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Review Paper on Treatment of Food Industry Wastewater by Sequencing Batch Reactor

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Abstract: ***Food industries have an important place in the Indian economic development. However, the wastewater generated from these industries bear a high degree of pollution load. A membrane separation process was coupled to a sequencing batch reactor (SBR) for biological nutrient removal (BNR) processes and a combined system was named a membrane sequencing batch reactor (MSBR). MSBR was used for the treatment of dairy industry wastewater and optimized to increase the treatment efficiency. Since a diffuser-attached module design, subcritical flux operation, and intermittent suction method were adapted to the system, long-term operation was possible, i.e. the system could be operated for more than 110 days with only one membrane washing. BOD removal was high (97–98%) and stable. SS (suspended solid)-free effluent was obtained by membrane separation. Since nitrogen was mainly consumed as nutrient for synthesis of new cells due to the low influent concentration, the removal rate reached 96%. Phosphorus removal was relatively low because of the limit of the biological process, i.e. removal efficiency ultimately depends on the amount of excess sludge wasting. A removal rate of 80% was reached after system optimization.***

Keywords: SBR, Membrane separation, Membrane bioreactor, Diary Industry Wastewater,

1. Introduction

Sequencing batch reactor (SBR) is the name given to wastewater treatment systems based on activated sludge, operated on a sequence of fill and draw cycles. These systems normally include a biological nutrient removal process. The unit operations involved in an SBR are equivalent to those of conventional activated sludge systems. Therefore, aeration and sedimentation-clarification are performed. The difference between the systems is that, in conventional systems, these two processes take place in two different tanks whereas, in SBR systems, they occur sequentially in the same tank. Research on SBR reactors began in the 1970's, simultaneously with the development of other discontinuous processes. Even in 1914, the reactors based on active biomass designed by Arden and Lockett were operated according to the principles of SBR technology. One of the advantages of these batch systems is that they can easily be adapted for continuous variations of pollutant concentrations. In fact, mass balances of batch systems describe the unstable behavior produced by the natural variations of volumetric flows and pollutant concentrations. With the growth in the use of microprocessor-based programmable logic controllers (PLCs) and the increase in the reliability of these systems, SBR treatment technology has become more popular. SBR treatment for food industry kitchen wastewater can produce an effluent that is better than that obtained by a secondary treatment and can operate over a wide range of hydraulic and organic flow variations. Papers by Norcross and Ketchum dealing with the design and physical features of sequencing batch reactors are important for an understanding of SBR characteristics. The first considers mechanical, process, and control aspects of the design of SBRs; the second clearly describes the SBR physical system and explains approaches used to develop the bases of design needed to meet different treatment objectives.

2. Literature Review

2.1.Sule Abubakar , Ab aziz Abdul Latiff , I. M. Lawal , A. H. Jagaba in Aerobic treatment of kitchen wastewater using sequence batch reactor (SBR) and reuse for irrigation landscape purposes paper describes the study as " Despite abundant freshwater resources in India on the whole, there are regions where demand exceeds supply. Within the holistic concept of total water cycle management, one solution to the challenge is wastewater reuse, which facilitates the use of treated kitchen effluents as a new source for non-potable water supply. Reuse or recycling of treated kitchen wastewater reduces effluent discharges into receiving waters and offers a reliable alternative supply of water for applications that do not require high quality water, freeing up limited. This study was mainly focused on the applicability of aerobic SBR to overcome the deficiencies in lack of prior treatment of kitchen wastewater before depositing into body of water and for reuse for irrigation purposes. Performances were investigated for twelve different hydraulic retention times as 135 minutes to 300 minutes. It could be found that regardless of HRT, COD removal efficiencies were not more than 63 %, besides; better nitrate removal efficiency was achieved when the system was running for HRT 300 min and it was 86%. Similarly, in terms of total suspended solid removal efficiency, HRT 300 min provided removal of 94 % from wastewater. Results obtained were within the standard. Finally, it was justified that HRT 300 minutes (5hours) was the best operating condition among them. The sequencing batch reactor is an efficient tool for biological carbon and nutrient removal, capable of achieving effluents with very low nitrogen and phosphorus concentrations from concentrated wastewaters.

2.2.Shalinee Naidoo and Ademola N. Olaniran in Treated Wastewater Effluent as a Source of Microbial Pollution of Surface Water Resources paper describes the study that

it is a well-known fact that man has dominated the planet for decades and with constantly increasing population numbers, hydrological variability and rapid urbanization coupled with the need for greater socio-economic development, man will continue to play an ever increasing dominant role. In addition, obtaining a global perspective of surface water quality has become increasingly difficult as different nations struggle with different environmental pressures, more so in developing countries where available resources are limited. One such visible example is the increasing volume and pressure on existing wastewater treatment plants together with surrounding inefficient hygiene practices and exacerbated nutrient and microbiological loads constantly entering receiving river systems and water supplies. Increased pressure on existing infrastructure coupled with the use of outdated guidelines for treated effluent has further compounded these issues.

2.3.Er. Devendra Dohare, Er. Mahesh Kawale in Biological Treatment of Wastewater Using Activated Sludge Process and Sequential Batch Reactor Process paper describes that "The treatment of sewage has been a challenge throughout the years due to varying raw water characteristics & strict effluent regulations . SBR system has oxygen dissolving capacity higher than ASP and provides Higher Fecal coliform removal efficiencies with less cost and space. Future expansion is one of the critical task in case of ASP but SBR system privides flexibility for the same. As the effluent quality is better in case of SBR system than in ASP system, hence helps in maintaining satisfactory quality of water body in which effluent is being discharged. Higher overall efficiencies with lesser cost and space requirement of SBR process provides itself the maximum probability in selection of technology for biological treatment of wastewater treatment."

