

Tank cleaning operations



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The primary purpose of tank cleaning aboard oil, product and chemical tankers is to remove the most recent cargo from the vessel's containment systems (tanks/lines/pumps) in readiness for the next cargo. Cleaning also prevents the accumulation of cargo residues and is a necessary step in preparing cargo tanks for gas-free entry.

Introduction

Due to the great number and variety of chemicals and petroleum products carried aboard tanker vessels, it is unlikely that two consecutive cargoes will be the same or compatible with each other. In most cases, the presence of previous cargo residues, even in small amounts, will be undesirable. Systematic cleaning allows tankers to completely change the grade of cargo carried from one voyage to the next.

The level of tank cleaning that needs to be undertaken will be determined by:

- the chemical and physical properties of the cargo that has been discharged;
- the type of tank coatings (or stainless steel); and
- the preloading specifications of the next cargo.

Machines and methods

The principle means of tank cleaning aboard all tanker vessels is the 'Butterworth' tank cleaning machines, which nowadays are permanently mounted in the most efficient locations within each cargo compartment to effect optimum coverage of the tank surfaces and are rated according to tank capacity. Alternatively, some vessels employ portable tank cleaning machines (with and without 'fixed' systems), raising and lowering them to 'drop' levels within the tank to achieve optimum coverage.

Tank cleaning utilises sea and fresh water as the wash fluid, with and without chemical additives such as surfactants, alkali or acidic wash agents (the latter is not suitable for zinc-coated tanks), and solvent components that are available as proprietary IMO-approved tank cleaning products. The wash fluids can be delivered by the tank cleaning machines at ambient temperature or heated, using the vessel's tank washing heat exchanger, to temperatures up to 70°C – 80°C.

Other tank cleaning techniques include direct spray of cleaning chemicals or distilled/deionised (DI) water to tank surfaces by high-pressure equipment and 'live' steaming of the tanks.

Establishing the correct tank cleaning plan is essential and here reference can be made to industry Tank Cleaning Guides (TCGs) such as Dr Verwey's, Miracle, Milbros, Energy Institute: HM50 and those provided by the many tank cleaning chemical providers and oil majors. Experienced owners often develop their own in-house methods and procedures. It is important to efficiently clean the cargo tanks and not perform unnecessary over-cleaning as this wastes energy and money.

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The objective of the wall-wash survey is to assess the surface cleanliness of the entire cargo tank; however, in practice, it is only possible to draw samples from the lower 2m of the vertical bulkheads, a zone that sometimes receives extra attention from a ship's crew during cleaning, creating the possibility of non-representative wall-wash samples being obtained.

Effectiveness

The effectiveness of tank cleaning operations is assessed by wall-wash inspection, which involves applying solvent to selected areas of the cargo tank bulkheads and thereafter analysing the recaptured solvent for 'key' quality parameters. Typically, approximately 0.5l – 1.0l of solvent, which is often methanol but can also be toluene/acetone/DI water or even the next cargo to be loaded, is sprayed at head height onto the vertical tank bulkhead. The solvent is allowed to run down the surface and is collected into a clean bottle using a truncated funnel.

Though it will never be a repeatable procedure, this inspection practice can be standardised by washing approximately 1m² of tank surface at a given number of locations on each bulkhead. *ASTME 2664 'Standard Test Method for Methanol Wall Wash of Marine Vessels Handling Polyester Grade Monoethylene Glycol'* is becoming a commonly used standard amongst inspection companies as well as ships' crew.

It is important to keep all wall-wash equipment chemically clean and to avoid contamination of the wash solution by contact with skin, clothing and sweat. It is not good practice to wall-wash wet or still-warm bulkhead surfaces.

Intertanko standards

With the advent of ever more sophisticated methods of analysis, the specifications applied to the carriage of chemical and petroleum cargoes have become increasingly stringent, sometimes driven by the commercial competitiveness of the shippers/charterers to market their goods to a higher specification than their rivals. Nowadays, there are five commonly recognised standards for tank cleanliness as outlined by Intertanko on the next page.

The ship's crew must be competent in performing the wall-wash survey and measuring the 'key' quality test parameters specified by the shipper/charterer:

- inorganic chloride;
- colour;
- water miscibility (hydrocarbons) test;
- Permanganate Fade Time (PFT).

Increasingly, owners are equipping their vessels with UV-vis absorption spectrometers, enabling UV absorption to be determined. At present, gas chromatography testing and 'Karl Fischer' testing for dissolved water is not performed aboard ships, but this is expected to change as technological advances improve the reliability and miniaturisation of the instruments.

By employing the above wall-wash survey techniques and 'key' testing of the wall-wash solution, the ship's crew can monitor each step of the tank cleaning plan to ensure the effectiveness of each cleaning stage.

