

**DEVELOPMENT OF A GRANULAR MEDIA BASED
SOLID-LIQUID SEPARATION TECHNIQUE FOR
AEROBIC BIOLOGICAL WASTEWATER TREATMENT**

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AEROBIC BIOLOGICAL WASTEWATER TREATMENT**

by

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CIVIL ENGINEERING DEPARTMENT

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CERTIFICATE

This is to certify that the thesis entitled '**Development of a Granular Media Based Solid-Liquid Separation Technique for Aerobic Biological Wastewater Treatment**' submitted by **Mr. Santosh Sharad Kolte** to the Indian Institute of Technology Delhi, New Delhi, India; for the award of the degree of **Doctor of Philosophy** in Civil Engineering, is a bonafide record of original research work carried out by him in conformity with the results and regulations of the institute.

The research reports and results presented in this thesis have not been submitted in part or full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

This research study evaluates performance of sand filtration technique for removal of activated sludge bio-solids in the wastewater treatment process with an objective to provide an alternative to the membrane bio-reactor by replacing membranes with granular media. Preliminary investigations were performed to study filtration hydraulics and performances in terms of headloss, filter yield as effluent volume and turbidity with time. Based on the preliminary investigations, a granular media based activated sludge process is developed by coupling filtration reactor and batch biological reactors. Two units of the experimental filtration reactors are indigenously designed that could use different filter media, different depths with provision to measure heads at different depths and different backwash modes. Characteristics of the filter media (sand and coal) were determined. Clean water headloss and media expansions during backwash were studied. Batch bioreactors for different SRT were operated for biomass growth and this biomass was introduced as feed in the filtration reactor. Besides, acclimated mixed liquor from aeration tank of an existing sewage treatment plant is also used. Granular sand and coal grades are used as single and dual media with depths varying from 100 to 400 mm at different hydraulic loadings (20 to 120 $\text{m}^3/\text{m}^2/\text{d}$), feed characteristics and backwash modes. The investigations are performed in two modes viz – operations without backwash and operations with intermittent backwash during the process. 17 configurations without backwash and 13 configurations with intermittent backwash are investigated.

Reactor performances are evaluated by measuring the effluent turbidity, reactor throughput and the backwash water requirements. The reactor throughput has been computed as total effluent volume produced in percentage of the respective volume of inflow. The backwash

water requirement is computed as the backwash water volume in percentage of the effluent volume yielded for the operation. The optimal configurations are evaluated considering effluent turbidity, throughput and backwash water requirement as the principal parameters.

Applications of air agitation and backwash with air are studied. Evaluations of the present work correlate the operational parameters with the performances in terms of effluent quality, throughput and backwash water requirements.

This study reveals potential capability of the sand and coal to retain high MLSS (4000 to 6000 mg/L), eliminating the requirement of secondary sedimentation and deliver excellent effluent quality and performances. In operations without backwash, the lowest effluent turbidity was 1.2 NTU, the highest throughput was 77.8% and the lowest backwash water requirement was 21.5% of the effluent. In operations with intermittent backwash, the lowest turbidity was 3 NTU, highest throughput was 99.7% and the lowest backwash water requirement was 31%. The evaluations conclude that the granular media filtration as an engineered system can be a potentially effective, economical, robust and sustainable technology for wastewater treatment operated with concept of membrane bioreactor, replacing membranes with granular sand/coal media to retain the biomass and produce high-quality effluent. Generic models relating headloss and time, BSRT (biological solids retention time) and SOR (surface overflow rate) have been developed for the experimental modules investigated.

CONTENTS

Acknowledgements	i
Abstract	iii
Contents	v
List of Figures	xiii
List of Tables	xviii
Notations and Abbreviations	xxiii
1. INTRODUCTION	
1.1 Background and problem statement	1
1.2 Need of the present study	5
1.3 Objectives and scope of the present work	7
2. LITERATURE REVIEW	
2.1 Activated sludge and membrane separation processes for wastewater treatment	8
2.1.1 Concept of membrane separation as applied in wastewater treatments	9
2.1.2 Types of membranes and membrane separation processes	10
2.1.3 Membrane Bioreactor (MBR)	11
2.1.3.1 Concept and key features of membrane bioreactor	12
2.1.3.2 Problems and issues with MBR	13
2.2 Application of filtration in wastewater treatment	22
2.2.1 The filtration process	23
2.2.2 Filter operation modes	26
2.2.3 Filtration process mechanisms	26
2.2.4 Filter backwash process	27
2.2.5 Filtration rates	29
2.2.6 Filter hydraulics	30
2.2.6.1 Clean water headloss	30
2.2.6.2 Filter backwash and expansion	32

