Evaluation of the Antipollution Potential of some Aquatic Plants in an Artificial Wetland: Eichhomia crassipes (Mart.)..

陳銘耀、彭元興

E-mail: 9607562@mail.dyu.edu.tw

ABSTRACT

At the Huaren wetland, Changhwa, Taiwan, we conducted a study to examine the effects of planting various aquatic plants, such as water hyacinth (Eichhomia crassipes (Mart.) Solm.-Laub.), water lettuce (Pistia stratiotes L.) etc. in a S-shaped artificial channel on the amelioration of water quality parameters such as the total suspended solids (TSS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH, electrical conductivity, and dissolved oxygen (DO). The results indicate that TSS removal was 50~75 %, COD removal as 50~60 %, BOD removal was ca. 75 %. Because the inflow polluted water had varying pollution loading, the channel needs to have sufficient hydraulic retention time (HRT) and slow flow to allow cleansing of the water through settling and filtration of the SS, and due to the entrainment of small particles in the polluted water by the interstices of soil particles, thus the longer the HRT, the better the removal rate became. With regard to electrical conductivity, there was an apparent lowering effect, with treated effluent all conforming to the water quality requirement of irrigation water (750 μs/cm)。After passing the S-shaped artificial channel in the wetland, the effluent conformed to the wastewater discharging standards and allow the ensuing ecological pond to operate at low pollution loading conditions. At our lab, we conducted experiments to examine the efficacies of various aquatic plants on pollutant removal. The water hyacinth removed 27 % of the electrical conductivity in winter and showing the best performance. COD removal by the species, on the other hand, was the highest in spring and summer at 90.9 %. At all seasons, the removal exhibited a first-order reaction mode, but the rate constants were faster during these 2 seasons with k1 = 0.64 and 0.58, respectively. Removal of BOD5 reached 75 % in winter which was the best. The first 72 h showed a zero-order reaction mode (k0 = 0.31) and the later 72 h exhibited a first-order reaction mode (k1 = 1.00). As for water spinach (, Ipomoea aquatica Forsk), the electrical conductivity removal was the highest in water reaching 32.1 %. The reaction then was a first-order reaction having a rate constant k1 = 0.26, the fastest among the seasons. COD removal reached 90.9 % in spring and summer and both seasons showed a first-order reaction with k1 = 0.39 and 0.57, respectively. The latter was the best rate constant for all seasons. Removal of BOD5 with the species reached 95 % in summer and showing a first-order mode with k1 = 0.62. Water lettuce showed the best electrical conductivity in winter as well reaching a removal rate of 25.6 %, which showed a first-order mode with rate constant k1 = 0.25. Removal of COD was the best during spring and summer at 90.9 %. The reaction order (first-order) was the same for all seasons. The rates were faster in spring and summer had constants of k1 = 0.63 and 0.65, respectively. The removal of BOD5 by the species reached 85 % in summer and 87.5 % in winter. Both exhibited a first-order mode and had rate constants of k1 = 0.50 and 0.58, respectively. The last aquatic plant examined, Hygrophila pogonocalyx Hayata, removed 35.6% of the electrical conductivity in winter, which showed a first-order reaction mode with rate constant of k1 = 0.57. The results suggest that this species was the most effective in lowering electrical conductivity. For COD and BOD removals, both were more effective in spring and summer. The probable cause was that decomposition of organic substances is mostly aerobic, and the longer periods of sunlight in those seasons lead to greater photosynthesis of the plants and greater oxygen releases which in turn fosters greater microbial activities. The higher removal efficacy of the Hygrophila pogonocalyx Hayata, on the other hand, might have something to do with its flowering in winter. Establishment of the Huaren wetland park not only consolidated a team of volunteers from the community, but also led to improved ambient environment. Thus it contributed to the enhancement of living quality of the community, becoming a center of recreational activities for the residents and a demonstration showcase of ecological education. Furthermore, the wetland purifies water and possesses the function of ecological restoration.

Keywords : Huaren Community, free surface wetland system, artificial wetland, ecological pond, water quality improvement, kinetics.

