Preparing Chemical Tankers for Cargo Operations

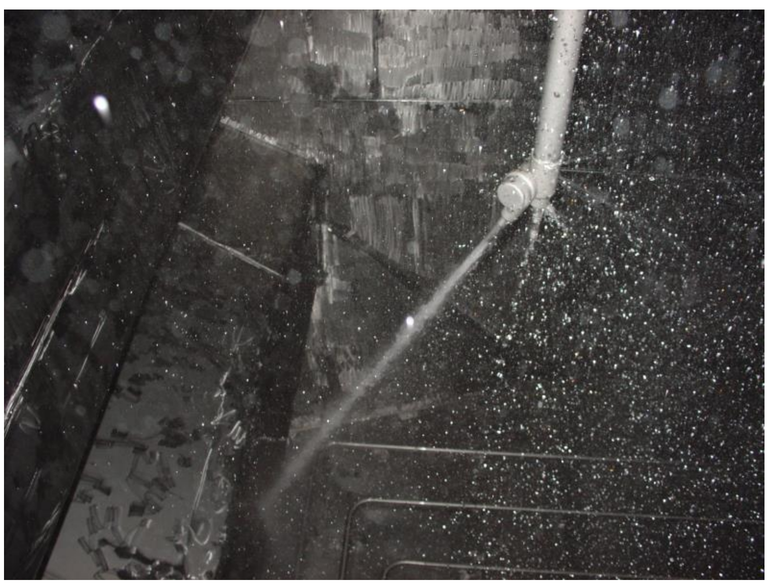
Cargo Tank Cleaning – The Basics

All tank cleaning procedures are essentially a logical sequence of events that will ultimately allow any vessel to change from one grade of cargo to another. The precise nature of the cleaning process is specifically determined by the chemical and physical properties of the cargo being cleaned from, the type of lining inside the cargo tanks, the size and dimension of the cargo tanks **and** the pre-loading specifications of the next nominated cargo.

Very simply, the key to any successful cleaning operation is knowing how far to clean and determining whether each step of the cleaning process has been effective.

In practice most tank cleaning procedures are very similar, because there are not that many different variables available to the vessels:

i.) Fixed tank cleaning machines or portables (or both)
ii.) Water or solvent for the pre-wash?
iii.) Reaction of the previous cargo(s) with the cargo tank coating
iv.) Cold water or hot water?
v.) Tank cleaning chemicals or not?



Determining the correct plan is essential, but this can usually be determined from the many and varied tank cleaning guides available on the market. Of far greater significance and importance is the monitoring of each step of the plan, in order to make sure that the step has actually been carried out.

Tank cleaning guides are useful but they can also be extremely misleading for the simple reason that inexperienced operators will tend to use the guides as a definitive method for any particular tank cleaning. This is a mistake which can and does cause problems.

The following pictures are real cases where vessel's crew followed a tank cleaning plan, but failed to monitor the process and assumed that each step had been effective, when clearly it had not:

Crude Tall Oil:

Paraffin Wax:

That said, still today in cases of legal dispute where the diligence of the vessel's crew is questioned, legal reference is drawn to whether the vessel cleaned within the guidelines stipulated in one or two of the most commonly used and published tank cleaning guides, despite the clear weakness noted earlier.

One has to ask the question, "how can the outcome of a legal case be influenced on a "guideline"?"; by definition an indicator and not a definitive procedure? The answer to this question is quite simply that there is no other indicator, apart from experience which is almost impossible to quantify.

In the same breath, many chemical cargoes are now only loaded if a wall wash inspection is found to be within a set of pre-determined specifications. Achieving a wall wash standard (particularly in coated cargo tanks) is extremely challenging and requires extensive tank cleaning. If a vessel fails to meet the required specifications, it implies that the vessel is still dirty, yet in many cases this is actually not true.

