Specific Moving Bed Biofilm Reactor For Organic Removal from Synthetic Municipal Wastewater

By

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CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and it has not been previously submitted as part of the requirements for any other degree at UTS or any other education institution except where acknowledgment is made in the text.

I also declare that this thesis has been written by me. Any help I have received in my research work, preparation of this thesis, and all the information sources used have been acknowledged in this thesis.

Signature of Candidate

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NOMENCLATURE

AFBR	anaerobic fluidized bed reactors
AHR	anaerobic hybrid reactor
AMBBR	anaerobic moving bed biofilm reactor
AOB	autotrophic bacteria
BOD	biochemical oxygen demand
COD	chemical oxygen demand
DAF	dissolved air flotation
DO	dissolved oxygen
DOC	dissolved organic carbon
F	flow rate
FBBR	fluidised bed bioreactor
HABR	hybrid anaerobic baffled reactor
HBR	hybrid biological reactor
HRT	hydraulic retention time
MBBR	moving bed biofilm reactor
MBR	membrane bioreactor
MF	microfiltration
MLSS	mixed liquor suspended solid
MLVSS	mixed liquor volatile suspended solid
MW	molecular weight
NF	nanofiltration
OLR	organic loading rate
OM	organic matter
OUR	oxygen uptake rate
PAC	powdered activated carbon

PAO	phosphorous accumulation organism
PIP	pharmaceutical industrial park
PTSE	primary treated sewage effluent
RBC	rotating biological contactor
RO	reverse osmosis
ROC	reverse osmosis concentrate
SBBR	sequencing batch biofilm reactor
SBR	sequencing batch reactor
SOUR	specific oxygen uptake rate
SS	suspended solid
TDS	total dissolved solid
T-N	total nitrogen
TOC	total organic carbon
TSS	total suspended solid
UASB	up-flow anaerobic sludge blanket
UF	ultrafiltration
UF-PAC	ultrafiltration-powered activated carbon
UF-RO	ultrafiltration-reverse osmosis
WWTP	wastewater treatment plant

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ABSTRACT

Due to the rapid urbanization, wastewater has been continuously and excessively released into the environment, causing significant impacts on human and wild life. Many organic compounds in municipal wastewater are detected in different types of wastewater, affecting water quality, human health and biodiversity in the ecosystems. These compounds have significant impacts on receiving water bodies so as finding an appropriate treatment technology to effectively remove organic matters (OMs) in wastewater is very essential. Recently, moving bed biofilm reactor (MBBR) has brought increasing research interest in practice for removal of biodegradable organic matter and its application have undergone various degrees of modification and development. Moreover, as the carrier using in the MBBR is playing a crucial role in system performance, choosing the most efficient carrier could enhance the MBBR performance. Hence, scientists have been looking for an appropriate carrier which is not costly and has a suitable surface for microbial growth. The main aim of this study is to evaluate a specific MBBR with polyethylene media as biofilm support carrier in terms of OMs removal along with nutrient removal and microbial growth and activity.

The optimization study for its practical application was conducted through a series of the investigations on the effect of carrier's filling rate, organic loading rate (OLR) and hydraulic retention time (HRT). The carrier used in this study was made of Poly Ethylene (PE) with a density of about 0.95 g/cm^3. The experimental results show that although increasing carrier filling rate from 10 to 40% resulted in augment of attached biomass from 0.95 to 5.0 mg/g, microbial activity was dramatically decreased from 2.22 to 0.25 mg O_2/g MLVSS.h. Thus, the best MBBR performance was achieved when the SOUR was at the peak of 5.04 O_2/g MLVSS.h at 20% of filling rate with the removal efficiencies of 95.33, 92.13, 57.41 and

67.58% in terms of DOC, COD, PO_4-P and NH_4-N, respectively. Moreover, 19.8% increase in DOC removal was resulted from the increasing amount of biomass from 5.68 to 11.96 mg/g due to the OLR increase from 0.15 to 0.8 kg COD/m^3d, respectively. Besides, 48.19% of TN removal was achieved at the highest OLR of 0.8 kg COD/m^3d in which microbial activity was 8.53 mg O_2/g MLVSS.h. The effect of HRT on OMs and nutrients removal efficiency was also investigated and the results reveal that at all of the HRTs, more than 95% and 96% of DOC and COD removal efficiency was achieved, respectively. In addition, the experimental result show that at HRT of 4 h, the lab scale MBBR had an average TN removal efficiency of 60.58% while it was only 48.2 and 42.15% at HRT of 8 and 25 h, respectively. Variation of HRT also affected microbial growth and activity. Decreasing HRT from 25 to 8 and 4 h resulted in enhancement of microbial growth on carriers from 11.23 to 14.07 and 16.43 mg/g as well as SOUR from 8.01 to 14.66 and 22.53 mg O_2/g MLVSS.h, respectively. This means HRT of 4 h was the favourable condition for the lab scale MBBR.

In conclusion, the results indicate that MBBR with polyethylene media as biofilm carrier possessed great potential to be used for OMs removal from water and wastewater.