Food Processing Wastewater Treatment Using a Series of Anaerobic and Membrane Processes

吳鴻榮、魏漣邦

E-mail: 9417346@mail.dyu.edu.tw

ABSTRACT

ABSTRACT Owing to the land availability, an existing food processing wastewater treatment was planned to increase its capacity without occupying more land. One alternative is to improve the three phase separator of the existing upflow anaerobic sludge blanket reactor (UASB) to trap more anaerobic sludge on the one end, and use the membrane process to remove the suspended solids and colloids from the UASB effluent on the other hand. It is a series of anaerobic and membrane processes to treat food processing wastewater. In this study, the full size existing UASB and modified UASB were tested in the field, and a bench-scale anaerobic sludge blanket without the three phase separator was used to validate the result. Two types of membrane the hollow fiber and the non-woven cloth were used for the membrane process evaluation. In order to prevent scaling (calcium carbonate), the UASB effluent was pre-aerated first, and then went to the membrane process. After evaluation of two months in this study, it can be concluded that the treatment capacity could be doubled by the modified UASB, and while the COD removal efficiency is almost the same for the two types of membrane in the short time, the non-woven cloth is degenerated earlier in the long term.

Keywords : food processing wastewater, anaerobic biological treatment, membrane process

Table of Contents

REFERENCES

參考文獻 American Water Works Association. Electrodialysis and electrodialysis reversal. Denver: American Water Works Association, 1995 Anderson GK, Saw CB, Fernandes MIAP. （1986a）State of the art of anaerobic digestion for industrial applications in the United Kingdom. Process Biochem;21:174. Anderson G, Saw C, Fernandes M. (1986b) Application of porous membranes for biomass retention in biological wastewater treatment processes. Process Biochem;21(6):174 – 82. Bai, R.B. and Leow, H.L. (2001) Microfiltration of polydispersed suspension by a membrane screen-hollow fiber composite module, Desalination 140, 277. Bai, R.B. and Leow, H.F. (2002a) Microfiltration of activated sludge wastewater —the effect of system operation parameters, Sep. Purif. Technol. 29, 189. Bai, R.B. and Leow, H.F. (2002b) Modeling and experimental study of microfiltration using a composite module, J. Membr. Sci. 204, 359. Bailey A. D., G. S. Hansford, and P. L. Dold. 1994. The enhancement of upflow anaerobic sludge bed reactor performance using crossflow microfiltration. Water Res. 28: 291-295. Baker, J. S., and Dudley, L. (1998). ‘ ‘ Biofouling in membrane systems. ’ ’ Desalination, 118, 81 – 90. Barker D.J., Stuckey DC. （2001）Modeling of soluble microbial products in anaerobic digestion: the effect of feed strength and composition. Water Environ Res;73(2):173 – 84. Benitez, J.; Rodriguez, A.; Malaver, R. (1995) Stablization and dewatering of wastewater using hollow fiber membranes, Wat. Res., 29 (10), 2281 Bouhabila, E. H., Aim, R. Ben, and Buisson, H. (1998). ‘ ‘ Microfiltration of activated sludge using submerged membrane with air bubbling. ’ ’ Desalination, 118, 315 – 322. Bouhabila, E. H., Aim, R. Ben, and Buisson, H. (2001). ‘ ‘ Fouling characterization in membrane bioreactors. ’ ’ Sep. Purif. Technol., 22 – 23, 123 – 132. Bowen, W. R., Calvo, J. I., and Hernandez, A. (1995). Steps of membrane blocking in flux decline during protein icrofiltration. J. Membr. Sci., 101, 153 – 165. Cantor, J.; Sutton, P.M.; Steinheber, R.; Novachis, L. (2000) Industrial Biotreatment Plant Capacity Expansion and Upgrading Through Application of Membrane Biomass-Effluent Separation. Proceedings of the WEF 73rd Annual Conference & Exposition, Anaheim, CA, CDROM. Chang, I. S. and Lee, C. H. (1998). Membrane filtration characteristics in membrane coupled activated sludge system —the effect of physiological states of activated sludge on membrane fouling. Desalination, 120, 221 – 233. Chang, I. S., Lee, C. H., and Ahn, K. H. (1999). “ Membrane filtration characteristics in membrane coupled activated sludge system—the effect of floc structure on membrane fouling. ” Separation Science and technology, 34 (9), 1743-1758 Chang, C. N., C. C. Chiu, C. P. Ho, and Y. S. Ma. 2000. Recovering dosmestic wastewater by submerged membrane bioreactor (SMBR). 