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HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Importance of water density for the efficacy of ballast water exchange using the flow-through or dilution methods

Submitted by the Institute of Marine Engineering, Science and Technology (IMarEST)

SUMMARY

Executive summary:	This document provides information regarding the importance of considering water density when conducting ballast water exchange using the flow-through or dilution method
Strategic direction:	7.1
High-level action:	7.1.2
Planned output:	7.1.2.2
Action to be taken:	Paragraph 11
Related documents:	MEPC 53/2/21 and MEPC 55/2/8

Background

1 The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) was adopted by the IMO in February 2004. Regulation D-1 of the BWM Convention stipulates that ships performing ballast water exchange shall do so with an efficiency of 95 per cent volumetric exchange of ballast water. This can be achieved by the sequential method, flow-through method or dilution method.

2 With sequential flushing, the tank is emptied of original ballast water and then refilled with local seawater. There is no significant contact or mixing between the two fluids. For the flow-through and dilution methods, the initial and incoming fluids do interact. The way that they interact is complex and partially dependent on the relative densities of the two fluids. Even a small difference in densities can have a significant impact.

3 Understanding the impact of the density differential between local water and ballast water is important to ensure efficient and effective removal of the original ballast water with the minimum tank volume exchanges.

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4 Understanding the mixing regimes within ballast water tanks is important to ensure optimal removal of suspended particles and aquatic organisms.

Summary of flow regimes

5 Two types of flow regime are possible – mixing and displacement.

6 A mixing regime occurs when the turbulence generated by the fluid entering the tank is strong enough to destroy any stratification present in the ballast water tank or when the inlet water is of the same salinity and temperature as the ballast water. Under this regime, the inlet water and existing ballast water become well-mixed. Such a system is effective at removing large suspended particles or organisms but less so smaller ones. Removal of the contaminant (sediment or aquatic organisms) is through dilution as fluid is flushed from the tank and the concentration decreases exponentially with time. With perfect mixing, 95.02 per cent of the original ballast water will be removed after three volume exchanges. In practice, mixing is less than perfect.

7 A displacement regime (also known as plug flow) occurs when the inlet fluid is of significantly different density than the original water in the ballast tank. Under this regime the inlet water and existing ballast water do not become well-mixed. Such a system can be very effective at removing small suspended particles or organisms but less so larger ones. In ideal conditions, perfect displacement flow can remove all of the original ballast water in a single volume exchange.

8 For effective flow-through operations, denser fluid must be introduced (at the base of the tank) allowing the light ballast water to escape from the top. A front forms between the different density fluids and the contaminant is effectively 'pushed' out of the tank. One problem is that larger particles can fall through the front. For the dilution method the reverse should be applied with light fluid being supplied to the top of the tank forcing out the denser fluid at the base.

9 Flow-though flushing can be ineffective if light fluid is introduced into denser ballast water, as the light fluid flows to the top of the tank with little mixing or displacement effectively setting up a short circuit. Even after three tank volume exchanges, a significant proportion of the original ballast water can remain. The dilution method will be equally ineffective if dense water is pumped into the top of a tank containing less dense ballast water.

10 Results from laboratory experiments to support the above hypotheses can be found at:

.1 Greig A.R., Eames, I., Tang, J.W. and Li, Y (2006). "The removal of contaminated ballast water". I.Mar.E.S.T. Proc. Part D. Intl Conf Marine Engineering Systems ICMES 2006. London, 6-10 March 2006, WMTC 06; and

.2 Eames, I., Landeryou, M., Greig, A. & Snellings, J. (2008). "Continuous flushing of contaminants from ballast tanks". Marine Pollution Bulletin 56 (2) 250-260 February 2008. Pub.: Pergamon-Elsevier Science LTD ISSN: 0025-326X doi:10.1016/j.marpolbul.2007.10.032.

Action requested of the Committee

11 The Committee is invited to note the information in this document.