

Upstream Global R&D Efforts Continuing, with Caution

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While 2008 closed with lower demand for oil and gas and a corresponding drop in energy prices from their record highs in the summer, research and development (R&D) efforts across much of the upstream sector continue, although with a sense of cautious optimism. This was one of the findings of a global survey of the state of R&D in the oil field, in which various operators, service providers, and academic institutions were asked to provide insight on the major research projects to which the industry is devoting time, effort, and money.

The survey was sent to upstream professionals around the world, and was aimed at uncovering major research projects, their intended aim, and their stage of development. In addition, professionals were asked if the recent worldwide economic downturn had negatively affected their research efforts or had resulted in cutbacks in R&D spending.

The International Energy Agency still estimates significant growth in energy demand over the next 25 years. Between 2006 and 2030, world primary energy demand is estimated to expand by 45%—an average growth rate of 1.6% per year and one that will be overwhelmingly supplied by oil. To meet this demand, responders have indicated that the industry is developing new technologies along the following major fronts:

Deepwater/Subsea

Baker Hughes. The oilfield services giant is focused on developing next-generation field development and production technologies for deepwater wells and extreme high-pressure, high-temperature applications. Research in these areas involves ongoing projects that encompass both sustaining engineering and new product development. The

company's new Center for Technology Innovation in Houston is the focal point for much of this research, and is capable of testing full-size prototypes of equipment in a test environment with gas pressure up to 40,000 psi and temperatures up to 700°F.

SBM Offshore. Offshore engineering and installation specialist SBM Offshore Group is developing a steel catenary riser (SCR) connector deployment system for use with deepwater floating production systems. "The aim of this research was to develop a faster, lower-cost SCR lay system using mechanical pipe connectors rather than welded connectors, which are typically used for today's lay vessels," said Jack Pollack, Vice President of Research and Deepwater Development with SBM Offshore. "The mechanical connectors will enable SCRs to be used in deeper water with high-strength pipes and also increases SCR fatigue life, making them applicable to more offshore developments." Research for the SCR deployment system is well under way, and SBM Offshore expects to have a certified SCR connector ready for offshore use in 2009.

Nalco Company. Other service providers are focused on developing technologies that will facilitate production from ultradeepwater assets. "Many of the challenges of producing in these environments are still unknown today, and we have been partnering with oil companies, engineering companies, and consultants to gain a comprehensive understanding of the challenges posed," said David Horsup, Global Technology Leader of Upstream Research for production chemical provider Nalco Company. As part of this

mandate to understand the technical challenges of operating in ultradeepwater, the Energy Services division of Nalco has invested USD 1 million in a new laboratory and state-of-the-art simulation tools dedicated to ultradeepwater production technologies. Nalco is currently focusing much of its chemical technology research on solutions for flow assurance challenges. "Our technology will enable the successful development of fields that were previously deemed too technically challenging to bring online," Horsup said.

Production optimization is another major research effort, with the aim of developing new technologies and processes that maximize production from existing assets. "Specific focus areas include developing technologies that unload brine and condensate from low-pressure gas wells, providing comprehensive technical solutions for in-reservoir modification to maximize production, and providing rheology modifiers to allow the production and transportation of heavy oil," Horsup said. "These projects are active and will remain so, and for each area there are a series of deliverables that will be commercialized over the next 6 months to 3 years."

Southwest Research Institute. The independent nonprofit research organization has major research efforts under way in the areas of multiphase flow measurement instrumentation for deepwater production and methods to convert gas from small offshore fields into a product that can be shipped to shore without a pipeline. "The aim of the first project is to test and develop instrumentation that can help instrument manufacturers develop better products for accurate measurement of multiphase and wet gas flows, including providing

performance data at field conditions,” said Chris Buckingham, the institute’s Manager of the Fluid Dynamics and Multiphase Flow Section. “This work has been ongoing for several years, but has recently increased in volume.”

