REAL-WORLD RESEARCH

BANU ÖRMECI DEVELOPED A TECHNOLOGY THAT WILL HELP WASTE-WATER TREATMENT PLANTS USE FEWER CHEMICALS. HER WORK MAY SAVE MILLIONS OF DOLLARS FOR CITIES AROUND THE WORLD. IT ALSO SHOWS THAT DESPITE THE MANY CHALLENGES OF COMMERCIALIZING ACADEMIC RESEARCH, THE WORK DONE IN UNIVERSITY LABS CAN SOLVE MAJOR PROBLEMS IN SOCIETY.

By Roger Collier

> "What is really rewarding for me as an engineer is to see my research being used at full scale at waste-water-treatment plants. It is useful. It solves an actual problem."

Banu Örmeci, professor and Canada Research Chair (Tier II) in Wastewater Treatment Engineering at Carleton University.

We are all familiar with the short list of life's inevitables. Death, taxes and that's about it. Well, not really. Let's consider a third item. In addition to paying taxes and propping up the casket industry, you also—without question, no matter who you are, no matter where you live—use the bathroom.

So does your spouse. And your neighbours. And your co-workers. And everyone else in Ottawa, in Ontario, in Canada, in every developed country on earth. Void, flush, gone—multiply by several billion, repeat again and again, forever.

Here's something many don't do: think about what occurs after you flush. Why would you? It's not your problem. But it is a problem—a very big and very expensive problem.

"Every city has to deal with waste water," says Paul Van Geel, chair of civil and environmental engineering at Carleton University. "That process produces sludge, and that sludge is of significant volume and is a significant cost to a city."

Sludge is the semi-solid material left over after sewage is treated to remove organic matter, pathogens and chemicals. It is sometimes used as fertilizer, and if not, it's incinerated or dumped in landfills. But first, regardless of destination, it goes through a process called dewatering. The less water in sludge, the lower its volume and weight and the lower the costs of transportation, handling and disposal.

But separating water from solid matter in sludge isn't easy. It requires the use of chemicals called polymers, which cause the solid particles to clump together so that they can be separated more easily. The problem with polymers, though, is their price. They are one of the biggest expenses for waste-water-treatment plants, and optimizing their use can save a large city millions of dollars in terms of the polymer cost and the disposal cost of sludge.

PhD candidate Muhammad Salam conducting a jar test experiment to determine the optimum polymer dose of sludge samples.

Sample emulsion and dry polymers that are used for sludge dewatering.

Photos: Ben Welland, Byfield-Pitman Photography

Oh, and there's another problem with polymers—a pretty big one. Turns out, it's difficult to determine how much the dewatering process needs at any given time. It's sort of a trial-and-error thing. That means many treatment plants end up using too much polymer—up to 50 percent too much, by some estimates. Not only is that bad for city budgets, it is also bad for the environment. Those excess polymers, which are toxic to aquatic ecosystems, remain in the water discharged to rivers, lakes and oceans.

Soon, however, waste-water-treatment plants will have access to a new technology that can determine, in real time, the concentration of residual polymer in water removed from sludge. That will allow plant operators to optimize the dewatering process, adjusting polymer amounts up or down as necessary, depending on the ever-changing composition of waste water. This technology was born in a lab at Carleton University, created by a member of Van Geel's department.

SIMPLE YET SENSITIVE

Before coming to Carleton, Banu Örmeci conducted research at Duke University in North Carolina. During that time, she collaborated with a company and learned a valuable lesson. If you want to work with industry, you have to protect your intellectual property. Think patent first, publish later.

"In academia, the priority is publication. People want to publish and present their results as soon as possible. After working with companies, I saw that for them, protecting intellectual property is the most important thing. In academia, we do great research but we just give it away," says Örmeci. "Companies want to make sure they own the rights to a technology if they are going to invest in it."

To get a patent, an applicant has to prove that an invention is novel and "non-obvious." That means it has to exhibit some degree of inventiveness—enough so that it couldn't be considered a minor and obvious improvement to a technology that has already been publicly disclosed. The funny thing is that in academia, because there is so much emphasis on publishing, it is often a researcher's own work that ends up destroying any chance of obtaining patent protection.

"The biggest problem is with the inventor himself," said Andrew Pasternak, director of commercialization and business development for GreenCentre Canada, a federal program that helps bridge the gap between academia and industry for green chemical technologies. "Has he disclosed his invention in a paper or at a seminar? Well, guess what. The intellectual property is gone."

In recent years, the federal government has pushed for increased

MASc candidate Yan Ze injects polymer in sludge before measuring its rheological properties to predict its behaviour during dewatering.

Photos: Ben Welland, Byfield-Pitman Photography

commercialization of academic research. On applications for grants from funding bodies, researchers now have to explain how their work could potentially benefit the economy. Protecting intellectual property is part of that equation, and some universities have made efforts to get researchers on board, with limited success.

