A big leap forward in subsea technology

Subsea Technology Project pursues new systems and equipment to prepare ExxonMobil for field development in deepwater and Arctic frontiers.

ExxonMobil is moving subsea technology into the next generation. The implications will be far-reaching not only for the company but the oil and gas industry as well.

Some 20 technology areas are being developed within the Subsea Technology Project – launched in 2008 and led by a multidisciplinary team of ExxonMobil Upstream Research Company and ExxonMobil Development Company engineers.

From leading-edge separators (devices that divide oil, gas, seawater, etc., produced from a well), pumps and de-sanding units to long-distance power transmission and distribution, the technologies have one thing in common: They all give ExxonMobil a competitive advantage in developing tomorrow's offshore frontiers.

"Our portfolio of development prospects will increasingly include areas in waters one to two miles deep and beneath remote stretches of the frozen Arctic," says Neal Sosdian, project manager, ExxonMobil Development. "When the economics are right, we want to be ready with the technologies to develop these prospects, and we want to have people who are adept in applying them. That's what the Subsea Technology Project will achieve."

Sosdian emphasizes that past efforts focused on generating individual technology components as needed.

"The goal here is to ensure a complete 'toolkit' of subsea technologies that can be readily applied across our entire slate of upstream opportunities. Our development planners can then select which tools will deliver the most value for a particular prospect."

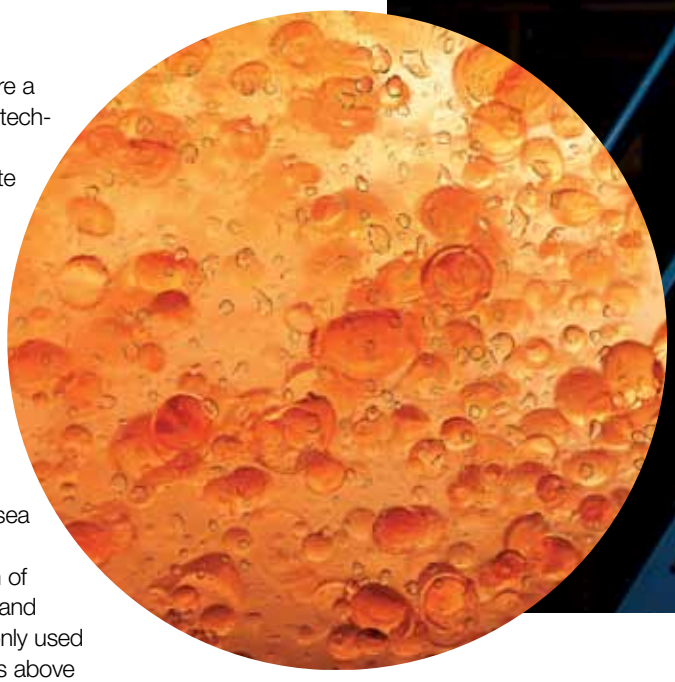
Seafloor innovations

Most of the technologies under development will offer capabilities not previously available to ExxonMobil subsea operations. The effort mainly revolves around modification of process vessels, machinery and electrical equipment commonly used on traditional surface facilities above water for operation more than a mile beneath the surface. Application of these technologies on the seafloor can make oil and gas reservoirs more productive by reducing backpressure on subsea wells.

Mandi Winter, of ExxonMobil Development and the project's Subsea Systems lead, says research has led to systems that can provide a greater level of separation in a variety of water depths up to the deepest ever developed.

"Our gravity separator, which expands on subsea technology first commercially applied only five years ago, will be ready by the end of the year," says Winter.

"Early on, ExxonMobil will have



Adam Bymaster (left) and Ed Grave, ExxonMobil Upstream Research, observe low-pressure testing of a pipe separator to be employed in the company's innovative subsea compact separation system. Low-pressure, transparent testing with model fluids provides insight into complex fluid behavior, such as droplet coalescence and the breakdown of foams and emulsions shown in the inset.

the option of using it to improve recovery rates from existing fields. Ultimately, it could have applications in developing isolated offshore fields in the Arctic and reduce or even eliminate the need for high-cost surface facilities."

Industry firsts

Several improvements make the ExxonMobil subsea gravity separator the first of its kind in the industry, most notably the capability for three-phase separation and delivery.

"We can process a wide variety of crude oils and meet target specifications on three distinct separation products – oil, water and gas – on the seafloor," says Ed Grave, ExxonMobil Upstream Research separation advisor for the project.

"Existing subsea separators were targeted for specific fields and must be re-qualified before they can be used with confidence in other fields that produce fluids with different physical properties."

Grave adds that the ExxonMobil subsea separator is designed for water depths up to about 5,000 feet.

