

Alberta & Nanotechnology Applications for Oil, Gas, Petrochemicals: November 2007

This column focuses on the province of Alberta in Canada as an emerging and important global center for nanotechnology research and commercialization and some current and upcoming applications of nanotechnology to the oil & gas extraction, petrochemicals, and fuels & lubricants industries.

All reader comments are welcome.

The province of Alberta in Canada has the only governmental body in North or South America that has no debt and runs an annual budget surplus! The oil sands are a major contributor to both the provincial budget and the investment and revenue that is driving the rapid growth of the Alberta's economy. Natural gas and coal provide additional investment and revenue growth and add to the boom.

While Clean Energy, solar (which I cover in another column), wind, biofuels, etc. is a rapidly expanding industry globally (20% of all new VC investment in Silicon Valley was devoted to Clean Energy in the first half of 2007), oil, gas, coal, and oil sands will be the dominant form of energy supply for many decades to come.

This is true fundamentally because these energy technologies have leveraged literally trillions of dollars of investment in the production, distribution, and usage to continually reduce costs and increase efficiency – and our global industrial economy is based on using these energy sources. And also because the energy density per unit volume of oil, gas, and coal generally significantly exceeds those of replacement renewable sources, leading to major economic advantages in storage, distribution and use.

The real impact of nanotechnology on energy production, distribution, and consumption through 2050 at least will be in the traditional energy sector. Clean Energy growth starts from a very small installed base and will still be a small percentage of global energy supply in 2050 – possibly as high as 20% or as low as 5%, depending on which study you read and which assumptions you believe.

This column outlines some contributions of nano to traditional energy industries, especially the petrochemical – oil, gas, and olefin (plastics) production as well as for fuels and lubricants.

An excellent overview of the capabilities and potential of nanotechnology contribution to these industries will be presented at the <http://www.ibfconferences.com> Nanotechnology and Clean Energy Conferences in Palm Springs on February 5,6,7 in 2008. These conferences provide a superb venue to network with start-up, mid-size, and large companies, as well as with angel, corporate, and VC investors and a range of service providers (including myself) and research institutes.

Companies that wish to sponsor, exhibit, or present their nanotechnology products or services are encouraged to contact Dr. Sandra Helsel, Shelsel@IBFConferences.com to participate in this conference.

One newly established research institute that will be presenting at the Nano Conference is the Advanced Energy Consortium at the University of Texas at Austin.

The Advanced Energy Consortium (AEC) plans to develop subsurface nanosensors that can be injected into oil and gas wells. These sensors would be forced out of wells, through the existing pore space and into the surrounding formation pore space. There they would collect the reservoir's physical characteristics, which could then be used for production optimization studies.

Consortium members presently include BP America Inc., ConocoPhillips, Marathon Oil, Occidental, Shell, Schlumberger Technology and Halliburton Energy Services. Project management will be provided by the University of Texas at Austin (UTA).

Industry members will each contribute \$1 million research funding per year for the first three years to underwrite the project. UTA will own all inventions resulting from the research and each member that contributes will receive a royalty-free, nonexclusive, irrevocable, worldwide perpetual license to use the inventions for noncommercial, internal use. They will also have the right to make, use and sell any patented inventions. UTA will license rights to third parties with the approval of AEC members.

More information about both the AEC and the application of nano to oil, gas, and petrochemicals is available at a web site provided by the American Association of Petroleum Geologists <http://www.aapg.org/explorer/2007/12dec/nanotechnology.cfm>

"Brian Towler is head of the Chemical and Petroleum Engineering Department at the University of Wyoming in Laramie. In a recent issue of the "International Journal of Nanotechnology," Towler and co-author Saeid Mokhatab theorized that nanotech could revolutionize the natural gas industry, from production to processing to pollution reduction.

"The gas industry represents a major prospect for substantial, near-term adoption of nanoscale technologies with sustained benefits . . . nanomaterials are incorporated into a wide variety of hydrocarbon extraction, gas separations, solid-state gas sensors for air pollution monitoring, nanoadsorbent materials for environmental separations and corrosion inhibitors that are used in a broad range of gas industry markets," According to Towler, nanotech research has advanced far enough to begin producing practical applications. "The payoff is starting to come. . . We will see significant advances and adoption of this technology in the next three to five years," he predicted.

Looking Into the Future

Possible nanotech breakthroughs for the oil and gas industry could show up in:

✓ **Enhanced materials:** Inclusion of nanoparticles may lead to more durable and effective drilling components, lighter and sturdier offshore platforms and a variety of corrosion-resistant materials, among other benefits.

✓ **New separators and nanomembranes:** Stable and lightweight membranes could be used to filter impurities from heavy oil and tight gas, as well as in environmental applications.