"It's a tough sell sometimes with academics. Many professors go charging out there and start publishing, and they are not interested," said Pasternak. "The incentives for commercialization and the incentives for the advancement of an academic career are not the same. They are completely misaligned, actually. For academics, their lifeblood is papers and the next research grant."

For chemical researchers who are interested in taking their inventions to market, GreenCentre Canada offers assistance on several fronts. It has lab space and in-house technical expertise to help inventors take their research to the next level. The centre's commercial group focuses on matching promising technologies with suitable partners in industry. It will also handle the process of obtaining a patent, which can be lengthy, tedious and expensive. GreenCentre, for example, has done all the intellectual property work for Örmeci's project, freeing her to focus on research rather than paperwork.

Before she began working with the centre, though, Örmeci had the foresight to apply for a provisional patent in the United States. That was in 2012, just before she presented her research at a conference in North Carolina. A provisional patent provides one year of intellectual property protection and can be obtained online for a small fee. It is also easy to apply for one in the United States, according to Örmeci, because unlike in Canada, you can do it yourself without the services of a lawyer.

That turned out to be a smart move, because her presentation at the conference generated a lot of interest from members of industry. Not long after returning to Ottawa, in fact, Örmeci found herself in business with a 162-year-old company with $35 billion in annual revenue and 179,000 employees all over the world.

GOING FULL-SCALE

Let's say you do everything right. You make a useful, novel discovery in the lab that can solve a real-world problem. You apply for patent protection before you disclose your research in a paper or at a conference. You get a government agency on board to help you take your invention to market. Surely a successful product is just around the corner. Actually, it's not so likely.

"It is rare that all the key players come together," said Örmeci. "Going from invention to commercialization takes 10 to 15 years normally, and there are many roadblocks."

To clear those roadblocks, it helps to pique the interest of a company with the resources to take your innovation from beaker level to full-fledged, field-tested, legitimate-product level. For Örmeci, that company turned out to be Veolia, a France-based environmental-services firm with activities in water and waste management. They also have several offices in Canada.

"Veolia is delighted to be working with Dr. Örmeci on this important project," Nathalie Martin-Ionesco, a director with Veolia Water Solutions and Technologies, wrote in an email. "She brings a deep understanding of both the technical and practical issues in developing new waste-water technologies, and her ideas are truly unique and impactful."

Örmeci worked with the company to test her polymer-detection method at several waste-water-treatment facilities in the United States. The results were so promising that commercialization may be completed in a fraction of the time it usually takes to go from lab to market.

Photos: Ben Welland, Byfield-Pitman Photography

"As a researcher, I don't have the resources to do full-scale testing," said Örmeci. "Veolia provided a team and the resources, and that is why everything has moved so quickly."

Another reason her innovation is speeding toward commercialization is that the equipment already exists. If a completely new instrument had to be manufactured to measure polymer concentration, that would have been a major, if not impossible, hurdle to overcome. Who would make it? Fortunately, Örmeci's method can be implemented by using spectrophotometers made by an Ontario company called Real Tech.

"The company has to make some minor changes—to change the wavelength—but that is not very difficult," said Örmeci. "It suddenly opened up a whole new market for them, so the company is pretty happy."

So that makes two companies that stand to benefit from Örmeci's polymer-detection method. That doesn't mean, of course, there aren't others. She isn't done researching in this area, and there are many more possible applications for her work—in waste-water treatment and beyond.

FROM SLUDGE TO SLURRIES AND TAILINGS

Waste-water treatment isn't the only process with a heavy, waterlogged by-product that is shipped to places elsewhere. Polymers are also used to dewater oil-sand tailings, for example. Other industries that have to deal with slurry by-products include agriculture, coal mining and plastics manufacturing.

These and other industries could potentially benefit from Örmeci's polymer-detection method as well. As for how Örmeci stands to benefit herself, it isn't what you might think. That is, it isn't about money. If this venture does eventually turn a profit, money will flow from Veolia (which will sell the product) to GreenCentre Canada (which owns the rights to the technology) to Carleton University (which has a deal with GreenCentre

Canada) and then, eventually, some may trickle back to Örmeci to further her research.

"What is really rewarding for me as an engineer, after working hard in the lab, is to see my research being used at full scale at waste-water-treatment plants," said Örmeci. "It is useful. It solves a problem, an actual problem, a real-world problem. That is the real satisfaction."

Still, despite the reward of seeing her work used in a practical application, Örmeci is quick to defend the value of fundamental research with no immediate commercial prospects. Her current project is being touted as a success story made possible by the government's efforts to commercialize academic research. That is all well and good, said Örmeci. Academic researchers shouldn't be embarrassed to work with companies, and there is nothing wrong with the economy and society benefiting from one's work. The fruits of innovation wouldn't exist, however, without the seeds planted in basic science.

"I've done a lot of other research, which I've published. Did it have commercial success? No. But that doesn't make that research less valuable," said Örmeci. "All that knowledge and information fed into my current research. It should not be about applied research at the expense of fundamental research. Good fundamental research can lead to good products." CU