Multi-organizational team advances seawater injection technology

Technical groups collaborate to develop a more compact and efficient deoxygenation system.

Like many of the offshore innovations in the oil and gas industry, Cameron’s CDX deoxygenation system is the result of a need for a technology that increases efficiency. And, as is typical when developing new designs, the idea lightbulb that illuminated the CDX system’s “Eureka!” moment didn’t come on all at once, nor was there just one lightbulb.

Starting in 2010, system development efforts were supplemented in part with ideas and contributions from technology providers Teledyne and LANXESS and technical and logistical support from Texas A&M University.

However, by 2010 the oil and gas processing industry had been using vacuum deaerator systems in combination with oxygen scavengers for decades, which had proven to effectively deaerate seawater for reservoir injection. These systems work by applying a vacuum to the water, which reduces the oxygen solubility, providing a basis for its removal through a vapor phase.

The result is water with oxygen levels low enough to be injected into a reservoir to enhance oil recovery without corroding pipes and other production equipment. So if vacuum deaeration systems could do the job, why did oil and gas processors have a need for another system?

Another option

As the first decade of the new millennium progressed, so did the technologies that enabled the quest for offshore oil and gas to increasingly move into deeper waters. Onshore, where process system designers are un fettered by height and weight restrictions, equipment with the dimensions of vacuum deaeration systems aren’t seen as a negative characteristic.

But for operators that need to treat water aboard FPSO units or on fixed offshore platforms, using a system with a tower that has an approximate flooded weight of 176-plus tons and a height of 24 m (80 ft) can require a titanic number of complex design accommodations. This is especially true for processing vessels acted on by motions related to offshore weather conditions.

Beyond these structural considerations and functionality, offshore process facility planners also face the challenge of complying with rigid size and weight design mandates that adhere to ever-tightening capex budgets.

The vacuum deaeration system’s chemical requirements also were presenting logistical challenges for operators using this system offshore. After being purchased, chemicals used to curb foaming and further reduce concentrations of oxygen below 50 parts per billion (ppb) are often stored onshore until they are shipped to offshore processing facilities, where they are stored until mixed for injection.

Beyond space and weight concerns, the offshore real-estate requirements and logistical challenges associated with this part of a vacuum-deaeration system were the main reasons customers started express-
The compact design of the CDX system offers a solution for operators needing to treat water aboard FPSO units or on fixed offshore platforms. (Source: Cameron)

### How it works

The compact design of the CDX as compared to traditional vacuum deaeration systems offers a solution for operators needing to treat water aboard FPSO units or on fixed offshore platforms. (Source: Cameron)

In a separate effort, the Cameron development team worked with catalyst technology provider LANXESS. This partnership enabled the team to identify compatible vessel materials that worked best with LANXESS catalysts. And, to prevent the catalyst from acting as a media filter, the team decided to install an ultrafiltration unit upstream of the catalyst vessel.

By late 2015, with problems solved and system tests completed—most were conducted at Texas A&M’s facility in Galveston, Texas—the Cameron team had developed the CDX compact deoxygenation system that uses no chemicals.

### The effort to develop an alternative to vacuum-based systems began with the idea that a wet catalytic process could be used to consume the dissolved oxygen in seawater. “Although this approach had been tried before with mixed results, we were convinced the theory of a catalytic process system was sound,” said Luis Caires, director of product development for liquids at Cameron. “And the principle of the system is simple: Hydrogen is produced and injected into a seawater stream in the presence of a palladium catalyst in a pressure vessel. This causes the hydrogen to react with the oxygen contained in the seawater, which produces water with oxygen levels low enough to be injected into a reservoir.”

Convinced that the wet catalytic process could not only work but could be used in a system with a compact design, members of the development team turned their attention to the catalytic process system’s four main components: palladium catalyst, liquid-filled catalyst vessel, inline mixer and a hydrogen generator.

“After some research, we determined that one of the weak links in the system was the hydrogen generator,” Caires said. “We approached Teledyne and decided to work with them because they’re considered the foremost experts in the field of hydrogen generation. They provided us with access to their hydrogen generation unit and shared the relevant technological information with us. And through this opportunity we were able to define a reliable hydrogen generator design for offshore applications.”

### How it works

It treats incoming seawater by first measuring it with a flowmeter, which produces a flow-rate value that is registered by the system’s controls. Based on this value, the system produces and injects a proportional amount of hydrogen gas into the water upstream of the system’s inline mixer. The mixer ensures the dissolution of the hydrogen gas into the water. The resulting water/hydrogen mixture is then routed to the catalyst vessel, where it contacts the palladium catalyst. Once there, the oxygen in the water reacts with the dissolved hydrogen. This produces water with oxygen levels below 10 ppb oxygen, which is adequate for reservoir injection.

The compact CDX system’s substantially lighter weight and overall height of less than 9 m (30 ft) enables it to fit or be retrofitted between decks on most offshore processing platforms or FPSO units. Its startup and shutdown times are a fraction of those for a vacuum tower. It doesn’t require high amounts of power to run vacuum pumps, and it eliminates the seals, gaskets and pipe joints that ensure a vacuum is maintained.

The system also eliminates the need for complex support structures and dynamic and motion performance issues that affect anti-foam measures. It operates at ambient temperatures, eliminating the need for heat exchangers and, depending on the water supply pressure, the CDX system might not require booster pumps.

The CDX system is the product of efforts from Cameron and its collaborating team members to advance seawater treatment technology. This technology gives those processing seawater for EOR a deoxygenating system that is compact and efficient. In this era of capex and opex scrutiny, it would be hard to overvalue these benefits.