2.4 LuisH.Abreu Sequencing Batch Reactors

An Efficient Alternative to Wastewater Treatment describes in his study that "Wastewater treatment has been a challenge throughout the years due to varying influent chemical and physical characteristics and stringent effluent regulations. Treatment systems using activated sludge have been able to handle many of these difficulties. Given the lack of on-line computer controls, continuous flow systems have been mostly used for these purposes versus sequencing batch processes. The availability of artificial intelligence has now made the option of a SBR process more attractive thus providing better controls and results in wastewater treatment. This is coupled by the flexibility of a SBR in the treatment of variable flows, minimum operator interaction required, option for anoxic or anaerobic conditions in the same tank, good oxygen contact with microorganisms and substrate, small floor space, and good removal efficiency. Sequencing batch reactors operate by a cycle of periods consisting of fill, react, settle, decant, and idle. The duration, oxygen concentration, and mixing in these periods could be altered according to the needs of the particular treatment plant. Appropriate aeration and decanting is essential for the correct operations of these plants. The aerator should make the oxygen readily available to the microorganisms. The decanter should avoid the intake of floating matter from the tank. The many advantages offered by the SBR process justifies the recent increase in the implementation of this process in industrial and municipal wastewater treatment.

3. Methodology

1) Collection of sample from the food industry kitchen wastewater and analyzing the parameter
2) Preparation of model of SBR (SBR reactor set up will have Screen, Oil Grease Trap with Air Bubbler and allied units, approximate volume 5 – 10 litre)
3) Treatment of food industry kitchen wastewater by SBR
4) Analyzing the effluent characteristics of treated wastewater and compare with MPCB disposal norms
5) To study the quantum of effluent and influent as well as parameter

4. Strengths and Weaknesses

4.1 Strengths

- Equalization, primary clarification, biological treatment and secondary clarification can be achieved in a single reactor vessel.
- SBR required small space.
- SBR has controllable react time quiescent settling.
- Minimal footprint
- High nutrient removal capabilities
- The BOD removal efficiency is generally 85 to 90%
- Filamentous growth elimination

4.2 Weaknesses

- A higher level of sophistication is required especially for larger systems, of timing units and controls.
- Higher level of maintenance associated with more sophisticated controls, automated switches, and automated valves.
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.

5. Research and Development

Evaluation on the impacts of predators on biomass components and oxygen uptake in sequencing batch reactor and continuous systems

An expanded unified model for the biomass fractions, soluble-organic fractions, and oxygen-uptake rates considering extracellular polymeric substances (EPS), intracellular storage products (X_{STO}), and predators for activated sludge is used to study the impacts of predators on biomass components and oxygen uptake. The new model is applied to evaluate how predation affects the oxygen-uptake rate (OUR) and the different forms of biomass: active bacteria (X_H), X_{EPS}, and X_{STO}, under dynamic feast-and-famine and continuous conditions. For the dynamic conditions of a sequencing batch reactor (SBR), eliminating predators from the model increases X_H and X_{EPS} fractions significantly, and this causes the substantial increases in OUR and MLVSS once the famine period begins. An analysis of how the OUR is distributed among the several

respiration processes shows that the predation of X_H is the most significant oxygen utilization rate process in the system under famine conditions of an SBR. Application of the model to simulate the long-term operation of an SBR indicates that predators reach their maximum fraction in the MLVSS (4% of MLVSS) at a solids retention time of about 13 days, but they are washed out at a solids retention time less than 3 days. Simulation for a continuous system indicates that predators take more time (about 800 h) to reach steady state and reach their maximum fraction (5.5%) at an SRT of 14 days. Comparison of SBR and continuous systems reveals that the predators have greater impact in the continuous system because the permanent near-famine condition accentuates predation processes.

6. Conclusion

Sequencing batch reactors (SBR) are useful for areas where the available land is limited. Equalization, primary clarification, biological treatment and secondary clarification can be achieved in a single reactor vessel.

SBRs are a variation of the activated sludge-process. They differ from activated sludge-plants because they combine all of the treatment steps and processes into a single basin whereas conventional facilities rely on multiple basins.

The pollutant removal efficiency of SBR system is higher for nitrogen and phosphate.

The SBR system can remove heavy metal such as Zn, Cu, Pb with organic pollutant and nitrogen.

River waters are to be kept clean in all possible way by minimizing the nutrients in the effluents and preventing unwanted excess growth of algae and aquatic weeds.

Food Industry Kitchen Waste water treatment plants are required to be designed to achieve nutrient removal in order to protect aquatic ecosystem

Adoption of state-of-the-art biological nutrient removal food industry kitchen wastewater treatment technologies to meet the stringent effluent norms is a need of the days.

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Author Profile

Mr. Ashok Iranna Pilgonde obtained Graduate Degree in Civil Engineering from Marathwada University. His area of specialization is waste water treatement by SBR. He has published 5 Research Paper in National Conferences and 1 in International Journal. He has own his Industrial Construction Company In Pune and is doing business with Multi National Companies.