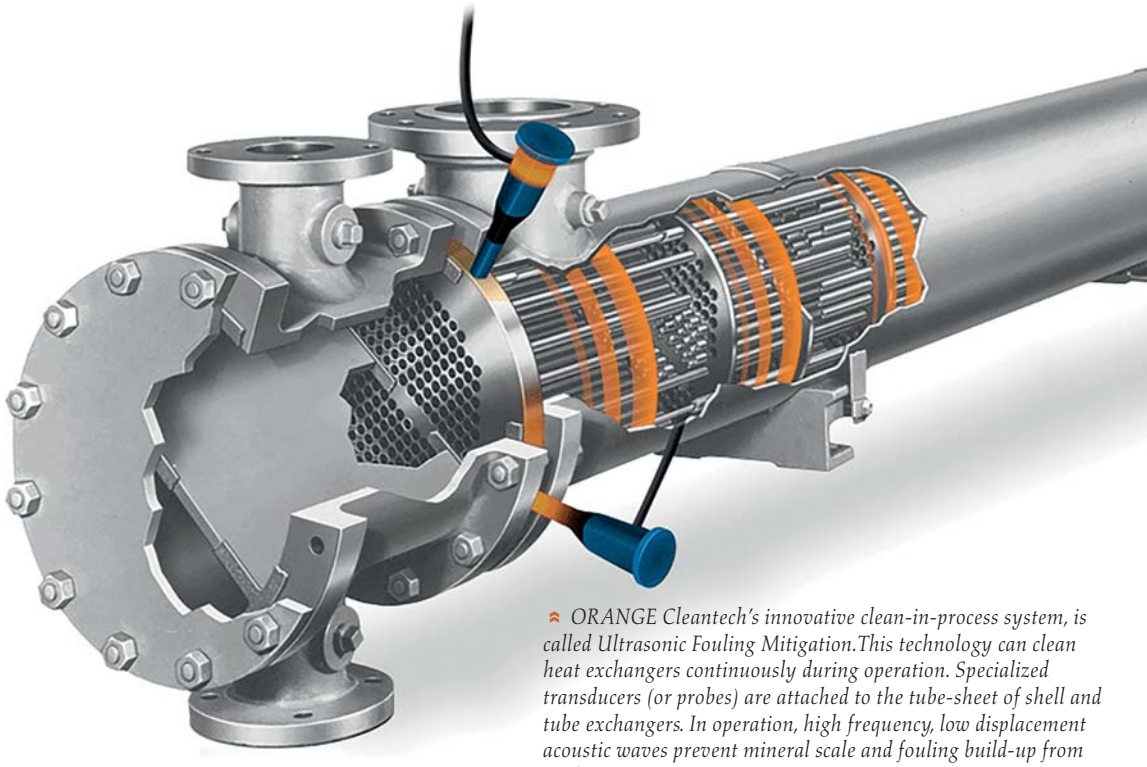
ORANGE Cleantech Inc.'s innovative *clean-in-process* technology

For heat exchangers, one of the biggest causes of failure or poor performance, is fouling. For years, engineers have been searching for solutions to stop fouling before it begins. ORANGE Cleantech Inc.'s innovative ultrasonic heat exchanger clean-in-process is an answer the industry has been looking for.

Heat Exchanger World **had the opportunity to speak with Russell Philion, President, and Chief Technology Officer of ORANGE Cleantech Inc., about the company's history, the carefully thought-out testing process for their innovative cleaning solutions, and his hopes for the future of industrial ultrasonic cleaning in the world of heat exchangers.**



ORANGE Cleantech's innovative clean-in-process system, is called Ultrasonic Fouling Mitigation.This technology can clean heat exchangers continuously during operation. Specialized transducers (or probes) are attached to the tube-sheet of shell and tube exchangers. In operation, high frequency, low displacement acoustic waves prevent mineral scale and fouling build-up from settling.

By Brittani Schroeder and Sarah Bradley

In 2008, Russell Philion started in the oil and gas industry working in applications development. In his role, he was in charge of bringing in new technologies to the processing, and oil and gas field. "2009 is when we introduced to the world, the use of industrial ultrasound for cleaning heat exchangers, in the form of a very-large bath," he relayed. "While originally based out of Fort McMurray in Alberta, Canada, I knew that for the business model of cleaning exchangers with ultrasound to be successful, it would have to be adopted by processors in Houston, Texas." Philion learned early in his career that Houston was a 'mecca' for new technologies, and knew he needed to create a go-to-market strategy to get the industrial ultrasound technology there.

