Study of Nitrogen removal process controlled by NADH

Year of Research | 2009～2012

(Interoduction)
Fukuoka city set up 'the advanced water treatment master plan in Hakata bay' to meet the environmental water standards in the Hakata bay in 1998, and discussing details to install an advanced waste water treatments process. Improvement project for phosphorus removal had started in 1993 and the project has been completed during 1999. For nitrogen removal, A2O treatment process has partly been installed since 2007. However, from the perspective of reducing of converting and maintenance cost as well as CO2 emissions, the new technologies for nitrogen removal are required.

Under these situations, a method of maintaining simultaneous nitrification and denitrification in a single tank at very low dissolved oxygen concentration controlled by NADH sensor has been caught attention, and this nitrogen removal process have been planned to be introduced in part of the wastewater treatment plant in Fukuoka city as the trial. The waste water process for nitrogen removal controlled by NADH has already been used in Europe, United States and Korea in the last decade.

The aim of this study is to establish the operating condition of nitrogen removal process controlled by NADH, the low-cost waste water treatment process which does not require conversion nor expansion of the facility, to achieve 'the designed treatment water quality for advanced water treatment'. In addition, the ease of maintenance and energy conservation ratio were also investigated.

(Results)
(1) Technical summary
NADH (nicotinamide adenine dinucleotide) is an indispensable coenzyme for chemical reactions of metabolism. NADH absorbs light at a wavelength 340 nm and fluorescence at a wavelength of 460 nm. The concentration of NADH in a living bacterial cell is monitored by the NADH fluorescence sensor (shown in figure 1). Changes in NADH concentration provide real-time information on the metabolic condition of sludge flocs; with this information, it is possible to determine whether the biological process is in state of oxygen respiration, nitrate respiration or anaerobic respiration. The nitrogen removal process controlled by NADH is consists of dual zone treatments. Figure 2 shows the DO concentration in sludge flocs. In DO curve (b), the shell of each flocs is under nitrifying condition while the core is under denitrifying conditions, which allow simultaneous nitrification and denitrification. Increase in oxygen concentration in the free water phase (DO curve (a) in figure 2) causes oxygen to diffuse further into inner part of the flocs. Then the higher fraction of biomass is maintained under nitrifying condition. Conversely, if the oxygen concentration drops (DO curve (c) in figure 2), higher fraction of the biomass is maintained under denitrifying condition. Therefore, the oxygen supply from blowers is controlled by NADH monitoring system to maintain low dissolved oxygen (DO curve (b) in figure 2), which permits simultaneous nitrifying and the denitrifying in the same basin.

(2) Study Results
The followings are the summary of study results of 2009 fiscal year.
①Accumulation of knowledge relating to design and application of NADH system. (Design material)
②Accumulation of knowledge relating to operation and maintenance of NADH system. (Management material)
③Feasibility steady of the project (significance of installation and evaluation of new technology)
④Future investigation plan

Research and examination for demonstration experiments was conducted in 2009 fiscal year. In 2010 fiscal year, facility conversion will be carried out for demonstration experiments of nitrogen removal process controlled by NADH. Consequently, NADH-dissolved oxygen monitoring system is planned to be installed in 2011 to 2012 fiscal year. Then operating conditions of nitrogen removal process controlled by NADH to achieve 'designed treatment water quality', the ease of maintenance, and energy conservation ratio will be examined.

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