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Multiphase Pumps Enhance Production

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Special Correspondent

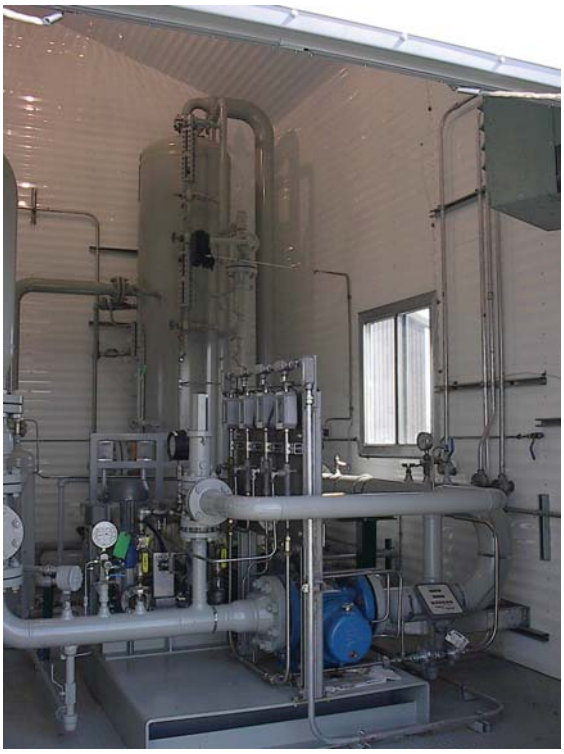
At the Primrose Air Weapons Range Northeast of Edmonton, Alberta, fighter planes roar across the frozen landscape as low as 200 feet off the ground as pilots from countries around the world better prepare themselves for combat. But on the ground below, Canadian Natural Resources Limited (CNRL) is engaged in a different kind of battle, where the fight is against the operational and economical challenges associated with producing crude oil so heavy that it clings to formation rock like sun-baked roofing tar. But CNRL is winning decisively, thanks largely to its new weapon of choice: multiphase pump technology.

Similar multiphase success stories are unfolding in fields from Devon Energy's 30-year-old Ferrier Field, only a stone's throw away in Central Alberta, to the Gulf of Mexico, where multiphase pumps are demonstrating powerful capabilities in subsea production applications.

Simply put, multiphase pumping enables the entire production stream–oil, gas, water, sand, etc.–to be moved from the wellhead to a centralized processing facility. This introduces a number of advantages, points out Stuart Scott, an associate professor of petroleum engineering at Texas A&M who leads the university's multiphase production systems research efforts and chairs an annual round table on multiphase technology and applications (see sidebar).

For one, dedicated processing facilities can be located miles from the production site, offering a number of advantages with respect to operating, economic and environmental factors. Wellhead separation and treating requirements, along with separate oil and gas flowlines, are also eliminated, Scott notes, along with costs related to capital equipment and maintenance needs.

But the biggest win for companies employing this new technology in enhanced recovery or marginal development scenarios is proving to be its im-



Multiphase pumps enable the entire production stream to move from the production site to a centralized processing facility, eliminating the need for wellhead separation, separate flowlines, etc. Perhaps even more importantly, however, the technology is enhancing production and improving profitability in both onshore and offshore operations.

Multiphase Round Table

Texas A&M University's Petroleum Engineering Department is conducting the Sixth Annual Multiphase Pump User Round Table May 5-6 in Houston, preceded on May 5 by the Multiphase Measurement User Round Table. The goal is to foster interaction between oil and gas operating companies, engineering design companies, equipment manufacturers and Texas A&M researchers, while presenting the latest information on multiphase pump and measurement technology advancements and field applications.

For more information, contact associate professor Stuart Scott at 979-847-8564 (e-mail scott@spindletop.tamu.edu) or round table coordinator Rudy Guerra at 979-458-2054 (e-mail rodolfo@spindletop.tamu.edu), or visit http://pumpjack.tamu.edu. ❐

By controlling pressures, multiphase pumping enhances reservoir flow and increases hydrocarbon production and recovery while mitigating pressure-related problems from the well bore to the gathering system. *Courtesy of Texas A&M Multiphase Research Group.*

pact on production enhancement, reports Tim Mabes at Bornemann Pumps. Installing a multiphase pump allows an operator to control the pressure in ways that enhance reservoir flow and ultimate recovery.

"A multiphase pump boosts pressures or allows reservoir draw-down so the well does not have to do all the work," Mabes explains. "It is easier for the oil and liquids to flow out of the well because there is less resistance. Traditionally, you would have to install a separator to separate the liquids from the gas, a compressor and a liquid handling system."

