Ballast Tank Water Treatment

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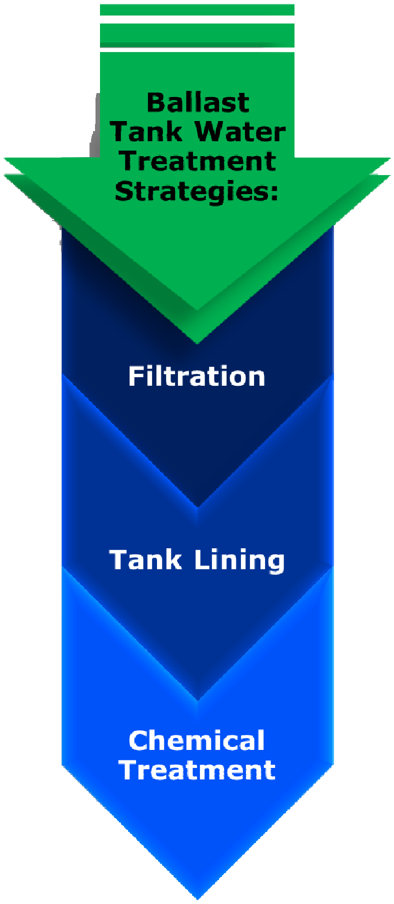

SPAR hulls and other floating production facilities may require temporary ballasting with seawater during transportation from the hull construction site to the integration location. Ballast water tanks may be completely or partially filled with seawater in this case, where some tanks may remain filled for the life of the asset and others will be drained and left dry once the installation process is complete. Seawater often contains significant concentrations of bacteria, which can cause corrosion when the seawater remains inside the ballast water tanks for extended durations.

In general, the temporary ballast tanks will only remain filled for a period of a few weeks and so do not present a significant corrosion risk. However, on occasion delays in the transportation or installation schedule can result in the tanks remaining full for periods of several months, at which point microbiologically-influenced corrosion (MIC) can become a concern. This GATEKEEPER discusses various options available for ballast water tank treatment in these circumstances.

MIC is used to describe the process by which a material is corroded due to biological activity. Temperature, water chemistry, metallurgy and other factors play a major role in determining the nature of the MIC risk. Bacteria are present in all seawater at ranges from 10^4 to 10^6 cells per milliliter (ml). Seawater obtained from shallow locations typically has about 5×10^5 cells/ml, with more than 25,000 different species of bacteria in each liter of seawater. Increasing seawater depth will decrease the bacterial concentration, but does not result in a decreased risk of MIC unless the water is kept at the cold temperature associated with deep seawater.

Organisms associated with MIC include acid producing bacteria (APB), general heterotrophic bacteria (GHB) and sulfate-reducing bacteria (SRB). These bacteria form colonies called biofilms that act to control their micro-environment and effect corrosion by a number of mechanisms, including influencing anodic and cathodic reactions, influencing protective surface films, the generation of sulfide deposits, pH reduction, and solids deposition.

Strategies

To prevent MIC, the following methods are commonly used:

- Filtration
- Tank Lining
- Chemical Treatment

Filtration

Standard practice has been to fill ballast water tanks with unfiltered, aerated seawater. This has been shown to increase the biological activity significantly as compared to filtered seawater.

Filtered seawater decreases the amount of solids and biomatter that enter the tank. As a simple and effective means of reducing corrosion risks associated with schedule slippage, it is recommended that the seawater should be filtered before it is transferred into the tank. Filtration can help control the supply of nutrients that encourage biological growth and fouling and also reduce sludge in the tank.

Tank Lining

Internal tank lining is another option to consider when trying to mitigate corrosion in ballast water tanks. Tank lining decreases the need for chemical treatment and, depending on the exposure duration and if filtered water is used, may eliminate the need for chemical treatment (see left hand column on next page).

Criticality Rating Matrix		Tank Lining	
		Lined Tanks	
Exposure Period Short Term: < 90 days Long Term: > 90 days		Short Term	Long Term
Filtration	Filtered Water to 50 µm or less	Low	Low
	Unfiltered or Filtered Water to > 50 µm	Mod	Mod

Criticality Rating Matrix		Tank Lining	
		Unlined Tanks	
Exposure Period Short Term: < 90 days Long Term: > 90 days		Short Term	Long Term
Filtration	Filtered Water to 50 µm or less	Mod	Mod
	Unfiltered or Filtered Water to > 50 µm	High	High

Risk	Biocide Use Needed?
Low Risk	May **not** be needed.
Moderate Risk	May be needed at some point.
High Risk	**Yes,** it is needed.

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Chemical Treatment

Chemical treatment is one of the most common methods used to control MIC, but once a chemical is injected into any volume of water, this water is now deemed to be chemically treated seawater and becomes subject to local regulations for water discharge. Ensuring that chemical treatments can be safely discharged to the environment can present a significant operational hurdle to the use of chemical treatments and so often make this a less suitable option than the use of filtration and tank lining.

Biocide dosage can be difficult to determine and depends on initial kill requirements, required treatment duration, and discharge specifications. Typically, a high initial dose of biocide will be needed as the biocide will degrade over time and the presence of oxygen in the seawater will serve to further increase this rate of degradation. Biocides typically used for ballast tanks include hypochlorite, glutaraldehyde, and THPS (tetrakis hydroxymethyl phosphonium sulfate).

The primary source of oxygen in the ballast water tanks comes directly from the seawater. Oxygen may ingress from vents or other openings but, as long as no mixing occurs, this is usually not substantial. Monitoring and re-dosing may be needed if ballasting and de-ballasting is performed. If this will not be performed during transportation then oxygen-related corrosion is typically not a concern.

Deaerated seawater has also been used for ballasting and has shown to decrease APB and GHB, but at the expense of increased SRB activity. THPS is highly effective in controlling SRB and degrades quickly in aerobic and anaerobic conditions producing trihydroxymethl phosphine oxide (THPO) and bishydroxymethyl phosphonic acid (BMPA). Both of these products further degrade into carbon dioxide and inorganic matters. These byproducts of THPS are less toxic to the environment.

If issues arise with water quality during chemical treatment then the following mitigation strategies may be implemented for THPS and glutaraldehyde-based products so that water can be safely discharged offshore.

1. Wait until the natural decay of the biocide is such that the treated water can be discharged. Decay rates are calculated based on half life of the chemical.
2. Dilution of the ballast water by fresh seawater prior to discharge.
3. Aeration by pumping air, with aerated seawater, into the tank to increase the rate of biocide degradation.
4. Neutralization of the residual chemical by using a neutralizing agent (e.g. THPS and hydrogen peroxide). Hydrogen peroxide will need to be controlled as an overdose will also lead to toxicity test failures.

Conclusion & Recommendations

During transport of production platform hulls, the following items should be considered with respect to the control of MIC in temporarily flooded ballast tanks.

1. Filtration reduces solids and biomass that otherwise encourage bacterial growth. This is recommended for all temporarily flooded ballast tanks filled for the duration of extended transport and installation campaigns.
2. Internally lined tanks can be used to mitigate MIC. Where feasible, this is preferred to the chemical treatment of tanks for corrosion control.
   - If lined, no chemical treatment needs to be used.
   - Water discharged offshore with no chemical treatment will not be an environmental hazard.
3. For non-lined tanks with anticipated exposure times of greater than 3 to 6 months, chemical treatment may need to be considered.
   - The type of biocide is critical in MIC control as it impacts both performance and discharge considerations. Care must also be taken to ensure that a suitable testing and discharge plan is developed prior to biocide application.

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