Table of Contents

REFERENCES

中文部份 于立平，1997，溼地公園規劃策略之研究-以高雄縣鳥松溼地公園為例，國立中山大學海洋環境學系，碩士論文。 李志源等人，1997，利用人工濕地三級處理生活污水，國立台灣海洋大學河海工程系。 林昭榮，2000，水生植物的水質淨化法，農田水利雜誌47(1):32-37。 行政院環保署，2004，自然淨化處理系統宣導手冊，金門縣。 行政院環保署，2005，水質自然淨化工法彙編，台北。 行政院環保署，1998，國家環境保護計畫，台北。 行政院環境保護署之環境檢驗所，2005-公告之水質標準分析方 法。 http://www.niea.gov.tw/index Fram e.htm/ 何茂賢，2003，以人工溼地系統處理受污染河水中營養鹽之探 討，嘉南藥理科技大學環境工程衛生系，碩士論文。 吳俊賢，2006，自然淨化與污水下水道系統聯合運用，第18 屆環工年會特輯17(4):6-10。 林春吉，2000，台灣水生植物(1)-自然觀察圖鑑，268。 林欣怡，1990，以礫石床人工溼地處理工業廢水之研究，國立中山大學海洋環境及工程學系，碩士論文。 施英隆，2002，環境化學，五南圖書出版社，80-144。 馬玉瑄，2005，水生植物在人工濕地中淨化污水之比較，國立 台灣大學農藝學系，碩士論文。 荊樹人、林瑩峰、李得元、陳欽昭、施凱鐘、劉邵希、張弘昌，2003， 台南市灣裡社區人工溼地系統介紹，台東縣河川流域污染防治計畫---水污染學術研討會，9-1-9-6，台東縣環境保護局。 荊樹人，李得元，林瑩峰，王姿文，何茂賢，魏家美，鐘雯如，2001， 人工溼地去除校園廢污水中懸浮固體物之效能，第26屆廢水處理技術研討會，國立高雄第一科技大學，高雄。 荊樹人、李得元、林瑩峰、王姿文、何茂賢、魏家美、張庭憲，2001，經人工溼地處理後校園污水再利用之探討，第6屆水再生及再利用研討會，國立成功大學，台南，137~142。 荊樹人、李得元、林瑩峰、薛正廷、吳堅瑜、何茂賢、廖秀女、趙志強，2001，經人工溼地處理後校園廢污水再利用之探討，第26屆廢水處理技術研討會論文集，國立高雄第一科技大學，高雄。 荊樹人，歐文生，林瑩峰，林憲德，2003，人工溼地淨化校區污水再利用之研究，第28屆廢水處理技術研討會論文集，國立中興大學，台中。 黃獻文，2003，人工溼地處理校園廢污水之效能機制探討，嘉南藥理科技大學環境工程衛生系，碩士論文。 陳志彰，2000，人工溼地改善水質之績效，國立台灣海洋大學河海工程系，碩士論文。 陳志雄、周雪美、張永達，2002，竹子湖人工濕地植物資源調查與監測，國家公園學報12(2):141-155。 張文賢，2005，建立人工濕地設置與操作作業程序及技術，推廣講習會，行政院公共工程委員會。 高裕群，供為污水自然淨化系統之溼地建造，台灣大學環境工程學系，碩士論文。 張文亮、張尊國、陳秋楊、林裕彬、游進裕、徐貴新，2004，水質自然淨化工法彙編，行政院環保署編印。 去水汙染植物介紹網頁:163.29.3.192/eemadm/files/product_2/th_11/1.pdf 曾憲郎，1996，人與環境的永續互動資源管理的政策方案，地方永續發展與生態政策研討會論文，高雄。 彭國棟，2001，如何營造有生命力的生態水池，自然保育季刊35:6-10。 彭國棟，2001，生態池之營造，行政院農業委員會特有生物研究保育中心。 環境資訊協會網頁: http://e-info.org.tw/special/wetland/2004/we04020301.htm 英文部分 Ayaz CS, Akca L 2000. Treatment of wastewater by constructed wetland in small settlement. Wat Sci Technol 41(1):69-73. Bavor HJ, Roser DJ, Adcock PW 1995. Challenges for the development of advanced wetlands technology. Wat Sci Technol 32(3):13-20. Brix H 1997. Do macrophytes play a role in constructed treatment wetlands. Wat Sci Technol 35(5):11-17. Brown DS, Reed SC 1994. Inventory of constructed wetlands in the United-States. Wat Sci Technol 29(4):309-318. Davies Jon, Claridge Gordon eds 1993. The potential for wetlands to support and maintain development. Published by Asian Wetland Bureau (AWB), International Waterfowl and Wetlands Research Bureau (IWRB) and Wetlands for the Americas (WA) .D ’ Angelo EM, Reddy KP 1994. Diagenesis of organic matter in a wetland receiving hypereutrophic lake water:I.Distribution of dissolved nutrients in the soil and water column. J Environ Qual 23:928-936. Haberl R 1999. Constructed wetlands: A chance to solve wastewater problems in developing countries. Wat Sci Technol 40(3):11-17. IWA 2000. Specialist group on use of macrophytes in water pollution control, constructed wetlands for pollution control---processes, performance, design and operation. 27-139. Jos Verhoeven TA, Arthur Meuleman FM 1999. Wetlands for wastewater treatment: opportunities and limitations. Eco Eng 12:5-12. Jetten MSM, Horn SJ, van Loosdrecht MCM 1997. Towards a more sstainable municipal wastewater treatment

system. Wat Sci Technol 35(9):171-180. Knight RL 1997. Wildlife habitat and public use benefits of treatment wetlands. Wat Sci Technol 35(5):35-43. Kadec RH 1999. Chemical physical and biological cycles in treatment wetlands. Wat Sci Technol 40(3):37-44. Kadlec RH 1995. Overview: surface flow constructed wetlands. Wat Sci Technol 32(3):1-124. Metcalf, Eddy Inc 1991. Chapter 3 wastewater characteristics. In wastewater engineering: treatment, disposd, reuse. 3rd. McGraw-Hill, New York. US EPA 1998. Constructed wetlands and aquatic plant systems for municipal wastewater treatment. US EPA 2000. Constructed wetlands treatment of municipal wastewaters. EPA/625/R-99/010 ” . Knight R, Ruble R, Kadlec R, Reed S, NADB(North American Treatment wetlands Database) 1993. Electronic database created for the US environmental the great lake states. North Central USA. Selma C, Akca L 2001. Treatment of wastewater by natural system. environment international 26:189-195. Worall P, Peberdy KJ, Millett MC 1997. Constructed wetlands and natural conservation. Wat Sci Technol 35(5):44-54. Zhu T, Sikora FJ 1995. Ammonium and nitrate removal in vegetated and unvrgrtated gravel bed microcosm wetlands. Wat Sci Technol 32(3):219-228.