After traveling the world and sharing the benefits of cleaning exchangers in an ultrasonic bath, Philion learned from many maintenance professionals that there were in fact multiples of critical exchangers that were too large for the ultrasonic baths, while other, more complex processes made the logistics and economics of removing certain exchangers for cleaning– impractical.

" Clearly, we were missing an effective clean-in-process solution for these heat exchangers". With Philion's idea for an ultrasonic clean-in-process technology, he decided it was time to begin a new chapter of his career. In 2013, Philion founded ORANGE Ultrasonics. "ORANGE Ultrasonics is where we originally focused our R&D efforts. ORANGE Cleantech became the pivot for where sonication products to market were realized," he said.

A partner in technology

Ultrasound technology has been around as a commercially viable cleaning entity since the 1950s and could be used anywhere from a jewelry store to sterilizing dental instruments. Formula 1 racing teams break down their engine components, put the pieces in an ultrasonic tank, clean them up, and put it all back together. The nuclear industry uses ultrasound for removing grease and oil from different components, and the PC industry uses it to remove soldering oils and impurities from circuit boards. "It made sense to create these baths for industrial equipment as well, especially heat exchangers," said Philion.

Before ultrasonic baths were used in industrial applications, the main method for cleaning equipment was high-pressure water. "To this day, I would have to say

that the method most used for cleaning exchangers is high-pressure water jetting. While the environmental and cost impact of water and wastewater are of concern to the customer, challenges around personnel safety, remain a key sticking point. Do not get me wrong, I am a supporter of "hands free", water jetting for many line-of-sight applications. However, I do not feel jetting the outside of a shell-and-tube bundle will benefit as well as you might think. This is not a criticism of the many, exceptional companies providing water jetting services. No, this has to do with the physical geometric shape of the tube-bundle. The tight layering of tube configuration inhibits jetting from effectively reaching the outside surfaces of multiple tube rows, closer to the core of the bundle. This is where the bath truly shines. Immersion of the bundle allows ultrasonic cavitation to remove fouling from the areas other methods simply could not. While the bath has proven to be a safe and effective solution, it was of no use for the many other exchangers that could not, for one reason or another, be removed from the processing-unit for cleaning," explained Philion.

On Philion's quest to build a clean-in-process solution, he partnered with Shell Global. "The idea was already planted, and we just needed to find a way to develop it," he said. "Shell was a great partner, because they allowed us to conduct our testing in key production facilities around the world." In 2015, after significant testing, ORANGE Ultrasonics observed a full installation, and ran a year-long study in A/B comparison to better understand how well the technology would work at stopping the fouling in a heat exchanger. Philion continued, "We were able to get this third-party verification on how well the technology mitigated the fouling from staying, which was how we led-up to eventually pivoting the business. It was brilliant! Ultimately, we knew that we could improve the performance of these heat exchangers, and customers were very receptive to what we had to offer."

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Ultrasonic fouling mitigation – how it works

The innovative clean-in-process system, is called Ultrasonic Fouling Mitigation (UFM).This technology can clean heat exchangers continuously during operation. Specialized transducers (or probes) are attached to the tube-sheet of shell and tube exchangers. In operation, high frequency, low displacement acoustic waves prevent mineral scale and fouling build-up from settling. "In this way, we are able to improve the heat transfer efficiency and significantly lower operational-energy costs," Philion stated. "In the study we did with Shell, the company saved USD$1.4 million in energy savings from two heat exchangers, and another USD$270,000 in cost-avoidance for cleaning and maintenance."

