Choosing the optimum tank cleaning system

Over time, usable tank capacity is reduced by the volume of sludge. The tank operator needs then to clean the tank in order to re-establish its full capacity.

In addition to this, national inspection regulations require a leak test every five or 10 years (double floor). To perform this inspection, the tank needs to be completely drained and cleaned. Repair work is often performed on this occasion.

The petrochemical industry and tank terminals are increasingly choosing the option of automated rather than manual tank cleaning. They look for cleaning methods that achieve the highest degree of cleanliness in the shortest possible time, while offering high levels of recycling valuable hydrocarbons and apply important safety and environmental protection standards.

Benefits of automated tank cleaning are:

1. High recycling rate: the residual hydrocarbons in the sludge are liquified and recovered (ongoing processing)
2. The volume of sludge is substantially reduced (sand, rust, etc.) and routed into professional waste disposal channels.
3. High level of occupational safety, personal and environmental protection
4. Shorter tank downtime.

Technological developments

Germany-based tank cleaning company Schäfer and Urbach has developed two tank cleaning systems in recent years:

- The modular tank cleaning system and
- The mobile liquid jet cannon

Additionally, a mobile tank cleaning unit has been developed for cleaning of smaller storage and filling station tanks.

Modular tank flushing system

Crude oil tanks are flushed using a closed system to ATEX Standard (ATEX 95), Zone 1. This eliminates the need for deploying persons in the tank during flushing. The basic principle involves dynamic (introduction of energy and heat) breaking down of the sludge through heated crude oil which is sprayed by special nozzles through the sealed roof into the innertised tank.

Before the tank is emptied a number of tank roof support legs, required for installing the injection nozzles, must be removed and bring the tank roof to maintenance position. When the tank roof is in repair position (landed), the volume of sludge is measured and the cleaning systems are installed. The tank is drained while at the same time inertising the tank interior.

A sufficient quantity of crude oil is pumped into the tank from a second adjacent tank. The crude oil is then extracted, heated and injected into the tank via injection nozzles. This closed flushing circuit is maintained for a certain period of time. The injected crude oil and the sludge liquified by it are then extracted by the suction module and pumped back into the supply tank, or directly to downstream processing. Special filters prevent organic components such as sand and rust also being pumped. The supply tank can be used for normal refinery operations during the cleaning process.

After completing flushing with crude oil, further flushing is performed with gasoil or other middle distillates, thus causing the sludge to fully liquify, further reducing the gases and achieving a maximum hydrodynamic cleaning effect of the roof, walls and bottom.

Once hydrodynamic cleaning has been completed, the tank is opened to remove the remaining non-organic matter and complete interior cleaning. Repair work such as welding can then be performed.

The mobile liquid jet cannon (injection cannon)

Features of the mobile spraying cannon system include:

- The spraying cannon, a unit composed of a cleaning nozzle, video camera and headlamp
- The supply and operations container.

The injection cannon is characterised in particular by easier installation and use, and greater efficiency. It is flexibly installed on a manhole using an adapter plate (min. DN400) whether on the roof, the side, or on suitable newly-created manholes (using a cold-cutting method at new positions in the tank). This means that installing the spraying cannon does not influence the structural stability of the tank roof.

Further benefits of the injection canon are:

- No holes are cut into the tank roof
- No time-consuming removal of the (roof-mounted) support legs is required
- Time-consuming installation of ring-pipes on the tank roof, and the material required for this, are no longer needed.

The liquid jet cannon swivels vertically and horizontally by 180°.

Flushing with the spraying cannon

The cleaning principle is based on the energy introduced into the tank by the liquid jet. The pressure acting on the injection nozzle of the liquid jet cannon creates a high-speed liquid jet, loosening the material deposited on the

walls and floor of the oil tank.

The objective is, with the tank still closed, to dissolve the highest possible fraction of volatile hydrocarbons in the sludge with the flushing medium, and to discharge these by pumping out. To allow this to happen, a defined volume of suitable flushing liquid (much less than required for the modular tank flushing system) is provided by the tank operator. Depending on the project, the volume of flushing liquid can be heated.

The cleaning cannon can use virtually any product as a flushing medium (including A1 products and highly volatile products such as benzene.) The maximum flushing pressure for cleaning is 40bar and 55m³ per hour. The flushing liquid is circulated by the cannon system; the energy introduced into the tank liquifies the hydrocarbons contained in the sludge and guides them to the extraction point. The saturated flushing volume is then pumped out and transfered to the tank operator for further processing.

At the next step, fresh flushing medium, possibly heated, is introduced and the circuit is restored. The flushing phase is repeated until discharging of the residues is completed.

The optional use of an additional suitable cleaning agent in addition achieves chemical separation of solids. This agent should be used as indicated until complete saturation has been achieved in the cleaning circuit.