Again referring to cases of legal dispute, where a cargo has become spoiled on board, for whatever reason, and the vessel has been subjected to a wall wash inspection prior to the commencement of loading, it is noted that the wall wash inspection actually provides no legal protection for the vessel. In other words, the fact that the vessel had to clean the cargo tanks to a condition where a wall wash inspection was found to be acceptable prior to loading, does not legally prove that the vessel cleaned diligently.

Moreover, there is no liability or responsibility placed on the inspection company (unless gross negligence can be proved), which surely means that the wall wash inspection is nothing more than an indicator of load readiness and as such, it is difficult to understand why and how it holds such weight in the chemical tanker business?

Wall wash specifications are very often set to the same levels of magnitude as the export specification of the cargo being loaded. For example zero hydrocarbons in the wall wash and zero hydrocarbons in the final loaded cargo. But in some cases, the wall wash specifications are actually **stricter** than the export specifications of the cargo being loaded, which is astonishing when one considers what the wall wash sample actually represents, which will be discussed throughout this article.

For the time being, we will focus on how the efficacy of the tank cleaning process is measured by means of an inspection process; more specifically the wall wash inspection.

Wall Wash Inspection of the Cargo Tanks – The Basics

The wall wash inspection, as the name implies, is an inspection process that involves washing the walls or bulkheads of the cargo tanks with a solvent and thereafter analysing the quality of the solvent against a pre-determined set of specifications. The concept is quite straightforward but as we will see, the wall wash today is very different from the wall wash of the recent past.

It is believed that the wall wash inspection was first introduced by ship owners as a means of demonstrating the ability to tank clean cargo tanks to better and higher standards. At these times, the wall wash specifications were considerably less stringent than they are today, which probably better reflected the capability of the vessels to analyse the samples, rather than the need to achieve higher specifications. Over time, the wall wash inspection has become synonymous with the loading of high purity chemical cargoes and as a consequence has become more and more relevant to the charterers and shippers of these chemical cargoes, resulting in stricter and more bespoke specifications. Today it is common for wall wash samples to be analysed to low or even sub parts per million (ppm) levels of contamination and it has to be made explicitly clear that this <u>does have a very real and direct impact on tank cleaning.</u>

Essentially, the wall wash inspection is the difference between a <u>visually</u> clean cargo tank and a <u>chemically</u> clean cargo tank; and contrary to some published tank cleaning guidelines, the amount and extent of additional tank cleaning required to upgrade a cargo tank from visually clean to chemically clean is far more than simply steaming or washing with de-ionised water. In very many cases, including both stainless steel and coated cargo tanks, it is impossible to see the contamination that will cause the wall wash sample to be rejected. Furthermore, it does not always follow that additional cleaning will lead to an improvement in the wall wash results, which is a concept that is quite difficult to understand, particularly for commercial interests who are very often responsible for setting wall wash specifications. This fact alone is at the heart of many disputes because it is wrongly assumed that if a vessel fails a wall wash inspection, it is just a matter of carrying out another round of tank cleaning and the vessel will then pass the wall wash inspection.

As the wall wash inspection is clearly a vital part of the chemical loading process and very often the one thing that stands between a vessel loading and standing idle, it is absolutely essential to ensure that the sample has been drawn appropriately and correctly. A poorly taken wall wash sample can directly result in a vessel being de-berthed (with the associated costs) and / or additional and unnecessary tank cleaning (with the associated costs).

The following points outline the basics for a standard wall wash inspection:

- All wall wash equipment should be chemically clean. This includes washing / flushing with the pure wall wash solvent prior to the start of the inspection and again inside the cargo tank just before the start of the inspection (to ensure contamination from one cargo tank does not carry over to the next). **Note:** Wall wash samples can also become easily contaminated from hands, clothes or sweat.

- Bulkheads that have not been inspected should never be touched or even leaned against because quite simply, if the wall-wash sample becomes contaminated as a direct result of surface contamination that has not come from the previous cargo or cleaning process, this could directly lead to the wall wash sample being rejected.