It is important to note that the UFM technology needs to be paired with a clean heat exchanger, and the technology will keep it clean and stop fouling during operation. "I have had customers request the clean-in-process technology for dirty heat exchangers, thinking it will get rid of all the fouling that has built up, but it simply was not built for that. It is a preventative technology," he explained. "By design, the power distribution of our system is just enough to disrupt anything from sticking to heat transfer surfaces in the first place, but safe for all tube weld-integ-

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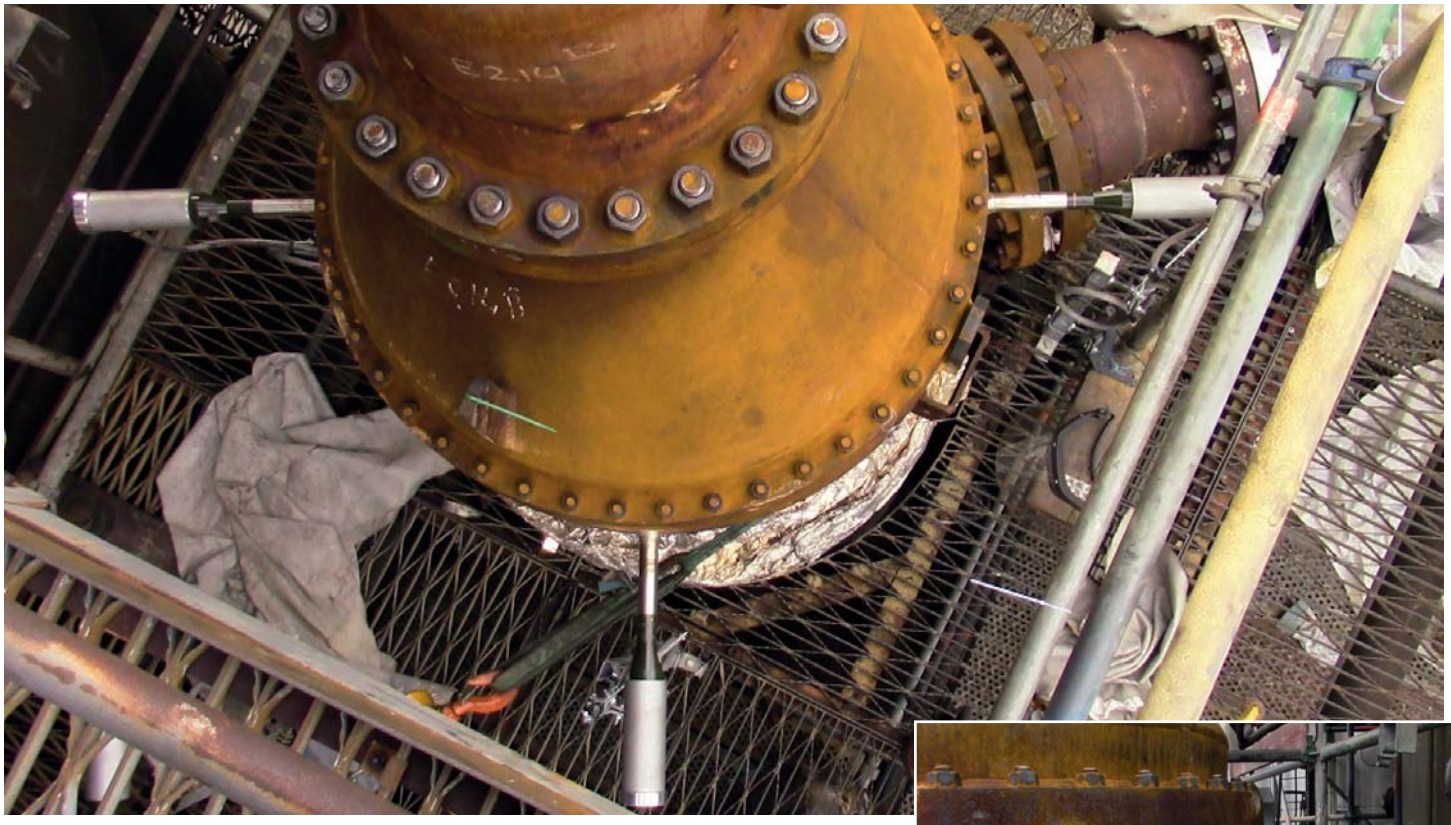

