nutrients. As part of the investigation, the team developed a prototype macroalgae culture system that would allow the growing of kelp in wide swaths of the U.S. Exclusive Economic Zone.

To test the system, CAG&A came to Ohmsett to gain an understanding of the effects of currents and waves on the structure and the cultured kelp. The test program consisted of the characterization of three separate elements: the drag and behavior of full-scale kelp in currents and waves; the drag and behavior of 1/20th-scale models of simulated kelp in currents and waves; and the drag and behavior of various configurations of a 1/20th-scale seaweed farming structural array that supports kelp grown on long lines.

A towing apparatus with a movable tow point was constructed on the main bridge of the Ohmsett tank to support the kelp system throughout testing. Over five days, tests were performed at several tow speeds and various wave types while load cell and ultrasonic wave height sensor data was collected. "The resulting data has been analyzed, scaled up to prototype size to inform the engineering process ensuring the adequacy of that design," said Cliff Goudey. "Its installation is planned in a subsequent Phase II project."



This prototype macroalgae culture system will allow kelp to grow in the open ocean to help improve the ecosystem by absorbing CO_2 and excess nutrients.

Menlo Park Elementary TAG Students

On May 16 a group of very bright third-grade students from the Talented and Gifted Program at Menlo Park Elementary School in Edison, New Jersey visited Ohmsett to learn about oil spills. As part of their engineering curriculum, the students are studying "A Slick Solution – Oil Spill Cleanup Engineering" where they are focusing on the understanding of different cleanup approaches, including hands-on experiments in the classroom using different cleaning materials.

Ohmsett

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