

GUIDANCE

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SAFE HANDLING OF MONO ETHYLENE GLYCOL

THE SURGE IN DEMAND FOR MONO ETHYLENE GLYCOL (MEG) ACROSS MULTIPLE SECTORS, SPANNING FROM AUTOMOTIVE, TEXTILE TO PHARMACEUTICALS OR COSMETICS, HAS SEEN A PROPORTIONAL RISE IN OFF-SPEC CARGO CLAIMS.

It is widely used as an ingredient for production of polyethylene terephthalate (PET) resins, fibres, films or antifreeze and coolants. This article aims to highlight the importance of understanding the intricacies of MEG and some of the safety considerations for its transportation.

CARGO OVERVIEW

FOR REFERENCE AND AS BACKGROUND TO UNDERSTANDING THE CARGO, IT'S IMPORTANT TO KNOW THAT MEG IS A HIGH SPECIFICATION AND PARTICULARLY SENSITIVE CARGO.

MEG is a chemically hydrophilic substance, meaning it can easily form hydrogen bonds with solvents such as water or alcohol, it also has a low freezing point. Typically, it is synthesised by reacting ethylene oxide with water and the product is practically colourless, odourless and sweet tasting with a syrupy appearance.

Therefore, the production process poses a unique challenge due to the formation of impurities such as aldehydes (by-products), which are inherently difficult to separate from MEG. Factors like production process instability or failure in process control can contribute to the presence of aldehydes, specifically formaldehyde or acetaldehyde, in MEG.

QUALITY VULNERABILITY

LIKE MANY OTHER CHEMICAL CARGOES, THE QUALITY OF MEG CARGO IS SUSCEPTIBLE TO EXTERNAL FACTORS SUCH AS PRESENCE OF WATER, ULTRAVIOLET TRANSMISSION (UVT), AND CHLORIDE CONTAMINATION.

Any compromise in these aspects can significantly reduce the cargo's value, so it's essential to take precautions to ensure safe transport. MEG cargoes may require strict exclusion of water, which in turn, requires tank cleanliness to a very high-purity standard. This protocol helps to prevent contamination by residual organic and inorganic substances within the ship's containment system, i.e., tanks, pumps, heating equipment, and pipelines. Consequently, a wall-wash survey before loading and sampling the initial "first-foot" cargo is important.

After prolonged intervals between MEG loading at the terminal, the loading arm or hoses may sometimes be exposed to inclement weather, i.e., rain or sun, etc and these lines should be flushed before loading starts. Consequently, it would be a common practice to request for manifold samples to be tested before opening up to nominated cargo tanks to ensure the cargo quality conforms to the agreed specification as per voyage instructions. The first foot sample should be tested to ensure the results are also in satisfactory condition. However, this may involve suspending the cargo operation which should be agreed amicably between all parties of interest.

Furthermore, extended exposure of MEG to the air for a prolonged period during transportation tends to deteriorate the cargo quality when dissolved oxygen reacts with the cargo in a process called oxidation (by both thermal and catalytic means). During this oxidation process, MEG reacts with oxygen or other oxidising agents to produce aldehydes (e.g., glycol aldehyde, glyoxal, formaldehyde, acetaldehyde) and the corresponding acids. Therefore, it may be advisable to carry out nitrogen padding in ship's cargo tanks after loading (particularly for long voyages). The process of nitrogen padding for cargo tanks containing MEG is common to prevent or at least, avoid any further deterioration of the cargo during voyage and most charterers/shippers will require these additional steps to preserve the quality of the cargo.

In some cases, off spec issues with MEG can be attributed to the ship not receiving proper guidance or voyage instructions from shippers and/or charterers including the handling and nitrogen padding requirements. When a member's ship does not have this type of facility onboard, then they may seek alternative arrangement with the shippers/ charterers to address this concern and/or shore supply from the terminal.

An example of the sales specifications of MEG cargo provided to the customers would contain the quality parameters and test methods (*list may be updated from time to time*).

