University of Technology, Sydney

Specific Moving Bed Biofilm Reactor in Nutrient Removal from Municipal Wastewater

By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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LIST OF ABBREVIATIONS

AOB	Ammonia oxidizing bacteria
AOP	Advanced oxidation process
BF-MBR	Biofilm membrane bioreactor
BNR	Biological nutrient removal
BOD	Biochemical oxygen demand
CAS	Conventional activated sludge
C/N	Carbon Nitrogen ratio
CFMF	Cross flow membrane filtration
COD	Chemical oxygen demand
CP	Cylindrical polypropylene
CSTR	Continuous stirred tank reactor
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
DOC	Dissolved organic carbon
EPS	Extracellular polymeric substance
FBR	Fluidized bed bioreactor
FC	Circulation frequency
FS	Flat sheet
GAC	Granular activated carbon
h	Hours
HDPE	High density polyethylene
HF	Hollow fiber
HRT	Hydraulic retention time
H_2SO_4	Sulphuric acid
J	Permeate flux
KE	Kinetic energy
KET	Total kinetic energy
LDPE	Low density polyethylene
MBBR	Moving bed biofilm reactor
MBBR-MF	Moving bed biofilm reactor –Membrane filtration
MBR	Membrane bioreactor
MF	Microfiltration
MLSS	Mixed liquor suspended solid
MLVSS	Mixed liquor volatile suspended solid
NaClO	Sodium hypochlorite
$NaHCO_3$	Sodium carbonate anhydrous
NaOH	Sodium hydroxide
NF	Nanofiltration
NH_4-N	Ammonium nitrogen
NOB	Nitrite oxidizing bacteria

NOM	Natural organic matter
O_3	Ozone
OLR	Organic loading rate
OUR	Oxygen uptake rate
PAC	Powdered activated carbon
PAO	Phosphate accumulating organism
PB	Polyethylene Bead
PCL	Polycaprolactone
PE	Polyethylene
PG	Polyethylene Granule
PO_4-P	Ortho - phosphate
PS	Polyethylene sheet
PTSE	Primarily treated sewage effluent
PUF	Polyurethane foam
PVA	Polyvinyl alcohol
RBC	Rotating biological contactor
RC	Cake layer resistance
RM	Membrane Resistance
RO	Reverse osmosis
RP	Pore block resistance
RT	Total resistance
S	Sponge
SBF	Sponge biofilter
SBR	Sponge batch reactor
SBR	Sequencing batch bioreactor
SMBR	Submerged membrane bioreactor
SMP	Soluble microbial product
SRT	Sludge retention time
SSMBR	Sponge submerged membrane bioreactor
SVI	Sludge volume index
T	Temperature
TMP	Transmembrane pressure
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TSS	Total suspended solid
UASB	Upflow anaerobic sludge blanket
UCT	University of Cape Town
UF	Ultrafiltration
UTS	University of Technology Sydney
UV	Ultraviolet
VFA	Volatile fatty acid
ΔPT	Transmembrane pressure
μ	Viscosity of water

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ABSTRACT

Wastewater treatment technology has been improved and modified to get higher removal efficiency and to meet the stringent effluent regulations. However, from a worldwide perspective, wastewater treatment process is facing many challenges, especially nutrients removal, thereby resulting in the serious concern for enhancement and modification of the existing wastewater treatment processes to achieve better removal efficiency. Nutrient and organic removal from wastewater is becoming an important priority for wastewater treatment plants due to the detrimental impact of these components on the receiving bodies. Therefore my research study aims to evaluate a moving bed biofilm reactor (MBBR) system for effective nutrient and organic removal from municipal wastewater which has promising prospects in terms of achieving high nutrient removal efficiency by reducing the operating cost. This study puts forward a systematic study on the effect of polyethylene (PE) carriers filling rates, the influence of aeration rate and different hydraulic retention time (HRT) on the organic and nutrient removal from municipal wastewater using continuously operated MBBR system in order to determine the optimum operating condition. To further verify the feasibility of MBBR system operated at optimum condition, this system was combined with a membrane filtration system to investigate the performance of the combined system in terms of organic and nutrient removal efficiency. My research activities during my research period were mainly focused on literature review in this field and lab scale investigations. This report compiles introduction of the study, literature review, materials and methodologies used, all the specific experimental results, findings and conclusion drawn from the whole study period.