- Wet bulkheads should never be wall washed. Water or moisture will directly affect the ability of the solvent to absorb contaminants from the surface of the cargo tank / coating, which may give misleading results. It is also advisable not to wall wash when the cargo tanks are too hot, for example directly after hot washing or steaming, because volatile wall wash solvents tend to quickly evaporate, leading to a “concentrating” effect of any contaminants in the sample.

- **The basic wall wash procedure is to spray 500ml of pure solvent from a plastic squeeze wash bottle over approximately 1 square meter of the cargo tank bulkheads for collection via a flat sided funnel into a glass sample bottle.** Some solvent will always run past the funnel and / or be lost to evaporation, but a recovery rate of 50 – 60% of the 500ml is normal, leaving 250ml – 300ml of sample for analysis.

- The primary objective of the wall wash inspection is to finish with a sample that represents the chemical condition of the entire tank. However, in practice it is accepted that "normally" the sample can only be taken from the lower accessible areas of the cargo tanks.

Suggested Standard Practice

- Choose two places from each bulkhead to sample, meaning the completed wall wash sample will be representative of a minimum of 8 spots (samplings) for each cargo tank.

- Place a flat-sided funnel with the lower spout inside a glass sample bottle, against the bulkhead at waist height with one hand. In the other hand, extend a wash bottle containing the wall wash solvent (usually methanol, but not always) as high as possible directly above the funnel.

- Spray the wall wash solvent and allow it to stream / flow down the surface of the bulkhead. Collect as much of the solvent as possible via the funnel into the sample bottle.

- Repeat as described above so that at the end of the inspection, the volume of collected wall wash sample is around 250ml and the total surface area sampled is approximately $1M^2$.

- **Note:** Choose areas that represent the good, the typical and the worst (cleaning machine blind spots) parts of the cargo tanks, rather than just the best parts. If through experience or visual observation there are a number of areas that appear to be non-typical, take and analyse a separate wall wash sample just from these spots, in order to identify the source of the contamination, if at all possible.

At the top of the cargo tank, put on clean shoe covers.

At the bottom of the tank, put on clean gloves (typically disposable latex type).

Transfer the pure solvent to the wash bottle.

Rinse the flat sided wall wash funnel with the pure solvent.

With the flat side of the wall wash funnel against the bulkhead, extend the wash bottle above the funnel and spray the methanol so that it runs down the bulkhead to be collected in the sample bottle, via the funnel.

When the sampling process has been completed, rinse the sample bottle cap with clean solvent and securely screw it onto the sample bottle. Clearly mark the sample bottle with the relevant tank number. Good sample identification is important.

The most commonly used wall wash solvent is methanol because it has the ability to extract / dissolve both organic and inorganic residues from the surface of the cargo tanks, meaning the wall wash sample can be tested for the presence of previous cargoes and the presence of washing water residues. Other wall wash solvents can be equally well employed, based on the quality of the cargo to be loaded, the nature of the previous cargo and in some cases, historic contamination claims.

Most commonly:

Acetone	Generally accepted to more aggressively extract hydrocarbon based residues compared to methanol
Toluene / Xylene	Most commonly to extract persistent hydrocarbons for example vegetable oils, lubricating oils etc., particularly prior to loading pure aromatic cargoes like BTX.
DI Water	Almost exclusively to extract inorganic chlorides, but sometimes also tested for UV quality prior to loading HMD

Wall Wash Inspection – Pros and Cons

As already noted, the primary reason why the wall wash inspection was introduced in the first place was a means of distinguishing between visually clean and chemically clean cargo tanks. With this in mind, it becomes clear that the wall wash inspection has two distinct roles to play in the chemical business.

Firstly, it is used by load port surveyors to determine whether a vessel is suitable (or not) to load any nominated cargo.

Secondly, it is used by the vessel also to determine final cargo tank suitability for loading, but far more importantly, it is used to monitor the efficiency of cargo tank cleaning operations.