第25屆廢水處理研討會論文集, 145-150。 Chang, I. S., Clech, P. L., Jefferson, B., and Judd, S. (2002). “ Membrane fouling in membrane bioreactors for wastewater treatment. ” J. Environ. Eng., 128, 11, 1018-1029. Cheryan, M., “ Ultrafiltration and Microfiltration Handbook, ” Technomic Publishing Co. Inc., Lancaster, PA, USA, 1998 Chiemchaisri, C., Wong, Y. K., Urase, T., and Yamamoto, K. (1992). ‘ ‘ Organic stabilisation and nitrogen removal in membrane separation bioreactor for domestic wastewater treatment. ’ ’ Water Sci. Technol.,25, 231 – 240. Chiemchaisri, C.; Yamamoto, K.; Vigneswaran, S. (1993) Household membrane bioreactor in domestic wastewater treatment, Wat. Sci. Technol., 27 (1), 171 Choo KH, Lee CH. (1995) Membrane fouling mechanisms in membrane-coupled anaerobic bioreactor. Water Res;30:1771. Choo, K.H. and Lee, C.H. (1996a). Membrane fouling mechanisms in the membrane-coupled anaerobic bioreactor. Wat. Res., 30, 1771 – 1780. Choo, K.H. and Lee, C.H. (1998). Hydrodynamic behavior of anaerobic biosolids during crossflow filtration in the membrane anaerobic bioreactor. Wat. Res., 32, 3287 – 3397. Choo, K.H., Kang, I.J.,Yoon, S.H., Park, H., Kim, J.H., Adiya, S. and Lee, C.H. (2000) Approaches to membrane fouling control in anaerobic membrane bioreactors. Water Science and Technology Vol 41 No 10 – 11 pp 363 – 371 Cicek, N., Dionysiou, D., Suidan, M. T., Ginestet, P., and Audic, J. M. (1998b). ‘ ‘ Performance deterioration and structural change of a ceramic membrane bioreactor due to inorganic abrasion. ’ ’ J. Membr. Sci., 163, 19 – 28. Defrance, L.; Jaffrin, M. Y.; Gupta, B.; Paullier, P.; Geaugey, V. (2000) Contribution of various constituents of activated sludge to membrane bioreactor fouling, Bioresource Technol., 73, 105-112 Dorr-Oliver, Inc. (1969); U.S. Patent 3,472,765, October. Fane, A. G., Fell, C. J. D., and Nor, M. T. (1981). “ Ultrafiltration/Activated sludge system---development of a predicted model. ” Poly. Sci. Technol., 13, 631-658 Fan, X. J., Urvain, V., Qian, Y., and Manem, J. (1996) Nitrification and mass balance with a membrane bioreactor for municipal wastewater treatment. Water Sci. Technol., 34, 129 – 136. Fuchs, W., Binder, H., Mavrias, G., and Braun, R. (2003) Anaerobic treatment of wastewater with high organic content using a stirred tank reactor coupled with a membrane filtration unit. Water Research 37, 902 – 908. Gander, M. A.; Jefferson B.; Judd, S.,J. (2000) Membrane bioreactors for use in small wastewater treatment plants: membrane materials and effluent quality, Wat. Sci. Technol., 41 (1), 205 Gunder, B., “ The Membrane-coupled Activated Sludge Process in Municipal Wastewater Treatment, ” Technomic Publishing Co. Inc., Lancaster, PA, USA , 2001 Imasaka T, Kanekuni N, So H, Yoshino H. (1989) Cross-flow of methane fermentation broth by ceramic membrane. J Ferm Bioeng;68:200. Kang, I. J. Yoon, S. H.and Lee, C. H. (2002) Comparison of the filtration characteristics of organic and inorganic membranes in a membrane-coupled anaerobic bioreactor. Water Research 36, 1803 – 1813 Kawakatsu, T., S. I. Nakao, and S. Kimura. 1993. Effects of size and compressibility of suspended particles and surface pore size of membrane on flux in crossflow filtration. J. Membrane. Sci. 81: 173-179. Kayawake E, Narukami Y, Yamagata M. Anaerobic digestion by a ceramic membrane enclosed reactor. J Ferm Bioeng 1991;71:122. Kim, J. S., Lee, C. H., and Chang, I. S. (2001). ‘ ‘ Effect of pump shear on the performance of a crossflow membrane bioreactor. ’ ’ Water Res., 35, 2137 – 2144. Kishino, H., Ishida, I., and Nakano, I. (1996). Domestic wastewater reuse sing a submerged membrane bioreactor. Desalination, 106, 115 – 119. Knoblock, M.D.; Sutton, P.M.; Mishra, P.N.; Gupta, K.; Janson, A. (1994) Membrane Biological Reactor System for Treatment of Oily Wastewater: Pilot to Full Scale Results. Water Environment Research, 66, 133. Leow, H.F. and Bai, R.B. (2001) Nylon screen incorporated into hollow fiber microfiltration system for wastewater treatment, Water Sci. Technol. 1, 131. Lettinga G., Velsenv. A.F.M., Hobma S.W., et al (1980). Use of the upflo sludge blanket (USB) reactor concept for biological Wastewater treatment, especially for anaerobic treatment. Biotechnology and