QUALITY PARAMETER	TEST METHOD	UNITS	MEG GRADES ¹
MEG purity	By difference	% wt	20
Diethylene Glycol (DEG)	ASTM E2409	% wt	0.1
Acidity	ASTM E2679	ppm	20
Iron	ASTM E1615	ppm	0.1
Chlorides	ASTM E2469	ppm	0.2
Water	ASTM E1064	% wt	0.05
Colour	ASTM E5386	pt/co	5
Appearance	ASTM E2680	pass/fail	pass
UV transmit @ 220nm	ASTM E2193	% T	75
UV transmit @ 250nm	ASTM E2193	% T	90
UV transmit @ 275nm	ASTM E2193	% T	94
UV transmit @ 350nm	ASTM E2193	% T	98
Total Aldehyde	ASTM E2313	ppm	6.5

Flashpoint ²	°C	111
Autoignition temperature	°C	398
Upper flame limit	Volume % in air	15.3
Lower flame limit	Volume % in air	3.2
Boiling point	°C	198
Melting point	°C	-12.9

The UVT test can be used in conjunction with gas chromatography-mass spectrometry (GC-MS) testing to investigate whether there is any aldehydes or aromatics present which causes damage to the cargo quality. However, these tests may be subjected to stringent sampling requirements and a requirement that no oxygen is introduced into the samples at ship's manifolds or lines. The key consideration for proper sampling is the sample bottles being put into use and that sampled liquid should be filled to nearly full to minimise air in the sample bottle headspace. Thereafter, the bottles should be logged and sealed properly and kept airtight until ready for use.

1 https://www.meglobal.biz/wp-content/uploads/2018/08/MEGlobal_Spec_EGPE_FINAL-2024.pdf

2 [https://www.cargohandbook.com/Ethyleneglycol_\(MEG\)](https://www.cargohandbook.com/Ethyleneglycol_(MEG))

The ship should retain this set of samples in case of any quality dispute and a record should be kept on the details of the sampling process, including time, sampling point, start/ stop and operational suspensions. Additionally, it is worth noting that samples should be taken not only during initial loading stage, but to practice the same during any suspension of cargo operations, tank switching, shore pump switching, after line flushing, etc.

MEG is hygroscopic and it can absorb significant amount of water from the atmosphere, especially in humid conditions. The carrier should ensure all cargo tanks, lines, pumps and vapour lines and fixed tank cleaning equipment are purged and contain no free water before loading operations.

EXAMPLES OF MEG GRADES

- **FIBRE GRADE** – e.g. fibres (textiles industry), films (packaging) or PET (bottles)
- **ANTI-FREEZE GRADE** – e.g. coolant
- **INDUSTRIAL GRADE** – e.g. prevent hydrate formations in oil and gas industry

TECHNICAL CONSIDERATIONS

NOTE THAT TANKERS EQUIPPED WITH CARGO TANKS FEATURING EPOXY-TYPE LINING SYSTEMS HAVE A DIFFERENT RISK LEVEL IF COMPARED TO TANKERS WITH CARGO TANKS CONSTRUCTED OF MARINE-GRADE STAINLESS STEEL COATING.

With the former, traditional wall-wash and first-foot survey methods might not always detect previous cargo residues (i.e., aromatics hydrocarbon, Benzenes, Xylene, etc) that could have been absorbed into the coating itself. Hence, it's advisable to consider cargo sequencing or selective tank usage.

Often, a UVT test may be carried out, which is an indicator for contamination or measure of purity of the sample. As this may not be available to the ship, the master should always request a certificate of quality to ensure cargo integrity.

LOSS PREVENTION'S PERSPECTIVE

OFTEN, CLAIMS ARISE FROM CONTAMINATION DUE TO PREVIOUS CARGO RESIDUE, DEGRADATION DUE TO OXYGENATED IMPURITIES, AND/OR MOISTURE CONTENT.

Vigilant adherence to safety protocols and thorough understanding of MEG's unique characteristics are imperative to minimise the risk of such claims during maritime operations.

