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PERFORMANCE EVALUATION OF MEMBRANE BIOREACTOR FOR TREATING INSTITUTIONAL WASTEWATER

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Abstract: Water scarcity is one of the world's most promising challenges, with millions of people lacking access to safe drinking water. Untreated wastewater is commonly used in agriculture in various countries, which causes many disorders to the human being as well as environmental. Instead of using untreated wastewater, it has been discovered that using treated wastewater is a more practical and environmentally friendly approach. The traditional activated sludge process (ASP) is the most common and oldest bio treatment technology used to treat municipal and industrial wastewater. The membrane bioreactor (MBR) has evolved into a small and efficient wastewater treatment technology for municipal and industrial uses. Domestic wastewater with an organic loading rate (OLR) of 0.795 kg COD/m3.d was applied to a laboratory membrane bioreactor. The pH of the feed was maintained between 6.1 and 7.8 in the reactor. The entire start-up period took 21 days, with a HRT of 24 hours to achieve the steady state. After the acclimatization the reactor was run with the various influent COD concentration of Institutional wastewater such as 750.66 mg/l and 784 mg/l with the operating parameters of HRT and OLR. The results showed that the maximum COD removal efficiency 90.10% was attained at a HRT of 1.025 days with an OLR of 0.7879 kg COD/m3.d.

Keywords **– Activated Sludge Process, Chemical Oxygen Demand, Hydraulic Retention Time, Organic Loading Rate, Membrane Bioreactor.**

I. INTRODUCTION

Wastewater is unclean water that is produced as a result of precipitation runoff and human activity. It's also known as sewage. It is typically categorized according to how it is produced, such as household sewage, industrial sewage, or storm sewage. Wastewater treatment is the process of removing and removing contaminants from wastewater and transforming it into effluent that may be recycled back into the water cycle. Once restored to the water cycle, wastewater has a minor environmental impact or is used for other purposes. Aerobic treatment units (ATUs), artificial wetlands, lagoons, and media filters are some of the modern wastewater treatment components. This article describes the major components of an advanced treatment system.

Membrane bioreactors (MBRs) combine membrane techniques such as microfiltration or ultrafiltration with a biological wastewater treatment approach known as activated sludge. It is now widely used for municipal and industrial wastewater treatment. A submerged membrane bioreactor (SMBR) and a side stream membrane bioreactor (SSMBR) are the two most prevalent MBR variations. The membrane in an SMBR is located inside the biological reactor and submerged in the wastewater, but in a side stream membrane bioreactor, the membrane is located outside the reactor as an additional step following biological treatment.

Industrial waste, mining activities, sewage and waste water, pesticides and chemical fertilizers, energy use, radioactive waste, urban development, and other causes all contribute to water pollution. Water is polluted simply by being used: every activity, whether household, agricultural, or industrial, generates effluent carrying unwanted pollutants that can be toxic. In this context, a continuing effort must be made to protect water supplies. Morin-Crini and Crini (2017), Rathoure and Dhatwalia (2016), and Khalaf (2016).

Over the last three decades, several physical, chemical, and biological technologies, such as flotation, precipitation, oxidation, solvent extraction, evaporation, carbon adsorption, ion-exchange, membrane filtration, electrochemistry, biodegradation, and phytoremediation, have been reported (Berefield et al. 1982; Liu and Liptak 2000; Henze 2001; Harvey et al. 2002; Chen 2004; Forgacs et al.2004 ; Anjaneyulu et al. 2005; Crini and Badot 2007; Cox et al. 2007; Hai et al. 2007 Barakat 2011; Rathoure and Dhatwalia 2016; Morin-Crini and Crini 2017).

A chemical pollution is a material that is toxic to both plants and animals, as well as humans, and is present in such large quantities that it has an impact on the environment and human health in general. Water pollutants, soil pollutants, air pollutants, and noise pollutants are all categorized as pollutants based on their source (Crini and Badot 2007).

90% of the COD in the primary UF permeate was removed by the MBR system. This is consistent with recent findings in aerobic MWF wastewater treatment, which indicated that approximately 10 to 15% of COD in comparable effluent was nonbiodegradable. The COD left over after MBR treatment does not appear to be biodegradable. The elimination of TKNs followed the same trend as the elimination of CODs. In contrast, the TKN removal appears to be more susceptible to overloading than the COD removal. Because the TKN was mostly alkanolamines, (B. R. Kim et al. 2006)

The major purpose of this work was to investigate the start-up process performance of a laboratory-scale MBR with trash collected from the Annamalainagar wastewater treatment facility in order to determine the maximum removal efficiency in terms of OLR.