Without the wall wash inspection, it would be difficult to determine whether the use of specific cleaning chemicals had been effective or not. For example, many cleaning chemicals are detergent based, meaning they are designed to remove cargo residues that are insoluble in water from the surface of the cargo tanks. If the cleaning chemical is unsuitable, or the vessel's tank cleaning equipment is malfunctioning, the cargo tanks may still be contaminated with traces of hydrocarbon residues, insufficient to see visually, but sufficient in concentration to cause a positive identification in the wall wash sample. This would alert the vessel to either repeat the cleaning with a more appropriate choice of cleaning chemical, or to find and repair the fault in the tank cleaning equipment.

Likewise the removal of:

i.) Traces of discolouration
ii.) Traces of salt from the washing water
iii.) Contaminants that react with potassium permanganate

Can only be measured by means of a wall wash inspection and without this, vessels would not be able to execute effective tank cleaning operations.

But when the wall wash inspection is used <u>only</u> as a means of determining cargo tank suitability prior to loading by the load port surveyor, the positive benefits start to become questionable.

One has to ask; "how can a cargo tank be rejected simply because an independent load port surveyor finds a wall wash sample does not meet a set of pre-determined specifications?" Specifications that generally apply to all cargo tanks of all vessels, irrespective of vessel type, volume, shape, coating type etc.

In other words, if the wall wash specification prior to loading cargo A was a maximum of colour 10 APHA, would this specification apply and have equal significance to both a $2000M^3$ stainless steel cargo tank and a $150M^3$ coated cargo tank?

The answer is "yes but no" ..

Yes because in the vast majority of cases the wall wash specification applies to the previous and / or next cargo, not the vessel carrying the cargo.

And no, because the impact of having a colour of 10 APHA on the walls of both cargo tanks would have a completely different impact on the quality of the cargo, assuming each cargo tank was fully loaded.

One then has to look at what the wall wash results actually mean relative to the fully loaded cargo tank. Clearly the wall wash inspection is an inspection of the internal surface area of the cargo tank, but how much surface area is actually inspected, compared to the fully loaded volume of the same cargo tank? This is a question that is never considered yet it has huge significance on the validity of the wall wash specifications.

Furthermore, the wall wash test by definition is <u>random</u> and the sampling technique (which can only be carried out on accessible areas of the cargo tanks, typically 10 – 15% of the internal surface area of the cargo tank) is <u>impossible to standardise</u>. Yet the sample is commonly analysed to the highest levels of analytical precision in the surveyors' / cargo supplier's laboratories and it is these results that ultimately determine whether a vessel is considered to be clean or not and of course whether the nominated cargo can be loaded.

This goes against all the laws of science which state that the validity of any analytical test procedure is directly governed by the quality of the sample. If the sample is not representative / typical / reproducible / standardised, <u>the analytical procedure is not</u>

valid. So, as a method of accepting or rejecting the suitability of a cargo tank prior to loading a cargo, the wall wash inspection has to be, at best, questionable.

Moreover, failing a wall wash inspection does not always mean that the tank cleaning plan has been ineffective; similarly it does not mean that the next nominated cargo cannot be successfully loaded. On the contrary, passing the wall wash inspection in no way guarantees that the next nominated cargo can be loaded without risk of contamination, yet still there is over-riding pressure to achieve this standard and without acceptance, the vessel does not load and the competence of the crew is always questioned.

The key here is the actual wall wash specifications and their relevance to the next cargo, but in reality the vast majority of wall wash samples are all tested for the same parameters with only the final specification differing, based on the cargo to be loaded and specific charterers requirements. Typically these parameters are:

- i.) Inorganic chloride
- ii.) Colour
- iii.) Water miscibility (hydrocarbons)
- iv.) Permanganate Time Test

It is also quite common for the same cargo to have different wall wash specifications dependent upon the charterer and load port, meaning it becomes extremely confusing for the vessels if one charterer demands a maximum colour specification of 15 APHA but another demands a maximum of 5 APHA for the same cargo. Who is right?