bioengineering. Vol. 22 PP. 699～734. Lettinga G. (1995) Anaerobic digestion and wastewater treatment systems. Antonie van Leeuwenhoek;67:3 – 28. Lim, A.L. and Bai, R. (2003) Membrane fouling and cleaning in microfiltration of activated sludge wastewater. Journal of Membrane Science. 216, 279 – 290 Liu, R., X. Huang, C. Wang, L. Chen, and Y. Qian. 2000. Study on hydraulic characteristics in a submerged membrane bioreactor process. Process Biochemistry. 36: 249-254. Lubbecke, S., Vogelpohl, A., and Dewjanin, W. (1995). “ Wastewater treatment in a biological high performance system with high biomass concentration. ” Water Res., 29, 793-802. McCarty, P. L. 1964. Anaerobic Waste Treatment Fundamentals III. Public Works. 95: 91. Mccarty P.L., Smith D.P. (1986). Anaerobic Wastewater treatment. Environ Sci. Technol. Vol. 20 No. 12. Thompson, D., Mourato, D., Penny, J. (1998) ” Demonstration of the ZenoGem Process for municipal wastewater treatment. ”, WEF Annual Conference , Chicago . Muller, E. B.; Stouthamer, A. H.; van Verseved, H.,W.; Eikelboom, D. H. (1995) Aerobic domestic wastewater treatment in a pilot plant with complete sludge retention by cross-flow filtration, Wat. Res., 29 (4), 1179 Nagano A, Arikawa E, Kobayashi H. (1992) The treatment of liquor wastewater containing high-strength suspended solids by membrane bioreactor system. Water Sci. Technol.;26(3 – 4):887 – 95. Noguera DR, Araki N, Rittmann BE.Soluble microbial products (SMP) in anaerobic chemostats.Biotechno l Bioeng 1994;44:1040 – 7. Parameshwaran, K. Fane, A.G. Cho, B.D. and Kim, K.J. (2001) Analysis of microfiltration performance with constant flux processing of secondary effluent, Water Res. 35 4349. Ross WR, Barnard JP, Strohwald NK, Grobler CJ, Sanetra J. (1992) Practical application of the ADUF process to the full-scale treatment of a maize-processing effluent. Water Sci Tech;25:27. Sahm H. (1984) Anaerobic Wastewater treatment. Advances in Biochemical Engineering/Biotechnology (Fiechter A., ed) No. 29 Springer-Verlag. Seung H. B. and Krishna P. (2003) Comparison of Aerobic and Anaerobic Membrane Bioreactors for Municipal Wastewater Treatment. Proceedings of the WEF 76th Annual Technical Exhibition & Conference, Los Angeles, CA, CDROM. Shimizu, Y., Shimodera, K. I., and Watanabe, A. (1993). Cross flow microfiltration of bacterial cells. J. Ferment. Bioeng., 76, 493-500 Shino, H. (2004) Kubota submerged flat sheet membrane application and its future direction to be headed. Kubota presentation document. Stephenson, T., Judd, S., Jefferson, B., and Brindle, K. (2000). Membrane Bioreactors for Wastewater Treatment, IWA, London. Sutton, P.M.; Li, A.; Evans, R.R.; Korchin, S. (1983) Dorr-Oliver ’ s Fixed Film and Suspended Growth Anaerobic Systems for Industrial Wastewater Treatment and Energy Recovery. Proceedings 37th Industrial Waste Conference, Purdue University, Lafayette, IN, Ann Arbor Science, Ann Arbor, MI, p. 667. Sutton, P. M. (2003) Membrane bioreactors for industrial wastewater treatment: the state-of-the-art based on full scale commercial applications. Proceedings of the WEF 76th Annual Technical Exhibition & Conference, Los Angeles, CA, CDROM. Tardieu, E., Grasmick, A., Geaugey, V., and Manem, J. (1998). ‘ ‘ Hydrodynamic control of bioparticle deposition in a MBR applied to wastewater treatment. ’ ’ J. Membr. Sci., 147, 1 – 12. Tardieu, E, A. Grasmick, V. Geaugey, and J. Manem. 