Environment

Janet Raloff reports from Tampa, Fla., at the 1993 International Oil Spill Conference

An Alaskan feast for oil-eating microbes

The *Exxon Valdez* oil spill, which fouled Alaskan waters on March 24, 1989, provided the first major test of whether hydrocarbon-eating aquatic microbes can help clean oil-stained beaches. Ten weeks after the spill, Environmental Protection Agency scientists began seeding small patches of blackened shore with fertilizers containing nitrogen and phosphorus to spur the growth of indigenous, oil-noshing bacteria (SN: 6/17/89, p.383). After initial signs that the fertilizer accelerated microbial breakdown of beached crude oil (SN: 7/15/89, p.38), regulators approved expansion of the test.

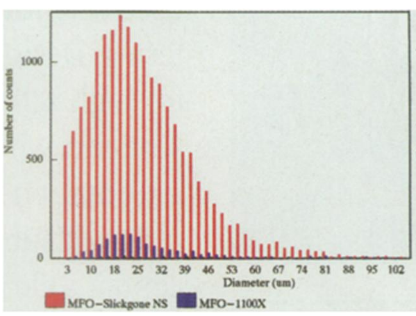
Between Aug. 1 and Sept. 15, 1989, cleanup crews applied either liquid fertilizers or granular, slow-release fertilizers at 750 sites along more than 74 miles of beaches in Prince William Sound and the Gulf of Alaska. On heavily oiled beaches, crews first rinsed the shores with pressurized water. Over the next two years, these and other, less heavily oiled shores received some 1,600 additional applications of fertilizer.

Although treated beaches whitened more quickly than untreated ones, suggesting that microbial cleaning occurred faster there, researchers were unable to determine exactly how much oil had disappeared. Complicating the problem was the fact that all beaches experienced changes in oil composition, including natural weathering (loss of volatile constituents) and some microbial breakdown. Differences in the initial amount of oil present and the type of beach also made the standard technique of comparing weights of treated and untreated beach material all but useless here. Finally, researchers could not tell how well the bacteria had degraded the more complex and potentially toxic compounds within crude oil, such as polycyclic aromatic hydrocarbons (PAHs).

James R. Bragg, a chemical engineer with Exxon Production Research Co. in Houston, says he and his co-workers ultimately solved that problem by comparing levels of hopane – a petroleum hydrocarbon ignored by microbes and unaffected by weathering – to compounds that microbes do eat. The results for one treated beach showed that bacteria degraded about 60 percent of total hydrocarbons and 45 percent of the PAHs within three months, Bragg says. Overall, he reports, in south central Alaska, oil degraded up to five times faster and PAH levels dropped five times faster on beaches stimulated with sufficient fertilizer than on beaches left alone.

Laser sizes up dispersed oil

When tankers or offshore wells unleash thousands of barrels' worth of oil at sea, cleanup crews immediately look for help from chemical dispersants – agents that work together with natural wave action to break large bodies of oil into droplets that resist coalescing. While dispersants do not remove oil from the water, they do foster a dilution that can minimize hydrocarbons' toxicity to aquatic life.



Lunel/Warren Spring Laboratory

Efficient (red) and inefficient (blue) dispersants shear oil into similar proportions of small droplets.

Until recently, scientists studying the dispersal of oil droplets were limited to laboratory experiments. Chemists were unsure exactly how oil and water mix at sea, with or without chemical dispersants, asserts oceanographer Tim Lunel of Warren Spring Laboratory in Stevenage, England. Now, Lunel and his co-workers have developed a laser device that not only distinguishes oil droplets from other particles below an oil slick on the basis of features such as symmetry and refractive index, but also gauges the size of those droplets.

The researchers tested their "phase Doppler particle analyzer" on crude oil experimentally released in the North Sea. The results provide "the first measurements of oil droplet sizes at sea," Lunel says. One major surprise was the small size of the dispersed oil particles, which averaged only about 20 microns in diameter. "There had been expectations that particle diameters would vary more," particularly on the basis of the type of oil spilled or the relative effectiveness of the dispersants used, Lunel says. But neither those factors nor winds, which largely determine wave turbulence, played a major role in the size of dispersed oil droplets. Again and again, Lunel's team found, roughly 90 percent of dispersed oil breaks into droplets smaller than 45 microns – accounting for half of the dispersed-oil volume – and 99 percent breaks into droplets smaller than 70 microns.

The investigators also compared spills of medium fuel oil (MFO) treated with a highly efficient dispersant called Slickgone NS to spills treated with a less efficient dispersant called 1100X. These experiments indicated that dispersants affect only the amount of oil sheared into small particles (see diagram), not the proportion of sheared particles that end up small.

Plugging these data into computer programs that model oil spills should yield "slightly different predictions of the shape of slicks and very different predictions of the amounts of oil that will be dispersed," Lunel says.

Coast Guard scouts oil trade's 'dogs'

On July 21, 1991, the *Kirki*, a Greek-registered tanker, encountered gale-force winds while carrying 82,600 tons of oil from the Persian Gulf to Australia. Before long, its bow broke away and sank, fires erupted, oil began to leak into the sea, and the crew abandoned ship. Members of the Australian Maritime Safety Authority (AMSA) were shocked to see what awaited them when they arrived to secure and unload the remaining oil from the vessel, then drifting off Australia's coast.

Only 22 years old, the *Kirki* had seen six owners and little maintenance. "The deck's thickness in the area of the forepeak had literally rusted to the thickness of a razor blade," reports Donald Brodie, then AMSA's technical adviser on marine pollution and coordinator of Australia's federal effort to stabilize the ship. Ragged, gaping holes in manhole covers to the ballast tank had been covered with canvas and painted to match the adjacent metal. Indeed, Brodie told SCIENCE NEWS, "there was a lot of paint on that ship – more paint than metal."

Though Australia maintains a tanker surveillance program, "some vessels escape the net," Brodie acknowledges, because "we don't have the resources to go on board and use a hammer on every ship and make sure it's in sound condition."

That should be the role of owners, insurers, and organizations that certify seaworthiness, contends Coast Guard Rear Adm. Arthur E. Henn of Washington, D.C. But many of these parties have abdicated their safety responsibilities in recent years, Henn says. In response, the U.S. Coast Guard is stepping up its policing of ships, he adds. New rules and stricter enforcement of existing safety standards will make it harder for what he calls the "dogs" of the petroleum trade – rust buckets like the *Kirki* – to enter U.S. ports. Even if most other nations don't follow suit (though Henn suspects they will), many of these tankers will be repaired or retired, he says. After all, "the United States is the world's biggest customer," he notes. "Where are they going to go?"