Development of Measurement Instrument of Dissolved Inorganic Nitrogen and Dissolved Inorganic Phosphorus

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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 nutrient because data must be obtained by chemical analysis. This paper introduces a simplified measurement instrument 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; phosphoric, silic acid, dissolved inorganic nitrogen; monitoring; flow injection analysis; nutrient; eutrophication.

INTRODUCTION

In coastal sea area, fundamental wastewaters 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.

However, it is difficult to measure nutrient such as dissolved inorganic nitrogen (DIN) and phosphoric, silic acid (PO4), automatically. Measurement of these factors is most important because it is useful for understanding specific behavior of phytoplankton as the primary production. DIN, which is classified into nitrate (NO3), nitrite (NO2) and ammonium ions (NH4), and phosphoric (PO4) are analyzed in a laboratory. Since we have to collect discrete samples or use research vessels with on-board 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. Gallegos 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 and PO4, automatic in-situ measurement of DIN and PO4 should be developed for monitoring the marine environment.

Spectrometry in UV wavelength range 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. 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 nitrate and nitrite, K. S. Johnson et.al.(1986) and J. N. Pant et. al. (2009) reported a high solution in situ UV spectrometer (ISUS) for ocean and success to measure the nitrate concentrations in depth profiles. 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 and phosphorus ions that do not show an absorption characteristic in the UV region. It is not appropriate to neglect the ammonia and the phosphorus concentrations since these ions are generally one of the main components in the growth of phytoplankton in coastal seas.

Alternatively, flow injection analysis (FIA) is very effective for continuously measuring all kinds of chemical matter. Its concept was conceived by Jaromir et al, whose first paper on the subject appeared in 1975. The technique rapidly captured the imagination of analytical chemists and has been well known in such areas as process and industrial chemistry, pharmaceutics and biochemistry. The authors (2005, 2006) have already developed a specific instrument for measuring the nitrate concentration of seawater, and have shown its effectiveness when applied to nitrite ion. Johnson K S et al. (1986, 1989, 1994) developed an in-situ instrument using FIA and used it to measure nitrate and nitrite ion concentrations at over 2000m depth. David et al. (1998, 1999) measured nitrate, nitrite and ammonia ion concentration in seawater using FIA with fluorescence detection, which provides precise measurement at low concentrations (µmol/L). These remarkable results indicate that it is possible to determine many kinds...