

WASTEWATER TREATMENT USING MEMBRANE BIOREACTOR

by

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Dedicated
to
My Loving Parents,
Renu and Rohan

CERTIFICATE

This is to certify that the thesis entitled, **“Wastewater Treatment using Membrane Bioreactor”**, being submitted by **Mr. Vikrant Sarin**, to the Indian Institute of Technology, Delhi, for the award of degree of **‘Doctor of philosophy in Chemical Engineering’**, is a record of bonafide research work carried out by him. **Mr. Vikrant Sarin** has worked under our guidance and supervision and has fulfilled all the requirements for the submission of this thesis, which to our knowledge has reached the requisite standard. The results embodied in this thesis have not been submitted in part or in full, to any other University or Institute for award of any degree or diploma.

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ABSTRACT

Membrane bioreactor (MBR) combines membranes with biological processes for treatment of waste water. MBR provides high quality of treated water with complete solid removal and disinfection capability, combined with high rate and efficiency of organic and nutrient removal in one unit, small foot print low or near zero sludge production, high loading rate capability, rapid start up, modular and retrofit. It is free from sludge bulking problem thus, has high performance and low maintenance. This research work involves studying the treatability of municipal wastewater, industrial effluent taken from Juice processing unit and examines the bio kinetics and fouling characteristics. The operational conditions during the experimental trials had prolonged sludge age upto 50 days, recirculation ratio as 5, hydraulic retention time as 16 (h) – 7.7 (h), organic volumetric load as 0.691 – 3.17 Kg COD m³ d⁻¹ and food/microorganisms ratio as 0.0864 – 0.845. The contaminants removal efficiency in both the cases was observed for COD removal as always higher than 90% the mean effluent COD being as 21 ppm, ammonical nitrogen and Total Kjeldah Nitrogen (TKN) removal efficiency observed as higher than 90% with mean in the effluent as 1.5 and 2.8 ppm respectively, total phosphorus removal was low upto 31% and TSS removal observed was always above 98.5% with mean of 99.6%. Respirometric tests were carried out to verify microbial activity during growth, stationary and decay phase. Specific oxygen uptake rate (SOUR) was determined for biomass samples having 5, 10, 18 and 25 days SRT and was found as 19.35, 4.6, 2.82 and 3.15 mg O₂ /g VSS/h respectively.

Further, this research work investigated the fouling of membranes which is one of the major factors affecting the performance of MBR, thus, limiting the use of application of MBR. The experimental assessment of flux criticality was carried out by flux – stepping tests. The reliability of short term tests trial were verified over a long period by determining the time of sustainability, t_{sust} of four different sub critical fluxes ranging between 14 and

$32 \text{ l m}^{-2} \text{ h}^{-1}$. Coefficient of fouling propensity was determined from the model. An exponential fitting was observed in terms of fouling rate both before and after t_{sust} , though fouling after t_{sust} is likely to be ascribed not only to cake formation. A comprehensive mathematical formulation was proposed according to the local flux approach to model the sub-critical TMP (Trans Membrane Pressure) transients. The model involved both bound and free form of EPS and provided a fair prediction of the sustainable time duration and TMP jump.

TABLE OF CONTENTS

	Page No.
Certificate	i
Acknowledgement	ii
Abstract	iv
List of Figures	vi
List of Tables	xi
Nomenclature	xiii
CHAPTER 1: INTRODUCTION	1-8
1.1 Background	1
1.2 Activated Sludge Process	1
1.3 Membrane Bio Reactor	2
1.4 Advantages of MBR	3
1.5 MBR Operational Difficulties	4
1.6 Need for MBR piloting	5
1.7 Motivation to take-up studies in MBR treatment performances and fouling	6
1.8 Objectives of the Present Study	5
1.9 Scope of Present Research Work	7
1.91 MBR configuration selected for Pilot Plant for this research work	8
1.92 Waste water selected for assessing MBR treatability	8
CHAPTER 2: LITERATURE REVIEW	9-53
CHAPTER 3: MATERIAL AND METHODS	54-69
3.1 Membrane Bio Reactor set up	54
3.1.1 Vacuum rotating membrane (VRM) module and its working	56
3.2. Standard Chemical Analysis	59
3.3 Operating Conditions	59
3.3.1 Hydraulic Retention Time (HRT)	60

3.3.2	Solids Retention Time (SRT)	61
3.3.3	Food to Microorganism (F/M) Ratio.	62
3.3.4	Net Biomass Yield and Observed Yield	63
3.4	Method for determining permeability	65
3.5	Flux-step method for the critical flux determination	65
3.6	Respirometric methods for biomass characterization	67
3.7	Extra polymeric substances (EPS) extraction	68
3.7.1	Definition of bound or soluble EPS	68
3.7.2	Method for EPS extraction	68
CHAPTER 4: MODELLING OF MBR SYSTEM		70-82
4.1	Development of mathematical model for MBR design	71
4.1.1	Case – I - Optimization of operating condition of MBR: Considering sludge treatment and aeration costs.	72
4.1.2	Case II - Foot print being the limiting factor for design of MBR.	73
4.2	Sludge production in MBR	74
4.2.1	Sludge production	75
4.3	Aeration requirement	76
4.4	Development of the mathematical model for determining coefficient of fouling propensity and time of sustainability.	78
CHAPTER 5: RESULTS AND DISCUSSION		83-128
5.0	Background - Membrane Bio Reactor (MBR)	83
5.1	Permeability of membrane	83
5.2	Performance of MBR with Municipal wastewater – Study - I	84
5.2.1	Characterization of Municipal wastewater	84
5.2.2	Biomass growth rate in MBR	86

	5.2.2.1	Mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS) production	87
	5.2.2.2	MLSS Concentration	89
5.2.3		Performance assessment of organics removal	92
	5.2.3.1	Effect of HRT on COD removal efficiency	94
5.2.4		Nutrient removal	96
	5.2.4.1	Nitrogen Removal	96
5.2.5		Total Phosphorus observed in MBR process	101
5.2.6		Permeate Water Quality	103
5.2.7		Summary of treatment performance.	103
5.2.8		Microbial Activity in MBR system	104
5.3		Study II - Performance of MBR using Industrial wastewater from Juice processing unit	108
5.3.1		Characterization of wastewater	108
5.3.2		Growth of MLVSS in MBR - II	109
	5.3.2.1	MLSS Concentration	111
5.3.3		Performance assessment of organics removal	112
	5.3.3.1	Effect of HRT on COD removal efficiency	114
5.3.4		Nutrient removal	115
	5.3.4.1	Nitrogen Removal	115
	5.3.4.2	Total Phosphorus observed in the MBR process	118
5.3.5		Permeate Water Quality	119
5.3.6		Summary of treatment performance.	120
5.3.7		Application of the proposed mathematical model – Study – I	121
	5.3.7.1	Sludge Production Rate	121
	5.3.7.2	Oxygen requirement and aeration rate	126
5.3.8		Application of the proposed mathematical model – Study – II	128

5.4	Hydraulic Performance	129
5.4.1	Short Term Trials	129
5.4.2	Long-term tests: flux sustainability	134
5.4.3	Application of the proposed mathematical model	143
CHAPTER 6: CONCLUSION AND RECOMMENDATIONS		149-151
6.1	Conclusion	149
6.2	Recommendations	151
REFERENCES		152-161

APPENDICES

- I. Matlab Programme
- II. Matlab Results
- III. Photographs
- IV. Cleaning procedures

CURRICULUM VITAE OF THE AUTHOR