II. EXPERIMENTAL METHODOLOGY

2.1 Membrane Bio Reactor Configuration

The laboratory model is employed as the ultra-filtration membrane with the External membrane configuration for the current experimental study. The membrane package is designed for high-rate aerobic outdoor application with air supplied by an aqua blower. Air is pumped into the reactor to aid with membrane scouring and microbial oxidation.

For this project, 10-inch UF, Aqualex, and Pokar RO membranes were used. Municipal (River) Water Direct Purification with Membrane Hollow Fibre 0.001 Micron The reactor was made of plexiglass that was 8 mm thick. The reactor has a 10.45 liter working volume and 11.4 liter overall volume. It has also been claimed that in recent years, MBR membranes with external configurations have been more effective and have attracted more application value.

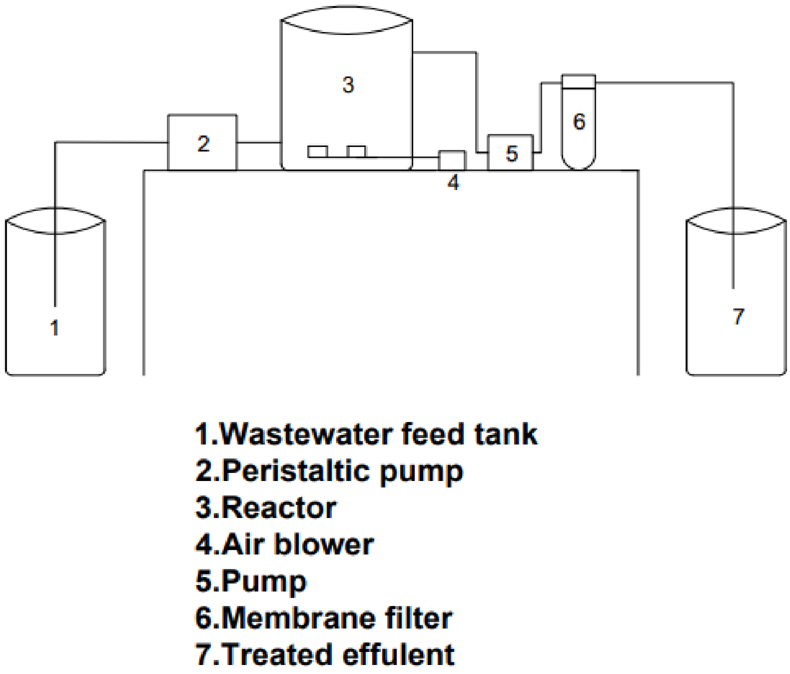

Figure 1 the schematic of the experimental model line diagram

The growth of active microorganisms (MLSS), molecular dissolved oxygen (DO), and, most importantly, the flux rate of the ultra-filtration membrane must all be maintained for the MBR's biochemical treatment process to be successful. The concentration of MLVSS and molecular do in the MBR may vary according on the selected ultra-filtration package's filtration rate per unit area and pore size.

Table 1: Design Features of Experimental Setup

Description	Measurements
Size of the reactor, m	0.19 X 0.20 X 0.30
Effective size of the reactor, m	0.19 X 0.20 X 0.27
Volume of the reactor, Litres	11.4
Effective volume of the reactor, Litres	10.45
Membrane module	Ultra-filter
Membrane size, Micron	0.001
Manufacturer	AQUALEX Prokar
Dia of Influent & Effluent pipe, mm	100
Peristaltic pump	PP – 15 Model

Analytical Method Every 24 hours, samples of the influent and effluent were taken and swiftly evaluated in accordance with the Standard Methods (APHA 2016).

III. RESULT AND DISCUSSIONS

3.1 Characteristic of institutional Wastewater

The real time institutional wastewater was collected from the treatment unit of Annamalai University, Chidambaram, Tamil Nadu. The samples were analyzed and characterized as per the standard procedure (APHA 2017), such as pH, Total solids (mg/l), Total suspended solids (mg/l), Total dissolved solids (mg/l), BOD5@20ºC (mg/l), COD (mg/l), Chlorides (mg/l), Turbidity, NTU, Phosphate (mg/l), Calcium (mg/l), Nitrogen (mg/l).

3.2 Acclimation and Process stability

During the start-up of an aerobic reactor, the biomass is acclimated to new environmental conditions such as substrate, operating strategy, temperature, and reactor design. At the Annamalai University Faculty of Agriculture in Annamalainagar, granular sludge was obtained from the biomass plant that was in operation. The establishment of a microbial population is the overarching goal of the Membrane Bio reactor start up procedure. Daily samples of the reactor's influent and effluent were taken and examined. At first, Chidambaram Municipal wastewater was used to collect the influent feed of wastewater. A low initial loading rate was suggested for the Membrane Bio reactor's successful start-up.