Tank coatings

A common problem faced during tank cleaning is the property of certain epoxy-type tank coatings to absorb certain volatile chemical cargoes during laden voyage, only to be reintroduced as a contaminant into the subsequent parcel carried in the same tank by an absorption/desorption mechanism. Past experience has shown that conventional tank cleaning techniques are incapable of removing all previous cargo residues absorbed into the epoxy coatings.

Intertanko's five standards of tank cleanliness

Definition	Tanks suitable for	Additional comments
1. Visually clean		
Dry, free of visual residues of previous cargo and/or foreign matter	Phosphoric acid, caustic soda, FAME, veg oils after CPP/veg oils, CPP after CPP/veg oils	
2. Water white standard		
Dry, odour free, free of visual residues + wall-wash with suitable solvent shows <ul style="list-style-type: none"> – colour PtCo (ASTM D 1209) less than 10 	Styrene monomer, acrylonitrile, MTBE, ETBE, hydrocarbon solvents, chlorinated solvents, isopropyl alcohol, acetone, MEK, MIBK	Methanol is a suitable solvent for wall-wash tests in most cases
3. BTX standard		
Dry, odour free, free of visual residues + wall-wash with toluene <ul style="list-style-type: none"> – colour PtCo (ASTM D 1209) less than 10 Acid wash* – colour (ASTM D 848) less than 2 	Benzene, toluene, xylene, sulphuric acid	Acid wash colour is affected by unsaturated products, such as all inhibited cargoes, veg oils, olefins, pygas and gasoline
4. Methanol standard		
Dry, odour free, free of visual residues + wall-wash with methanol confirms to: Water miscibility test (ASTM D 1722) passes <ul style="list-style-type: none"> – colour PtCo (ASTM D 1209) less than 10 – Chlorides less than 2 ppm – Permanganate time test above 50 min – UV spectrum passes 	Methanol, ethanol, MEG fibre grade, food grade and pharmaceutical grade cargoes (acetic acid, MPG-USP grade)	IMPCA specification is the international methanol standard and includes strict UV specification. Readings: <ul style="list-style-type: none"> – Max 0.25 at 220 nm – Max 0.10 at 250 nm – Max 0.02 at 268.5 nm – Max 0.01 at 300 nm
5. Ultra clean standard		
Passes methanol standard + wall-wash with suitable solvent: <ul style="list-style-type: none"> – Non-volatile matter less than 10 ppm* – Last cargo by GC* or other suitable method less than 2 ppm 	Highest purity chemicals, such as 1-hexane, 1-octene, HMD, acetic anhydride	Tank is completely free of residues as detectable by modern instrumental methods

* Acid wash test, Gas Chromatography (GC) and non-volatile matter cannot be tested onboard.

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As such, due care and consideration with regard to the sequencing of cargoes is required to ensure that incompatible cargoes which may adversely affect the sensitive quality parameters of the next loaded cargo are not carried in the nominated tank immediately prior. An example of this includes the carriage of any aromatic type cargo prior to loading a parcel of monoethylene glycol (MEG), which would adversely affect the UV properties of the MEG cargo. A pictorial depiction of the cargo absorption/desorption mechanism is provided below.

Cleaning times and temperatures

Whilst TCG recommendations for cleaning times and temperatures are a useful guide, it is essential to monitor the effectiveness of the operations in order to avoid under and over cleaning. For example, if too many tank cleaning machines are employed at any one time, this will lead to a reduction in water pressure and dramatically impair the effectiveness of the cleaning. While the above is undesirable, effective monitoring of the tank cleanliness will ensure that the cleaning stage is repeated until the required degree of cleanliness is attained.

Cargo-specific properties need to be given careful consideration; for example, too high or low a temperature at the initial washing stage can result in significant problems during the latter cleaning stages. For example,

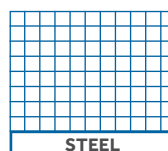
styrene monomer has a tendency to polymerise and a number of edible/vegetable oils, including soyabean, cottonseed, linseed, castor and fish oils air-dry, leaving behind hardened deposits which are difficult to remove. These polymerising and drying/semi-drying cargoes require prompt initial washing with ambient temperature water to avoid the formation of hardened deposits. Ambient temperature water should also be used for the removal of volatile/flammable cargoes in order to reduce the fire/explosion risk. Water-soluble cargoes, such as alcohols/glycols, need only be warm water washed, preferably with fresh/deionised water.

In contrast, using higher-temperature cleaning water is desirable in some instances. The use of hot/warm water improves the solubility of high melting point cargoes such as phenol and vegetable oils, including palm and coconut oil products, which require elevated temperatures to ensure the products remain liquefied, thereby expediting removal.

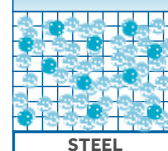
Completion

Finally, the ship's crew, upon completion of tank cleaning operations, can perform a final wall-wash survey to ensure that the ship's tanks will 'pass' the preloading wall-wash inspection for the standard of cleanliness appropriate for the next nominated cargo advised by the charterers.

Clean Epoxy Paint



Cargo Laden



After Discharge with Absorbed Cargo

