Wastewater Treatment and Reuse Using A^2O Process

Coupled with Microfiltration

by

LU, Qihong (Nick)

A thesis submitted for partial fulfillment of the requirements for the degree of

Master of Science in Civil Engineering

2012

Faculty of Science and Technology
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Approved by _____Prof. Hojae Shim
Supervisor

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Date _____

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CONTENT

VITA

LU, Qihong (Nick) was born in the city of Jinghzou in Hubei province on June 20, 1986. He graduated from Middle School of Shashi and received the bachelor degree in Chemical Engineering from South China University of Technology in China in 2009. He continued his MS study at the University of Macau under the supervision of Professor Shim, Hojae.

Conference presentation:

1. Guo, L., **Lu Q.H.**, Xie, W.B., and Shim, H., (2011). Comparison of A^2O and SBR processes for the advanced biological wastewater treatment. 5th International Congress of Chemistry and Environment. Negeri Senbilan, Malaysia, May 27-29.(as coauthor)
2. **Lu, Q.H.**, Xie, W.B., Sun, J., and Shim H., (2011). Wastewater Treatment and Reuse Using A^2O Process Coupled with Microfiltration, Bioinformatics and Biomedical Engineering (iCBBE) 2011 5th International Conference.Wuhan, China, May 10-13. (as presenter)
3. **Lu, Q.H.**, Xie, W.B., Guo, L., and Shim, H. (2010). Coupling A^2O/SBR process with membrane filtration: Comparison of biological nutrient removal performance and effluent reuse potential. 17th International Petroleum & BioFuels Environmental Conference. San Antonio, U.S.A. August 31-September 2. (as presenter)

Journal paper:

1. Guo, L., **Lu, Q.H.**, Xie, W.B., and Shim, H., (2011), Comparison of A^2O and SBR Processes for the Advanced Biological Wastewater Treatment, Research Journal of Chemistry and Environment, 15, (2), 629-632.
2. **Lu, Q.H.**, Guo, L., Sio, H.M., and Shim H., (2012). Comparison of Biological Nutrients Removal Performance and Effluent Reuse Potential after Wastewater

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3. Guo, L., **Lu, Q.H.** Chung, J., and Shim, H. (2012), Comparative study on the effect of hydraulic retention time on SBR and A^2O processes for advanced wastewater treatment, Water Environment Research.(under review)
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University of Macau

ABSTRACT

Wastewater Treatment and Reuse Using A^2O Process Coupled with Microfiltration

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A laboratory-scale anaerobic/anoxic/oxic (A^2O) reactor followed by the microfiltration (MF) system was operated to evaluate the performance on the organics and nutrients removal from synthetic and real wastewater and find the effluent reuse potential. In synthetic wastewater test, the effects of hydraulic retention time (HRT) and internal recycle ratio, as the operating parameters, as well as the characteristics of influent wastewater, such as influent C/P ratios were investigated for the A^2O process. The optimum performance of the A^2O reactor was realized at 13.8-h HRT with the internal recycle ratio of 200% of the influent flux. When the influent C/N ratio was at 10 or above and the C/P ratio was at around 200, the effluent quality for the reactor was excellent, with the removal efficiency for chemical oxygen demand (COD), ammonia nitrogen (NH_3-N), total nitrogen (TN), and total phosphorus (TP) at 97%, 98%, 89%, and 80%, respectively. Among operational parameters for the microfiltration (MF), the trans-membrane pressure (TMP) was not much related to the permeate quality which was affected by the quality of effluent from the pretreatment

A^2O process. The A^2O reactor coupled with the microfiltration membrane filter showed an excellent performance on the further removal of suspended solids (SS) (to <1 mg/L) and turbidity (to <0.1 NTU). In addition, the final effluent/permeate showed a stable and excellent quality in terms of color, COD, and NH_3-N contents (3 PtCo, 10 mg/L, and 0.01 mg/L, respectively), good enough to meet the quality goals for many regional reuse purposes. In the real wastewater test, the percentages of COD, BOD_5, NH_3-N, TN, and TP removals were averaged at 86.0, 97.5, 88.9, 84.7 and 67.5, respectively, for the A^2O process. The hybrid process showed a good performance then fed with real wastewater as well. There is a great potential to upgrade retrofit the traditional activated sludge processes to A^2O coupled with MF system for the advanced wastewater treatment in Macau WWTP.

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LIST OF ABBREVIATIONS

A^2O:	Anaerobic / Anoxic / Oxic
AS:	Activated Sludge
BDL:	Below Detection Limit
BNR:	Biological Nutrients Removal
BOD_5:	Biological/Biochemical Oxygen Demand (value after 5 days)
C:	Carbon
Cl^-:	Chloride
C/N:	Chemical Oxygen Demand to Total Nitrogen Ratio
COD:	Chemical Oxygen Demand
DAF:	Dissolved Air Floatation
DO:	Dissolved Oxygen
DPAO:	Denitrifying Phosphorus Accumulating Organism
EBPR:	Enhanced Biological Phosphorus Removal
GAOs:	Glycogen Accumulating Organisms
HRT:	Hydraulic Retention Time
IC:	Ion Chromatography
L:	Liter
mg/L:	Milligram per Liter
mg:	Milligram
mL:	Milliliter

ML(V)SS: Mixed Liquor (Volatile) Suspended Solids

N: Nitrogen

NAR: Nitrite Accumulating Rate

N.A.: Not Applicable

N.M.: Not Measured

NH_3-N: Ammonia-Nitrogen

NOB: Nitrite-Oxidizing Bacteria

NO_2-N: Nitrite-Nitrogen

NO_3-N: Nitrate-Nitrogen

NOx-N: Nitrogen Oxides-Nitrogen

PAOs: Phosphorus Accumulating Organisms

PHA: Polyhydroxy-alkanoate

PHB: Poly-beta-hydroxybutyrate

PO_4^{3-}-P: Phosphate-Phosphorus

SAR: Special Administrative Region

SBR: Sequencing Batch Reactor

SCOD: Soluble Chemical Oxygen Demand

SND: Simultaneous Nitrification–Denitrification

SRT: Solids Retention Time

SS: Suspended Solids

TKN: Total Kjeldahl Nitrogen

TN: Total Nitrogen

TP: Total Phosphorus

VFA: Volatile Fatty Acid

WWTP: Wastewater Treatment Plant

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