Nitrogen removal and anammox-bacterial community in continuous reactors inoculated with mixed biomass composed of marine- and freshwater- anammox bacteria under different culture conditions

Yasunori KAWAGOSHI[1], Yuki YAMASHITA[2], Hiroaki ITO[1], Takehide HAMA[1], Luong Van DUC[1], Tsuguhiro WATANABE[1]

1 Center for Water Cycle, Marine Enviroment and Disastar Management, Kumamoto University
2 Kyushukensetsu Consultant Co., Ltd

E-mail: goshi@kumamoto-u.ac.jp

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Abstract

Anaerobic ammonium oxidation (anammox) is relatively-new nitrogen oxidation-reduction reaction discovered in 1995. In anammox, ammonium is oxidized by nitrite under anaerobic condition and both nitrogen compounds are converted to nitrogen gas. Anammox is catalyzed by anammox bacteria which are anaerobic autotroph and has been considered to be one of the most important metabolic pathway in nitrogen cycle of nature. Commonly, the reaction rate of anammox is considered higher than conventional nitrification-denitrification reaction and anammox bacteria require no carbon source or oxygen for their growth. Thus anammox has been expected as a promising reaction to apply to nitrogen removal technology in wastewater treatment process from the perspective of cost saving. Anammox bacteria have been detected in various water environments including freshwater and ocean, and divided broadly into five genera at present. Among five genera of anammox bacteria, four genera are freshwater-derived anammox bacteria (FAB) and only one genus is marine-derived anammox bacteria (MAB). It has been known that their optimal growth conditions such as temperature and salinity are different, but there are still unknown in distinction of characteristics between them. Based on this sort of knowledge, we have attempted to develop a new anammox reactor by combining FAB and MAB in order to achieve robust and flexible nitrogen-removal performance under wide range of operation condition. In this study, we cultured mixed anammox biomass composed of FAB and MAB in continuous fixed-bed reactors under three different culture conditions (marine-condition, freshwater-condition, and average-condition) to reveal nitrogen removal performance and the transition of anammox-bacterial community. As a result, stable nitrogen removal efficiency was observed in every reactor within one month. However, the behavior of nitrogen removal performance was different in each reactor. The reactor under freshwater-culture condition (FReactor) showed better nitrogen removal performance than the other reactors and achieved 0.35 kgN/m^3/d of nitrogen removal rate within 24days after the beginning of operation. On the other hand, maximum-nitrogen removal rates were 0.12 kgN/m^3/d and 0.16 kgN/m^3/d in the reactors under average-condition (AReactor) and marine-condition (MReactor), respectively. Result of bacterial community analysis indicated that only FAB in FReactor and only MAB in MReactor were respectively detected. Besides, only MAB was detected in even AReactor contrary to our expectation.