BIOLOGICAL TREATMENT TECHNIQUES FOR WASTE WATER TREATMENT

Abstract

Rapid urbanization and abrupt expansion of industrialization like textile, pharmaceutical, fertilizer, mining, tanneries, distilleries and landfill leachate which intern result in the generation of wastewater formation of diversified recalcitrant and compounds. Owing to their low biodegradability index, the wastewater containing the recalcitrant compounds cannot be treated with the biological methods. Therefore, advanced oxidation processes (AOPs) have to adopt other than the conventional treatment methods to treat the wastewaters prior the discharge into the streams. Initially, AOPs were applied for potable water treatment in 1980s by generating and utilizing hydroxyl and sulfate radicals. These radicals are strong oxidants which can easily degrade the recalcitrant compounds in wastewaters or increase the biodegradability index. The AOPs which are used are Fenton oxidation, electrooxidation, electrocoagulation, hydrodynamic cavitation, ozonation and sonication. The AOPs when clubbed with biological methods for treatment can yield higher efficiencies for degrading the recalcitrant compounds. In this chapter, the main objective is to summarize how different AOPs and biological methods work with wastewater treatment.

Keywords: Biological treatment, Advanced Oxidation Processes, biodegradability.

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I. INTRODUCTION

Microbiota forms the core of biological treatment techniques. The basic principle involved in these techniques is waste being utilized as a food source by microbiome [1].Unlike physico-chemical treatment techniques, biological treatment techniques won't require any addition of excess chemicals which in turn may end up as secondary pollutants. Hence these biological techniques form most feasible technologies to treat biodegradable waste [2].

These are broadly categorized as anaerobic and aerobic digestion techniques. Anaerobic digestion takes place in the absence of oxygen and it takes less reaction time as only partial biological degradation is involved in it.

It also results in large amounts of sludge when compared to aerobic digestion wherein complete biological degradation occurs in the presence of oxygen. But anaerobic digestion requires less amount of energy input as compared to aerobic digestion and also results in methane like gaseous byproducts with high calorific value[4].

Some of these biological treatment techniques include: UASB (Up flow anaerobic sludge blanket reactor), ASP (Activated Sludge Process), trickling filters, RBC (Rotating Biological Contactor)etc. But all the above mentioned biological treatment could work depending upon the biodegradability of the wastewater. Therefore, biological treatment can be used as a post treatment process to the advanced oxidation processes [10].

II. BIOLOGICAL TREATMENT

1. **UASB (Up Flow Anaerobic Sludge Blanket Reactor):** UASB is a closed anaerobic digester in which the waste water is pumped upwards from the bottom of the reactor with a velocity less than 0.5 m/h. The waste water flows upward passing through a blanket of sludge granules containing anaerobic microbes. This sludge blanket remains in suspension due to gravity and upward flow force.

   Thus the waste water undergoes anaerobic degradation of organic matter and also results in the formation of biogas with high methane content [3]. UASB is equipped with a deflector/dome at its top end which acts as solid, liquid and gas separator.

   The deflector and the baffles restricts the upward flow of excess sludge and allows the biogas outwards through a vent where it can be collected [9]. The liquid rises upwards and vented through another outlet. Biogas thus generated can be utilized for energy generation [7].

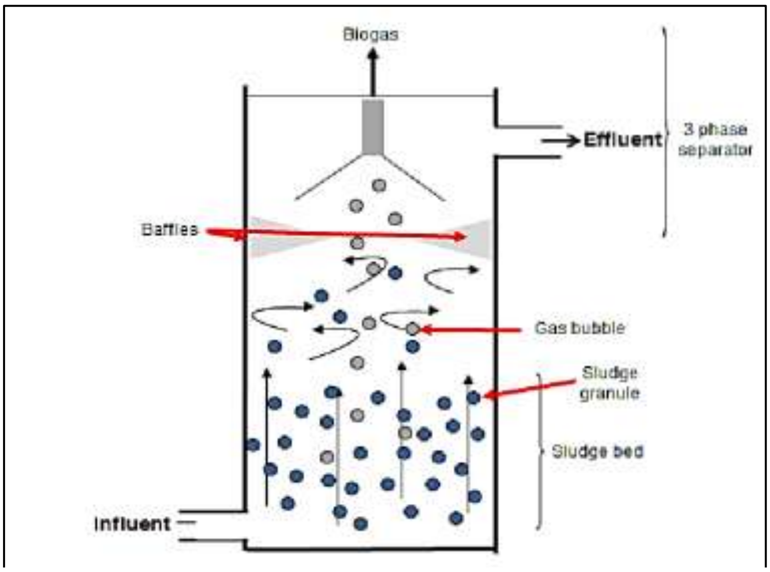

Figure 1: Schematic Diagram of UASB

2. **ASP (Activated Sludge Process):** It is an aerobic biological treatment technique in which microbes are suspended in the wastewater to be treated.ASP includes an aeration tank in which wastewater is treated using microbes in suspension and aeration is provided to meet the dissolved oxygen demand of aerobic microbial degradation [5].

