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Embracing nanotechnology's potential

Written by Elaine Maslin Tuesday, 01 March 2016 00:00

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Elaine Maslin examines some of the potential uses for nanoscale manufacturing in the oil and gas industry.

Nanotechnologies have seen a rapid increase in discovery and development over the past decade. In 2001-2008 there was a 25% increase in the discovery and in the invention of nanotechnology, including the discovery of new classes of materials such as quantum dots and graphene, most of which were passive nanostructures – i.e. not moving atoms to build structures, says Ricardo Melo, production enhancement advisor, at Spanish oil firm Repsol.

More recently, the US and China have been using nanoscale manufacturing, with China leading on an academic front and the US leading in terms of use in industry, he says. But, so far the oil industry is lagging behind adoption of this new technology.

"We are a little bit behind in the exploration and production industry. Renewables and biotechnology have been at this a long time, but [this means] we don't have to start from scratch, we can take it from the point they are at and move in to our world," Melo told the Production Optimization conference in Aberdeen, run by Offshore Network, in December.

Image provided by Repsol. Source: "Commercial scale production of inorganic nanoparticles," International Journal of Nanotechnology.

However, the potential to apply this technology in the industry is legion, he says. Potential uses include reservoir illumination, by enhancing the resolution for long range imaging, Melo says. This could be through nanosensors in the well bore or using nanoparticles as image contract agents for reservoir mapping.

In drilling and completions, they could be used in drilling fluids or to improve drill bit strength, using nanodiamonds, as well as in cement, using nano-emulsions or additives to enhance mechanical properties, he says. In logging and measuring while drilling, and next generation neutron porosity tools using Li-6 scintillation nanostructured glass

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ceramic, already being investigated by the likes of Baker Hughes (*OE: October 2015*).

In completions, high-strength nanostructured material could be used for flow control, frac balls, and plugs, as well as sand control, well bore clean up and more. In production, nanotechnology could be used in sensors, but also in fracking and acidizing work, though viscoelastic fluids, proppants and frac mapping. To remove has hydrates, air suspended self-heating Ni-Fe nanoparticles could be injected, or to prevent scale, production tubing could be lined with super hydrophobic surfaces.

Nanotechnologies could also be used in reservoir characterization and management, he says, suggesting reservoir flood mapping, oil-microbe detection tools using nano optical fibers, and nano sensors/reporters. There are also applications in enhanced oil recovery. Repsol's interest in nanotechnologies has seen it invest in technology start-up company Graphenea back in 2013.

So, what is holding use of these technologies back in our industry? The challenge in adapting them for the exploration industry, is making them able to withstand downhole pressure conditions, Melo says. "That's the main challenge."

Provided by: Repsol. Source: AEC

Reservoir illumination

The cost of developing and using nanotechnologies could also be prohibitive, which led Repsol to join a consortium – the Advanced Energy Consortium, or AEC. Its aim is to find technologies to illuminate reservoirs using micro and nano sensing technology.

AEC was founded in 2009, with 10 companies involved at the start. As the downturn has taken its toll, this has dwindled, but still includes Repsol, Statoil, Shell and Total. To date, the group has spent more than US$50 million in research, with some 50 patents filed and 200 publications, Melo says. The Bureau of Economic Geology at the University of Texas at Austin, is managing the organization.

In reservoir illumination, the AEC is looking to bridge the gap between seismic and well logging, or between long-range, low resolution seismic and high-resolution short-range logging. "We want a longer range but higher resolution using different types of sensors and contrast agents," Melo says. To do this, the research needs to aid understanding around the mobility of the nano particles in the reservoir, as well as finding the best contract agent and sensors (nanomaterial and micro-fabricated). There's some way to go yet. Contrast agents, for use in these areas, are 5-10 years away, he says.

Nano-sensor development, for use in reservoirs, is even further away, i.e. up to 20 years, he says. But, work is underway nonetheless. The University of Michigan developed 8mm X 8mm, optically charged and programmed temperature sensors. A second generation reduced the size to 3 x 1 x 2mm, pressure, temperature and ph sensors, containing a solar cell, radio, sensors, decoupling capacitor, batteries, and processor. But, it will still have to be a lot smaller still to be able to go into a reservoir.

In another area of research, the AEC is looking at two areas in enhanced oil recovery, active nano-EOR agents, which are coated with polymers to enhance the reaction, and reactive nano particles, or sensor effectors which could perform water shutoff when exposed to water.

Costs will also need to be addressed, Melo says. However, despite the cost of such materials, in an application such as enhanced oil recovery, by improving material cost effectiveness of surfactants, for examples, by lowering the interfacial tension, creating higher stability and lower adsorption, the amount of surfactant required would be lower, Melo says.

There are plenty more areas where nanotechnologies could be applied, he says. "There's a lot of application for technology. It's a completely new world, but we are not there yet. We are very close," Melo says.

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