Converting gas into a storable and shippable product is of particular interest to operators of small offshore fields with no pipeline infrastructure present. “We are developing novel processes to achieve this conversion, which includes pilot plant operations. This work has also been going on for several years, and will continue for several more, most likely through field implementations,” said Buckingham.

Aker Solutions. The Controls group of Aker Solutions has two active R&D projects ongoing related to data and power transmission for deepwater production systems. The first is a data communications program with the goals of providing an open communication infrastructure and a suite of interchangeable components that support flexible solutions. The current R&D aims of the project are to increase communications bandwidth to meet the increasing data demands for subsea systems, to increase the operational

envelope and stepout distances for subsea systems from host facilities, and to facilitate the use of legacy control components within the subsea system.

The second R&D project aims to develop electrical power distribution networks that will enable stepout distances to be increased for multiplexed electrohydraulic systems. The project will also provide a flexible power distribution network capable of serving a growing number of new power consumers.

Both projects will take place over a number of years. The data communications project is anticipated to be ongoing into the foreseeable future, providing year-on-year improvements to offshore communications networks.

StatoilHydro. The program New Development Solutions is developing technologies that address the business challenges related to deepwater, offshore heavy oil, and Arctic areas. This research is being undertaken in StatoilHydro’s three research facilities in Norway.

Drilling Advances

Weatherford. Weatherford International is in the initial field trial stage of its ECD-Reduction Tool (ECDRT),

a downhole tool that is designed to reduce the equivalent circulating density (ECD), and consequently the bottomhole pressure, while drilling. In situations where high ECD is a problem, drilling is usually performed with lighter muds to minimize mud losses. However, this scenario also increases the risk of fluid influx when circulation stops, particularly in situations where the difference between the pore pressure and formation fracture pressure is small. The ECDRT allows heavier drilling muds to be used, which improves wellbore stability. The tool also reportedly extends hole intervals, reduces the number of casing strings required, and reduces both lost circulation and differential sticking.

Saudi Aramco/Baker Hughes. Saudi Aramco and Baker Hughes are participating in the joint development of an advanced nuclear magnetic resonance (NMR) logging-while-drilling (LWD) tool for slimholes in both horizontal and deviated wells. The tool has been in development for the past 2 years at the Saudi Aramco EXPEC Advanced Research Center with the aim of improving real-time drilling decisions through the use of next-generation NMR tech-



An engineer tests the functionality of downhole gauges on an Intelligent Well System at Baker Hughes’ Center for Technology Innovation in Houston.

nology. This tool will reportedly allow drillers to understand rock-pore characteristics, as well as the quantity of hydrocarbon and water present. Saudi Aramco states that this marks the first time NMR and LWD have been combined for the successful evaluation of slimhole applications, and the company is currently running field tests with the aim of developing reservoirs with significant quantities of tar.

Completions

BJ Services. The New Product Fundamental Research group of BJ Services is conducting research in the area of cement durability. The aim of the research effort is to develop additives that can substantially increase the durability of Portland cement in extreme environments. The project has a development timeline of 2 years and is 50% complete.

Heavy Oil

University of Tulsa. Researchers at the University of Tulsa are investigating heavy-oil multiphase flow phenomena in wells and pipelines as part of a 5-year, USD-1.5 million joint industry project that started in 2007. The project aims to develop a heavy-oil multiphase pipe flow prediction model that can be used during production design and operation. A model such as this would yield greater understanding of multiphase flow in higher viscosity oils, particularly with regard to interfacial structures, droplet formation, bubble entrainment, and slug characteristics in a flowing pipeline. Researchers also aim to investigate the impact of low Reynolds number oil flows in combination with high Reynolds number gas and water flows, which may yield new flow phenomena and concomitant pressure drop behaviors.