Below are some practical considerations and recommendations when dealing with MEG cargoes:

PRE-LOADING

- Ensuring proper tank cleaning, including rinsing with fresh water after sea water washes, is essential for eliminating chloride-containing residues. In specific circumstances when the cargo grade demands 99% purity, it is advisable to consult with the shipper/charterer regarding the necessity of the final wash cycle (heated) with de-mineralised water prior commencement of the voyage
- Conducting thorough pre-loading surveys of the cargo tanks, pumps, heating equipment, fixed tank cleaning machines, and cargo/ vapour lines is a necessary step
- Prior to the initial cargo quality sampling, perform a visual inspection of the tanks and conduct wall-wash tests thereafter to determine if the tank is clean enough for MEG cargo. If required, prior to loading conduct a test for the presence of chloride in the tanks
- Ensure proper drainage of washwater from the lines to prevent undesirable moisture from being trapped and migrating into the cargo tanks
- Cargo tanks should always be mopped and dried thoroughly to limit any increase in water content during loading
- Obtain a certificate of cleanliness before loading to ensure the cargo tanks are dry and free from remnants of previous cargo residues and/or washwater
- Cargo tanks should preferably be nitrogen purged prior to loading in order to remove moisture
- The first-foot sampling provides valuable insights into the cleanliness of the cargo tanks and lines and the moisture content increase in the first foot sample may be expected so endeavour to avoid sampling repeatedly in a humid environment
- Promptly address any identified contaminants
- Be aware of cargo tanks equipped with epoxy-type lining systems that can potentially absorb light solvent species, such as aromatics
- For each set of samples that the cargo surveyors takes, one set should remain on board for the ship owners
- All the sample bottles should preferably be amber coloured glass bottles as MEG is very sensitive to sunlight
- All the samples should be taken to the maximum level of the sample bottle. This is in order to avoid air/oxygen being retained in the empty space
- All the sample bottles should be purged with nitrogen prior to the sampling as MEG is sensitive to oxygen
- Always use clean and appropriate sampling equipment (preferably closed sampling equipment)
- Always flush the sampling point prior to drawing a sample
- Issue a LOP to shippers/charterers if they do not arrange for nitrogen padding/blanketing.

DURING TRANSPORTATION

- MEG is a hygroscopic cargo, meaning it will readily absorb water from the atmosphere during transportation
- Check to ensure there are no leakage from the pressure vacuum (p/v) valves for each tank and the targeted tank pressure is maintained to prevent ingress of moisture
- Certain cargoes demand close control of temperature, or control headspace atmosphere, by either total exclusion of oxygen or partial reduction for oxygen to a prescribed range
- Shippers and/or charterers should also provide their instructions with regards to the cargo care and the use of nitrogen padding for a long sea passage
- A ship without nitrogen generator should have sufficient replenishment of nitrogen gas supply or compressed nitrogen bottles for topping up in later part of the voyage, if required
- Avoid unnecessary internal tank transfer of cargo after loading and reducing the transshipments between loading and receiving end to a minimum may help to avoid cargo contamination
- Keep a record of the nitrogen gas log for each tank(s) headspace during the voyage, starting from the completion of the nitrogen padding/blanketing until the ship reaches the destination port before discharging, to preliminarily rule out any improper handling of the cargo during transportation.

SAFETY TIPS

- Avoid carrying incompatible products consecutively in the same cargo tanks
- Cargo tanks should be thoroughly cleaned after shipment
- Take shore tank samples and samples from cargo tanks during loading operation at regular intervals
- Take samples from the ship's tanks during discharge for safe keeping
- Preserve the samples taken and store in a cool, dark place which is out of direct sunlight to avoid deterioration. The samples may serve as future evidence of the quality of the cargo.

Crew members' experience becomes crucial when it comes to handling such a sensitive cargo. Therefore, aside from the above considerations, conducting thorough risk assessments and providing comprehensive training are fundamental steps to identify any potential hazards and ensuring safe and efficient operations. It is important to also brief the team extensively on the cargo's properties, on correct sampling procedures and equipment usage before loading.

Britannia P&I has previously also conducted a loss prevention webinar on [Contamination Claims on Chemical Tankers](#) which is also relevant for MEG carriage.

FOR FURTHER INFORMATION

For further information, please do not hesitate to email lossprevention@tindallriley.com.

FEEDBACK

To keep our loss prevention material as useful and relevant as possible we want to hear your suggestions on topics you'd like our team to address. The form takes less than 5 minutes to complete.



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