Wastewater Treatment

Aerobic Granular Sludge Technology

Wastewater discharge from agro-based industrial sector contribute to water pollution if not properly treated. Water pollution give a negative impact to the live of aquatic ecosystem and environment which cause serious and prolong consequences. Agro-industrial wastewater that contains high organic pollutant need to be treated in order to create clean and safe environment. One of the advance treatment methods is aerobic granular sludge (AGS) technology which offer simple separation between solid and liquid due to high settling abilities. If you want to know more, you should have this book as a guideline for the treatment of wastewater from rubber processing industry.

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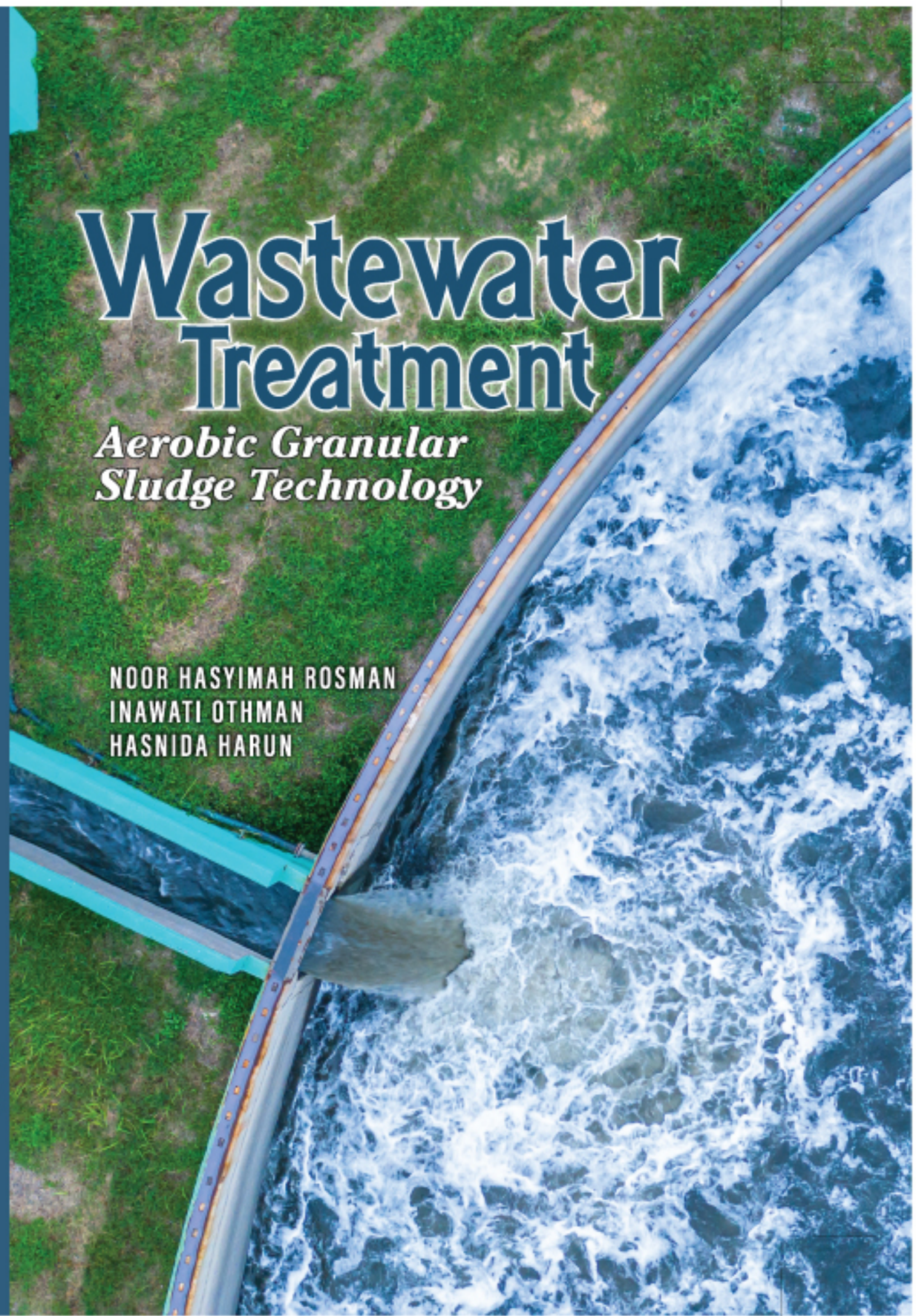

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Wastewater Treatment:
Aerobic Granular Sludge Technology