"At this water depth, our separator can process as much as 100,000 barrels of oil per day. And larger production capacity is possible in shallower water."

Use in even deeper water is also possible due to vessel-manufacturing advances beyond the original design.

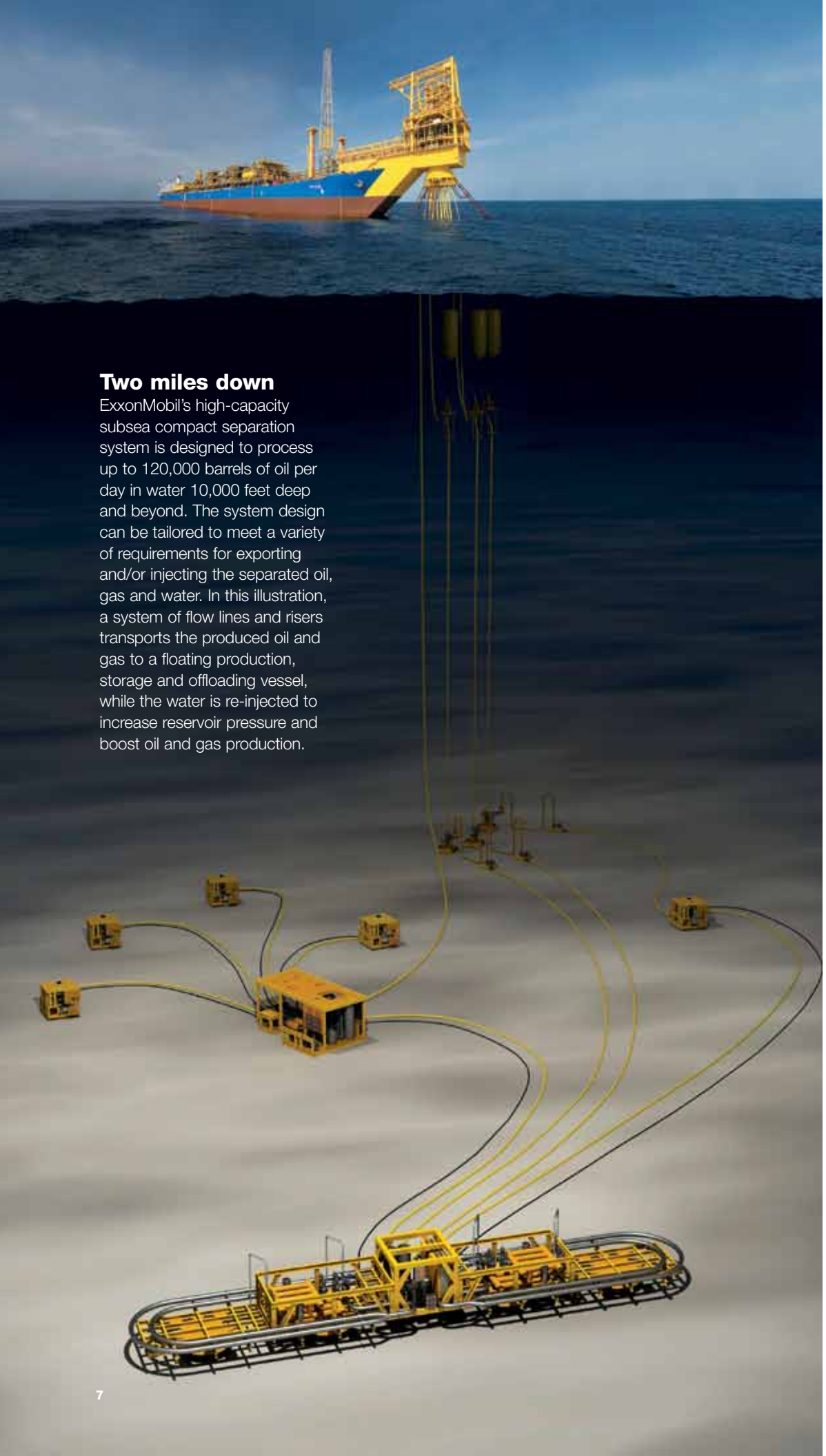
10,000 feet deep

However, the project's showcase technological advance for ultra deepwater is a state-of-the-art compact separation system, which can be applied in water depths of 10,000 feet and beyond.

The separation system features two novel components: an inlet slug-catcher for gas/liquid separation and a horizontal pipe separator for oil/water separation. Depending on the field, these components can be coupled with cyclonic devices that rely on centrifugal forces several thousand times the force of gravity to drive separation.

"The large vessels associated with gravity systems cannot withstand the high hydrostatic pressures nor the high well pressures found in very deep water," says Grave. "That is not the case with our compact separation system."