And in the absence of specific charterers instructions, which is a far more common occurrence than it should be, (charterers fall back on the default "cargo tanks to be inspected to the charterers inspectors satisfaction", which is scandalous if it is known that the cargo tanks will be wall washed) if a vessel presents cargo tanks with colour less than 15 APHA for a cargo at the load port where the maximum colour is 5 APHA, the wall wash inspection will fail, but how can the cargo tanks be considered dirty?

Consider also that neither the water miscibility nor the permanganate time tests are quantitative or indeed specific. In other words, if either of these tests fails to meet whatever the specification is, the cause of the failure (contaminant and concentration) remains an unknown.

The hydrocarbon or water miscibility test (ASTM D1722) is one of the most important parameters on a standard methanol or acetone wall wash, but as just noted, the test is not specific and does not tell the analyst what the hydrocarbon is. For vessels using the wall wash to monitor tank cleaning, it is extremely important to know the nature of the hydrocarbon, because this can directly impact on the subsequent cleaning steps.

If a wall wash sample shows a positive hydrocarbon, it could be:

i.) Previous cargo
ii.) Residual tank cleaning chemicals
iii.) Older cargo residues absorbed into coated surfaces
iv.) Reaction of the wall wash solvent with the coating
v.) Other – for example hydraulic oil, leaking adjacent cargo etc.

Different hydrocarbon products also have different responses to the hydrocarbon test, depending on the relative solubility of the hydrocarbon in water. The most common hydrocarbon products to slip under the net of the hydrocarbon test are aromatics, because many aromatics have a very slight solubility in water.

For example toluene has a solubility in water of approximately 0.18%, meaning that if the wall wash sample contained for example 0.175% toluene, it would pass the hydrocarbon test. Clearly having 1750 ppm of toluene in a wall wash sample is not the preferred objective, yet this is quite possible.

Accurately monitoring tank cleaning goes beyond just "passing" a wall wash sample and if done correctly, the cargo tanks will actually be much cleaner than simply passing an independent wall wash inspection.

The responsibility for the tank cleaning is always on the vessel and in the case of a cargo tank rejection or cargo contamination claim there is no recourse on the choice of tank cleaning guide or the validity of the independent load port inspection. The vessel has to know how clean the cargo tanks are before any cargo is loaded and without monitoring the tank cleaning process this is impossible. There is a growing realisation that vessels need to have the ability to identify specific contaminants in wall wash samples rather than just knowing if the hydrocarbon and / or permanganate time tests "pass or fail"; indeed more and more vessels are using relatively sophisticated laboratory instrumentation to help them achieve this.

The "randomness" of the wall wash inspection also explains why no two wall wash samples will ever be exactly the same and it is quite possible for one sample from a cargo tank to be considered as acceptable whereas another sample from the same cargo tank may be unacceptable. And as noted, the upper areas of the cargo tanks are largely and routinely not represented at all.

The following is a picture of the aft bulkhead from a zinc silicate coated cargo tank on a chemical tanker. The areas marked in black on the picture show where a wall wash sample may typically be taken from:

<u>Consider the relevance of the wall wash areas to the fully loaded tank.</u>

Furthermore and perhaps one of the most over-looked parts of the wall wash inspection, is the volume of solvent used and the area of the cargo tank that is washed. Industry standards and practices dictate that one square metre of the cargo tank should be washed using 500ml of solvent, but very often neither the volume of solvent nor the surface area are measured, <u>but this has a massive impact on the final wall wash results.</u>

Let us assume that there is a fixed concentration of contamination in any given square metre of the cargo tank and for the sake of this discussion we can call it 10mg. It follows that if this area is wall washed with 1 litre of wall wash solvent, the concentration of contamination in the wall wash sample will be 10mg/L.

However, if the volume of solvent recovered is 500ml, the concentration of contamination increases to 10mg/500ml or 20mg/L. Similarly if the volume of solvent recovered is 250ml (which is very common), the concentration of the contamination in the wall wash sample increased to 40mg/L.

