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Automatic Measurement of Dissolved Inorganic Nitrogen Ions in Coastal Field using a Simplified Flow Injection Method

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ABSTRACT

Recently, measurement of certain environmental factors such as dissolved oxygen and chlorophyll using electric sensors has been realized. Such measurement is continuous and automatic, and is very important for monitoring the environment in coastal areas. However, it is difficult to continuously measure the chemical parameters because data must be obtained by chemical analysis. This paper introduces a simplified measurement system using absorption rate measurement of processed water by visible rays. The effectiveness of the present method is demonstrated in field measurements in Osaka Bay.

KEY WORDS: nitrate; nitrite; dissolved inorganic nitrogen; monitoring; flow injection analysis; nutrient; eutrophication.

INTRODUCTION

Since the 1960's, economic growth has caused an increase in the pollution of water around coastal areas in typical enclosed seas such as Osaka Bay. Recent technical innovations and countermeasures for emission sources have gradually improved the water quality; however, it has not yet been improved around urban coastal areas despite considerable and varied research, because the natural capacity for the emission source has already reached the ecological limitation with fundamental waste, such as industrial, domestic and wastewaters. These many kinds of wastewater contain high concentrations of nutrients and organic matter, which can lead to the so-called eutrophication phenomenon in coastal seas. Eutrophication of coastal waters has caused various environmental problems including red tide, anoxic water and so on. In order to deal with these problems appropriately, it is important to continuously and automatically measure these factors with high resolution in time and space, thereby providing a good understanding of coastal sea ecosystems.
Some electric and optical sensors allow for the measurement of certain environmental factors, such as salinity, dissolved oxygen and chlorophyll concentration. Such methods can be easily put to practical use for continuous and automatic measurement in the field. In order to monitor nutrient concentration in the ocean, measurement of dissolved inorganic nitrogen (DIN) is most important because it is useful for understanding specific behavior of phytoplankton as the primary production. It is classified into nitrate (NO_3^-), nitrite (NO_2^-) and ammonium ions (NH_4^+), all of which are analyzed in a laboratory. Since we have to collect discrete samples or use research vessels with onboard facilities, it is difficult to measure in detail the fluctuation of nutrients in time and space.
Degobbis et al. (2005) and Zou et al. (2001)have analyzed many seawater samples and strongly expressed a need for "in situ measurement" of nutrients via DIN measurement. Galegos et al. (1992) indicate that the inputs of nutrient-rich waters to coastal seas due to storms can have a dramatic effect on primary production. This means that monitoring schemes in which only a few samples are collected can fail to identify transients, such as storms events, which can pass in a matter of hours. In order to eliminate such problems in the conventional measuring of DIN, automatic in-situ measurement of DIN should be developed for monitoring the marine environment.

Spectrometry is very effective for measuring chemical matter concentration without any chemical treatment. Since nitrate and nitrite ions show particular absorption decay of radiation in the ultraviolet range wavelength, as discussed by Armstrong (1963), spectrometry has been used for many years to monitor nitrate in fresh water. It is already included in the American Public Health Association Standards for nitrate analysis and the Japanese Industrial Standards methods for total nitrogen analysis. With regards to seawater, it is very difficult to measure nitrate and nitrite concentrations from the presence of high-concentration bromide and dissolved organic matter included in seawater. In order to measure the summation of nitrate and nitrite (DINOx), the authors (2007) previously proposed a new method that determines DINOx concentration using a spectra model of seawater in the ultraviolet (UV) region. This method is most effectiveness for determining the distribution or vertical profile of DINOx concentration because of its high response speed. However, this method cannot measure ammonia ions that do not show an absorption characteristic in the UV region. It is not appropriate to neglect the ammonia concentration since ammonia is generally one of the main components