Under the Tulsa University Artificial Lift Projects (TUALP) program, the university is working on research projects that will develop next-generation electrical submersible pumping (ESP) systems for performance in heavy oil systems and under two phase flow. TUALP is also developing models and correlations to simulate ESP performance under two-phase flow conditions and when handling viscous fluids. The program is devising a transient simulator model for artificially lifted wells that will include reservoir and

tubing transient performance, downhole completion details such as storage and flow in the annular space, an artificial lift system, and downhole devices such as gas-liquid separators, pumps, and gas lift valves. This is an industry-funded project consisting of support from nine operating and service companies with no specific end date.

StatoilHydro. The Norwegian oil company has two R&D efforts under way in heavy oil. The first, which is part of StatoilHydro's New Development

Solutions program, is developing technology that addresses the business challenges related to developing heavy oil fields. The second effort, under the Oil and Gas Value Chains program, is developing competence and technologies that add value to existing heavy oil projects through production and transportation. Most of this work is taking place at the company's Heavy Oil Technology Center in Calgary. Like many StatoilHydro research efforts, these projects follow a timeline ranging from 3 to 10 years, the duration of



At Baker Hughes' drilling simulator lab in The Woodlands, Texas, this pressurized test simulator is used to reproduce downhole stresses on the rock while drilling.

which may change with changes to the company's technology strategy.

Increased Oil Recovery (IOR)

StatoilHydro. A program called the IOR-Reservoir Drilling and Well program has been established to supply StatoilHydro assets with the necessary technology and work processes to achieve desired recovery factors from all relevant areas. This includes identifying remaining oil; efficient drainage of reservoirs; and integrating people, processes, and technology. This project follows a timeline ranging from 3 to 10 years, the duration of which may change depending on changes to the company's technology strategy.

Unconventionals/Shale Gas

In its Annual Energy Outlook 2009, the US Department of Energy's Energy Information Administration (EIA) projects that unconventional gas resources like shale gas will make up more than 13 trillion cubic feet of the estimated total 24.3 trillion cubic feet of gas produced by 2030 in the US. The EIA attributes this unconventional gas supply increase to higher prices and improved gas production technology.

Pennsylvania State University. This estimated increase is the driver for the unconventional gas research projects under way at the Pennsylvania State University's Department of Energy and Mineral Engineering. According to Turgay Ertekin, Professor of Petroleum and Natural Gas Engineering at Penn State and an SPE Distinguished Lecturer in 2005, the department has basic and applied research efforts under way. "Our basic research involves understanding multiphase fluid flow dynamics in complex porous media, while the applied research program focuses on the development of optimized production strategies for unconventional gas reservoirs including tight gas sands, shale gas, and coalbed methane technology."

Ertekin explained that the overall purpose of both research programs is to develop models that can capture the actual physics of the fluid flow processes in complex domains while also providing practical implementations of that data from the user's perspective. "Both the basic and applied research programs are conducted in an integrat-

ed manner with the goal of providing an effective feedback mechanism from one to another," Ertekin said. "In other words, any further understanding that we develop in fluid flow dynamics in complex domains is implemented in new generation numerical models as well as artificial expert systems." The projects have already yielded some prototype models that are being evaluated as a screening tool for enhanced-oil-recovery processes, and some artificial expert systems that can be used in optimized field development schemes have been developed.

BJ Services. The New Product Fundamental Research group of BJ Services is working to develop a new series of additives for fracturing fluids that can improve production and ultimate recovery in unconventional gas plays. The project is 30% complete and has a total development timeline of 2 years.

Other Research Gaps Described

In addition to these research efforts, survey responders pointed to other areas in which the industry should invest resources.

James Pappas, SPE's Technical Director for Production and Operations, described several technology gaps that require additional development for success. "Economical methods to capture, measure, and store carbon and other greenhouse gases need development and testing in very short order. Near-term requirements will place a substantial financial and timeline burden on all companies, and the likelihood of this becoming a universal regulatory requirement means that it is imperative that operating companies plan now for their use."

