

**TREATMENT OF RECYCLED PAPER MILL EFFLUENT
USING MODIFIED ANAEROBIC INCLINING-BAFFLED
REACTOR**

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UNIVERSITI SAINS MALAYSIA

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REACTOR**

by

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LIST OF ABBREVIATION

AOX	Adsorbable organic halides
ABR	Anaerobic baffled reactor
ACR	Anaerobic contact reactor
AD	Anaerobic digestion
AF	Anaerobic filter
ANOVA	Analysis of variance
BOD	Biological oxygen demand
CABR	Carried anaerobic baffled reactor
COD	Chemical oxygen demand
R^2	Coefficient of determination
CV	Coefficient of variance
CSTR	Completely stirred tank reactor
DF	Degree of freedom
DOE	Department of environment
EGSB	Expanded granular sludge bed
FISH	Fluorescent in situ hybridization

DGGE	Gradient gel electrophoresis
HABR	Hybrid anaerobic baffled reactor
HUASB	Hybrid up-flow anaerobic sludge blanket
HRT	Hydraulic retention time
COD _{in}	Influent chemical oxygen demand
ISR	Inoculum to substrate ratio
JSTP	Jelutong sewage treatment plant
MABR	Modified anaerobic baffled reactor
MAI-BR	Modified anaerobic inclining-baffled reactor
NCBI	National Center for Biotechnology Information
OLR	Organic loading rate
POME	Palm oil mill effluent
PABR	Periodic anaerobic baffled reactor
pH	Potential of hydrogen
PPME	Pulp and Paper Mill Effluent
R.E.	Removal Efficiency
RPME	Recycled paper mill effluent

RSM	Response surface methodology
RSM	Response surface methodology
rRNA	Ribosomal ribonucleic acid
SEM	Scanning electron microscope
SBR	Sequencing Batch Reactor
SRT	Solid retention time
SD	Standard deviation
TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total Suspended Solids
2FI	Two factor interaction
UASB	Up-flow anaerobic sludge blanket
VFA	Volatile Fatty Acid
VSS	Volatile Suspended Solids
WWTP	Wastewater treatment plant

**RAWATAN EFLUEN KILANG KERTAS KITAR SEMULA
MENGUNAKAN REAKTOR ANAEROBIK SESEKAT CONDONG
DIUBAH SUAI**

ABSTRAK

Pembangunan teknologi rawatan ringkas dan efisien bagi efluen kilang kertas (RPME) kitar semula adalah sangat mencabar disebabkan oleh kandungan tinggi bahan-bahan organik dan pepejal di dalamnya. Dalam kajian ini, objektif utama ialah untuk merawat RPME menggunakan reaktor anaerobik sesekat-condong (MAI-BR) yang telah diubahsuai. Reaktor anaerobik sesekat condong diubah suai (MAI-BR) telah berjaya direka bentuk, difabrikasi dan dikendalikan untuk rawatan efluen kilang kertas kitar semula (RPME). Keputusan pencirian RPME menunjukkan bahawa RPME mengandungi nilai permintaan oksigen kimia (COD) yang tinggi iaitu 3,812 mg/L dan nilai permintaan oksigen biologi (BOD_5) 1,875 mg/L. Teknik permulaan yang berbeza telah dijalankan bagi mengkaji kesan suapan kelompok, nisbah inokulum substrat (ISR), sumber inokulum dan kitar semula efluen. MAI-BR berjaya dimulakan dalam tempoh 30 hari dengan menggunakan enapcemar POME dengan nilai OLR awal sebanyak 0.33 g COD/L hari, nisbah efluen kitar semula, 2 dan suhu mesofili 37 °C. Tambahan pula, kajian proses MAI-BR telah dijalankan bagi nilai COD_{in} yang berbeza, 1,000-4,000 mg/L, HRT, 1-3 hari dan suhu, 29-55°C. Sepanjang kajian kesan COD_{in} dan HRT, kecekapan penyingkiran COD maksimum sebanyak 96% telah dicapai pada nilai COD_{in} sebanyak 4,000 mg/L dan nilai HRT 3 hari, manakala kecekapan penyingkiran COD minimum sebanyak 83% telah dicapai pada nilai COD_{in} sebanyak 4,000 mg/L dan HRT 1 hari. Kesan suhu telah menunjukkan bahawa

kecekanan penyingkiran COD maksimum diperoleh sehingga 94%, 96% dan 76% untuk sub-mesofili (29°C), mesofili (37°C) dan termofilik (55°C). Menurut analisis statistik RSM, semua model adalah bermakna dengan nilai kebarangkalian yang sangat rendah, antara 0.0337 dan < 0.0001. Walau bagaimanapun, interaksi COD_{in} dan HRT adalah penting bagi mengetahui kadar penyingkiran COD dan BOD, VFA efluen, pH efluen, kealkalian efluen dan penghasilan metana. Interaksi ini walau bagaimanapun tidak penting bagi menyukat kecekanan penyingkiran COD, BOD, lignin dan kandungan metana. Keputusan pengenalan mikrob menunjukkan bahawa sistem MAI-BR terdiri daripada *Bacillus* dominan (25 jenis) dan *Bacterium* (1 jenis) yang telah diasingkan daripada kompartmen 1, 2, 4 dan 5, manakala *Bacillus* (2 jenis), *Pseudomonas* (2 jenis) dan *Chryseobacterium* (2 jenis) telah diasingkan daripada filem bio yang terbentuk pada bahan pembungkusan. Enapcemar POME umumnya mengandungi empat jenis mikrob iaitu *Stenotrophomonas* (2 jenis) dan *Bacillus* (2 jenis). Keputusan scanning electron microscope (SEM) daripada mikroorganisma menunjukkan bahawa ia mempunyai beraneka *biofasies*, manakala mikroorganisma dominan mempunyai pelbagai morfologi dalam setiap kompartmen tersebut sistem.