Grave notes that this new gravity/cyclonic hybrid approach will be the industry's most robust and comprehensive subsea compact separation system, capable of handling



Two miles down

ExxonMobil's high-capacity subsea compact separation system is designed to process up to 120,000 barrels of oil per day in water 10,000 feet deep and beyond. The system design can be tailored to meet a variety of requirements for exporting and/or injecting the separated oil, gas and water. In this illustration, a system of flow lines and risers transports the produced oil and gas to a floating production, storage and offloading vessel, while the water is re-injected to increase reservoir pressure and boost oil and gas production.

Illustration by Charles Wiese

higher production rates while meeting the challenges of flow fluctuations, heavy oil and sand.

The compact separation team at ExxonMobil Upstream Research, led by Adam Bymaster, is pursuing multiple ExxonMobil patents around the component and system innovations. Several ideas are also expected to find useful applications within more conventional topside facilities.

Qualification milestones

Meanwhile, testing of the gravity separator is scheduled for completion at ProLabNL in the Netherlands this summer, followed by tests of the compact separation equipment. ProLabNL features the world's largest publicly available high-pressure flow loop, which allows commercial-size testing of process equipment. The flow loop was designed with the ExxonMobil test program in mind.

"The flow loop enables three-phase separation tests using crude oil, simulated brine water and methane," says Michael Olson, an ExxonMobil Upstream Research engineer who is managing the gravity separator testing and qualification. "The flow loop is designed for 45,000 barrels per day of liquids and more than 100 million standard cubic feet per day of gas. That has allowed us to study our separator design under actual operating conditions."

Olson notes that due to hazards associated with high-pressure methane, ProLabNL built the loop outside with the appropriate safeguards.

"Other test facilities are typically indoors and use air, carbon dioxide or nitrogen as the gas phase for safety reasons. While acceptable for preliminary studies, these gases do not reproduce the physical properties you would actually see in the field."

In addition to influencing the flow loop design, Olson says

Michael Olson (left), ExxonMobil Upstream Research, and René Ubachs, ProLabNL, examine a water sample from the subsea separator qualification trials in the Netherlands. ExxonMobil and ProLabNL jointly developed safe work practices for the high-pressure tests, including sampling procedures and personal-protective equipment requirements.

ExxonMobil has contributed to the safety culture of ProLabNL, which was founded only three years ago.

"There is mutual respect and close collaboration between our two organizations, especially around safety," he says.

"ProLabNL modeled its safety program after our Operations Integrity Management System. They have also invited safety experts from ExxonMobil Development and the Rotterdam refinery to participate in several reviews and conduct safety-leadership seminars. We work together on a daily basis to meet our shared objective that Nobody Gets Hurt."

Working across organizations

Jim Zimmerman, offshore manager at ExxonMobil Upstream Research, who oversees the research company's contributions to the Subsea Technology Project, says the project has generated a highly effective level of interchange between ExxonMobil's upstream organizations.

"Both the research and development sides have roles to play on the same integrated, cross-company project team," says Zimmerman. "This has encouraged us to enhance relationships across traditional organizational boundaries. The engineers from the Development Company are being exposed to the rigor and depth of scientific investigation typically associated with researchers, and the research engineers are gaining a better understanding of the business needs and the practical side of technology application. This collaboration will benefit the entire upstream over the long term."

Zimmerman adds the project has also partnered highly experienced employees with new engineers, including Bymaster and Olson.

"Not only are the newer staff getting opportunities to work on the cutting edge of technology, they're also learning from seasoned engineers that ExxonMobil's total focus on operations integrity and reliability drives us to leave no stone unturned in technology qualification."

Value added from R&D

Lee Tillman, vice president of Engineering, ExxonMobil Development, says the Subsea Technology Project will add to the company's global reputation as a partner of choice.

"We can offer a comprehensive suite of subsea technologies to go with our project-execution expertise, our reservoir-simulation know-how and other competitive advantages to fit a specific opportunity that both we and a resource holder want developed."

Tillman notes that ExxonMobil regularly stresses in its communications to shareholders the importance of the company's strong investment in research, development and technology application of more than $1 billion annually.

"The subsea technologies generated by this project represent the types of value-added products made possible by that investment. They are broad and far-reaching and will greatly benefit ExxonMobil's forward-looking portfolio of resource-development opportunities around the world." the**Lamp**

Providing leadership for the Subsea Technology Project are (from left) Jim Zimmerman, ExxonMobil Upstream Research; Mandi Winter, ExxonMobil Development; and Neal Sosdian, project manager, ExxonMobil Development. The background photo shows ProLabNL's unique high-pressure flow loop for subsea separator testing.