Abstract

Enclosed coastal seas are suffering from serious environmental problems which caused by hypoxic condition occurring at the bottom of sea during summer season. Although many restoration technologies for supplying oxygen to the bottom of the sea are developed, it is necessary to understand the characteristics of sediment oxygen consumption (SOC) before applying these technologies in actual field because it is thought that the sediment oxygen demand increases under hypoxic condition. In this study, we carried out the field investigations for a year at Osaka bay by using a new chamber method which can measure SOC under hypoxic condition in order to examine the seasonal variations of SOC. In addition we conducted the laboratory experiment for examining the effects of biological and chemical factor on the SOC.

Introduction

Environmental Enclosed Coastal Seas

Fig 1: Spatial distribution of dissolved oxygen (DO) concentration of the bottom water in Osaka bay. Hypoxic bottom water appears widely at closed-off section of Osaka bay.

Fig 2: Impact of hypoxic water on the coastal environment. (1) Situation that crabs were escaping from hypoxic water. (2) Snapshot of seabed at closed-off section of Osaka bay.

Investigation Summary

Investigation Period
- Once every two weeks in neap tide from April 2008 to April 2009

Investigation Items
- Sediment oxygen consumption
- Vertical profiles of water quality (DO, Temperature, Salinity, ...)

How do we measure the SOC?

Fig 6: Apparatus and process to measure the SOC.

1. Putting the chamber above the seabed keeping the water inlet open.
2. Supplying aerated bottom water from the aeration tank into the chamber.
3. Shutting the inlet by rubber stopper after replacing the hypoxic water.
4. Measuring the SOC at every 5 minutes.

Experiment

Experimental Setup

Fig 9: Experimental Setup. In this experiment, we prepared (A) sediment and seawater (B) formalin-inactivated sediment and seawater (C) only seawater

Experimental Condition

Fig 10: Time variations of NH4+ concentration in water tank. NH4+ did not elute in CASE B. It is confirmed that the biological activities in Case B could be inhibited by adding formalin.

Tab 1: Oxygen consumption factors contained in each experiment case

Result 1

Fig 3: Proposed breakwater for generating vertical circulation flow (VCF breakwater, Endo, et al. 2006). Oxygen rich surface water is transported to the bottom of sea by the circulation flow generated in front region of the VCF breakwater.

Result 2

Fig 7: Time variations of ∆SOC which were measured on Oct. 7, 2008 and Dec. 12, 2008.

Result 3

Fig 11: Time variations of DO concentration in CASE A, B and C

Fig 12: Time variations of the chemical SOC and the biological SOC.

Conclusions

1. The sediment oxygen consumption under hypoxic condition was varying with time while the sediment was consuming oxygen.
2. The sediment oxygen consumption in hypoxic summer season was larger than that in winter.
3. The oxygen consumption pattern of sediment under hypoxic condition was changing by chemical and biological factors.

Reference