The prospective benefits the technology introduces have major implications for operators striving to make the most of maturing or marginal fields, helping make assets that had been uneconomic profitable to operate. "The technology is being used as an alternative for artificial lift in marginal fields," Scott says. "Operators are putting them in gathering systems where they may have had a separator and a compressor. Rather than resizing an existing separator/compressor system, they are installing a multiphase pump to draw pressures down in a wet gas pipeline system."

Strong Economic Driver

At its thermal heavy oil fields in Northeastern Alberta, investing in multiphase pumps has allowed CNRL to turn off the gas flares and turn up the profits. "The project was not predicated on installing the multiphase pumps to enhance profitability. Yet, at $5,700 a day in recovered gas, there is certainly a strong economic driver," comments Derek Wilkinson, a facility engineer at CNRL. "We can pay out one of the pumps in considerably less than one year based on the recovered gas alone."

The company operates more than 350 horizontal wells grouped in 12-well clustered pads. To recover this bitumen, CNRL uses cyclic steam injection to heat and stimulate the tar-like oil. Historically, casinghead gas was vented and flared. But given the lost value of that gas and tightening restrictions on atmospheric flaring, Wilkinson says CNRL determined in 2001 that flaring the gas was no longer a viable option.

"We could see the writing on the wall," he remarks. "And soon thereafter, an Alberta Energy & Utilities Board ruling required us to install vapor recovery on the pads or we would not be able to resteam another pad and produce out of it effective Jan. 1, 2004."

CNRL had no intention of waiting until 2004 to begin addressing the problem. The operator of an adjacent heavy oil property had been studying testing the use of multiphase pumps for vapor recovery, but CNRL took the concept and ran with it. It installed a prototype vapor recovery system using multiphase pumps in 2001, initially purchasing two Bornemann Model NW8.5ZK-85 pumps.

"We tried them and said, 'Yes, they work!' After installing the first two pumps, we began purchasing more in 2002, installing one pump per pad," Wilkinson offers. "We now have a total of 34 multiphase pumps in operation– the largest multiphase pump installation in the world. We did not invent this application, but we definitely get credit for the implementation."

The payback is significant. "Not only did we avoid a total shut-down from an environmental regulation standpoint, but we are adding 27 Mcf of gas per 12-well pad. Keep in mind we have more than 350 producing wells in the field," notes Wilkinson. "As of December, we were conserving 1.7 million cubic feet of gas a day. At a value of $6 per Mcf gross, that is obviously a strong economic incentive, and we were not capturing any of this gas prior to putting the pumps in. Actually in Wolf Lake Field, where our pads are quite played out, we use this recovered gas to make steam, allowing us to keep producing in a field we would not be producing if we were using purchased gas "

The economics are so persuasive, in fact, that Wilkinson avers, "Once you see the rewards, it is not hard to justify purchasing more multiphase units. We pay for a new pump installation in about 150 days gross to gross, and about 300 days net to net."

New Solution

In another production enhancement success, Devon Canada turned to multiphase pumps initially as a hydrate mitigation solution for its Ferrier Field. In production for more than three decades, the field still has more than 200 active producing wells.

"Portions of the field were basically freezing off for eight months of the year, from the time of the first frost until the ground warmed," notes Les Smyth of Calgary-based TG Engineering Inc, which installed the equipment for Devon. "Our investigation revealed that the low hydrate temperature (5 degrees Celsius at 200 psi) was being caused by the high pressures. It was clear the pressure needed to be reduced. We looked at conventional ways of doing it, but Devon is a progressive company and agreed to try a new technology."

Consequently, Devon installed a Model L4K 82-40 Leistritz screw pump. "Devon wanted only one piece of equipment instead of several, and obviously liked the added benefit of potential operating cost savings," Smyth goes on. "The pump successfully adjusted system pressure, allowing for continued production flow throughout the year and improved ultimate reserve recovery. It was estimated that before implementation, the field was frozen up an average of 210 days out of every year. All the down time was eliminated after the installation of the new pump."

On top of the added revenue stream

from producing year around, Devon is saving almost $84,000 a year in operating costs alone, according to John Carey, a Devon Canada production engineer who oversaw the project.

"We had estimated the payback period for the purchase of the pump at a little more than a year, but it has turned out to be far less," he states. "It has certainly done the job we hoped it would. The installation was so successful, in fact, that we immediately bought another pump."

Subsea Applications

Multiphase pumps are also being applied to improve the economics of subsea production in all types of offshore applications. "We have delivered 30 subsea pumps in projects all over the world," updates Per Skiftesvik with Framo Engineering Houston Inc., a company co-owned by Frank Mohn AS and Schlumberger Holding Norge AS. "The latest installations were completed in November and December for Amerada Hess in the Ceiba Field offshore Equatorial Guinea, where there are now six pumps in operation."