1999. Influence of hydrodynamics on fouling velocity in a recirculated MBR for wastewater treatment. J. Membrane Sci. 156: 131-140. Ueda, T., Hata, K., and Kikuoka, Y. (1996). ‘ ‘ Treatment of domestic sewage from rural settlements by a membrane bioreactor. ’ ’ Water Sci. Technol., 34, 189 – 196. Ueda, T., Hata, K., and Kikuoka, Y. (1996). ‘ ‘ Treatment of domestic sewage from rural settlements by a membrane bioreactor. ’ ’ Water Sci. Technol., 34, 189 – 196. Urbain, V.; Benoit, R.; Manem, J, (1996) Membrane bioreactor; a new treatment tool. J. AWWA, 88, 75 Wang, P. Tan, K.L. Kang, E.T. and Neoh,K.G. (2002) Plasma-induced immobilization of poly(ethylene glycol) onto poly(vinylidene fluoride) microporous membrane, J. Membr. Sci. 195, 103. Wen, C., X. Huang, and Y. Qian. 1999. Domestic wastewater treatment using an aerobic bioreactor coupled with membrane filtration. Process Biochemistry, 35: 335-340. Wisniewski, C., and Grasmick, A. (1998). “ Floc size distribution in a membrane biorezctor and consequences for membrane fouling. ” Colloids surf., A, 138, 403-411 Wisniewski, C., and Grasmick, A., and Cruz, A. L. (2000). “ Critical particle size in membrane bioreactors case of a denitrifying bacterial suspension. ” J. Membr. Sci., 178, 141-150 Xavier, F. (2003) the current status of the use of membranes for wastewater treatment. Proceedings of the WEF 76th Annual Technical Exhibition & Conference, Los Angeles, CA, CDROM. Yanagi C, Sato M, Takahara Y. (1994) Treatment of wheat starch waste water by a membrane combined two phase methane fermentation system. Desalination;98:161 Yamamoto, K., Hissa, M., Mahmood, T., and Matsuo, T. (1989). “ Direct solid liquid separation using hollow fiber membrane in an activated sludge aeration tank. ” Water Sci. Technol., 21, 43-54 Yeom, I. T; Nah, Y. M.; Ahn K. H. (1999) Treatment of household wastewater using an intermittently aerated membrane bioreactor, Desalination, 124, 193 Zhang, B., Yamamoto, K., Ohgaki, S., and Kamiko, N. (1997). “ Floc size distribution and bacterial activities in membrane separation activated sludge processes for small scale wastewater treatment/reclamation. ” Water Sci. Technol., 35, 37-44. 黃森元、鄭幸雄、邱創汎， ” UASB處理低濃度廢水適用性及污泥顆粒特性之研究 ”，1990第15屆廢水處理技術研討會。 經濟部工業局 ” 厭氣處理新技術 ” 工業污染防制技術手冊37冊，中華名國八十五年。 劉茱娥等（1998）， ” 逆滲透 ”，膜分離技術，化學工業出版社，184-208 高山鎮， ” 薄膜阻塞控制之研究 ” 成功大學環境工程系89年碩士論文。 謝淵林、曾四恭、張育傑(2000) 利用中空矽膠管薄膜生物反應槽進行廢水同時硝化脫硝之反應. 第25屆廢水處理研討會論文集, 270-274。 財團法人工業技術研究院環境與安全衛生發展中心 ” 上流式厭氣污泥床處理槽設計及應用技術手冊 ”， 中華名國九十一年。 梁德明， ” 薄膜分離應用於厭氣生物產氫程序 ” 成功大學環境工程系92年博士論文。 游惠宋、吳鴻榮、簡志賢等， ” 統一企業新市總廠廢水處理擴建工程實務 ”，2003工業污染防治工程實務技術研討會。 洪仁陽、張王冠等， ” MBR處理醱酵食品廢水之案例研究 ”，2003工業污染防治工程實務技術研討會。 張敏超， ” MBR用膜材及過濾分離機制 ”，2003環安簡訊電子報24期。 張王冠， ” 新世代水與廢水處理技術—膜離生物反應器 ”，2003環安簡訊電子報24期。 倪振鴻 陳廷光 陳治欣 陳重男， ” 國內第一座沈浸式生物薄膜程序廢水處理廠處理TFT-LCD製程有機廢水回收再利用之長期操作經驗 ”, 2003產業環保工程實務技術研討會。 游惠宋 ” 統一企業新市總廠廢水厭氣生物處理系統技術開發合作專案報告 ” 財團法人工業技術研究院環境與安全衛生發展中心。