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

SANTOSH SHARAD KOLTE

CIVIL ENGINEERING DEPARTMENT
INDIAN INSTITUTE OF TECHNOLOGY DELHI
NEW DELHI – 110016, INDIA

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by

SANTOSH SHARAD KOLTE

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.

Prof. Shashi Mathur
Chairman, SRC

Professor,
Civil Engineering Department
Indian Institute of Technology Delhi
Hauz Khas, New Delhi-110016 (India)

Prof. B. J. Alappat
Expert Member, SRC

Professor
Civil Engineering Department
Indian Institute of Technology Delhi
Hauz Khas, New Delhi-110016 (India)

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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 $m^3/m^2/d$), 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.

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