Typically, operators see increased production after installing multiphase pumps subsea, he continues. "It depends on the application, but significant production increases–on the order of 50 percent or more–have been experienced," Skiftesvik says.

The key is the amount of pressure in a subsea system, and by their nature, subsea developments tend to be under higher pressures–especially as water depth increases. "More water depth means more back-pressure, and the higher the back-pressure on the well, the lower the production," Skiftesvik explains. "If you can reduce pressure with a multiphase pump, you will be able to produce more. Plus, in the case of long subsea tiebacks, multiphase pumps can regulate pressures to ensure flow."

That comes as encouraging news for independents in the Gulf of Mexico. Independents already operate the majority of subsea developments in all water depths in the Gulf, and are increasingly using subsea completions tied back to infrastructure on the Shelf to develop smaller-sized discoveries in deep water.

"Marginal fields are one of the main applications for subsea pumps, helping to enable the development of marginal or small accumulations of hydrocarbons often located in remote areas," Skiftesvik points out. "If you find reserves too small to support a standalone development, you can use a subsea tieback to existing infrastructure and a multiphase pump to boost to the existing facilities. That combination can make small discoveries economically viable, and that is big."

Leistritz has installed multiphase units on platforms offshore Brazil and China to produce subsea tiebacks. "A multiphase pump stabilizes the whole production process," says Leistritz Corp.'s Sven Olson. "We see a lot of potential in the Gulf of Mexico for multiphase pumping, and think the technology will play a big role in the near future."

Bornemann Pumps has a unit in operation for McMoRan Exploration in the Gulf of Mexico, which potentially saved the expense of replacing a failed flowline, according to Mabes. "When one of its single-phase lines failed, McMoRan installed a multiphase pump and begin putting the gas and liquids through the same line," he details. "There was no need to replace the system with separate oil and gas lines running off the platform, and the cost of that expense was avoided."

Up-And-Coming Applications

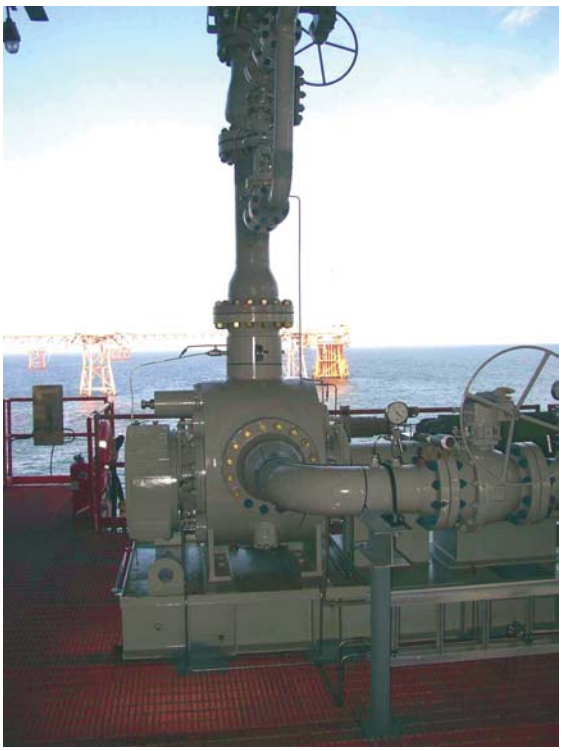
These early multiphase pump installations underscore the technology's ability to optimize production and improve operating economics in marginal and subsea applications, but what does the future hold for multiphase pumping?

"I see three up-and-coming applications right now: subsea, wet gas and downhole multiphase pumping," notes Texas A&M's Scott. "Several companies are looking at installing multiphase pumps at the bottom of the well, where you have to pump less gas than at the surface. But that is still in the research stage, whereas applications like subsea and wet gas have already progressed to commercial availability.

"The bottom line is that while multiphase pumping is still a new animal to the industry, it is presenting very attractive options for enhancing overall production economics," Scott adds.

Like any new advancement, there is a certain amount of hesitation when it comes to adopting multiphase solutions, but Leistritz's Olson says that can be expected to change once operators see what the technology can do. "The benefits are hard to resist," he comments. "Because of that, I think the acceptance of multiphase pumping will lag that of multiphase metering by only a few years."

Framo's Skiftesvik agrees. "A number of multiphase systems are now available and qualified, and the need for this technology will only grow in the future because the economics are so attractive, and because unlike a lot of other technologies, there is a big upside associated with using multiphase pumping," he concludes. ❐



In a Gulf of Mexico field that had separate single-phase flowlines for oil and gas, a multiphase pump was installed after one of the lines failed, allowing McMoRan to begin transporting produced gas and liquids through the same line and avoiding the cost of replacing the second line. ***Courtesy of Texas A&M Multiphase Research Group.***