

Small Bubbles, Big Rewards for Separation Technology

Trent Jacobs, *JPT* Senior Technology Writer

Reminiscent of the song made famous by late Hawaiian crooner Don Ho, tiny bubbles are the focal point of a new innovation aimed at transforming produced water from a costly byproduct into a valuable asset.

Termed nanobubbles, they are several times smaller than a human red blood cell, which allows them to play with the physics of how dissolved gas interacts with liquids, according to Nano Gas Technologies. The suburban Chicago-based startup says its technology is capable of cheaply producing these nanobubbles to treat produced wastewater that is among the “worst of the worst.”

The technology works by pushing gas, either oxygen or nitrogen, through a nozzle head that shoots the tiny bubbles into a treatment tank. The result is what the company’s chief executive officer, Len

Bland, calls “fluffy water” that causes suspended solids to fall and oil to float to the top where it is easily skimmed off.

“If you want to put it in technical terms,” he said, “we change the specific gravity of the liquid so that it enables the oil that is stuck in the water to rise.”

Bland went on to explain that because the bubbles are so small, significantly higher levels of dissolved gas in water can be achieved than under normal temperatures and pressures. For instance, tap water tends to have a dissolved oxygen concentration of about 5 ppm. Nano Gas says its technology generates concentrations more than 10 times that figure.

Founded in 2013, the company is hoping the industry will take notice of its first unit that it began operating last year for a disposal well company in the Permian Basin town of Seminole, Texas.

“This stuff is just sludge,” Bland said of the produced water quality being processed at the site that is mostly coming from the bottom of settling tanks and the washout from trucks used to haul the water to and fro.

Before it is run through the nanobubble system, the water has already been through multiple conventional separation processes but “at the end of the day, they still have this dirty water that they are putting into their disposal well, potentially clogging up that well,” Bland said.

He noted that despite such problems, injecting produced water deep underground is still the most affordable option for nearly every operator around the world. But the company believes its system makes water handling cheaper, and possibly profitable, by enabling companies to recover the oil that typically represents 0.5% to 3% of injected fluids.

The company designed its business model to introduce as little risk to the client as possible. Instead of charging a per barrel fee, renting, or selling the equipment as many other treatment services do, the company retains ownership of its system and makes money by splitting the sales of the recovered oil with the disposal well operator.

After processing, any revenue derived from the sale of the treated water is also shared. Bland said the end product is of a good enough quality that it can be sold back to an oil company that may be looking to reduce the amount of fresh water used in hydraulic fracturing.

Because many oil producers operate a sizeable portion of their own disposal wells, Nano Gas believes the payoff would be substantially greater for them since they could recover more of their own oil



A nanobubble-based wastewater treatment system operating for Permian Disposal Services in Texas. The system’s developer says it is treating about 11,000 B/D day of produced water and enabling the operator to recover nearly all of the 2–3% of oil (by volume) that is mixed in with the water. *Photo courtesy of Nano Gas Technologies.*

and not have to pay a third party for the recycled water.

The company reports that it has successfully clarified tank bottom water without any upfront treatment processes. Such demonstrations are hoped to show that the technology can work under nearly any circumstances and that capital costs can be further reduced by eliminating the need for equipment such as heater-treaters, centrifuges, and settling tanks.

The company also says that when oxygen-nanobubbles are injected into produced water, a chemical reaction takes place that knocks out hydrogen sulfide (H₂S), a toxic chemical that is so corrosive it easily eats through thick steel. The oxygen also acts as a biocide, killing harmful bacteria that could cause further downhole damage.

But because oxygen is itself corrosive, nanobubbles containing nitrogen gas are introduced into the treated produced water to displace the oxygen-containing nanobubbles. The final product is a nonreactive water that could help extend the lifespan of disposal wells prone to skin and plugging issues caused by the extremely poor quality of the injected fluids.

The nitrogen-infused water could also be beneficial to waterflooding operations since the gas is known for reducing the interfacial tension of residual oil trapped in mature reservoirs. Building on this advantage, the company claims its nanobubbles are long-lasting. This characteristic not only keeps oil and water separated for weeks, but in a waterflood scenario, the nitrified bubbles should also remain intact and

exposed to the formation long after the initial treatment.

The microscopic size of the nanobubbles gives them stability and an average half-life of 15 days—meaning that after that period, half of the bubbles remain intact and in solution. Large bubbles, such as those generated by other water treatment and separation technologies, tend to burst in seconds which Bland said wastes up to 90% of the energy and gas used to create them. Nano Gas believes that its bubbles are two orders of magnitude smaller than what anyone else in the oil and gas industry uses.

The company's research found at least 50 other industries that might benefit from nanobubbles, including wastewater treatment and poultry farming—the oxygenated water may help chickens grow faster.

Search for Flight MH 370 Shows Durability of AUVs

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The unprecedented search effort for Malaysian Airlines flight 370 has yet to achieve its main goal of locating the vanished aircraft and the 227 persons on board. However, it has served as an endurance test of sorts for offshore surveying systems such as the autonomous underwater vehicle (AUV), which just a couple of years ago was considered an emerging technology with a small track record. Edward Saade, president of the ocean surveying firm Fugro Pelagos, the company contracted by the Australian government to carry out much of the search operation, said he knows of no other commercial project where AUVs have been successfully deployed for such an extensive period of time.

Speaking at the 2016 Offshore Technology Conference in Houston, Saade said that to cover large swaths of sub-sea terrain as quickly as possible and capture high-resolution data, Fugro first deployed vessels equipped with conventional deep-tow side scanning sonar. Then starting in January of last year, the AUV vessel was deployed from Perth.

“The purpose of the AUV was to try and get into all those areas that turned

out to be blocked in the side-scan operation, either by the steep slopes or other types of data anomalies,” Saade said. “We would preprogram the AUV, launch it and it would do its thing for about 24–28 hours and very effectively fill in all the gaps.”

In the future, he suggested that it may be possible to use a larger number of AUVs and deploy them from multiple points to carry out such large surveys. But the limits of today's AUV technology meant covering the 120,000 km³ of Indian Ocean that make up the search area—roughly the size of New Zealand—would have taken about a decade.

“I have completely bought in to the AUV approach,” Saade said. “So going to a deep-tow approach almost seemed like a step backward, but it turned out to be the exact right approach for something on this massive scale.”

The AUV that Fugro used in the project is the Kongsberg-Hugin 100 model, which was selected because of its technological abilities, and since there are many in production, replacements or spare parts would be readily available. The sensors on both the AUV and the deep-tow

units were the same, which allowed the data to be seamlessly integrated.

Saade discussed many other details of the search effort which has taken place in one of the most remote and unexplored areas of the planet.

He said the initial seabed survey revealed that the actual water depths in some areas were more than a mile shallower than what existing ocean maps suggested. This proved to be a critical data point in helping Fugro select which sensors to use and it also meant the operations would be a little easier to perform.

When investigators turned to Australian satellite operators to look for any sign that the aircraft's communications system sent locating information up to space, the companies all said that they use the area in question for downtime and maintenance.

And despite the “hellacious seas” that are common during the winter months in this part of the Indian Ocean, Saade noted that the project has incurred very little downtime, most of which was due to crew illnesses and not equipment failure. **JPT**