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Press Release

Can sound science guide dispersant use during subsea oil spills?

(April 16, 2012) Two years ago this week, oil began streaming from the seafloor into the Gulf of Mexico following the explosion of the Deepwater Horizon platform. All told, the disaster cost 11 lives, released 4.9 million barrels of crude oil, and caused still unspecified impacts to marine life and the Gulf economy.

Now, a pair of researchers at the Virginia Institute of Marine Science is using a 1-year, $350,000 contract from the U.S. Department of the Interior to test whether sound waves can be used to determine the size of oil droplets in the subsea—knowledge that could help guide the use of chemical dispersants during the cleanup of future spills. The effort is also supported by the VIMS-Industry Partnership.

Ohmsett Wave Tank: The VIMS researchers compared the performance of acoustic and optical instruments using this oil slick in the Ohmsett wave tank. Photo by Paul Panetta.

Chemical dispersants have conventionally been applied to surface oil slicks to produce smaller droplets that can more easily be mixed downward by ocean turbulence. Dispersal through a larger water volume lessens the immediate threat to the shoreline and to organisms such as seabirds, marine mammals, and turtles. Dispersion also increases the surface area available for bacterial decay.

During the Deepwater event, however, the oil industry for the first time released dispersants directly into a deep-sea blowout. Indeed, of the 1.84 million gallons of dispersants used during the spill, 42%—771,000 gallons—was applied at the wellhead, 5,067 feet below the surface. The idea was to reduce both the amount of oil reaching the surface and the amount of dispersants that needed to be applied.

Today, the effectiveness and safety of this deep-sea dispersant application remains unknown, at least in part because of the difficulty of monitoring the size of the oil droplets within the subsea plume. That's where the VIMS research comes in.

Project leader Paul Panetta, a scientist with Applied Research Associates, Inc., and an adjunct professor at VIMS, says "To maximize biodegradation, dispersants are designed to produce oil droplets that are less than 100 microns across. But there are currently no tools available to monitor droplet size in deep subsea blowouts. Our goal is to develop acoustic techniques for that purpose, giving spill responders a means to gauge the effectiveness of the dispersants and how much they should use."

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Tools do exist to measure droplet size within dispersed oil slicks at and just below the sea surface—including ultraviolet fluorometers and LISSTs (for Laser In-Situ Scattering and Transmissometers). But these optical devices are poorly suited for use within highly opaque plumes of oil.

Acoustic instruments and techniques offer a promising alternative. "There's a reason that many marine mammals use sound rather than sight for long-distance communications," says team member Carl Friedrichs, Chair of Physcial Sciences and head of the Coastal Hydrodynamics and Sediment Dynamics lab at VIMS. "Light can't go nearly as far in water—let alone turbid water—as compared to sound waves." Friedrichs notes that acoustic instruments also tend to be less delicate than their optical counterparts, and are better able to withstand "biofouling" and the high pressures of the deep sea.

Experiments

Panetta and Friedrichs conducted the first experiments for the project in December 2011 at the Ohmsett Wave Tank in Leonardo, New Jersey, which serves as the National Oil Spill Response Research & Renewable Energy Test Facility for the U.S. Department of the Interior. This 2.6-million gallon concrete basin—one of the largest wave tanks in the world—measures 666 feet long by 65 feet wide by 11 feet deep. It features an immense piston for generating waves up to 3 feet high, an oil distribution and recovery system, and a motorized bridge for deploying instruments.

During their Ohmsett tests, Panetta and Friedrichs compared the performance of optical and acoustic instruments borrowed from their labs at VIMS, transmitting, receiving, and interpreting sound waves and light as they reflected against an aqueous slurry of 20 parts of oil to 1 part dispersant.

In a second experiment at VIMS, the pair performed a similar experiment but on a much smaller—and simpler—scale. This time they compared the performance of their optical and acoustical instruments in a small bucket, adding dispersants to the same crude oil used at Ohmsett and creating turbulence with a drill-powered paint mixer.

They recently conducted a third test in Norway, in a tank operated by SINTEF, the largest independent research organization in Scandinavia. This "tower tank"—specifically created for studying subsurface releases of oil—measures 21 feet tall by 9 feet wide and allows room for various instruments including video cameras, a LISST, and, in this case, the acoustic equipment supplied by the VIMS team.

Preliminary results are promising

In all three cases, the team's preliminary results qualitatively confirm the potential superiority of an acoustic approach to monitoring oil dispersion. "Our tests showed that acoustic techniques were effective at penetrating the plume," says Panetta, "whereas the LISST would have been ineffective. Our initial measurements indicate the acoustic measurements can track the droplet size for a subsurface release of oil."

The next step, says Panetta, is to "take these data and turn them into a measurement method that would tell us exactly what the droplet size is. That would be valuable to the people spraying the dispersants, and valuable to the people modeling the fate of the oil, because during the cleanup of an oil spill, the size of the oil droplets affects everything."

Panetta and Friedrichs say their ultimate goal is to partner with the private sector so that commercial sonar manufacturers can adapt the new technology to their existing instruments for use by the oil and gas industry. "That's the longer term technology plan," says Panetta, "but we obviously have to first figure out the science behind it to make it work. We have to solve the physics problem—to figure out which signals to analyze and how to interpret them so we can get a quantitative measure of the oil-droplet size."