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Contents

List of Tables & Figures

List of Abbreviation

AGS	Aerobic granular sludge
AN	Ammoniacal nitrogen
AnSBR	Anaerobic sequencing batch reactor
AOB	Ammonia oxidizing bacteria
APHA	American Public Health Association
BAS	Batch activated sludge
BOD	Biochemical oxygen demand
CLSM	Confocal laser scanning microscopy
COD	Chemical oxygen demand
DGGE	Denaturing gradient gel electrophoresis
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
EGSB	Expanded granular sludge bed
EM	Effective microorganism
EPS	Extracellular polymeric substances
EQA	Environmental Quality Act
FESEM	Field emission scanning electron microscope
FISH	Fluorescence *in situ* hybridization
GAO	Glycogen accumulating organism
HRT	Hydraulic retention time
IC	Integrity coefficient
LB-EPS	Loosely bound EPS
MG-RAST	Meta genome rapid annotation using subsystem technology
MLSS	Mixed liquor suspended solids
MLVSS	Mixed liquor volatile suspended solid
OLR	Organic loading rate
ORP	Oxidation-reduction potential
PAH	Polycyclic aromatic hydrocarbon
PAO	Phosphate accumulating organism
PHA	Poly-β-hydroxyalcanoates
PHB	Poly-3-hydroxybutyrate
PLC	Programmable logic controller

PN	Protein
PS	Polysaccharide
RG	Residual granules
RNA	Ribonucleic acid
RRIM	Rubber Research Institute Malaysia
SBR	Sequencing batch reactor
SEM	Scanning electron microscopy
SG	Settled granules
SMA	Specific methanogen activity
SMR	Standard Malaysian Rubber
SRT	Solids / Sludge retention time
SS	Suspended solids
SVI	Sludge volume index
TB-EPS	Tightly bound EPS
TDS	Total dissolved solid
TGGE	Temperature gradient gel electrophoresis
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TP	Total phosphorus
TS	Total solid
TSS	Total suspended solids
UAFP	Upflow anaerobic filter process
UASB	Upflow anaerobic sludge blanket
UTM	Universiti Teknologi Malaysia
UV	Ultraviolet
VER	Volumetric exchange ratio
VFA	Volatile fatty acid
VSS	Volatile suspended solid
WWTPs	Wastewater treatment plants
16s rRNA	16 sequencing ribosomal ribonucleic acid
3D-EEM	Three-dimensional excitation-emission

List of Symbols

Al^{3+}	aluminium
Ca^{2+}	calcium
d_p	diameter of a particle
Fe (II)	ferum
H/D	column height to diameter ratio
HOCl	hypochlorous acid
H_2	hydrogen
M	biomass concentration
M_w	molecular weight
Mg^{2+}	magnesium
$NaHCO_3$	sodium bicarbonate
N/COD	nitrogen and organic ratio
NH_3-N	ammonia nitrogen
NH_4^+-N	ammonium
N-NO_{2^-}	nitrite
N-NO_{3^-}	nitrate
Na^+	natrium / sodium
N_2	nitrogen gas
N_C	number of cycles per day
O_2	oxygen
P	phosphorus
P/COD	phosphorus to chemical oxygen demand ratio
P-PO_4^{3-}	phosphate
Q_e	effluent flow rate
Q_I	influent flow rate
SO_4^{2-}	sulfate
SS_0	total amount of granular sludge
SS_t	amount of sludge solids in supernatant after t min
t_A	aerobic time
t_C	cycle time
t_D	decant time
t_F	filling time
t_I	idle time

t_R	reaction time
t_S	settling time
V_d	manually discharge mixture volume
V_e	effluent volume of the SBR operating cycle
V_F	filled volume
V_{MIN}	minimum volume
V_r	working volume of reactor
V_s	settling velocity of a particle
V_T	total volume
X_d	biomass concentration of manually discharged
X_e	mixed liquor volatile suspended solid in
effluent X_r	mixed liquor volatile suspended solid in
reactor X_{vss}	volatile solid concentration in reactor
μ	viscosity of a solution
ρ_p	density of a particle
ρ	density of a solution
θ	solid retention time

Preface

Praise Be To Allah S.W.T, the Lord of the World

Thank to Almighty Allah (S.W.T) for blessings that have been showered on me to reach this level of knowledge in life and also giving me the strength and patience to come up with this book. The writing of this book is an adaptation from a Doctor of Philosophy level thesis entitled "BIOGRANULAR SLUDGE FOR RUBBER PROCESSING WASTEWATER IN A SEQUENCING BATCH REACTOR". This book explores in detail the theoretical facts on the performances of aerobic granulation in a sequencing batch reactor system for rubber processing wastewater. The contents of this book are very suitable for environmental engineering students and researchers. Hopefully with the sharing of this knowledge opens the eyes of readers about the potential of aerobic granulation as a green technology in treating agro-based industrial wastewater.

With this opportunity, we would also like to thank our dear family members for their endless support and encouragement in completing this book. Our success is directly attributed by their understanding and patience. Not to forget to all the laboratory personnel and all staff in Universiti Teknologi Malaysia (UTM) for their precious cooperation and supports. Many thanks to UTM for providing facilities to conduct this exploration. The highest appreciation goes to Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM) who have supported us since the process of writing this book through Halim Razali Strategic Theory (HRST) Professional Expert until the publication of this book. Our gratitude also goes to the UKM Fund of Dana Penerbitan Buku (DPB-2022-031) and Geran Galakan Penyelidik Muda (GGPM-2021-007) which have contributed a lot financially throughout period of exploration as well as the publication of this book.

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