"There are particular separation technologies that will be extremely useful – not only for the exploration and production industry, but also for the carbon-capture issue," <Towler> added.

✓ **Advanced fluid additives:** Nano-scale additives might be used in everything from improved drilling fluids to more efficient and environmentally friendly fuels.

✓ **Sensors and imaging agents:** The special electrical and magnetic properties of nanomaterials make them well suited for use as injected sensors and contrast agents. "Because they can withstand high temperature and pressure, nano-scale sensors could be especially useful for characterizing deep reservoirs." <Towler commented>

<http://www.norcada.com> in Alberta has focused on nano-based temperature and pressure sensors. According to Graham McKinnon, founder & CEO, "Norcada has developed a thin-film based hybrid electronics fabrication process to produce electronics capable of operating at 225 °C or higher temperatures. Our initial focus in this area has been downhole applications where reliable operation at temperatures up to 225 °C is required for directional drilling control electronics and pressure and temperature measurements circuits."

The leading company in Alberta in the corrosion resistant nanotechnology area is www.quantiam.com. The founder and CEO, Dr. Steve Petrone, said on October 19, 2005, in an article published in the Globe & Mail newspaper, "Olefins – the extracts used as the basis for products such as plastics, lubricants, and antifreeze – represent the largest group of petrochemicals manufactured in the world. They are also among the most energy intensive, since the process of extracting them calls for a facility lined with thousands of metres of pipe, all of which must be heated to temperatures upward of 1,000 degrees centigrade.

The furnace structure is several stories, high . . . when you're trying to maintain an entire furnace, which is huge, at those temperatures, your losses are so high that the energy requirements are not linear with temperature . . . Whereas currently, the walls inside the furnace are coated with a material that is intended to remain neutral during the thermal extraction process, Quantiam has used nanotechnology to design a catalytic coating that participates in the process and brings down the required operating temperature by 50 to 100 degrees.

That might not sound like much, but the difference could be worth billions of dollars in energy savings to plant operators around the world. And in countries like Canada, which have approved the Kyoto Protocol, it allows these operators to decrease their greenhouse gas emissions at the same time. Mr. Petrone expects that solution to become even more sophisticated, with research intended to further enhance the catalytic participation of the furnace coating, so that the temperature can be dropped as low as 700 to 800 degrees. "That won't be an incremental change," he says. "That will be a total paradigm shift to the industry."

In November 2006 Quantiam launched a pilot plant to coat half a million square inches a year of pipes, valves, and fittings for olefin manufacturing plants. The fundamental benefit delivered by their nanotechnology coatings is the combination of the flexibility of metals combined with the corrosion and temperature resistance of ceramics. A blowout at a petrochemical plant can cost \$250,000 and a week of downtime to replace a \$5,000 fitting. Quantiam products can last the life of the plant, around five years, versus one year or so for standard products that are not nano-enhanced.

Per the company web site, in October 2007 Quantiam launched the "world-first mfg. facility to coat internal surfaces of complex shapes. Based on its novel platform coatings technologies, Quantiam is currently designing and capitalizing a new advanced manufacturing facility for application of coatings on the internal bores of complex shapes such as tubular/pipe products and other complex geometries. The launch capacity is projected at 5 million square inches (equivalent to ~35,000 linear feet of 4 inch diameter tubing) and readily expandable to 20 million square inches within 3 years. Quantiam has successfully developed platform coating technologies for a broad range of products and applications for addressing:

- severe materials degradation due to extreme temperatures, corrosion, or wear; and
- energy and GHG emissions reductions in major industrial processes.

Another new venture in the application of nanotechnology to oil and gas is funded by Shell. According to Offshore magazine, a publication of the Pennwell Petroleum Group, <http://www.offshore-mag.com/regionalreports/>

NanoDynamics, Shell Technology Ventures Fund establish JV *October 24, 2007 12:51 PM Offshore staff*: "BUFFALO, New York -- NanoDynamics Inc. and Shell Technology Ventures Fund 1 BV have formed a joint venture to develop new materials and products for exploration and production in the oil and gas industry. According to the companies, the joint venture, named Epik Energy Solutions Llc, capitalizes on NanoDynamics' capabilities in nanomaterial synthesis and product engineering.

"This joint initiative will target the application of nanomaterials and nano-enabled products to improve a broad range of exploration and production issues," says Keith Blakely, CEO of NanoDynamics. "With the rapidly increasing demand for energy across the globe, it is all the more important to examine ways of improving fuel extraction and processing methods through advanced materials and technologies."

http://www.nanostart.de/en/presscentre/pressreleases/2007/644.Oct_.html , a German VC investor, gave some additional information: "Epik Energy Solutions, L.L.C. will Develop Nano-enabled Processes and Products for Oil & Gas Industry: Buffalo, N.Y. Frankfurt am Main, October 31, 2007 – NanoDynamics Inc. an investment holding of Nanostart AG, announced the recent formation of a joint venture with Shell Technology Ventures Fund 1 B.V. to develop new materials and products expected to improve exploration and production efforts in the international oil and gas industry.