Which answer is right? The difference in results could be the difference between the vessel being accepted and the vessel being rejected, but actually the concentration of the contamination on the surface of the cargo tank does not change.

This is a fundamental flaw of the wall wash inspection.

If we now assume that a $1000M^3$ cargo tank has a surface area of $1000M^2$, we can easily calculate that if each square metre of the cargo tank was wall washed with 500ml of solvent, the total volume of solvent recovered would be $0.5M^3$. All the contamination in this sample would then be diluted into $1000M^3$ giving an overall dilution effect of 2000 times. In other words, the wall wash sample will be diluted 2000 times in the fully loaded cargo tank.

With all of this in mind, how can it be reasonably justified that the quality of a wall wash sample should be stricter than the quality of the fully loaded cargo? Yet this is a common occurrence today as commercial pressure is pushing the tank cleaning process to breaking point.

One example of this is fuel grade ethanol, which is essentially pure ethanol that has been denatured with gasoline or some other petroleum product derivative to prevent the cargo from being consumed. The cargo looks like pure ethanol, in other words, there is no visible clue that the ethanol is denatured and for this reason, many charterers are still demanding that cargo tanks nominated to loaded fuel grade ethanol are cleaned to a wall wash standard; typically zero hydrocarbons and chlorides less than 5ppm.

This is quite astonishing because in the case of gasoline as denaturant, it is routinely found that the ethanol can contain between 2% and 5% of a pure, water insoluble, hydrocarbon. So what commercial value can there possibly be in making the vessel clean to zero hydrocarbons, when the cargo itself contains as much as 50,000ppm hydrocarbons?

The wall wash inspection has become abused by commercial interests and this has potentially serious consequences not just for the vessels in terms of tank cleaning responsibilities, but also for the charterers themselves because it causes unnecessary delays and potentially increases cleaning chemical and bunker consumption which in many cases, is a charterer’s cost.

Wall Wash Inspection – The Pitfalls

The trust that is placed on the wall wash inspection as a means of determining cargo tank suitability has been discussed, but at the same time it should be accepted that in the absence of any other technique to determine cargo tank suitability, charterers of chemical tankers appear to have little option apart from the wall wash inspection to give them reassurance that any nominated vessel is suitable to load their cargo. But the tendency to make the wall wash specifications stricter in order to achieve higher levels of purity on shipped products can be counter-productive and lead to problems that might otherwise not be anticipated or expected.

There is no reproducibility of the wall wash inspection and coupled with the random nature of the technique, one of the major pitfalls is an over-reliance on what the results actually mean. As noted, the hydrocarbon or water miscibility test (ASTM D 1722) is commonly demanded by charterers, because the huge majority of cargoes that are cleaned from are hydrocarbon based. But achieving a hydrocarbon "pass" does not mean that the wall wash sample (and by implication the cargo tank) is free from hydrocarbons; it just means that the wall wash sample is free from hydrocarbons that do not mix with water. The example given earlier, referred to toluene in a wall wash sample, but different hydrocarbon based cargoes have different levels of solubility in water, meaning there could ppm to % levels of hydrocarbon residues in a wall wash sample that passes the hydrocarbon test.

Assuming that passing the hydrocarbon test means there is no risk of contaminating the next cargo, is dangerous and can lead to significant problems.

Ignoring or overlooking the volume of the recovered wall wash sample and the surface area "washed" has been discussed and whilst this is fundamentally a flaw in the procedure, the significance of generating different results from wall washing the same area of cargo tank should never be ignored.

