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Integrated Fixed Bed Biofilm Reactor-A Review

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Abstract—*The Integrated Fixed Film Activated Sludge process is comprised of a fixed film media, free moving or stationary combined with activated sludge. By allowing the fixed film phase to retain biomass in the basin at low Solid Retention Time The aim of this study is to present the hybrid bioreactor technology as an alternative method to treat domestic wastewater under different conditions. This technology presents several operational advantages, compared to other conventional biological treatments. Processes will take account of Moving bed biological reactors and fixed bed reactor or packed bed biofilm reactor with some sort of modifications including change in media i.e. natural or artificial media, performance, baffle configuration and aeration system. Conditions which may be studied will include organic removal with primary treatments. This study can be helpful to check possibility that the hybrid process may be used as an ideal and efficient option for the organic removal from domestic wastewater.*

Keywords: *Integrated Fixed Film Reactor, Hybrid Bioreactor, Moving Bed Bioreactor, Fixed bed Reactor or Packed bed biofilm reactor, Domestic Wastewater.*

1. INTRODUCTION

Per capita accessibility of freshwater is decreasing at a very fast rate. During the last few decades, number of countries experiencing water scarcity has increased. Particularly in developing countries, the quality of available freshwater are deteriorating due to pollution. Untreated sewage or industrial wastes are the major sources of pollutants in developing countries. The intensity of water scarcity is increasing due to increasing population, industrial growth, and also due to climate change. Wastewater reuse is an important approach for conservation of water resources.

Integrated fixed- film activated sludge (IFAS) process, combines fixed-film and conventional suspended- growth activated sludge treatment processes. The basic intent of an IFAS process is to provide additional biomass within the reactor volume of an activated sludge process, for the purpose of increasing the capacity of the system or upgrading its performance, as illustrated in Fig. 1. The IFAS process typically has been considered as an upgrade option in existing treatment plants that must incorporate nutrient removal.

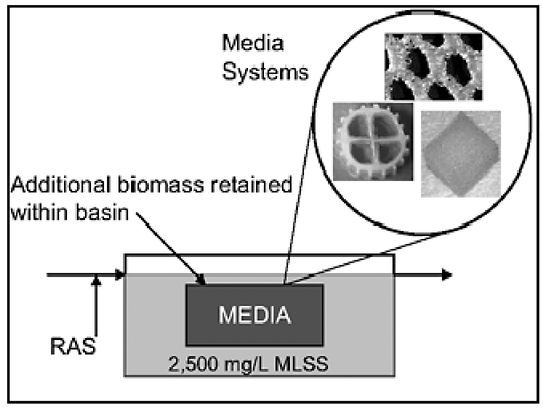

Fig. 1: Typical IFAS Process

In fact, the effective mixed-liquor suspended solids concentration essentially can be doubled by using media in an IFAS process. As the biomass is fixed on a media system, the suspended growth mixed liquor concentrations are not increased and the performance of the downstream final clarifiers is not negatively affected by an increase in the solids loading rate. In fact, in many cases, clarifier performance is improved by a reduction in the sludge volume index (SVI), as a result of the fixed-film growth [5].

The IFAS process can be applied to almost any type of process flow schematic and reactor configuration. It has been used primarily in the aerobic zones of treatment processes to enhance biochemical oxygen demand removal and nitrification. However, depending on the type of media, IFAS also has been applied to anoxic zones to enhance denitrification. As mentioned, the type of reactor configuration that can be adapted to IFAS also is flexible. The IFAS process has been used in both complete-mix and plug-flow reactors. Each type of reactor has its own special design considerations, depending on the typed of media used. The IFAS process also has been applied to lagoons and sequencing batch reactors.

The IFAS process sometimes is confused with the moving-bed biofilm reactor process, because both processes use the same type of media. However, the MBBR does not incorporate a return activated sludge and thus is a pure fixed-film process. The IFAS process does have a return sludge and maintains mixed-liquor concentrations that are typical of a conventional activated sludge process [5].

2. LITERATURE REVIEW

Literature survey has been carried out on IFAS Process for domestic wastewater and in discussed in this section.

Some researchers used nonwoven geotextiles baffles as suspended biomass media to treat wastewater from a combined sewer system [1]. Micro-organisms formed a biomass floc in the interior of the baffles, which grew to emerge on the surface. Suspended and non settleable colloidal solids in the influent wastewater were captured by both filtration and adsorption from the channel flow. Biochemical Oxygen Demand (BOD) removal efficiency was observed to be about 90-95 %.

The treatment of domestic wastewater in Geotextile Baffle Contact System (GBCS) reactor was conducted at different OLR and HRT. A reactor was operated at different Hydraulic Retention Time (HRT) of 24hr, 18hr, 12hr, 8hr and 6hr for synthetic wastewater in room temperature. Geotextile baffles were used as biofilm attachment media for wastewater treatment [3]. The removal of Chemical Oxygen Demand (COD) was monitored for different HRT and OLR. For HRT of 24hr and OLR of 0.31 COD/m^3/day, 84% COD removal efficiency has been achieved. For Hydraulic Retention Time of 18hr and OLR of 0.41 COD/m^3/day, 82% COD removal efficiency has been obtained. The COD removal efficiency increased as the Mixed Liquor suspended Solids (MLSS) concentration increases. There was an insignificant change in pH of the system. The performance of GBCS has been improved along the operating period, reaching a COD removal efficiency of 68%–86%. The efficiency of GBCS reactor is inversely proportional to OLR of the system.