    Aeration tank is followed by a sedimentation tank, in which the sludge gets settled down. A part of this settled sludge is recycled into aeration tank to maintain the required microbial concentration to treat the waste water. Supernatant from the clarifier is subjected to further treatment. This recycled sludge is called as return activated sludge.

    The remaining settled sludge from clarifier is removed as waste activated sludge (WAS). WAS upon further treatment like anaerobic digestion can result in biogas generation and it also contains nutrients like phosphorous which can be extracted [8].

    Detention time of waste water in aeration tank ranges between 4 to 8 hrs. Efficiency of removal of organic matter in ASP also depends upon food to microorganisms (F/M) ratio.F/M ratio is defined as ratio of B.O.D of influent to that of MLSS in aeration tank. Microbes in aeration tank are measured as mixed liquor suspended solids (MLSS).

    Some operational problems like sludge bulking and rise of sludge occurs in ASP. Rising of sludge can be avoided by increasing recycled sludge and decreasing influent wastewater. Sludge bulking can be avoided by increasing dissolved oxygen and decreasing F/M ratio.

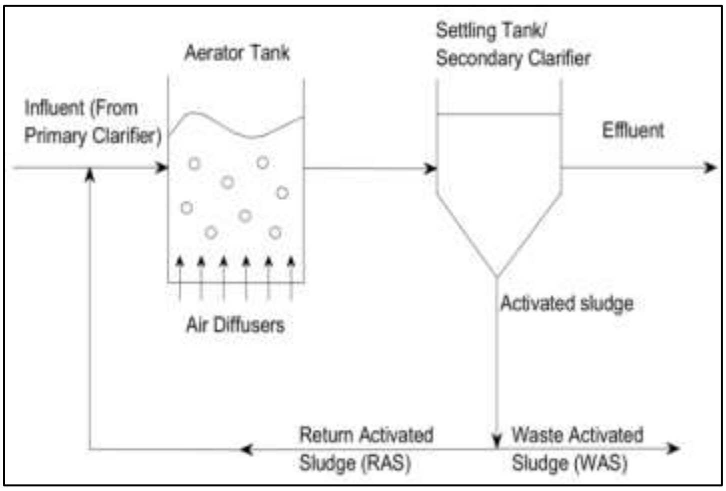

Figure 2: Schematic Diagram of Activated Sludge Process

3. **Trickling Filters:** Trickling filters comes under aerobic attached growth culture system. In trickling filters microbes are attached to the surface of aggregates as a biofilm. The waste water to be treated is applied over the filter bed of coarse aggregates with rotating arm distributers. While passing through the pores of coarse aggregates waste water comes into contact with microbes and thus the biological degradation of organic matter takes place. The biofilm outgrows on the media surface and gets sloughed after a period and regrows. This process is called as sloughing. The treated effluent from the tricking filter is sent to the clarifier where sludge gets separated by settling. In high rate trickling filters sludge is recycled and in standard rate trickling filters sludge is not recycled. Trickling filters are associated with operational problems like ponding (i.e. filter media gets clogged due to algae and fungi) and odour nuisance.

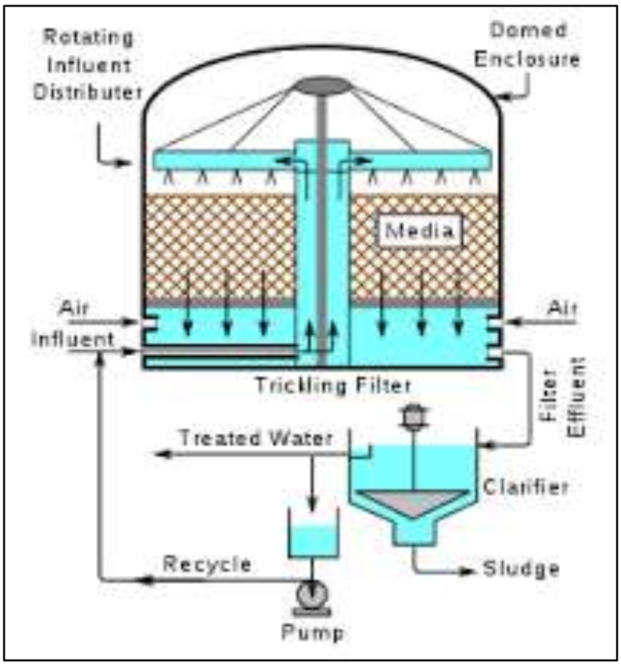

Figure 3: Schematic Diagram of Trickling Filters

4. **Rotating Biological Contractor:** RBC (Rotating Biological Contactor) also comes under aerobic attached growth culture system. But in RBC biofilm is attached to the surface of rotating discs. As seen in fig 4, a series of rotating discs are attached to a single shaft. A portion of these discs gets immersed in waste water to be treated. While rotating the biofilm on discs is alternatively exposed to air and waste water, thus maintaining the aerobic conditions [6]. RBC has an advantage of compact size and easy operation. But it needs a high capital cost, protection from weather conditions and has high chancesof mechanical failures.

