# การศึกษากระบวนการแอนแอมม๊อกโดยใช้กากตะกอนจุลินทรีย์จากถังปฏิกรณ์ซีเควนซิ่งแบตซ์ในการกำจัดแอมโมเนีย

# THE STUDY OF AN ANAMMOX PROCESS BY USING SLUDGE FROM A SEQUENCING BATCH REACTOR FOR AN AMMONIA REMOVAL

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**บทคัดย่อ:** กระบวนการแอนแอมม๊อกเป็นการเปลี่ยนแอมโมเนียให้เป็นก๊าซไนโตรเจน โดยใช้ไนไตรต์เป็นตัวรับอิเล็กตรอน ในการดำเนินงา นตะกอนจากถังปฏิกรณ์ซีเควนซิ่งแบตซ์ถูกนำมาเลี้ยงในถังปฏิกรณ์ระดับห้องปฏิบัติการแบบตรึงฟิล์มภายใต้สภาวะไร้อากาศ น้ำเสียสังเคราะห์ที่ใช้ในการทดลองมีอัตราส่วนของแอมโมเนียต่อไนไตรต์เท่ากับ 0.37 จากการศึกษาพบว่าระบบมีประสิทธิภาพในการกำจัดแอมโมเนียเท่ากับร้อยละ 75 ที่ระยะเวลาการเก็บกักน้ำ 24 ชั่วโมง และจากการทดสอบความสามารถของตะกอนแสดงให้เห็นว่าเกิดจุลินทรีย์กลุ่มแอนแอมม๊อกขึ้นในถังปฏิกรณ์แบบตรึงฟิล์ม โดย อัตราการกำจัดแอนโมเนียจำเพาะเท่ากับ 0.13 กรัม ไนโตรเจนต่อกรัมวีเอสเอสต่อวัน

**Abstract:** The anammox process is based on a direct removal of ammonia into nitrogen gas by using nitrite as an electron acceptor. In the operation, sludge from a sequencing batch reactor was cultivated in a laboratory-scale biofilm rector and operated under an anaerobic condition. Synthetic wastewater was used in the experiment by controlled the influent ratio of ammonia to nitrite of 0.37. The efficiency of ammonia removal was 75% at hydraulic retention time of 24 hours. Activity test showed that anammox microorganisms occurred in the biofilm reactor that the specific ammonia removal rate of 0.13 g N/g VSS.d.

**Introduction:** Nitrogen in wastewater is normally eliminated by a combination of two processes, nitrification and denitrification, under aerobic-anaerobic conditions. Nitrification is oxidation of ammonia to nitrate under an aerobic condition, and denitrification is reduction of nitrate to nitrogen gas under an anaerobic condition at the expense of organic matter. Recently, a novel nitrogen removal can be accomplished through anaerobic ammonium oxidation (anammox) under an anaerobic condition. The anammox process is the biological oxidation of ammonia into nitrogen gas by using nitrite as an electron acceptor ( $NH^{+}_{4(aq)} + NO^{-}_{2(aq)} \rightarrow N_{2(g)} + 2H_2O_{(l)}$ ) with low amount of organic carbon present in the wastewater. However, the practical application of the anammox process still limited by its long start-up periods due to the very low growth rate [1] and it cannot be cultivated using conventional microbiological techniques [2]. Therefore, the aim of this work was the study of the cultivation of anammox microorganisms in biofilm reactor by using mixed culture of excess sludge from aerobic-anaerobic sequencing batch reactor (SBR).

**Methodology:** The biofilm system was prepared in a fixed-bed reactor of 8 L which was contained the plastic-media (bio-ball) surface area of 1.81 $m^2$. Start-up of the reactor was done by using seed from an excess sludge of aerobic-anaerobic SBR. The reactor was fed with the synthetic wastewater by controlled the hydraulic retention time of 24 hours. The

synthetic wastewater, with the ammonia to nitrite ratio of 0.37, was consisted of 1.5 g/L $NaNO_2$, 0.5 g/L $(NH_4)_2SO_4$, 0.28 g/L $K_2HPO_4$, 0.15 g/L $CaCl_2$, 0.2 g/L $MgCl_2$, 0.01 g/L EDTA and 1 mL/L of trace mineral which was prepared by mixing 0.43 g/L $ZnSO_4.7H_2O$, 0.24 g/L $CoCl_2.6H_2O$, 0.99 g/L $MnCl_2.4H_2O$, 0.25 g/L $CuSO_4.5H_2O$, 0.22 g/L $NaMoO_4.2H_2O$, 0.19 g/L $NiCl_2.6H_2O$, 0.08 g/L $Na_2SeO_3$ and 0.014 g/L $H_3BO_4$. The pH of influent synthetic wastewater was adjusted to 7.0 by using $NaHCO_3$. For ammonia removal rate, it was conducted in batch test under an anaerobic condition. Samples withdrawn from the reactor were filtered through 0.45 μm of glass microfiber filter for removing suspended solids before analysis by standard.

