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BIOLOGICAL WASTEWATER TREATMENT: COMPARATIVE METHOD

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BIOLOGICAL WASTEWATER TREATMENT: COMPARATIVE METHOD

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ABSTRACT

Water is a natural resource that is essential for all living things. However, owing to the growth of the human population and eco-unfriendly practices, fresh water has been enormously polluted over the past century and form a low-quality water called wastewater. As mentioned, wastewater may come from the domestic, industrial, agricultural or commercial activities, surface runoff and any sewer inflow. The wastewater might cause severe threats to the environment which affects all kind of living organisms. Therefore, wastewater should be treated properly. Wastewater treatment is a system used to extract and transform pollutants from wastewater into effluent that can be added to the water cycle with an appropriate environmental effect or reused for different purposes. There are three classifications treatment process which are physical, chemical and biological treatment. This review study elucidates about the biological wastewater treatment using different small organisms such as algae, fungi, bacteria and yeast. Biological treatment is more preferred than chemical treatment since it is more economical and environmentally friendly. Besides, these microorganisms are effective for the treatment and have lots of advantages. For instance, these microorganisms are non-toxic, not require fresh water to grow, biodegradable, have high growth rate as well as it do not use arable land. The presence of algae, fungi, bacteria and yeast in the wastewater are to break down organic wastes which are mainly for nitrate, phosphate, ammonia and to remove the chemical oxygen demand (COD) and biological oxygen demand (BOD) in the wastewater. The removal percentage of these aspects have been discussed in this review which showed that yeast is able to remove COD up to 95% while algae can remove BOD, nitrate and phosphate up to 85.61%, 100% and 97.8%, respectively. Biological wastewater treatment can be done in continuous flow reactor or batch reactor with several methods like oxidation pond, aerated lagoon, and trickling filter. From this review, we can identify that most common method used for algae is high-rate algal pond (HRAP). Thus, this review summarizes and compares microbes used (algae, fungi, bacteria and yeast) in biological wastewater treatment in terms of method, species used and removal percentage of COD, BOD, nitrate, phosphate and any related substances.

Keywords: Biological wastewater treatment, microbes, eco-friendly, COD, BOD, nitrate, phosphate, economical

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1.0 BACKGROUD OF STUDY

1.1 INTRODUCTION

Water is a natural resource essential for life. It is present in multiple sources, such as rivers, streams, lakes and oceans. Owing to the human population growth and eco-unfriendly practices, fresh water has been greatly exhausted over the last century. Approximately 80% of the wastewater generated worldwide is dumped into the atmosphere untreated, leading to widespread water contamination [1]. Wastewater superficially resembles organic masses such as protein, carbohydrates, volatile acids and inorganic content involving nitrate ions, phosphate ions, sulfur, ammonium salts, heavy metals and others. These unnecessary nutrients in the water will engender eutrophication or algae blooms because of the anthropogenic waste production [2]. Therefore, treatment for wastewater has been created in order to overcome this problem.

Wastewater treatment is a system implemented to extract and transform pollutants from wastewater or sewage into effluent that can be released to the water cycle with a permissible environmental effect or reused for different purposes, called water reclamation. Wastewater treatment is key component of the broader sanitation field. Management of human waste and solid waste as well as sewage management are also involved in sanitation [3]. There are three types of wastewater treatment which are chemical, physical and biological treatment. All of these treatments have their own advantages and disadvantages, however, among these three treatments, biological treatment it has become more relevant and more influential in recent years since it is more economical and safer to the environment [2]. This review is focusing on biological wastewater treatment in which it is a process that looks straightforward on the outside as it employs natural processes to assist with the decomposition of organic compounds, however it is indeed a complicated process at the intersection of biology and biochemistry that is not properly addressed. Biological wastewater treatment system is a technique that mainly uses bacteria and perhaps other advanced microbes to purify the contaminated water. In order to break down organic waste using normal cellular process, biological wastewater treatments rely on small organisms [4]. The microorganisms remain intact as they break down organic pollutants for nutrition, which tends to cause a flocculation effect that helps the organic matter to settle out of the solution (water). This creates a sludge that is easier to treat, which is then dewatered and discarded of a solid waste [5].

In biological wastewater treatment, organic matter is oxidized by microbes preserved in either a suspended growth or an attached growth reactor. Both of the reactors utilizing mixed cultures, that is to say, cultures like a group of microorganism species. These ecosystems are self-optimizing in that the culture is governed by the most productive species for an important part of ecological parameters. By analyzing Eq 1 below, the basic definition of biological treatment processes can be understood [6].

$$\eta_1\,[\text{Organics}] + \eta_2\,[O_2] + \eta_3\,[NH_4^+] + \eta_4\,[PO_4^{3-}] \xrightarrow{\textit{organisms}} \eta_5\,[\text{New Cells}] + \eta_6\,[CO_2] + \eta_7\,[H_2O]$$

(Eq. 1)

In wastewater, biodegradation of organic materials has two main products which are new cells and carbon dioxide, CO2. The new cells are a waste product and should be taken away from the treated water as they are a result of a lower carbon compound and therefore will put a load on the obtaining water. Besides, the most oxidized form of carbon is carbon dioxide, CO2. Carbon dioxide, CO2 does not place a load on the collection of water. Address the issue that oxygen, O2, nitrogen and phosphorus are demanded by the organisms to perform the reaction.

Biological wastewater treatment is secondary treatment since it requires intricate biological processes that will be used to separate the organic matter that did not removed during primary treatment. Primary treatment is mainly to remove larger items which lead to secondary treatment in order to clear the additional pollutants. There would be many dissimilar types of biological waste water treatments, but depending as to whether or not oxygen is available, each treatment is being classed as either an aerobic, anaerobic, or anoxic treatment. Aerobic treatment is a biological treatment which takes place in the existence of oxygen while anaerobic treatment does not demand the oxygen. In anoxic treatment case, the microbes manipulate other molecules to replicate [7].

1.2 PROBLEM STATEMENT

Waste generated is a part of any processes in the industry hence, needed wastewater treatment system to guarantee safety measures and discharge regulations are compliant. A very desirable wastewater treatment system would help a facility avert harming the environment, human health, and the process or products of a facility, specifically if wastewater is recycled [7]. The application of chemical treatment is not as good as biological treatment since it is not completely safe due to the usage of chemicals in order to treat the contaminants as well as chemical treatment is quite expensive. Therefore, biological treatment is carried out in the past few years as it employs small organisms like algae, fungi, bacteria and yeast to break down the organic matter and leaves no negative impacts to the environment as well as to the human health. Furthermore, these microorganisms are able to remove various types of substances including nitrogen, phosphorus, suspended solid, chemical oxygen demand (COD), etc. Biological treatment can be pricey with the use of technology and controls to track temperature, pressure, aeration, pH and so on, but it ends up to be cost-effective option in the lengthy period [8].