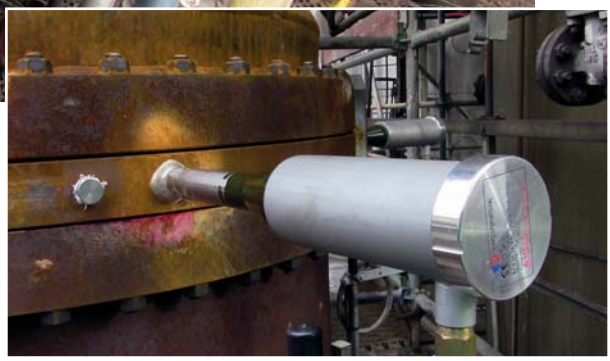

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UFM safe for all equipment

Every process is slightly different, whether it is chemical, petrochemical, oil and gas, water to water, and so on. Due to this, the fouling characteristics will all differ as well. "We match the equipment we use to the type of setup required, which means that every heat exchanger is going to be a little different. When we set up the probes on the heat exchanger, we have to calibrate them," Philion said. "We take the heat exchanger, which is essentially a big chunk of metal, and we search for the bundle's own acoustic resonance, and that is exactly what we are looking for." Philion's site team will cycle through ultrasonic frequencies on the scale' until they find the bundle's sweet spot, because they want to provide just enough ultrasound current to keep anything from sticking inside/outside of the tubes.

Philion has found that it is important for the process and reliability engineers to know how the system works, because "When I tell them we are going to agitate their heat exchanger, we hear a lot of 'You are doing what?' and 'No, you cannot do that,'" said Philion. The displacement of the tube sheet with the ultrasonic equipment running, is less than 5 microns, which is very low. This means that the UFM system is safe for the heat exchanger and all surrounding equipment.

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Prolonging heat exchanger life

Heat exchangers require significant logistics to move and replace. As they are such big components, a lot of work that goes into removing a fouled or damaged exchanger from its location and reinstalling it once it has been repaired. Philion and the ORANGE Cleantech team worked with a customer who had to swap out their heat exchanger every six days. "These heat exchangers fouled-out so quickly because they were in an unusually heavy Hydrocarbon visbreaker service, that after six days, they would switch to the second heat exchanger while they cleaned the first exchanger. This means that every six days, the customer would need to crane out the heat exchanger, take it apart, clean it, reinsert it, and bolt it back together. It was a huge safety and logistical concern," Philion relayed. "Generally speaking, if your maintenance team is taking out a heat exchanger for cleaning once a year, after ap-

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plying our ultrasonic clean-in-process technology, we can extend that to two to three years. When we installed our technology for this particular customer, we were able to extend from six days to 22 days," explained Philion. "The customers were so happy, and they just wanted us to get it to 12 days before they would swap the heat exchangers out. With some fine tuning on our part, we eventually reached a 30 day run time. It saved a lot of manpower and time for the maintenance team."

Future goals

Over the past three years, Philion and his team have seen their customers starting to participate in the evolution of the product. "Customers come back and say, 'Hey, you know it would be great if you could do this…or that'. They know their equipment better than we do, and they spend a lot more time with their equipment. Customers have become an integral part of our R&D side." revealed Philion.

Looking at the next five to ten years, Philion hopes to see more adoptions of the company's Clean-In-Process technology. "The company is still in the infancy stage, so I just want to continue to learn from our customers, and evolve technologies in-line, with customer needs," he said.

ORANGE is using a digital twin scenario to simulate some machine-to-machine learning. "We provide an acoustic signal that goes into the heat exchanger to disrupt the fouling, but the interesting thing is that we get an echo coming back. That echo can provide us data. Over the last six months, we have been working to translate and define those echoes, because as we work on different heat exchangers – in upstream or downstream processes – we are seeing the echo change. This is definitely indicating specific exchanger metrics that we should be able to translate into proactive steps for greater fouling prevention or clues to improved heat transfer."

With the recent social distancing requirements being implemented in all aspects of life, industry has been looking for alternative ways to ensure proper safety precautions. The ability to put preventative measures in place can help alleviate the necessity for unnecessary human interaction. "Social distancing has truly ramped up the need for smarter monitoring and process improvement tools to land in more forward-thinking refinery locations. Tools that deliver better heat transfer metrics—with less key personnel, having to be face to face," said Philion. "Ultimately, our end goal is to give companies the opportunity to run their equipment longer before they even consider maintenance, and we are looking forward to seeing that happen for more customers in more locations." «

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