**Results, Discussion and Conclusion:** Fig. 1(a) and 1(b) show the ammonia and nitrite concentrations were decreased from 117.0±11.1 mg N/L to 28.7±9.6 mg N/L and from 318.2±21.4 mg N/L to 27.4±7.1 mg N/L, respectively. The removal efficiency of ammonia was 75.0±9.6 %. The loss of ammonia and nitrite under the anaerobic condition indicated that ammonia may be oxidized by anammox microorganisms by using nitrite as an electron acceptor. For nitrate, it was observed in the effluent (Fig. 1(b)) with the concentration of 88.5±17 mg N/L. The accumulation of nitrate was found from the ammonia oxidation reaction in the anammox process [1].

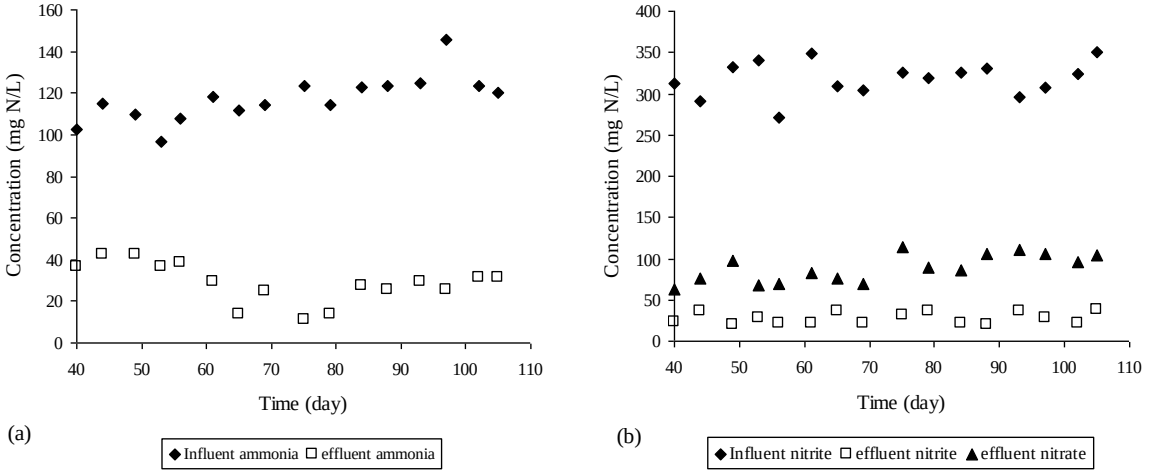


**Figure 1** Profile of nitrogen concentrations for: (a) influent and effluent of ammonia, and (b) influent and effluent of nitrite and effluent of nitrate in the reactor under an anaerobic condition.

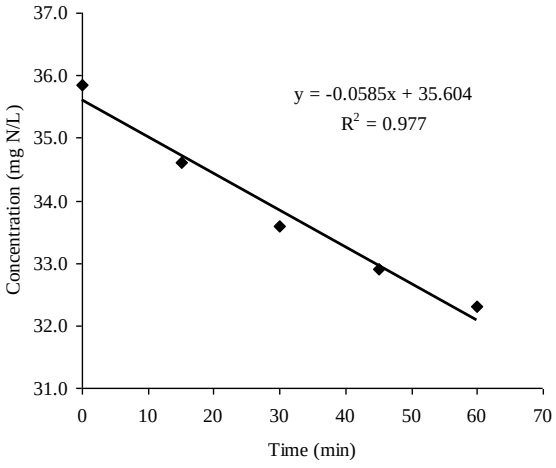


**Figure 2** The ammonia removal rate under an anaerobic condition in the batch test with the concentration of sludge of 656 mg VSS/L. (The ammonia removal rate is defined as the slope of graph).

However, the activity of anammox microorganisms was confirmed in batch test. The ammonia removal rate of sludge from fixed bed was tested under an anaerobic condition by using nitrite as an electron acceptor (Fig. 2). The specific ammonia removal rate of anammox microorganisms is defined as the ratio of ammonia removal rate to sludge concentration. This rate was 0.13 g N/g VSS.d which was similar to the previous reports (0.15 g N/g VSS.d) [3,4]. It could be concluded that the proposed system, using sludge from aerobic-anaerobic SBR, could be used as seed for start-up an anammox process.

**References:**

1. C. Trigo, J.L. Campos, J.M. Garrido and R. Méndez, *J. Biotechnol.*, 2006, **126**, 475-487.
2. T. Fujii, H. Sugino, J.D. Rouse and K. Furukawa, *J. Biosci. Bioeng.*, 2002, **94**, 412-418.
3. M. Strous, E. van Gerven, J.G. Kuenen and M. Jetten, *Water Res.*, 1997, **31**, 1955-1962.
4. A.O. Sliekers, N. Derwort, J.L.C. Gomez, M. Strous, J.G. Kuenen and M.S.M. Jetten, *Water Res.*, 2002, **36**, 2475-2482.

**Keywords:** anammox, ammonia, biofilm

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