Biological De-Oxygenation

Executive Summary

Biological de-oxygenation is based on the fact that addition of nutrients to ballast water will stimulate the growth of the indigenous bacteria in the ballast water. The solubility of oxygen in water is low, and the bacterial growth will consume the dissolved oxygen. When the ballast water becomes anoxic, organisms that require a steady supply of oxygen will die. The aim of the studies reported here was to develop a de-oxygenation process that could be applied in large scale, and to test the efficiency towards selected organisms in the meso-scale trials in Newcastle.

In a series of laboratory studies performed in 3 liter fermentors with seawater from the Trondheim Fjord, a promising nutrient solution for biological de-oxygenation was composed. However, it may still be necessary to slightly modify the composition to prevent excessive formation of H_2S. The time it takes to consume all the oxygen in seawater decreases with increasing temperature. At 4 °C it takes 3-4 days, at 10-20 °C 1-2 days, and above 20 °C less than 1 day to obtain anoxic conditions.

In Newcastle, biological de-oxygenation was tested in meso-scale in 50 liter polypropylene vessels covered with black plastic bags to simulate the darkness in a ballast tank. The efficiency of the treatment was tested against three species of zooplankton; the copepods *Acartia tonsa* and *Tisbe battagliai*, and the polychaete *Nereis virens* (nectochaete larvae), and two species of phytoplankton; the dinoflagellate *Alexandrium tamarense*) and the diatom *Thalassiosira pseudonana*.

Biological de-oxygenation of the seawater killed all the added zooplankton species. The killing rate increased with increasing time under anoxic conditions. After 4-6 days of anoxia, more than 95 % of all the tested zooplankton species were dead.

De-oxygenation of seawater had little effect on the survival of the two added species of phyto-plankton. A slight decline in the concentration of the dinoflagellate was observed as a function of incubation time, but this was most likely due to the fact that the water was incubated in darkness, and not the removal of the oxygen. For the diatom even the incubation in darkness seemed to have little effect on the survival within the time-frame studied.

Corrosion effect estimated with FMECA analysis allowed to pay attention to the following aspects: a slight decrease of pH with possible consequences on metal corrosion, coatings and gaskets, a slight increase in CO_2 concentration with possible consequences on metal corrosion and gaskets, the production of H_2S with possible consequences on metal corrosion, coatings and gaskets, the addition of inorganic substances with possible consequences on metal corrosion, coatings and gaskets, the addition of organic substances with possible consequences on coatings, and a significant increase in the concentration of bacteria with possible consequences on metal corrosion, coatings and gaskets.