The process was set up by continuously feeding the reactor over a 24-hour period with an initial influent COD concentration of 680 mg/l, resulting in an astonishingly low organic loading rate of 0.795 Kg COD/m3.d. The COD elimination rate was low over the first two days, varying between 30% and 40%. Due to biomass adaptation to the new environment, the process's initial low removal efficiency can be attributed to this. Between 18 and 21 days, the reactor achieved a steady-state COD removal efficiency of 90.54 %. The pH of the reactor ranged from 6.1 to 7.8, and it was also quite constant.

3.3 Effect of Organic Loading Rate in a Membrane Bioreactor

Two stages of the experimental study were conducted with varying COD concentrations. In stages 1 and 2, institutional wastewater with average COD contents of 750.66 mg/l and 784 mg/l was fed as an influent to the reactor. The COD elimination efficiency was reached from 59.78 to 79.17 % at the conclusion of stage 1. The COD elimination effectiveness increased from 81.91 to 90.01% in stage 2.

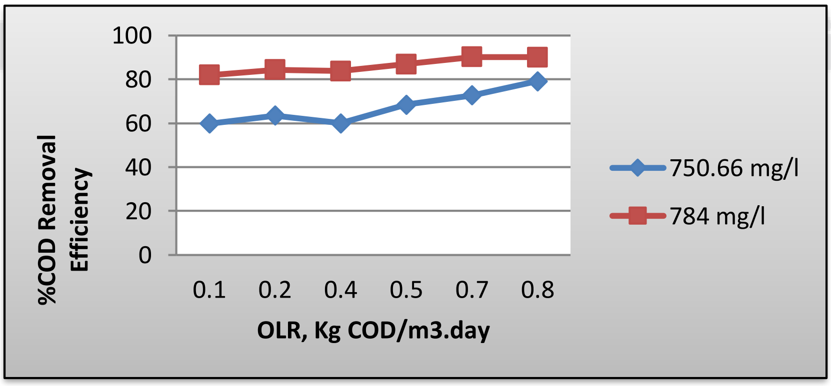

Figure 2 Profile of % COD Removal Efficiency with the function of OLR, kg COD/m^3.d in a MBR

According to Figure 2, the OLR grew gradually from 0.1 to 0.8 Kg COD/m3.days. A COD elimination effectiveness of 90.10% at an OLR of 0.7879kg/m3.d was the maximum.

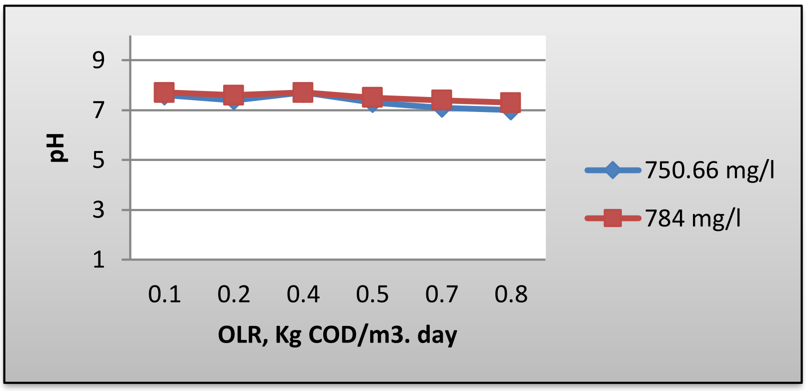

Figure 3 Behavior of pH with the function of OLR, kg COD/m3.d in an MBR

Figure 3 shows the measured pH concentration for various COD values with associated OLR. For the breakdown of organic contaminants, the levels in the reactor showed very good agreement. First stage pH levels ranged from 7.6 to 7.0, and second stage pH levels ranged from 7.7 to 7.3.

IV. CONCLUSIONS

The results of the current investigation showed that the steady state was achieved in 21 days by self-inoculated MBR with domestic sewage. This reactor was found to be quite successful for COD removal efficiency of about 90.54 % during start-up, with an OLR of 0.795 kg COD/m3.d. The reactor's influent was institutional wastewater, which had average COD concentrations of 750.66 mg/l and 784 mg/l. The COD removal efficiency was reached from 59.78 to 79.17% at the conclusion of stage 1. The COD removal efficiency increased from 81.91 to 90.01% in stage 2. In this study, the maximum COD removal efficiency was attained at a HRT of 1.025 days with an OLR of 0.7879 kg COD/m3.d.

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