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# Choosing the best available technology

## Alexandrs Vdovins, sales project manager, Oreco A/S, discusses the criteria for best tank cleaning practices and examines how three automated tank cleaning technology groups respond to the criteria

The market for automated tank cleaning equipment has undergone major developments in the past decade. Growing interest in modern technologies for operation in potentially explosive and hazardous zones is related to a higher focus on health, safety and environmental (HSE) issues and awareness of corporate ethics, together with demand for better working conditions in oil companies.

The constant increase in the cost of disposing oily sludge in an environmentally-friendly way also forces end-users to search for service providers with a sustainable tank cleaning technology, which recovers hydrocarbons and minimises the quantity of waste for re-utilisation.

The Automated tank cleaning equipment market is attracting more and more players. However, only few of them fulfil all strict industry requirements. Operating in explosive and hazardous atmospheres does not allow any compromises on safety and operational reliability. This article discusses the key success factors for the tank cleaning industry and evaluates existing tank cleaning methods in order to identify the technology that matches the 'Best Practice' principles the most.

**Automated tank cleaning market**

More and more oil companies and tank terminal owners choose automated tank cleaning solutions. Final customers are searching for the most efficient tank cleaning and hydrocarbons recovery methods. Market research based on the performance of European service companies in the past 20 years demonstrates a clear trend towards an increase in the application of automated tank cleaning technologies, as depicted in Fig 1.

The number of equipment manufacturers has increased correspondingly over the past 10 years. In this article we only discuss complete solutions that provide tank cleaning from A to Z which can be applied to aboveground storage tanks of different construction containing different oil types, including crude and HFO. Main stages for tank cleaning are desludging, water wash and solids separation, but main process differences between tank cleaning technologies are sludge extraction methods and the type of desludging agents.

The tank blanketing during the tank cleaning is considered as a necessary procedure for any type of system and equipment application. Nitrogen is the most efficient blanketing agent and is widely used for that purpose. Nitrogen generators are considered as independent units out of the tank cleaning equipment scope of supply, with specific individual requirements for the process and nitrogen purity.

**Technologies can be divided into 3 groups:**

**Group 1: Canons and robots**

Systems that use robotic spray canons and sludge extractors for desludging. Manway canons liquidise the sludge with hot water or a cutter stock type and sludge extractors mechanically remove the sludge from the tank.

**Groups 2:** Spray nozzles with removal of support legs

Systems that require removal of the floating roof's support legs for spray nozzle assembly. Desludging performed by pre-heated cutter stock addition and liquidised sludge pumped out from the tank.

**Group 3: Spray nozzles integrated in existing tank construction**

A spray nozzle system with cutter stock delivery from the top of the roof which is assembled using existing service manholes or cold tapping method. Desludging is performed by pre-heated cutter stock and the liquidised sludge is pumped out of the tank. The BLABO technology from Oreco is included in this group.

**Defining criteria for best practice**

Oil tank cleaning is a complex process, which includes multiple stages. When choosing a tank cleaning technology, owners and service providers base their decision on a variety of parameters. Not all technologies offer a seamless, integrated process. Operational and occupational safety is imperative. Stringent environmental legislation and high industry safety requirements call for systems built with HSE in mind.