For even faster and more efficient cleaning, a heat exchanger module and a three-phase separation system can be used. The use of the heat exchanger module establishes a separate heating circuit where a side flow is continually extracted from the tank, heated and fed back in. This improves the hydrocarbon liquifying results.

If a separation unit is used, a pump extracted auxiliary flow is continually separated in three phases (oil, water, solids). The volume of oil recovered can be fed back into the tank. The separated solids are professionally disposed of and the water is pumped to wastewater treatment plant.

Permanent monitoring during the cleaning process, measurement of the explosive gases (LEL) and the O_2 content in the interior of the tank ensures that limit values are not exceeded.

For applications with volatile products (A1 products), nitrogen blanketing in accordance with the limit value (O_2 content) guarantees conversion from Zone 0 to Zone 1.

The complete cleaning process is managed and controlled from the control room on the inside of the container. It can be documented on a DVD.

Mobile tank washing

The mobile tank cleaning method is designed for cleaning small, decentralised storage tanks, for example at filling stations, with a diameter of up to 25m. The flushing medium used is diesel oil or hot water. Thanks to the use of a special cleaning nozzle, the tank can be cleaned without needing to deploy staff in the tank.

To perform cleaning, a cleaning lance with a special manhole cover is installed on the tank. During the flushing process, the discharged sludge is separated and the cleaning medium recirculated for flushing.

After completing flushing and discharging the sludge, the tank can be cleaned with hot water. Approximately 3m³ of water is available for this in two 'on board' storage tanks .

After final ventilation, the tank is ready for inspection or performing repairs.

In case of ignitable products, the tank chamber is inertised and the atmosphere monitored online by means of a monitoring station.

The individual units and assemblies (vacuum pump, flushing pump, high pressure pump, nitrogen generator with air compressor and breathing apparatus, and hose reels) are all driven hydraulically by the vehicle's power take-off with stepless adjustable speed control available at the control unit.

In cases where external disposal of the tank content, or the cleaning materials, is required, a 12m³ vacuum tank is available for handling transportation requirements.

Time savings for automated tank cleaning compared with manual tank cleaning

All three system solutions offer the benefit that, no matter what product the tank contains, there are no delays due to a high LEL, other measurable gases, installation/idle times, or staff changes, etc. This means the cleaning duration will typically be cut by more than half in each case.

Product recovery

In tank cleaning, great emphasis is naturally placed on achieving the highest possible recovery of the

What benefits do the individual system solutions offer?

	1	2	3
Fully automated flushing	✓	✓	✓
Cleaning time reduction	✓	✓✓	✓
Reduction of hydrocarbons and volatile gases	✓	✓	
Compliant with legal requirements	✓	✓	✓
Transportation requirements	✓✓	✓	✓
Staff requirements	✓✓	✓	✓
Handling, installation, maintenance	✓✓	✓	✓
User-friendly, simple operation and reliability	✓	✓✓	✓
Flexibility/applications	✓	✓✓	✓

Where can each system solution be used?

System solution	1	2	3
Floating roof tank	✓	✓	✓
Fixer roof tank	✓	✓	✓
Fixed roof tank with internal floating roof	–	✓	–
Tank with a diameter of < 25m		✓	✓
Tank with a diameter of 25m > 80m	✓	✓✓	–
Tank with a diameter of > 80m	✓	✓*	–

A third injection cannon is installed through the roof manhole

Basic considerations for selecting a suitable separation method

Separation method	Stage	Brief description
Mechanical filters	1	Coarse material traps for plastics, large stones and other waste from the tank protects the pumps and the pipelines
Settlement tank	2	Settlement tanks primarily act as separating basins where the phases separate within a short time solely due to their different specific gravities
Two-/three-phase decanter	2	After the coarse materials and the water phase have been separated from the product, further mechanical/chemical treatment occurs here to separate all non-desirable foreign materials and thus achieve the highest possible degree of product purity
Active carbon filters (water treatment)	3	These are used for water treatment if the separated water cannot be treated, or if this is not desirable (e.g. discharge into reservoires of water)

Summary

In order to select the optimum cleaning system, it must be clarified which product is stored in the customer's tank, and how much of it. Only after obtaining the clear facts can it be decided which type of flushing medium can be used and the required quantity.

The automated tank cleaning systems and, in particular, the spraying cannon offer excellent economy combined with occupational and environmental protection.

product stored in the tank.

This is achieved by further processing of the residues in the tank. The remaining, non-organic sediments remain on the tank floor and are then broken down further by the use of suitable separation technologies.

Again, the requirements are clear: high level of separation of waste products. These are solids (e.g. sediment, rust), hydrocarbons (oil phase) and water.

The solid fraction is channelled into waste disposal or incineration for power generation, the oil phase is fed into crude oil processing and the water is routed into wastewater treatment. This concludes the complete residual material circuit.

For more information:
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