2.3	Filter media characterization	36
2.3.1	Significance of size of filter media	37
2.3.2	Grain size	38
2.3.3	Average size	39
2.3.4	Effective size	39
2.3.5	Uniformity coefficient	39
2.3.6	Selection of the filter sand	40
2.4	Developments and applications of granular media filtration for wastewater treatment	41
2.5	Solid-liquid separation techniques with specific applications	44
2.6	Inference from literature	46
3.	MATERIALS AND METHODS	
3.1	Overview of the experimental methodology and research activities	47
3.2	Preliminary investigations: Assessment of performative feasibility and filtration hydraulics	49
3.2.1	Preliminary reactor configurations and experimental system	49
3.2.2	Operation configurations and assessment parameters	49
3.3	Research methodology and design: Biomass growth and granular media based activated sludge bioreactor	50
3.4	Biomass growth in batch bioreactors	51
3.4.1	Biomass growth parameters and coefficients	51
3.4.2	Substrate source and reactor composition	52
3.4.3	Activated sludge biological reactor operations	52
3.5	Design and fabrication of granular media activated sludge bioreactor	55
3.5.1	Systems and components of the granular media based reactor	59
3.5.1.1	Filter media	60
3.5.1.2	Headloss measurements	60
3.5.1.3	Aeration mechanism	61
3.5.1.4	Backwash design	62
3.5.1.5	Equipments and accessories	63
3.5.2	Design flowrates	63
3.6	Characterization of filtration media	64

3.6.1	Sieve analysis	65
3.6.2	Specific gravity, water content, voids ratio and porosity	65
3.7	Investigations on clean water headloss	67
3.8	Investigations on backwash and media expansions	67
3.9	Experimental investigations in granular media bioreactor operations	68
3.9.1	Reactor performance data and statistical measurements	69
3.9.2	Experimental investigations in operations without backwash	69
3.9.3	Experimental investigations in operations with intermittent backwash	71
4.	RESULTS AND DISCUSSION	
4.1	Preliminary investigations	73
4.1.1	Variation of headloss with time	73
4.1.2	Variation of effluent volume with time	75
4.1.3	Variation of effluent turbidity with time	77
4.1.4	Overall comparison and inferences of preliminary investigations	79
4.2	Filter media characteristics	83
4.2.1	Sieve analysis and grading curves	83
4.2.2	Specific gravity, water content, void ratio and porosity	83
4.2.2.1	Specific gravity	86
4.2.2.2	Void ratio and porosity	88
4.2.3	Summary of the sand analysis	89
4.3	Clean water headloss analysis	90
4.3.1	Clean water headloss for outlet coinciding top of the media	90
4.3.2	Clean water headloss for outlet 670 mm above top of media	91
4.3.3	Inferences of clean water headloss investigations	92
4.4	Filter media backwash and expansion analysis	93
4.4.1	Analysis of backwash and expansion (fluidization) of sand media	93
4.4.2	Stabilization of sand media after backwash and expansion	94
4.4.3	Inferences of backwash, expansion and fluidization examinations	98

4.5	Batch bioreactor operations and biomass growth	100
4.6	Biokinetic coefficients	103
4.7	Granular media bioreactor operations without backwash	105
4.7.1	Evaluations of sand and coal media of depth 300 mm	105
4.7.1.1	Bioreactor operation for Sand-1, Depth-300	105
4.7.1.2	Bioreactor operation for Sand-2, Depth-300	107
4.7.1.3	Bioreactor operation for Sand-3, Depth-300	109
4.7.1.4	Bioreactor operation for Coal-1, Depth-300	111
4.7.1.5	Bioreactor operation for Coal-2, Depth-300	111
4.7.1.6	Bioreactor operation for Coal-3, Depth-300	113
4.7.1.7	Inferences of analysis of Sand and coal grades for depth 300 mm	113
4.7.2	Evaluation of sand grades of depth 100 mm	114
4.7.2.1	Bioreactor operation for Sand-1, Depth-100	115
4.7.2.2	Bioreactor operation for Sand-2, Depth-100	116
4.7.2.3	Inferences of evaluations of different sand grades for depth 100 mm	118
4.7.3	Evaluations of combinations of sand and coal for depth 150 mm	118
4.7.3.1	Bioreactor operation for Configuration-1 (Sand-1+Coal-1, Depth-150)	119
4.7.3.2	Bioreactor operation for Configuration-2 (Sand-2+Coal-1, Depth-150)	120
4.7.4	Evaluations of combinations of sand and coal for depth 200 mm	122
4.7.4.1	Bioreactor operation for Configuration-3 (Sand-1+Coal-1, Depth-200)	122
4.7.4.2	Bioreactor operation for Configuration-4 (Sand-2+Coal-1, Depth-200)	124
4.7.5	Evaluations of combinations of sand and coal for depth 300 mm	126
4.7.5.1	Bioreactor operation for Configuration-5 (Sand-1+Coal-1, Depth-300)	126