Pappas also points to water usage and conservation as requiring more significant research investment. While produced water and fracture stimulation water are both vital to hydrocarbon production and further development, "sufficient cleansing and filtration comes at a cost that continues to rise, and in many cases that water must be disposed rather than reused," he said. While steps are being taken to improve and speed up the cleaning of this water, it often comes at great cost. "There is much to be done to improve the economics," Pappas continued. "With the

limitations of fresh water sources, it is becoming increasingly burdensome to find and/or transport water from source locations to well sites."

Other research areas on Pappas' wish list include improved single-trip completions systems. "These systems have made advances in terms of swellable packers and new hole cleaning methods, but still suffer from high costs and reliability problems." Improvements in power generation and efficiency are also needed, he said.

Pappas also pointed to subsea processing and pumping systems as requiring greater research focus. "Thus far, subsea processing, pumping, and compression systems have been limited to shallow water or projects with specific needs. Weights and complexities are an issue, as is the transportation of power, hydraulic fluids, and specialty fluids for corrosion and hydrate prevention. More needs to be done on all of these issues for these systems to gain acceptance."

More accurate field production measurement systems must be developed, he added. "In complex environments such as remote locations and deep-water, accurate measurement is difficult and expensive to accomplish. Yet many regulatory agencies require accurate determination of the production of individual segments, and operators need that data to effectively optimize production and reserve recoveries. Current measurement systems are just not adequate to provide this level of data... they are too expensive to install and maintain in all but the largest of projects worldwide."

In the arena of reservoir simulation and evaluation, Alberto Sampaio de Almeida, SPE's Technical Director of Reservoir Description and Dynamics, would like to see more research effort into developing the next generation of reservoir simulators with the capability of processing block models with grids in the hundreds of millions. He also mentioned a need for improved enhanced-oil-recovery methods for offshore, as well as improved recovery methods for extra-heavy-oil reservoirs. de Almeida also expressed a need for improved seismic evaluation of deep carbonate (presalt) reservoirs, including better seismic imaging and resolution techniques, 4D seismic, and multicomponent seismic imaging for fractured carbonate reservoirs.

Programs Continue Despite Economic Woes

In spite of the recent worldwide economic downturn, most research programs are continuing, with a long-term outlook of world energy needs. Nalco's Horsup expressed a research philosophy that many other survey responders shared, namely that, "We tend to take a long-term view, so a downturn today may not mean a reduction in investment. The medium- to long-term growth for a project may still be more attractive than for other projects that await resourcing in the R&D portfolio."

The key to success, Horsup continued, is "to focus on a handful of critical projects, resource them correctly, and ensure that they deliver on a timely basis. We cannot spread our investment across a diverse portfolio of technologies and try to progress all of them equally."

Many service companies see technology innovation as an imperative, regardless of the economic environment. "We are in the offshore contracting market,

where innovation is a requirement for future growth," said SBMs Pollack. "As long as the dollar-per-barrel price is sufficient for oil companies to continue to develop new fields with new technology needs, we must continue to develop the technology to make it possible and profitable for the oil companies. We also need to continue to invest in the means to stay ahead of our competition in existing markets."

While service providers are not scaling back projects yet, they are watching operators closely and will take appropriate measures based on their cues. Baker Hughes stated that while it does not plan its technology based solely on commodity prices, it does react to industry activity levels. The company has reviewed its research and engineering priorities in light of the current downturn, and it will make appropriate adjustments if industry interest or demand for technology currently under development wanes.

For academic institutions, many of which rely almost solely on industry

funding to drive their research engines, there is slightly greater concern as to what lower energy prices will mean for them in 2009. None of the academic responders have as yet experienced a slowdown because many of the current research contracts were initiated months or years before the recent economic downturn. Still, if the current economic trend continues past 2009, there is concern that academic R&D budgets will be reduced.

However, some academic researchers believe that lower energy prices will not translate to across-the-board funding reductions, but rather a shifting in funding priorities to other university projects. "We believe that as the price of oil and/or natural gas changes there will changes on the thematic research areas," said Ertekin. "For example, low oil prices most probably will slow down research efforts in the area of enhanced oil recovery and focus will be more on the development of more economical drilling and stimulation technologies." **JPT**

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