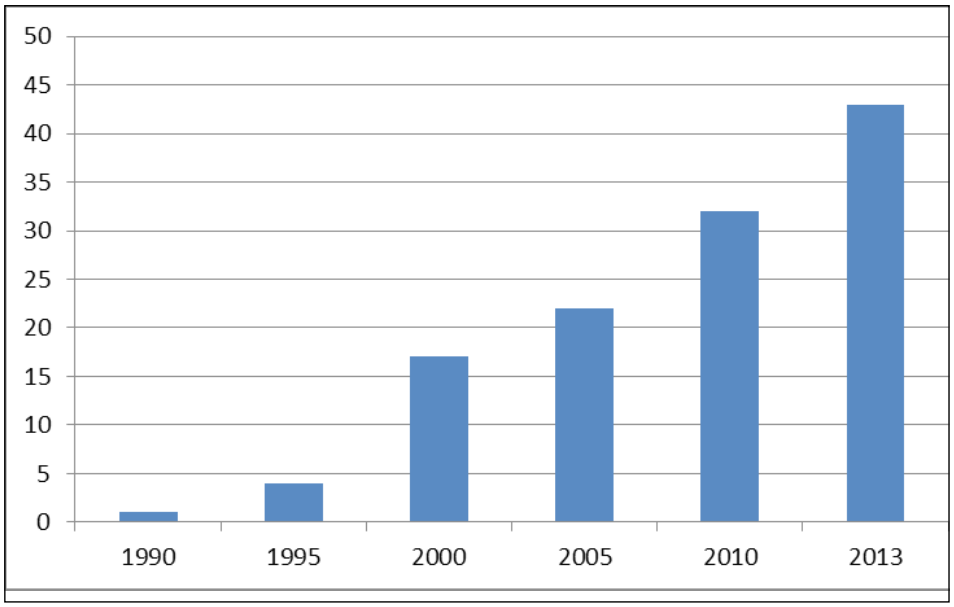



*Fig 1. Oil terminals which use automated systems for tank cleaning*
*Source: Registered automated tank cleaning jobs in Oreco A/S partners network*

| Num | Key Criteria | HSE | Process Quality | Cost Efficiency |
|---|---|---|---|---|
| 1 | Non-man entry | ✓ | ✓ | |
| 2 | Tank cleaning time | | ✓ | ✓ |
| 3 | Hydrocarbons recovery and waste re-utilization | ✓ | | ✓ |
| 4 | Process control and monitoring | ✓ | ✓ | ✓ |
| 5 | Applicability to different tank types | ✓ | ✓ | ✓ |
| 6 | Compliance with regulations | ✓ | ✓ | ✓ |

*Table 1. Key criteria for selection of "Best practice" for tank cleaning industry*
*The six best practice criteria identified earlier are now dealt with in more details and are matched with the three technology groups. This allows us to detect those technologies that qualify as best available technology (BAT).*

Technologies must encompass process quality. This includes performing tank cleaning jobs that leave the tank entirely freed from sludge. Also, the operation should be carried out by thoroughly trained, certified operators. And system providers should present a reference list that documents the durability, versatility and flexibility of the systems from a variety of tank cleaning situations around the world. Last but not least, users also demand a cost-efficient solution.

The best available technology (BAT) must correspond to these demands and preferences. In other words, technology for tank cleaning best practice should be based on three main values: HSE, process quality and cost efficiency. Each of the selected key criteria is complex and includes several main values. The selected six key criteria for the tank cleaning industry's 'best practice' are stated in Table 1.

**Non-man entry** is a key criterion in relation to HSE and process quality. Fully-automated non-man entry processes minimise human failures, which are the main cause of accidents. Technology can be non-man entry or man entry. However, man entry is acceptable only after performed desludging when entry is considered safe, not before or during the tank cleaning process.

Despite expensive components, man-entry equipment has no added value according to process safety in comparison with manual tank cleaning and has increased risk of human failure. Only systems considered in groups 2 and 3 above can be considered as true non-man entry technology, whereas group 1 is a man-entry technology, as human presence in 'black' oil tanks is necessary when operating manway canons, internal suction pump relocation and sludge extractors.

**Tank cleaning time.** All three equipment groups allow reduced total tank cleaning time compared with manual cleaning. The total time saved during tank cleaning is variable for each system depending on the tank sizes and construction.

**Hydrocarbons recovery and waste re-utilisation.** Hydrocarbons recovery is an important environmental and financial issue for tank cleaning. It is imperative to recover maximum hydrocarbons from the sludge, reduce the water content of the oily sludge and of course to minimise the costs of sludge disposal.
The chosen desludging method can seriously influence later separations stages and affect hydrocarbons recovery. It is important to remove as much of the sludge from the tank without adding any chemicals, because chemical application during the tank cleaning makes the subsequent separation process more complicated or inefficient. For the same reason, desludging with hot water is not efficient; it is difficult to separate sludge mixture with large amounts of water. The best desludging method for the most efficient separation process is cutter stock addition.

Effective hydrocarbons recovery processes can be ensured only by involving multiple-stage separation systems, with options to switch treatment phases, depending on sludge parameters and cleaning agents. This technique allows recovery of maximum hydrocarbons and minimises solid waste and water for disposal.

Hydro cyclones can be used as additional equipment during the cutter stock recirculation stage. Using a three phase decanter application instead of a two phase decanter and high speed separator is not recommended for the following reasons:

- Three phase decanter is sensitive to incoming sludge composition variations
- Three phase decanter is inefficient with large amounts of water in incoming sludge flow
- Three phase decanter cannot operate in two phase separation mode

Water and solids treatment and disposal after tank cleaning is considered as a separate processes. It is dependent on local state regulations and available treatment facilities and is not included in following comparison.