In addition to this flaw, there are two additional factors that could be considered individually or together, both of which have a direct impact on the wall wash results:

i.) Contact time

The actual time the wall wash solvent is in contact with the surface of the cargo tank. This is influenced by the actual method of wall washing employed, the surface area washed, the volume of solvent used and the temperature of the cargo tank and / or solvent.

ii.) Cargo tank lining

There are three types of cargo tank lining most commonly employed on chemical tankers:

1. Stainless steel
2. Organic coating (generally epoxy phenolic, or epoxy based)
3. Inorganic coating (generally zinc silicate)

Each lining has different chemical and physical characteristics that are most commonly linked to the cargoes carried on the vessels. Moreover, each lining has a unique surface profile that directly influences the absorption / adsorption and retention of previous cargoes in that lining. It therefore follows that each of these different linings will potentially respond differently to any given tank cleaning procedure, and the subsequent wall wash results are likely to reflect this. For example organic cargo tank coatings will absorb and retain small molecular sized, “solvent type” cargoes, whereas these same cargo types will readily evaporate from the surface of a zinc silicate coating. In contrast, large molecular sized cargoes, typically oils, mid / heavy distillates, waxes etc. are strongly retained in the surface profile of zinc silicate coatings, but not so in organic coatings.

iii.) Contact time and cargo tank lining in combination

Understanding the relationship between the different types of cargo tank lining and the different cargoes is one thing, but translating this into meaningful wall wash results is another. If one considers that organic cargo tank coatings retain low molecular weight solvents, it would be expected that residues of these cargoes would be evident in a wall wash sample after tank cleaning and indeed, this is usually the case. But the question remains; how much of the previous cargo has been removed by the wall wash? The contact time is of course critical, but of equal importance is the ability of the wall wash solvent to extract the retained cargo residues and this is dependent upon both the coating type and the nature of the retained cargo residues.

It is a mistake to assume that just because the wall wash sample of an organic coated cargo tank with last cargo styrene monomer has identified for example 5 mg / L of styrene monomer, this is the total amount of styrene monomer retained in the coating.

Likewise with persistent hydrocarbons retained in zinc silicate coatings.

Finally on this subject, one of the most serious pitfalls of the wall wash inspection is largely over-looked, because it falls under the safety banner; and that is confined space entry. Each time a wall wash inspection is carried out, at least one crew member or cargo surveyor or terminal representative has to enter a confined space; with all of the safety implications that this brings. When one considers the actual value of the wall wash result and the fact that "passing" a wall wash inspection does not actually provide any guarantee (legal or otherwise) that the nominated cargo can be loaded without risk of contamination, one has to sincerely question whether the outcome justifies the safety risk.

Alternative Inspection Process

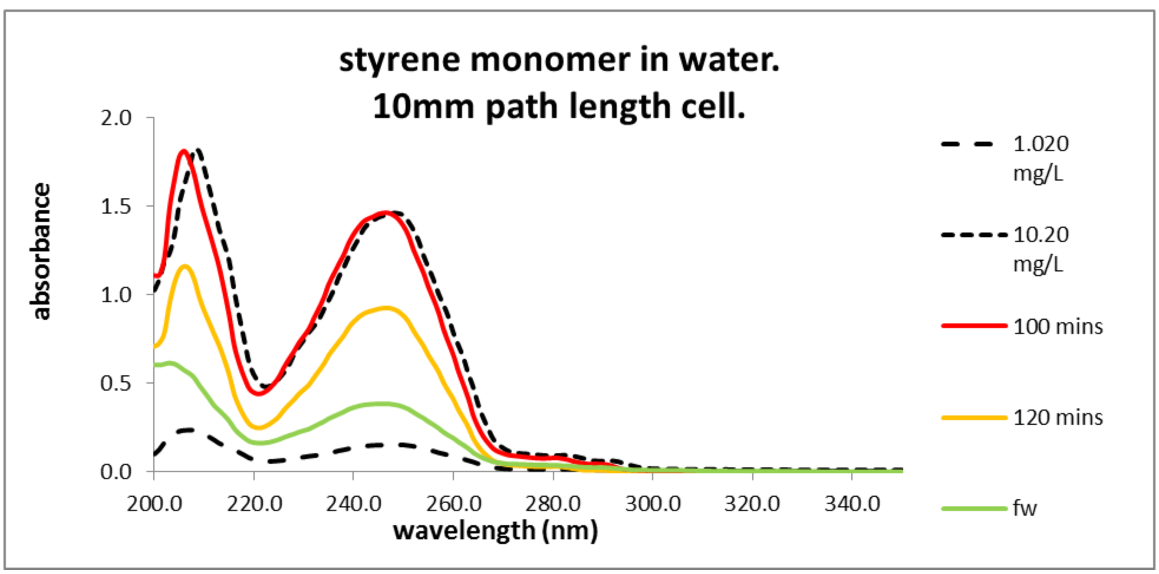
If it is accepted that the real value of the wall wash inspection is at best limited and certainly provides no assurance that the nominated cargo can be loaded without risk of contamination, it is clearly evident that there is an immediate need for an alternative process that is at least equal or potentially better at determining cargo tank suitability.