4.7.5.2 Bioreactor operation for Configuration-6 (Sand-2+Coal-1, Depth 300)	128
4.7.6 Evaluations of combinations of sand and coal for depth 400 mm	130
4.7.6.1 Bioreactor operation for Configuration-7 (Sand-1+Coal-1, Depth 400)	130
4.7.6.2 Bioreactor operation for Configuration-8 (Sand-2+Coal-1, Depth 400)	132
4.7.6.3 Bioreactor operation for Configuration-9 (Sand-1+Coal-2, Depth 400)	134
4.7.6.4 Bioreactor operation for Configuration-10 (Sand-2+Coal-2, Depth 400)	135
4.7.6.5 Bioreactor operation for Configuration-11 (Sand-2+Coal-2, Depth 400, SOR-40)	137
4.7.6.6 Discussion and inferences of operations of combinations of sand and coal for different depths	139
4.7.7 Comparative evaluation of operations without backwash	142
4.7.8 Parameter wise evaluation of bioreactor operations without backwash	144
4.7.8.1 Evaluation with perspective of run time for operations without backwash	144
4.7.8.2 Evaluation with perspective of throughput for operations without backwash	144
4.7.8.3 Evaluation with perspective of backwash water requirement for operations without backwash	145
4.7.8.4 Evaluation with perspective of effluent turbidity for operations without backwash	147
4.7.9 Performances of operation configurations considering principal parameters (without backwash)	148
4.7.10 Optimization of reactor configurations for operations without backwash	150
4.7.11 Performances of configurations by ranking (operations without backwash)	151

4.7.12	Comparative evaluations of single and dual medium bioreactor at high SOR	153
4.7.12.1	ASSB operation for Single medium and dual medium (SRT-20 d, SOR=80 m ³ /m ² /d)	154
4.7.12.2	ASSB operation for Single medium and dual medium (SRT-25 d, SOR=120 m ³ /m ² /d)	155
4.7.12.3	Inferences of comparative operations of single and dual medium bioreactor at high SOR	156
4.8	Granular media bioreactor operations with intermittent backwash	158
4.8.1	Evaluations of sand and coal media of depth 100 mm, and backwash at every 15 minutes for 1 second (BW@15min-1s)	158
4.8.1.1	Bioreactor operation for Sand-2, Depth-100, BW@15min-1s	158
4.8.1.2	Bioreactor operation for Coal-2, Depth-100, BW@15min-1s	159
4.8.2	Evaluation of sand and coal media of depth 200 mm, and backwash at every 15 minutes for 2 seconds (BW@15min-2s)	160
4.8.2.1	Bioreactor operation for Sand-2, Depth-200, BW@15min-2s	160
4.8.2.2	Bioreactor operation for Coal-2, Depth-200, BW@15min-2s	161
4.8.3	Evaluation of sand and coal media of depth 200 mm and backwash at every 15 minutes for 2 seconds, at high SOR of 40 m ³ /m ² /d (BW@15min-2s, SOR-40)	163
4.8.3.1	Bioreactor operation for Sand-2, Depth-200, BW@15min-2s, SOR-40	163
4.8.3.2	Bioreactor operation for Coal-2, Depth-200, BW@15min-2s, SOR-40	163
4.8.4	Evaluation of Sand-2, depth 200 mm and backwash at every 15 minutes for 4 seconds, operated at high SOR of 40 m ³ /m ² /d	165
4.8.5	Evaluation of sand and coal media of depth 200 mm and backwash at every 30 minutes for 4 seconds	167

4.8.5.1	Bioreactor operation for Sand-2, Depth-200, BW@30min-4s	167
4.8.5.2	Bioreactor operation for Coal-2, Depth-200, BW@30min-4s	168
4.8.6	Evaluation of sand and coal media of depth 200 mm for laboratory mixed liquor of different MCRT	170
4.8.6.1	Bioreactor operation for Sand-2, depth 200 mm and backwash at every 15 minutes for 2 seconds with mixed liquor of MCRT (θ_c)-5 days	170
4.8.6.2	Bioreactor operation for Sand-2, depth 200 mm and backwash at every 15 minutes for 2 seconds with mixed liquor of MCRT (θ_c)-10 days	172
4.8.6.3	Bioreactor operation for Sand-2, depth 200 mm and backwash at every 15 minutes for 4 seconds with mixed liquor of MCRT (θ_c)-15 days, at high SOR of $40 \text{ m}^3/\text{m}^2/\text{d}$	174
4.8.6.4	Bioreactor operation for Sand-2, depth 200 mm and backwash at every 15 minutes for 4 seconds with mixed liquor of MCRT (θ_c)-20 days, at high SOR of $40 \text{ m}^3/\text{m}^2/\text{d}$	175
4.8.7	Comparative evaluations of bioreactor operations with intermittent backwash for different configurations of media and depths	177
4.8.8	Parameter wise evaluation of bioreactor operations with intermittent backwash	180
4.8.8.1	Evaluation with perspective of run time for operations with intermittent backwash	180
4.8.8.2	Evaluation with perspective of throughput for operations with intermittent backwash	181
4.8.8.3	Evaluation with perspective of backwash water requirement for operations with intermittent backwash	181
4.8.8.4	Evaluation with perspective of effluent turbidity for operations with intermittent backwash	182

4.8.9	Performances of operation configurations considering principal parameters (with intermittent backwash)	183
4.8.10	Optimization of reactor configurations for operations with intermittent backwash	184
4.8.11	Performances of configurations by ranking (operations with intermittent backwash)	186
4.9	Generic models for relationship between headloss and time, BSRT and SOR	188
5.	CONCLUSIONS AND SCOPE FOR FUTURE WORK	
5.1	Conclusions	194
5.2	Scope for future work	196
	References	198
	Bio-data	233