The level of hazardous emissions escaping to the atmosphere during tank cleaning must be minimised. Only closed-loop, automated non-man entry tank cleaning systems with

| Separation method | Stage | Description |
|---|---|---|
| Mechanical filter | Pre-treatment | Mechanical filter is required as pre-treatment unit for large amount of solid fraction removal and equipment protection |
| Skimming | Water wash | Because of high flow rates and big water content, gravity separation is most efficient during water wash |
| Two phase decanter | Solid and liquid phase separation | Sludge solid and liquid separation |
| High speed separator | Water oil separation | Oil and water separation |

*Table 2. Application of separation equipment*

| | Group 1<br>Canons and robots | Group 2<br>Spray nozzles with removal of support legs | Group 3<br>Spray nozzles integrated in existing tank construction |
|---|---|---|---|
| **Floating roof** | Sludge extractors are not applicable for floating roof tanks with support legs | ✓ | ✓ |
| **Fixed roof** | Sludge extractors are not applicable for tanks with piping in the bottom | Is not applicable | ✓ |
| **Diameter >30m** | Manway canons have difficulties in cleaning tanks with piping in the bottom and big diameter tanks (bigger than 30 m) | Only for floating roof | ✓ |

*Table 3. Groups 1-3 systems applicability for different tank types*

gas return and gas control functions can be considered as industry best practice.
Process control and monitoring. Tank cleaning processes must be automated and have centralised control systems. It is imperative that the LEL and oxygen level in and around the tank is constantly monitored. Safe performance tank cleaning equipment must be equipped with automated turn-off alarm connected with gas measuring equipment. SCADA control system is considered as necessary part of modern tank cleaning equipment.

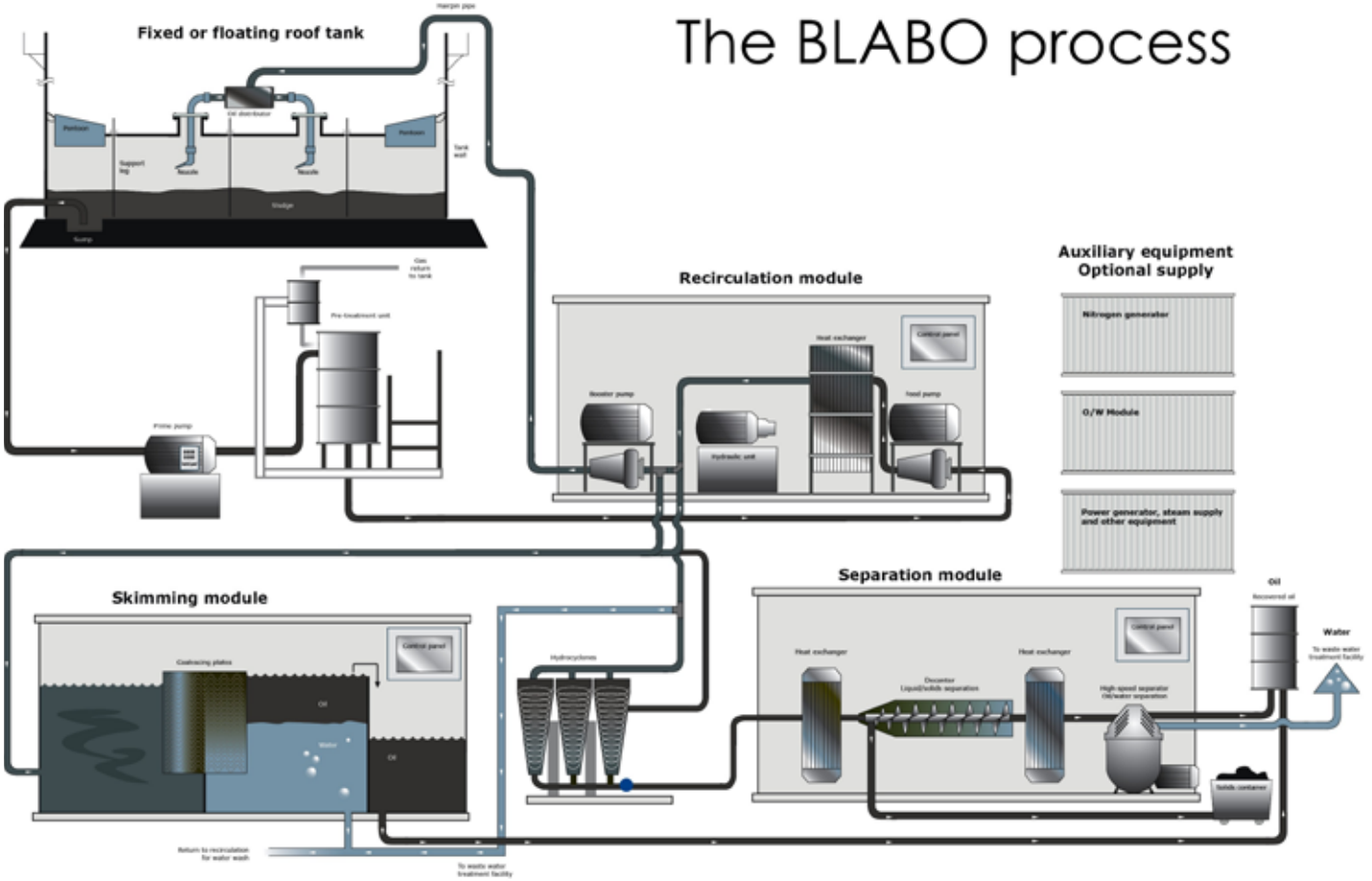
**Applicability to different tank types.** Versatility and flexibility are important issues for tank cleaning equipment. In this regard, technology can only be categorised as best practice if it is applicable to most existing tank types.