The demand for higher purity cargoes will continue to increase, but at some point the industry has to accept that at the end of the day, the vessels are limited by how far they can actually clean, regardless of how strict pre-loading wall wash inspections may become in the future. It is impossible to completely remove all retained cargo residues from coated cargo tanks and even stainless steel has a profile that can retain certain types of chemical / oil cargoes. If the receivers are demanding maximum levels of contamination in parts per billion or even parts per trillion levels, the simple answer is that they will have to seek other methods of transportation to satisfy these requirements. Already it is common practice to see wall wash specifications stricter than the export specifications of the cargoes to be loaded, but clearly this trend cannot continue because even though a wall wash sample shows no level of previous cargo, this does not mean that the cargo tank is completely free from the previous cargo, for the reasons discussed earlier in this document.

There certainly needs to be a better and more in depth understanding of the characteristics and properties of the cargo tank linings and just as importantly, a better method of measuring the cleanliness of all of the cargo tanks (not just the areas that are currently being wall washed) and the cargo lines, which is the part of the vessel that is most likely to cause cargo contamination, yet remains untested.

The answer is washing water analysis, which is actually a method that has been used by BP as a replacement for the wall wash inspection for a number of years now with good success. But whereas the BP procedure involves testing the washing water for the presence of contamination that contribute to a positive chemical oxygen demand (COD), the author has identified an alternative approach that is not only quicker (the COD test takes a minimum of 2 hours to complete one test), but also allows the vessel to dynamically monitor cargo tank cleaning operations, in situ. The method uses a preprogrammed UV / Visible spectrophotometer (L&I WAVE II) which allows the washing water samples to be analysed primarily by UV spectroscopy, but also by visible spectroscopy if required.

Each UV scan takes less than a second to run, but the information generated, directly reflects the amount of previous cargo being removed from the cargo tanks via the cargo lines. The information is powerful and because it is live, it allows the vessel to modify cleaning operations successfully, which has already saved significant time and fuel for these vessels currently using this method.



The above data was generated during the cleaning of a vessel from styrene monomer and it shows that after 100 minutes of washing with ambient temperature seawater, there is approximately 10mg/L of styrene in the washing water. 20 minutes later the styrene content of the water has dropped to around 5mg/L after which, the vessel cleaned for 15 minutes with hot FW and the styrene content of the water dropped to just around 1mg/L.

The principle is very simple; when the washing water sample no longer contains traces of the previous cargo, the cargo tank is clean. Always accepting that cargoes that are not soluble in water will usually require chemical additives to enhance the cleaning operation and cargoes that are routinely absorbed into the cargo tank linings, will need to be carefully considered.

Washing water analysis allows the vessels to be far more aware of how clean the cargo tanks and lines are and makes tank cleaning precise and reliable, because there is no longer a dependence on a testing procedure that is imprecise and unreliable.

Moreover, the ability to accurately monitor any tank cleaning process without repeated episodes of confined space entry is a massive step forward in the fight towards a safer working environment on board all chemical tankers.

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