The joint venture, Epik Energy Solutions, L.L.C., capitalizes on NanoDynamics' capabilities in nanomaterial synthesis and product engineering, in applications ranging from solar energy conversion, energy storage, lightweight wear-resistant materials and water purification to enhanced down-hole and construction materials and taggants."

Another company, operating in stealth mode, provided us the following information: "we are working to develop existing mems/nano sensors to function as a compatible sensor system with an acoustic reservoir monitoring system. . .The primary focus right now is on identifying the location and progression of steam and water pressure plumes used in secondary recovery techniques in reservoir optimization, although we predict that as this project progresses we will discover additional applications. Over time we expect to be able to deliver 5x to 10x greater range than currently used systems, which translates to 125x to 1,000x greater volume for oil & gas reservoir mapping than is currently available."

Another article at: <http://www.aapg.org/explorer/2007/12dec/nanotechnology.cfm>
"Alicia Jackson studied nanotech at the Massachusetts Institute of Technology. She's now a legislative fellow for the U.S. Senate Committee on Energy and Natural Resources in Washington, D.C. "The main thing about nanotechnology is the incredible amount of surface area you have on each nanoparticle, or whatever you're using," she said . . . today's high oil and gas prices and growing energy demand, with projections for even higher demand in the future, have led nanotech researchers to look for uses in petroleum production, refining processes and fuels.

"The whole idea of putting nanoparticles into fuels to make them more efficient, or to burn cleaner, that's definitely something people are working on," Jackson noted. She cited work done by Oxonica, an international nanomaterials group with headquarters near Oxford, England. The company's energy division has developed ENVIROX™, a fuel-carried catalyst for diesel. According to Oxonica, ENVIROX saves fuel, catalytically removes engine deposits and reduces harmful emissions.

An interesting company working in this area is another stealth company that has developed a nano-based lubricant solution, initially used in power plants, that claims:

“10%-20% reduced fuel consumption; 5%-10% increased power; 40-95% reduction in exhaust emissions; and 80-98% reduced engine deposits!”

The oil lubricant additives reputedly sold to Chinese power plants are based upon:

“a nanodiamond core; a hydrophilic layer holds the core in place, a hydrophobic layer enables the nano-lubricant additive to stay dispersed with lubricant, and the additive turns moving friction into rolling friction – reduces the friction coefficient by over 20 times!”

This technology was developed in Tsinghua University in Beijing, China and is currently being commercialized for a variety of applications.

The Nano Applications and Advanced Materials Forum is sponsored by one of the groups promoting nanotechnology in Alberta, <http://www.edmonton.com>, who has invited Professor Steve Kuznicki, Canada Research Chair in Molecular Sieve Nanomaterials at the University of Alberta to participate in the lead panel at: <http://ibfconferences.com/ibf/viewdetails.asp?lstconfname=206>

Dr. Kuznicki’s prior engagements include commercial work as CTO of Engelhard Company, now owned by BASF, where he led research into new catalysts and materials and helped the manufacturing ramp up of new catalysts and materials to the 1,000 metric ton level. His current research focus includes (i) low cost and low energy method to “sweeten” sour gas, that is to remove contaminants such as CO₂ and Sulfur and (ii) a process for removing hydrocarbons from oil sands/tar sands without the use of water. Water usage is a major problem in recovering oil from oil sands, as clay is normally a component of the feedstock. When water is used the very fine clay forms a colloidal suspension that contaminates water for years, possibly decades, and the water can neither be reused for other purposes or returned to the environment.

There are many other applications of nanotechnology to the oil, gas, & coal extraction and power generation and fuel & lubrication industries that will be covered in later columns and in greater details.

Bo Varga of <http://www.USnano.biz> has a primary focus on nano & clean technology ventures. Much of his work in the past two years has focused on solar power. He works in the field of technology commercialization by helping start-up & early stage companies & projects acquire funding, customers, & teams, by leveraging a focused marketing process. Bo also works with a boutique investment banking firm <http://www.newcap.com> providing research and business input for nanotechnology-related projects. He has 28 years work experience in Silicon Valley & globally. From 2001 through 2004 he & his associates organized & staged over 60 nanotechnology forums & conferences in Silicon Valley and Washington, DC via the nanoSIG.

Bo’s prior high technology experience includes business development, funding, & marketing for image processing, reconfigurable computing, and software & hardware processing engineers for pre-press, & graphic arts & design companies, as well as stints at senior technical & executive recruiting. Contact: bvarga@nanotech-now.com