Automated crude oil tank cleaning

The benefits of Life Cycle Cost (LCC) analysis to automated tank cleaning are discussed. Examples of tank cleaning in practice are provided by independent tank cleaning service providers who use automated non-man entry tank cleaning methods.

Carlos Legorreta
Oreco A/S

For many, the cleaning of above-ground oil storage tanks is seen as a nuisance. However, tank cleaning should be thought of as an integrated part of the business cycle/revamp schedule and subjected to the same assessments. Doing so will reveal that automated tank cleaning offers several advantages over conventional manual cleaning. It can greatly improve safety and the work environment, as well as have an impact on the overall economy of operation. Potential profit areas include reduced downtime and oil recovery. And when companies include these advantages in their overall considerations, effectively applying a Life Cycle Cost (LCC) approach to the cleaning process, they may well adopt new habits.

Cleaning allows for safe and full access to tanks for maintenance and repairs, greatly improving safety. However, the tank cleaning process itself can be hazardous to both humans and the environment when conducted manually, but these hazards are eliminated by automated cleaning.

Legislation prompts new cleaning approaches
Health, safety and environment (HSE) issues are a growing concern within the oil and gas industry. Legislation is becoming stricter with great regularity, new codes and policies are being issued, and refineries and tank farms are introducing new guidelines of their own volition. Everyone agrees that these initiatives protect human health, promote safety and help prevent negative impacts on the environment, but many assume they also entail considerably higher costs. That assumption is likely to be proven false when you consider the wider picture, as when companies include these advantages in their overall considerations, effectively applying a Life Cycle Cost (LCC) approach to the cleaning process, they may well adopt new habits.

Cleaning allows for safe and full access to tanks for maintenance and repairs, greatly improving safety. However, the tank cleaning process itself can be hazardous to both humans and the environment when conducted manually, but these hazards are eliminated by automated cleaning.

Manual cleaning: a hazard to workers
When conducted manually, tank cleaning involves hazardous conditions for workers, imposing strict requirements on safety measures. Accidents still happen, though, mostly due to human error, and sometimes with dire consequences for employees and companies alike. It can be difficult to assess the potential cost of such accidents, but the value of totally avoiding them should not be underestimated.

So when it comes to HSE, what exactly should be considered? Most agree that the safety practices for tank cleaning should match those for the rest of the processing or storage facilities. To ensure they do, this checklist may be useful, as it essentially constitutes an HSE assessment of crude oil tank cleaning:

Health issues
— All personnel should undergo thorough and comprehensive training on the process chosen and the safety procedures associated with it
— All personnel should undergo thorough training on working in potentially explosive and hazardous environments. Full theoretical and practical understanding of the hazards of dangerous gases, liquids and solids should be ensured through tests and simulations
— Cleaning-related pollution that could cause health hazards for neighbouring areas should be eliminated
— LEL and H₂S measuring devices should be positioned in areas where personnel may be exposed to hydrocarbon vapours.

Safety issues
— The tank cleaning process should comply with the same regulations as the rest of the facility (refinery or tank farm). These include regional or local standards such as ATEX in the European Union, UL in the US and CSA in Canada
— All process equipment and piping with a high-temperature surface must be properly insulated
— The use of fire-protective clothing, helmet, gloves, antistatic footwear and safety glasses must be enforced without exception
— All moving parts should be protected by mechanical covers that cannot be opened without tools
— Always carry out tank blanketing with inert gas to reduce oxygen levels below 8%. This prevents the risk of explosion (e.g. from static electricity build-up). Proven sources of accidents include liquid jet streams, turbulence on liquid surfaces and high velocities of fluids in piping
— Like other production facilities, the cleaning system should be equipped with continuous process monitoring and automatic shutdown in the event of danger
— Electrical grounding must be used for all external piping and process...
equipment to eliminate sparks. All should be grounded to the same point as the tank to ensure the tank and cleaning equipment have the same electrical potential at all times.

Environmental issues
— Contamination due to the venting of oil tanks should be eliminated or reduced to the greatest possible extent. For example, vent tanks only when the hydrocarbon concentration is low — Contamination of soil, air and underground water caused by the extraction and disposal of oily sludge should be eliminated or minimised by separating hydrocarbons and inorganic matter. This reduces the environmental impact and the costs of final disposal — Contamination by polluted, oily water should be eliminated or minimised by removing the hydrocarbons. Water recycling will reduce the total water volumes used during tank cleaning — Hydrocarbons should be recovered. Furthermore, the recovered hydrocarbons must not cause technical disturbances when introduced to the processing plants. The recovered hydrocarbons should be evaluated with regard to BS&W and any added chemicals.

Non-man entry tank cleaning
Obviously, the best way to promote health and safety in connection with tank cleaning is to make sure no-one enters the tank. The Blabo technology developed and produced by Oreco eliminates the need for man entry, increases safety and ensures the recovery of valuable hydrocarbons. The procedure carries out desludging, cleaning and oil recovery in a single, integrated process by means of automated systems. The potential polluting streams are also greatly reduced, as more than 95% of the hydrocarbons present in the sludge are recovered.