Groups 1 and 2 equipment sludge extraction methods have serious constraints in their applicability to specific tank types. For example, when the sludge level inside the tank is higher than the service manhole and the sludge is not pumpable, it is impossible to place a manway canon or sludge extractor inside the tank. Because of this, group 1 technology is not applicable. Group 2 equipment is only able to clean tanks with floating roofs. Hence, group 1 and 2 equipment have limited application range.

Only Group 3 equipment is applicable to all tank types and matches best practice demands.

Compliance with regulations – it is essential that equipment is manufactured in accordance to local and international standards and regulations, certified for application in classified potentially explosive and hazardous zones.

In conclusion group 3 equipment has several advantages compared with the other two equipment types and should be considered as industry best practice. Best available



technology should therefore be selected from group 3. A comparison of three equipment groups is summarised in Table 4.

Group 3 technology matches the Oreco manufactured BLABO system. The company has more than 20 years' experience in developing and manufacturing tank cleaning equipment. The technology has performed more than 400 tank cleaning jobs worldwide, by more than 20 different service companies. The BLABO process is based on cutter stock addition through single nozzle sweepers located on top of the roof. The system is fully-automated and is non-man entry. Multiple-stage separation allows maximum recovery of valuable hydrocarbons.

Only high quality components from world leading suppliers are used for constructing the system. The company operates according to ISO 9001 and ISO 14001 certification and offers approved training programmes and certification for operators. The BLABO system adds value to the tank cleaning process in accordance to HSE issues, tank cleaning time, hydrocarbons recovery and can be considered as best available technology.

| Criteria | Group 1 Canons and robots | Group 2 Spray nozzles with removal of support legs | Group 3 Spray nozzles integrated in existing tank construction | Comments |
|---|---|---|---|---|
| **Non-man entry** | ✓ | ✓✓✓ | ✓✓✓ | Group 1 equipment is considered as man entry system |
| **Tank cleaning time** | ✓✓ | ✓✓ | ✓✓ | For different types of the tanks different equipment performance is variable, but total tank cleaning time reduction compared to manual tank cleaning method is significant |
| **Hydrocarbons recovery and waste re-utilization** | ✓ | ✓✓ | ✓✓✓ | Group 1 equipment for desludging usually applies hot water which makes the separation process less efficient. Sludge after sludge extractors is not always pumpable and ready for re-processing |
| **Process control and monitoring** | ✓✓ | ✓✓✓ | ✓✓✓ | Group 2 and Group 3 have better process control as manway canon's and sludge extractors usually require man entry and cannot ensure controllable, stepwise desludging. |
| **Applicability to different tank types** | ✓✓ | ✓ | ✓✓✓ | Group 2 equipment is applicable only for floating roof tanks. Group 1 equipment is not applicable to big crude oil tanks. |
| **Compliance with regulations** | ✓✓ | ✓✓ | ✓✓✓ | Group 3 equipment and cleaning procedures match all necessary standards and regulations. |
| **Summary** | 9✓ | 13✓ | 17✓ | |

*Table 4.*
*Conclusions for Groups 1, 2 and 3 systems according to tank cleaning industry best practice key criteria*