

**DIRECT CONTACT MEMBRANE
DISTILLATION FOR PALM OIL MILL
EFFLUENT TREATMENT**

IYLIA BINTI IDRIS

UNIVERSITI SAINS MALAYSIA

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**DIRECT CONTACT MEMBRANE DISTILLATION APPLICATION FOR
PALM OIL MILL EFFLUENT TREATMENT**

by

IYLIA BINTI IDRIS

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LIST OF ABBREVIATIONS

ABR	anaerobic baffled reactor
Al ₃ (SO ₄) ₂	Aluminium Sulphate
AFM	Atomic force microscopic
AGMD	Air Gap Membrane Distillation
ANN	Artificial neural network
BOD	Biological Oxygen Demand
CaCl ₂	Calcium Chloride
COD	Chemical Oxygen Demand
CPO	Crude palm oil
DCMD	Direct Contact Membrane Distillation
DO	Dissolved oxygen
DOE	Department of Environment
EFB	Empty fruit bunch
FANN	Fundamental artificial neural network
FeCl ₃ .6H ₂ O	Iron (III) chloride hexahydrate
FFB	Fresh fruit bunch
HCl	Hydrochloric Acid
HRT	High retention time
K ₂ HPO ₄	Dipotassium Sulfate
KH ₂ PO ₄	Potassium dihydrogen phosphate

KLCE	Founding of KL Commodity Exchange
LDPE	Low Density Polyethylene
LEP	Liquid entry pressure
MD	Membrane Distillation
MEK	Methyl ethyl ketone
MF	microfiltration
MgSO ₄ .7H ₂ O	Magnesium Sulfate heptahydrate
MLP	Multilayer perception
MnSO ₄ (H ₂ O)	Manganase Sulphate
MPOB	Malaysian Palm Oil Board
MPOC	Malaysia Palm Oil Council
MSE	Mean Square Error
MSDS	Material Safety Data Sheet
N	Number of fibers
Na ₂ HPO ₄ .7H ₂ O	Sodium Phosphate dibasic heptahydrate
NaOCl	Sodium Hypochlorite
NaOH	Sodium Hydroxide
NF	Nanofiltration
PE	Polyethylene
POME	Palm Oil Mill Effluent
PP	Propylene
Pr	Prandtl number

PSD	Particle size distribution
PURELIN	linear activation function
PTFE	Polytetraflouroethylene
PVC	Polyvinyl Chloride
PVDF	Polyvinylidenedifluoride
R	Regression
Re	Reynolds number
RO	Reverse osmosis
UASB	Up-flow anaerobic sludge blanket
UASFF	Up-flow anaerobic sludge fixed-film
UF	ultrafiltration
SEM	Scanning Electron Microscopic
SGMD	Sweeping Gas Membrane Distillation
TANSIG	Sigmoid function
TE	Thermal efficiency
TMP	Tranmembrane pressure
TPC	Temperature Polarization Coefficient
VMD	Vacuum membrane distillation
WCA	Water contact angle

LIST OF SYMBOLS

ΔH_v	Latent heat of vaporization	KJ/Kg
A	Membrane area	m ²
C_f	Concentration feed side	%
C_p	Concentration permeate side	%
C_p	Specific heat	J/kg.K
J	Membrane distillation flux	kg/m ² .hr
d_h	hydraulic diameter	m
d_i	Inner diameter fiber	m
d_o	Outer diameter fiber	m
d_s	Shell diameter	m
h_f	Heat transfer coefficient feed	W/m ² .K
h_m	Heat transfer coefficient membrane	W/m ² .K
h_p	Heat transfer coefficient permeate	W/m ² .K
H_v	Heat of vaporization	KJ/Kg
K_f	Thermal conductivity feed	W/m.K
k_m	Thermal conductivity membrane	W/m.K
k_p	Thermal conductivity permeate	W/m.K
h_m	Heat transfer coefficient membrane	W/m ² .K
L	Length of membrane	m
Nu	Nusselt number	-