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An Insight into Research and Studies on Modeling and Simulation-Biological Treatment Methods for Wastewater

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ABSTRACT

The effluent treatment plants are developed based on laboratory scale experiments and then scaled up to pilot scale. This is very rigorous process and lot of time and investment is required. The effluent quality variation affects the performance of the plant. For varying load, the parameters need to be adjusted. Factors like microbial attachment process, the kinetics of microbial growth and details of the microbial community influence the activated sludge process. Simulation of the process can save considerable amount of money and time. The modeling of the process helps in predicting the data values. The current review summarizes research and studies on simulation and modeling of biological treatment facilities.

Key words: Biofiltration, accuracy, contaminants, biomass, filter media.

INTRODUCTION

Biological treatments are commonly used in sewage and industrial treatments. Activated sludge process (ASP) can be modified to yield better results. [1-4] The factors affecting it are MLSS, cell concentration, organic loading, composition of effluent etc. The effluent treatment plants are developed based on laboratory scale experiments and then scaled up to pilot scale. This is very rigorous process and lot of time and investment is required. The effluent quality variation affects the performance of the plant. For varying load, the parameters need to be adjusted.

Methods like biofiltration and trickling filters are also used according to the need. [5-9] They have advantage in terms of space utilization. Sequencing batch reactors are also useful and offers excellent alternative. Membrane bioreactors, advanced oxidation processes and many other modifications of conventional biological processes are being used and explored for effective and efficient treatment of wastewater. [10] The current review summarizes the research and investigations on modeling and simulation for biological treatment facilities.

REVIEW ON MODELING AND SIMULATION OF BIOLOGICAL TREATMENT FACILITIES

An investigation was carried out by Kader on sequencing batch reactor (SBR) and conventional activated sludge (AS). [11] He explained various aspects of SBR. In these reactors, metabolic reaction and solid/liquid separation take place at different times. Under different operating conditions; he studied the performance and treatment capability of both activated sludge (AS) and sequencing batch reactor (SBR) systems. He carried out simulation of both the reactors. He used software named 'The GPS-X (version 5.0) simulation program. Belia et. al. carried out investigation on uncertainties involved in the modeling of wastewater treatment plants. [12] According to them, it is important to identify the uncertainties in modeling of wastewater treatment operations. The investigation provided an insight into the accuracy of methods used for evaluating accuracy and uncertainty. Halle, in his investigation studied reduction of membrane fouling and biodegradation of organic trace contaminants. [13] The multicarrier approach along with several drinking water treatment processes was used. According to him the presence of pharmaceutically active compounds

(PhACs), personal care products (PCPs) and endocrine disrupting compounds (EDCs) in drinking water sources causes serious threat to the human health. Membrane separation solves these problems to a great extent. The limitation to these operations is membrane fouling. In his work he tried to establish biofiltration pretreatment without prior coagulation for controlling fouling.

Kandasamy et. al. carried out investigation on biological filtration and adsorption. [14] According to them, high reliability, energy efficiency, design flexibility, technological maturity and the ability to regenerate the exhausted adsorbent makes adsorption very widely applied method for separation and purification. The activities of the community of micro-organisms that become attached onto the filter media are used in the biofiltration. They discussed factors like microbial attachment process, influence biological filtration, the kinetics of microbial growth and details of the microbial community. According to them, the most important factor in efficient operation of biofiltration is the efficient maintenance of biomass attached to the filter media. Detachment mechanisms are also important, which includes erosion, abrasion, sloughing, grazing or predation and filter backwashing. Gray, in his work, discussed relationships between dissolved organic matter and organic phosphorus. [15] He also studied methods for removal of organic phosphorus from waster. Also he investigated current limitations of pH simulation in the wastewater treatment process. Also few advanced oxidation processes were studied by him for their potential to remove phosphorus.

Wei employed data driven approach for modeling and optimization of wastewater treatment process. [16] Normally physics based models are used for predicting the behavior of the wastewater process and optimization of its operations. These models have several limitations. In order to maintain the effluent quality, he attempted to predict the influent flow rate, the influent pollutants including the total suspended solids (TSS) and CBOD. He discussed the challenges in simulation and modeling of wastewater treatment plants. Noisy, uncertain, and incomplete data is major problem. Wang et. al. carried out investigation on hot air and hot water treatments. [17] They developed simulation model based on heat transfer theory. They observed that water circulation rates have very little effect heat transfer rate. Mulas carried out modeling and control of activated sludge process. [18] Activated sludge process is most acceptable and common due to its flexibility and cost effectiveness. He considered different building blocks such as process, sensors, control system and actuators.

Li et. al. carried out investigation on quality assurance (QA) of biologically related models for treatment planning. [19] In their work, they studied and discussed strategies, limitations, conditions, and cautions for using biologically based models and parameters in clinical treatment planning. Kuriqi studied dynamic modeling of biological waste water treatment. [20] He discussed the application of Simulink for dynamic modeling of biological treatment. He developed simulink modeling in MATLAB on aerator tank model. Equilibrium of biomass and organic matter depends on weather. It reaches early in wet weather. Sotemann et.al. discussed mass balance-based models for wastewater treatment. [21] They found that steady state mass balance of activated sludge and aerobic digestion models, which were modified to inorganic suspended solids (ISS) concentration, together can produce a plant-wide WWTP model for aerobic stabilization of sludge.

Kuvendziev et. al. carried out investigation on modeling for municipal wastewater treatment plant. [22] They studied modeling of biological reactors. Modern treatment procedures and eco-separation processes are important factors. They studied the process of rural wastewater biological treatment. They presented a set of

mathematical model for this process. They found that completely mixed activated sludge (CMAS) can be applied to many treatment plants.

CONCLUSION

The effluent quality variation affects the performance of the plant. For varying load, the parameters need to be adjusted. Factors like microbial attachment process, the kinetics of microbial growth and details of the microbial community influence the activated sludge process. Simulation of the process can save considerable amount of money and time. The modeling of the process helps in predicting the data values.

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