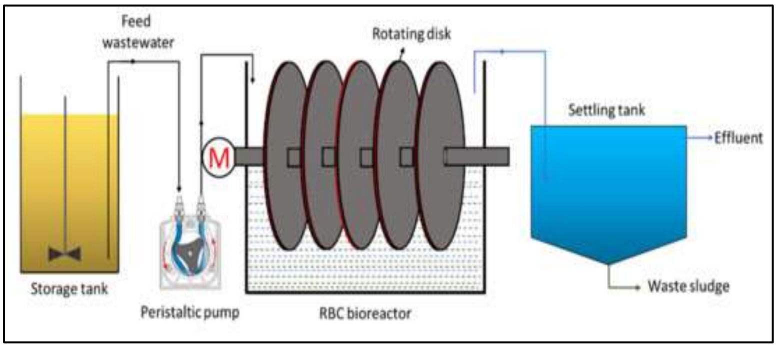

Figure 4: Schematic Diagram of Rotating Biological Contactor

III. INTEGRATION OF BIOLOGICAL TREATMENT AS POST TREATMENT FOR ADVANCED OXIDATION PROCESSES

AOPs liberated hydroxyl radical, which mineralize the organic compounds. It has been established beyond a doubt that AOPs can increase the biodegradability of water or trash that has a low biodegradability. Degradation of synthetic organic materialspollutants caused by the radicals' attackin the aqueous medium and the production that followed of biodegradable organic substances, such as intermediate products are the primary cause of the increase in biodegradability [11-13].The oxidation potentials of $OH^{\cdot}$and O_3 are 2.85 and 2.07, respectivelyand cannot be compared. The hydroxyl radicals attack organic contaminants in wastewater and degrade them into CO_2, H_2O, and other inorganic minerals. The main advantage of AOPs is that there is an enhancement of biodegradability. A possible way to test the biodegradability is oxygen uptake. When waste water is treated by fenton oxidation, the oxygen uptake increases significantly. Also average oxidation state is a tool to assess biodegradability of wastewaters. However, the transformation products created as organic molecules degrade can sometimes be more dangerous than the original substance [13]. The biological mechanisms that follow facilitate the simple oxidation of intermediates produced by AOPs. The biological process must be coupled with AOPs for industrial wastewater treatment to be effective since it can lower compound concentrations below discharge requirements. Consequently, a two-stage chemical/ biological treatment could be a successful treatment method for eliminating organic pollutants given the environmental compatibility of biological treatment and the limited biodegradability of organic pollutants [13].

Improving biodegradability of wastewater by AOPs can significantly be economic than the traditional treatment methods. However, enhancement of biodegradability doesn’t necessarily reduce the toxicity.Despite the successful use of combined techniques; a thorough economic analysis of coupled therapies has not yet been done. It is appealing to use biological treatment. Due to its minimal operating costs. On the other hand, even though AOPs have a reasonable elimination rate running costs are proportionately high [12]. Due to the need for chemicals, to it. Sincethe expense of biological capital and operations AOPs are more expensive than therapies, and the combination of cutting-edge oxidation methods and biological techniques can significantly lessen the total cost of the treatment by completing it the mineralization of substances.AOPs significantly increase the wastewater's capacity for biodegradation and decrease biological loading, which lowers the cost of biological process treatment.

IV. CONCLUSION

In recent years, the occurrence of recalcitrant contaminants in wastewater has drawn attention. With traditional biological processes, persistent organic pollutants in water and wastewater are not sufficiently destroyed. Effective use of AOP for reactions with hydroxyl radicals to remove these resistant contaminants has been made. However, the cost of treatment and stable intermediates are the two main issues impeding the use of AOPs.In this chapter, we have outlined the significance of AOPs as a pretreatment to biological processes for the elimination of organic pollutants in this review, as well as their biodegradability. Additionally, the effectiveness of various processes including Fenton's, photocatalysis, sonolysis, ozonation, etc. as well as the mechanism for improving biodegradability by AOPs were also covered. The economic impact of various integrated techniques used in wastewater treatment was also briefly examined.To do this, each stage of the process should include a biodegradability test to properly analyze the processes' efficacy. To create highly competitive water and wastewater treatment technology, the compatibility of processes with other processes must be evaluated regardless of the kind of wastewater. Longer pretreatment times have been associated with a drop in biodegradability, which could be tuned for improved performance. As the transformation products during the degradation of organic compounds might be more toxic than the parent component, it is also important to take care of the toxicity of influent wastewater in order to maintain the activity of the microbes in the biological processes. To put it simply, rigorous analyses of these processes through extensive trials are needed to determine the viability of the hybrid technology for wastewater treatments.

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