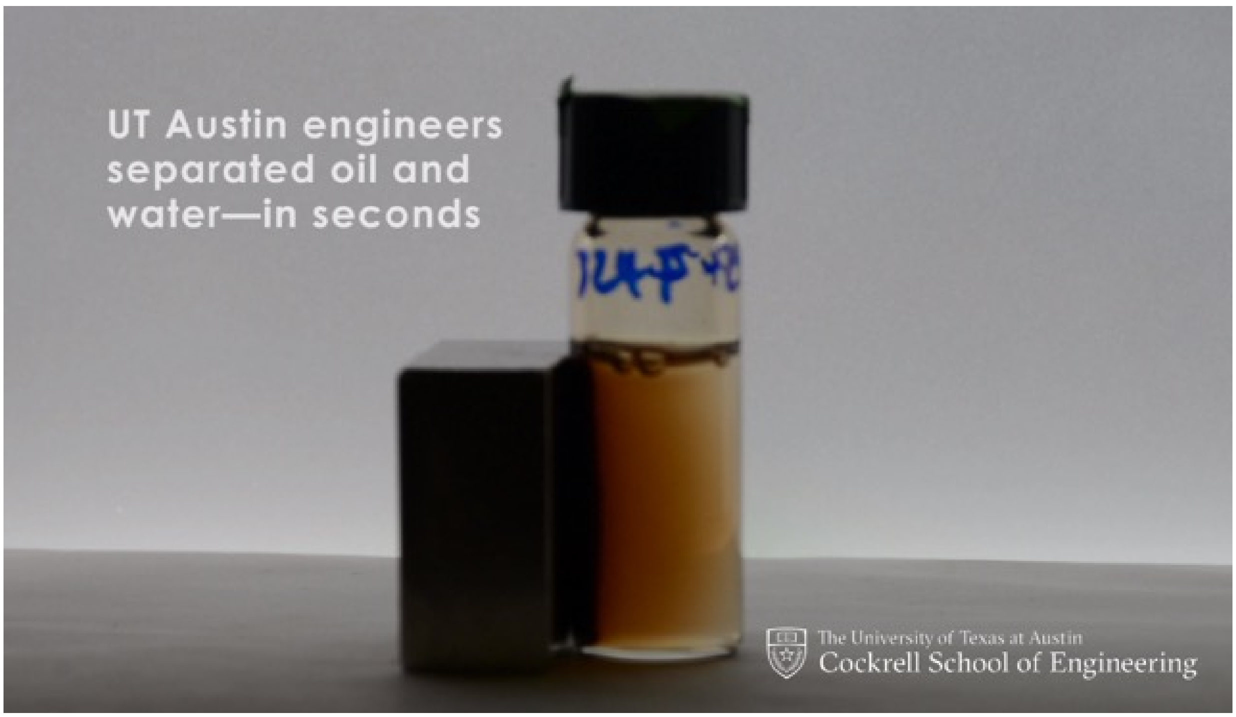
Nanoparticles and magnets offer new, efficient method of removing oil from water

June 8 2017



UT Austin researchers used a magnet and nanoparticles to separate oil from water in seconds. Credit: Cockrell School of Engineering

When oil mixes with or enters into water, conventional methods of cleaning the water and removing the oil can be challenging, expensive and environmentally risky. But researchers in the Cockrell School of Engineering at The University of Texas at Austin believe they may have developed a better method.

In a study published this spring in the *Journal of Nanoparticle Research*, the researchers used magnetic nanoparticles to separate oil from water through a simple process that relies on electrostatic force and a magnet. The engineers believe their new technique could improve water treatment for oil and gas production, more efficiently clean up oil spills and potentially remove lead from drinking water.

Today, nanoparticles, which are tiny particles that can be coated with different chemicals such as polymers, are used in a wide variety of areas and industries including medicine, energy and electronics. The versatility of nanoparticles inspired the UT Austin team to explore how the particles could be applied to oil production to lessen its environmental footprint and increase efficiency in both onshore and offshore drilling. They believe their technique could also be used to treat the millions of gallons of fresh water used in hydraulic fracturing and to help clean drinking water.

Modern oil production methods separate 95 percent of the oil from produced water but leave behind small oil droplets that are difficult to extract, which makes water treatment and disposal more challenging and environmentally risky.

"This new technique is really aimed at removing that little bit of oil in that water that needs to be removed before you can consider it treated," said Saebom Ko, a research associate in the Department of Petroleum and Geosystems Engineering and lead author on the study. "The advantage of employing magnetic nanoparticles is that the small oil droplets that attach to the nanoparticles are much more quickly separated from water than traditional physical separation processes because magnetic force can be orders of magnitude larger than gravitation."

Ko worked with a team including petroleum and geosystems engineering professor Hugh Daigle, biomedical engineering professor Thomas Milner and researcher Chun Huh to design surface coatings for magnetic nanoparticles that could be used for the removal of oil. They employed a technique, called high gradient magnetic separation, that has been used in mining to remove metals and in the food industry to remove toxic particles.

The team's main advancement is designing surface coatings for nanoparticles that are able to adhere to oil droplets using electrostatic force. The team coated the magnetic nanoparticles with polymers whose surface charge is positive. The positively charged magnetic nanoparticles then latch on to the negatively charged oil droplets through electrostatic attractive force, similar to how a dust-trapping cloth picks up dust. The process—which takes seconds in laboratory tests— could also happen in reverse. If the target substances have positive surface charges, the magnetic nanoparticles could be coated with negatively charged polymers to attract the target.

"It's a simple idea," Daigle said. "We are leveraging the magnetic properties of these nanoparticles to get them to stick to the oil droplets and essentially magnetize the oil droplets so they can be pulled out with a magnet."

The ease of the technique and the flexibility of magnetic nanoparticles have motivated the researchers to consider different applications.

"The applications can extend far beyond the oil field because, with an appropriate surface coating design, you can take your magnetic core and coat it with whatever chemical you choose on the outside to stick to the target and pull it out with a magnet," Daigle said.

The researchers have envisioned designing a method for using these nanoparticles to clean up oil spills in the ocean. They are also exploring how magnetic nanoparticles can be used to remove lead and other contaminants from drinking water, with plans to test their ideas this summer.

For oil and gas production, the team plans to develop a treatment system that would have the capacity to rapidly handle a high volume of oil and water, which would be crucial for onshore and offshore oil drilling sites.

"We are currently developing a chemical-free regeneration process to reuse nanoparticles. Other regeneration methods use chemicals to extract the oil, resulting in production of other hazardous waste," Ko said. "We believe that by recycling and reusing nanoparticles, it could not only reduce operational costs, but it could be an environmentally friendly process that reduces hazardous waste."

Provided by University of Texas at Austin