Two sets of experiments were conducted to study the effects of detention time, elevated NH_3-N concentration. This present study revealed the study of COD, BOD and NH_3-N removal in two reactors, one filled with gravel bed and other areca fibers [4]. Fibrous material was effectively used which in increasing the surface area of the support media in fixed film reactors. Several fibrous biomass support mediums are available for use in attached growth system. The experiment was conducted for a batch mode of operation. The bio-reactors were continuously aerated and fed with residential wastewater having an initial average COD of 860 mg/L, BOD of 450 mg/L and NH 3-N of 70 mg/L. The reactors with gravel bed and areca fibers showed reasonable amount of COD removal (72-74%), BOD removal (92%-94%) and NH_3-N removal (58%-60%) within 4-16 hrs. of detention period. In both the reactors denitrification was almost absent. Here comparative study of both reactors has been done and it is hypothecated that at fixed MLSS concentration of 2210 mg/L, efficiency of areca fibers bio- reactor seems to be satisfactory and effective for batch mode of operation.

The research has focused on modeling and testing the use of either moving bed biofilm reactor or integrated fixed film activated sludge in three different locations with respect to the installed surface aerators [4]. A software simulating program was used to compare the performance of both systems. Results indicated that MBBR with polyethylene media acting as Biofilm carrier possessed greater potential to be used as an ideal and efficient option for different flow rates. The MBBR removal efficiencies of COD and TSS, in winter were 91.62%, 87.92% respectively, while in summer, corresponding RR were 90.53%, 89.70%, respectively compared to IFAS system which achieved RRs of 91.62%, 88.26% in winter and 90.53%, 90.13% in summer. MBBR also achieved excellent removal of Ammonia in winter with residual value of 0.38mgN/l while in summer it was 0.99mgN/l, compared to IFAS system., in winter it was 19 mgN/l, while in summer it was 0.49 mg N/l. Concerning the number of aerators needed for maintaining a DO concentration of 2 mg/l, the results showed that in winter two aerators with hp 75 were sufficient, while in summer just one aerator was sufficient for the MBBR process. However, the number of aerators needed for IFAS process was more in winter and in summer. The values of HRT in IFAS process achieved better results than MBBR; On the contrary the SRT achieved better results in MBBR than in IFAS.

3. ANALYSIS OF RESEARCH PAPER

Nonwoven geotextiles baffles in the reactor used as suspended biomass media to treat wastewater from a combined sewer system. [1]. If a fixed media is located at the head of an activated sludge basin in a plug-flow reactor, the relatively high concentration of carbon will promote the growth of a thick biomass populated primarily by heterotrophic bacteria. If the media is located at the end of a plug-flow reactor, it is possible that there would not be adequate substrate to promote the growth of a useful population of biomass. The location of the media and concentration of the various substrates in the bulk liquid are important design considerations.

GBCS reactor for synthetic wastewater was operated at different OLR and HRT [3]. Synthetic substrate consisting of glucose, peptone as organic source was used as substrate throughout the period to ensure a consistent quality of influent to the reactor. Due to dynamic characteristics of actual wastewater, the removal efficiency of the reactor varies which is true representative of any treatment unit. So it is beneficial to use domestic wastewater.

Two sets of experiments were conducted in two reactors, one filled with gravel bed and other areca fibers to study the effects of detention time, elevated NH_3-N concentration on COD, BOD and NH_3-N removal [4]. For further study, different naturally occurring media with different configuration can be used for comparative study.

The research has focused on modeling and testing the use of either moving bed bio film reactor or integrated fixed film activated sludge in three different locations with respect to the installed surface aerators [2]. MBBR could be a preferable option for that study as a minimum number of aerators would be required for that MBBR Coarse diffused aerators can be tried in IFAS to minimize the energy requirement. In IFAS process, for lowering the cost, naturally occurring fixed media can be used.

4. CONCLUSION

IFAS process has wide applicability for treating wastewater for the effect of variations in operating parameters such as HRT (4-16 hrs.), greater SRT, low F/M ratio, OLR(0.8-1.6 kg COD /m^3.day). MLSS plays key role in treatment process. It is also significant to assess the performance of IFAS for treating wastewater for an individual house to group of houses.

There is a requirement to assess the performance of IFAS system with some sort of modifications such as source of wastewater, change in media i.e. natural or artificial media, performance evaluation, baffle configuration and aeration system. Conditions which may be studied will include organic removal with primary treatments. This study can be helpful to check possibility that the hybrid process may be used as an ideal and efficient option for the organic removal from domestic wastewater.

5. ACKNOWLEDGEMENT

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