

# THE ROBOTIC REVOLUTION

**Fintan Duffy, Re-Gen Robotics, Northern Ireland,** outlines the benefits of robotic tank cleaning solutions through the real-life example of an operation at a refinery in the UK.

**U**ntil the launch of 100% no man entry robotic tank cleaning in March 2019, the only option available to terminal operators was to send personnel inside fuel tanks with highly-explosive atmospheres, using breathing apparatus and chemical suits.

Traditionally, people have had to enter oil tanks to implement inspections, de-sludge, and clean for product change. Although safety regulations and industry standards are stringent, accidents can occur due to human error and the failure of safety devices. Exposure to

hazardous petrochemicals, heat stress, lack of oxygen, slips and falls, fires and explosions are the main risks faced by personnel who manually clean oil tanks.

In response to the rising number of confined space deaths, and after years of extensive research, a patented solution was developed to help ensure that workers are not endangered by operations carried out in hazardous confined spaces.

Four main robotic tank cleaning services for fixed roof, floating roof, heavy fuel oil (HFO) and coned floor tank cleaning are offered. The operator remains in a Zone 1

control unit where activity is scrutinised through a series of ATEX cameras and gas monitoring equipment fixed to a robot.

The entire tank cleaning system can be set up in 2 hours, which is a fraction of the time required for human crews to prepare for tank entry. Primarily, however, it removes individuals from hazardous spaces filled with chemicals and gasses that can lead to serious long-term health issues.

No man entry tank cleaning solutions have clear advantages for tank terminal operators: there are fixed costs, reduced paperwork and permits, and no requirement for capital outlay or standby rescue teams.

Since 2019, 10 000+ hours of confined space cleaning have been eliminated, leading to an overall reduction in both accidents and health and safety incidents onsite. The bar for safety has been raised in an industry with potential dangers, and the frequency of injuries and fatalities in the tank terminal sector has been significantly reduced.

## Case study

Following a full demonstration of its service, whilst cleaning a 48 m crude oil tank with steam coils, Re-Gen Robotics was commissioned on Phillips 66's Humber Refinery site in North Lincolnshire, England, to clean a 50 m fixed roof, cone-up floor crude oil tank.

Phillips 66 Humber Refinery is one of the most complex refineries in the company's portfolio and one of the most sophisticated refineries in Europe. The vast range of products it produces not only includes fuel, but also raw



**Figure 1.** Self-contained crange system.



**Figure 2.** Control room.

materials that are transformed into everything from essential components for electric vehicle (EV) batteries, to toiletries. Approximately 20% of all UK petroleum products come from the Humber Refinery.

Given the information provided by the client, Re-Gen Robotics received a sample proposal on the indicative timings and cost of the tank clean, as exact tank furniture details and volume of sludge were unspecified. The team then visited Phillips 66 onsite to gain a detailed understanding of the scope of work.

Following the site visit, a final proposal outlining the method, timeframe and cost was provided.

The tank had numerous steam coils which the robot was required to navigate. The volume of waste inside the tank was understood to be approximately 135 t and the product temperature was ambient.

This was the first no man entry tank clean for Phillips 66 and the company was pleased at the prospect of eliminating the need for personnel to physically enter the tank.

The robotic tank cleaning system has an offset suction head to allow meticulous cleaning underneath heating coils, as well as an auger system for the removal of heavy sludge. In addition, it has front and rear ATEX CCTV and lighting for easy internal tank navigation and inspection. This tool alone can decrease tank cleaning time by 10 – 12%.

Using high pressure, low flow jetting systems, and a powerful 4800 m<sup>3</sup> vacuum, the heavy oil tank cleaning robotic system was designed to easily fit through a standard 600 mm manway, using externally-fitted hydraulic ramps.

## Results

The operator remained in the Zone 1 control unit where he could monitor activity through a series of ATEX cameras and gas monitoring equipment that was fixed to the robot.

In total, 536 t of sludge was removed from the tank, with 92 t of water utilised during the entire tank clean. Robots use up less water than human crews use when cleaning the same tanks. The robots also clean the tanks in half the time that humans do, reducing environmental impact.

Traditionally, it would have taken a team of six men 95 days to complete the clean. Using no man entry cleaning, the three-man team took 43 days (1520 robotic hours) to complete the job (30 of those days were spent on sludge removal alone).

Overall man hours onsite were reduced from 12 160 to 1032 and the standby rescue team was not required. Re-Gen Robotics is classed as a medium risk contractor, therefore less paperwork and permits were necessary. In addition, there was no requirement for capital outlay or spading of the tank, which can take a full day to accomplish.

Upon completion of the tank clean, client feedback was positive. This was the first tank to be completely cleaned and inspected by the company without the need for human presence in the tank.

Following the initial contract, Re-Gen Robotics was commissioned to clean a further three tanks at the site and has recently been included in the tender process for 14 tanks

over the next three years. At present, the company is 75% through its clean on the second of the three tanks.

Phillips 66 has acknowledged the success of the no man entry tank clean because the system could be adapted to suit the company's individual needs and timeframes, resulting in safer, faster and cost-effective tank cleaning, with measurably better results than the man entry method.

The entire tank cleaning operation was recorded on CCTV from the ATEX cameras and was made available to Phillips 66 upon completion of the works. All files are date and time stamped to ensure the process is traceable for auditing purposes.

A record of gas detection readings was produced by the onboard gas monitoring equipment and issued on completion of the tank clean. The intelligent onboard truck telemetry system collects data that can then be aggregated and analysed to optimise the process. The combination unit provides real-time information on all key parameters, which helps monitor energy consumption and waste generation, and is vital for both conserving funds and running a cleaner, greener business.

## Conclusion

Hazards relating to tank cleaning are as many and varied as the designs and physical dimensions of the tanks themselves. As such, robotic tank cleaning technology continues to develop at pace so that the equipment can perform an increasing number of tasks remotely.

Rapid technological advancements are powering this new generation of smarter, more mobile, and safer robotic tank

cleaning systems. They are dexterous and versatile and can navigate and work in their environmental using multiple sensors, while operators remain in an air-conditioned control room, protected from hazardous conditions.

Applying fully-integrated, 100% no man entry, closed loop robotic cleaning technology could make a significant difference to safety in the oil tank industry. Robotic tank cleaning is eradicating industry fatalities and decreasing all risk categories by eliminating human exposure to confined spaces.

In terms of speed and efficiency, the robotic system completes a job 40 – 80% faster on average than a manned crew. For example, a white oil tank that would usually take eight days to clean with an eight-person team can now be cleaned in two and a half days with just two people operating the robot. It has eradicated the requirement for 260 man hours of confined space entry, carrying with it an enormous safety benefit.

The last two years have been a groundbreaking time for the industry with respect to health and safety, and there has been a paradigm shift in attitude towards safety in the tank cleaning industry. To date, over 30 tanks consisting of white oil, black oil and distillate tanks in gas plants have been cleaned and the first worldwide, 100% no man entry tank cleans for oil majors such as Shell, Phillips 66 and Vermilion have been completed by Re-Gen Robotics.

These companies have now adopted no man entry tank cleaning and this service sits at the core of their safety strategy. To this end, Shell has made a commitment to end manned tank cleaning across its operations by the end of 2022, with other majors looking at 2025. 