Mopping Up Disasters: Textiles Protect People and the Planet

By Glenna B. Musante

It's difficult to forget the images from the 2010 Deep Horizon disaster. Miles of once pristine white beach and turquoise waters along the Gulf of Mexico were mired for months in a carpet of heavy black crude oil, punctuated by tides bearing fish kills and beach fowl drowning in sludge.

The gusher, which began with an explosion on an oil rig, dumped as much as 210 million gallons of oil into the Gulf. It drenched shores from Florida to Texas in oil and sludge and caused billions of dollars in damage to the environment and local economies.

The Deep Horizon oil spill, considered the worst oil rig disaster in history, was so massive that few technologies were in place to help stem the impact of the hemorrhage along adjacent shorelines. Yet ironically, at about the same time as the Deep Horizon disaster, some exciting materials research related to mass oil disaster cleanup was just beginning to take place not far away in Lubbock, Texas, USA.

In 2010, The Nonwovens & Advanced Materials Laboratory at Texas Tech University, which had already gained attention for another invention designed to mitigate smaller-scale oil and chemical disasters, was just beginning to experiment with using an inexpensive, natural, renewable resource to clean up large scale disasters.

A Bumper Crop

The lab was testing the use of low grade cotton to soak up oil.

Texas is one of the world's largest suppliers of cotton. About 20% percent of the annual crop doesn't make the cut for use in clothes or linens because it's too waxy to evenly pick up dye. The technical designation for this type of cotton is "low micronaire," which means it is less mature and has less cellulose deposition than cotton used in clothing.

Seshadri Ramkumar, the professor at Texas Tech who runs the Nonwovens & Advanced Materials Laboratory, says the lab's primary focus is inventing new products that provide personal protection and/or protect the environment. "These are the two major goals of my work," says Ramkumar.

From a timing perspective, he says, the lab was not able to help clean up the 2010 Deep Horizon oil spill. But since 2010, when the research began, he explains, "we have established the basic [premise] and have found that raw, low micronaire cotton can be used successfully to mop up oil spills."

The mechanism is very simple, explains Ramkumar. Low grade cotton, which has not matured fully, is waxier than the mature cotton that would be used in a t-shirt. Because it is waxier, it repels water. At the same time, however, it absorbs oil and other chemicals, which then become trapped in the fibers and wax.

"We are working primarily with cotton [because] it is a natural fiber," says Ramkumar. "It is a natural alternative to synthetic fibers and it's biodegradable." He adds that his graduate student, Vinitkumar Singh, did some of the initial research investigation into the concept, which was then followed by preliminary testing.

Another advantage to using low micronaire cotton is that it can expand to many times its weight. As a result, "you can pack more volume in a given area, which makes that area more absorbent," says Ramkumar, explaining that low micronaire cotton can pick up to 30 times its weight. That would mean that one pound of low micronaire cotton could soak up to 30 pounds of crude oil.

In addition, he says, "you can use it multiple times and you can squeeze it out and use it again." Then, when the cotton's job is done, it can be disposed of easily. "Over time, the cotton, unlike synthetic fibers, will be eaten by the natural bacteria in the soil, and will be released back into the environment," says Ramkumar.

Expanding Use for Another Nonwoven

This is not the first innovation designed to clean up oil and chemicals that has emerged from the lab at Texas Tech.

Another, which has been commercialized and is now being sold through a company called First

Line Technology, is a new three-layer nonwoven fabric made of activated carbon that soaks up and traps small chemical spills, oil spills, and the resulting fumes. The outside layers are typically made from polyester and the middle layer from activated carbon. All three layers are needle punched together into a nonwoven fabric that absorbs and retains oil, chemicals, and fumes. Called Fibertect, this is an inert, flexible, drapable, nonwoven composite that absorbs and adsorbs chemical warfare agents, toxic industrial chemicals, and pesticides.

This technology has applications in wipes but may also be used in components of some suits worn by hazmat workers cleaning up chemical, biological, and oil spill-related disasters. The primary markets have been the military and emergency response units, but First Line Technology is discovering new applications for use in manufacturing facilities where even a small-scale spill can shut a factory down for hours.

Amit Kapoor, president of the company, gave the example of an aging factory where a chemical line goes through a corroding pipe. "The corrosion can create [a leak], dripping on the production floor," he says, "then you may have to shut down a large manufacturing facility [to clean it up]." A small-scale spill can escalate into a large-scale disaster, he explains. "Time is money for these companies."

First Line Technology is now developing large sheets of Fibertect to clean industrial spills. Depending on the type of potential spill, a coating agent can be added to the Fibertect that neutralizes noxious chemicals during the absorption process. This could be critically important in the case of sulfuric acid, for example.

They are also considering developing large sheets that could, as just one example, be used to cleanse

Fabric to clean industrial spills.

Raw cotton as effective oil sorbent.

the hull of a ship that has been at work cleaning up an oil spill. Says Kapoor, "You do not want to wash the boat down in dock, because the resulting secondary oil spill there could become a disaster of its own."

Personal Protection

There are numerous materials used in hazmat suiting, but the heavy weight and a lack of breathability of some materials can quickly lead to heat exhaustion. With that concern in mind, WL Gore has taken its proprietary membrane technology and used that to develop an alternative hazmat fabric that is both protective and breathable.

Referred to as a "selectively permeable fabric," this textile allows the body's moisture vapor to escape, but prevents chemicals from entering. It is now in use for protective clothing worn by hazardous waste workers and teams sent to clean chemical spills. One commercial application of this fabric, which is called Chempak, is a single-piece coverall CBRN (chemical, biological, radiological and nuclear defense) response suit made by Blauer Manufacturing Company, which can be worn for up to eight hours.

"Gore has a history of developing high-quality fabrics for chemical and biological protection," says Jason Rodriguez, the spokesperson for Gore's military fabrics division. "This one is designed to provide durable, broad range protection in warm-zone operations and is certified to NFPA 1994, Class 3. The fact that it's lightweight, breathable, and engineered for worker comfort is essential in disaster scenarios," he says. The technology's breathable barrier provides protection against toxic chemicals while allowing moisture vapor from perspiration to escape from the garment. This reduces worker heat stress and increases work time productivity.

In the Future

With concerns about chemical hazards, oil spills, and even biological warfare agents not going away any time soon, inventions such as these and others will continue to emerge. Meanwhile, textile and materials innovations designed for other uses—for example, coatings that make clothing self-cleaning—may end up being used in the effort to clean up oil spills or other environmental disasters.

The Natick Soldier Research, Development and Engineering Center recently announced the development of a durable, omniphobic coating used to produce self-cleaning fabrics. The technology was developed for use in clothing worn by soldiers.

The coating reportedly lowers dirt and dust attraction and repels water, oil, and many liquid chemicals. A future version could be used on leather boots and gloves and eventually might be applied to flexible/hard surfaces, such as goggles, visors, shelters, and marine structures, such as ship hulls, according to a press release from Natick.

Some day, in the event of another major oil spill, ships with an omniphobic coating—originally invented to reduce apparel laundering—may be dispatched to some unlucky shore, ready to deliver carefully-clad hazmat teams bearing tons of Texas low-grade cotton, there to soak up the oil.

It's not the happiest of thoughts, but at least it's good to know research continues toward inventions designed to help mop up modern man's bigger messes.

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