At present, more than 300 tanks worldwide have been cleaned using the Blabo technology. The process complies with the most demanding safety regulations in the world, including ATEX in Europe, UL in the US and CSA in Canada, and other standards can be met upon request. But is non-man entry cleaning far more costly than manual cleaning? No, if you consider the LCC of non-man entry tank cleaning, it will prove to be more cost-efficient.

LCC analysis
LCC analysis, which considers all costs from inception to disposal, has gained prominence within business communities of all descriptions. Industries are currently elevating procurement policies based on LCC analyses from recommendation status to prescriptive requirements.

Similar steps are being taken within the cleaning of oil storage tanks, but the approach has yet to become standard. Also, even among those who do take a LCC approach, the calculations do not always include all the elements that should be considered. LCC analysis is complex, but in essence is a mindset. It considers intangible as well as tangible elements and looks far beyond the immediate contractors’ costs.

It is particularly challenging to perform proper LCC calculations for processes such as automated tank cleaning. Most LCC calculations are made for specific products and focus on the reliability of the different choices to determine the net present value (NPV) of each option. Being a process rather than a product, automated tank cleaning requires a slightly different approach. Even so, this can bring added value to all who require tank cleaning and highlight the less apparent benefits of automated cleaning. Table 1 lists some of the factors that should be considered. Most of these points are self-explanatory and will be looked at briefly in the following two case studies.

Case study 1
UK refinery
The choice between manual and automated tank cleaning does not always appear clear cut, and sometimes a process of trial and error is to be expected. The Fawley refinery in the UK, an Esso facility, was having problems with its catalytic fines sludge tanks. Over time, the tanks stratified as catalytic fines gathered in the bottom strata and consolidated sediments at the bottom. The refinery first used manual cleaning to clean one of the tanks, but the results were not entirely successful. The manual cleaning led to considerable waste, very high costs for disposing of that waste and the entire process took a long time, which further added to the total cost. All this prompted the refinery to try automated tank cleaning for the other tank.

The automated tank cleaning process will vary according to several parameters: the type of tank involved, its size, its contents, the recovery requirements stipulated by the tank owner or operator, and more. As previously described, the tank at Fawley was used for catalytic slurry, had a fixed roof, a flat bottom and...
was fitted with internal steam coils. It had a diameter of 39.5m and a height of 14.5m, and minimal downtime was a key consideration.

In a typical automated tank cleaning process, the initial mobilisation includes nozzles being installed in the roof of the tank. Known as Single Nozzle Sweepers, these will handle the actual cleaning, using recirculated oil as the primary cleaning media, which is distributed in far-reaching, low-pressure yet high-impact jets. The nozzles are positioned according to an indexed washing pattern to cover the entire tank.

Naturally, the plant safety check list is completed and all work permits obtained before the cleaning process begins. The tank is then blanketed with nitrogen to provide a safe atmosphere for the cleaning, which is the final preparation prior to desludging. The oxygen volume is also reduced to the 8% value required to eliminate the risk of explosion.

Desludging is the first stage of the cleaning process, where most of the oily sludge from the tank is removed. Nozzles are operated one at a time, eventually covering the entire tank. During the next stage, the actual cleaning, the nozzles perform an oil wash. At the Fawley refinery, heated LCO (light cycle oil) was used as the recirculating medium. The entire process can be remote controlled so that problem areas can be addressed without anyone entering the tank. Once this stage is complete, the tank is clean.

At Fawley, no final water wash was necessary once the hot LCO washing was complete. The tank was opened, and ejectors degassed the tank and raised the oxygen concentration above 20%. At this point, the Blabo system was dismantled and the tank handed over to the customer.

After 15 days of operation, the tank was inspected and declared ready to be put back in operation (Figure 2).

Jorge Oteiza, Managing Director of STS Tank Cleaning Services, which carried out the automated cleaning at Fawley, concluded: “The Blabo non-man entry closed loop system lets us offer cleaning options that minimise costs through shorter downtime, waste reduction and better safety. Our task was
The commitment to safety did not mean cost could be ignored. However, the refinery essentially took an LCC approach when making its choice and saw how the added cost of automated cleaning would be comfortably offset by other factors. As Marc Schindler, CEO of C&S International Service, which has now supplied non-man entry tank cleaning to the MOL refinery for five years, says: “The MOL refinery was, of course, aware that traditional tank cleaning, performed manually by people, was more competitive in terms of immediate investment costs. However, it was also aware that safer processes save money on intangible aspects such as accident prevention.

“A more easily quantifiable factor concerns the value of recovered oil; automated tank cleaning allows users to recover vast quantities of oil that would otherwise have gone to waste, and to impose specific requirements on the quality of that oil.”

Over the five-year working relationship, C&S has cleaned a total of 24 tanks in Hungary. The tanks cleaned so far have been both large and small, with floating or fixed roofs, double or simple decks, crude oil tanks, fuel oil tanks, asphaltene and catalyst tanks. The variety of tasks to be solved is one of the key reasons behind C&S’s choice of the Blabo system for its automated tank cleaning services.

While Blabo technology was not the client’s first experience with non-man entry tank cleaning, it decided to adopt the system in 2003 due to additional advantages specific to the system: