

Use of bioreactors in sewage treatment



**ASSIGN
BUSTER**

Bioreactor has been accepted as multi-purpose tools and has been a great demand. The growing demand can be related to the uses in many ways especially in sewage treatment purpose.

The understanding of bioreactor and membrane bioreactor is really important to understand why it is really require for these treatment. Also, the understanding of characteristic of the membrane bioreactor (MBR), which is designed from the combination of membrane process like microfiltration, and also ultrafiltration and now is widely used as a sewage treatment method are important in making the wastewater treatment done flawlessly.

This review thesis is meant to provide an overview over the last several years in these technologies of the background, types of membrane bioreactor and the sewage treatment method using membrane bio reactor. Also provide some relevant examples of this application schemes from recent research.

INTRODUCTION

BIOREACTOR

1. 1 Background Studies

Bioreactor is a vessel that carries out the chemical process, which can either be anaerobic or aerobic, where biochemically or organism substances that being derived from organism are involved. These bioreactors are usually cylinder. varies in size from liters to cubic meters, and commonly made of stainless steel to avoid oxidization process.

It is also definite as any device or system that supports a biologically active environment, device or system that are used to grow cell or tissues in the cell culture process which nowadays developed widely for tissue engineering usage.

In basic mode of operation, it can be divided into batch reactor, fed batch reactor and continuous reactor. We will discuss about this later.

Meanwhile, by using bioreactor, it will suspend and immobilize the organism that growing in it. There are two method that is simple method where petri dish with agar as a nutrient are used to grow bacteria and large scale immobilized method such as Moving Bed Biofilm Reactor(MBBR), packed bed, fibrous bed and membrane method.

1. 2 Bioreactor Design

Bioreactor design is studied under the biochemical engineering discipline which is a complex engineering task. The microorganism and cells in it can perform 100 percent rate of success of their desired function even they are in optimum conditions. To make this happened flawlessly, we need to monitored and controlled closely the bioreactor's environmental conditions such as gas flow rates, temperature, pH, and dissolved oxygen levels and also the agitation speed and circulation rate.

The bioreactor must be easily cleaned and works as smooth as possible to avoid Fouling that can harm the overall sterility and efficiency of the bioreactor, especially the heat exchanger. That is the reason why bioreactor are round shape built.

To maintain the bioprocess at a constant temperature, heat exchange is needed. Refrigeration is needed in most case of bioreactors because the major source of heat in bioreactors comes from biological fermentation. Refrigerated can be done by using an external jacket or with internal coils for a very large vessel.

The most difficult task to accomplish in an anaerobic bioreactor process is the optimal oxygen transfer. Oxygen is needed to mix nutrients and also to keep the fermentation homogenous, which is helped by agitation to transfer it. That's why, in practice, to increase the solubility of oxygen in water, bioreactors are pressurized.

1. 3 Types of bioreactor

There are many type of bioreactor that been use by company all over the world such as Radial Flow bioreactor, Membrane bioreactor, Mechatronic bioreactor and others. Here I will introduce a little about commonly used bioreactor like Moving Bed Biofilm Reactor (MBBR), batch reactor, packed bed reactor, Photo Bioreactor (PBR) and continuous reactor.

Photo Bioreactor

PBR is a bioreactor that takes in some type of light sources. Almost all the transparent container could be called PBR but it is more used as a closed system. Small phototrophic organism such as cyanobacteria, or algae are grown by Photo bioreactors and photosynthesis light is used as their energy sources which means that sugar or lipid are not required as energy sources.

Batch Reactor

<https://assignbuster.com/use-of-bioreactors-in-sewage-treatment/>

Batch reactor is a vessel that widely use in the process industries such as solid dissolutions, product mixing, chemical reactions, batch distillation, crystallization, liquid extraction and polymerization. It is formed of a tank with an agitator and integral heating/cooling system that vary in size.

Versatility or capabilities is its advantages where a single vessel without the need to break containment can carry out a sequence of different operations.

Continuous Reactor

Continuous reactor is also referred as flow reactors can carry materials as a flowing stream and widely use in chemical and biological process within the food, chemical and pharmaceutical industries. It size is smaller than batch reactor which makes higher mixer rates possible and designed as pipes with or without baffles or series of interconnected stages. Due to their great heat transfer capacities, it can cope with much higher reactant concentrations. And by varying the run time, their output can be altered which will lead to increase the operating flexibility.

Packed Bed Reactor

Packed bed reactor is a reactor that most often used to catalyze gas reactions which are filled with solid catalyst particles. The surface of the catalyst is the place where the chemical reaction took place. By using this reactor, conversion per weight catalyst can be obtained higher than other catalytic reactor. Rather than the volume of the reactor, the reaction rate is based on the amount of the solid catalyst.

1. 3. 5 Moving Bed Biofilm Reactor (MBBR)

MBBR process is a process that utilized the activated sludge and other biofilm system advantages without being restrained by their disadvantages and it is based on the aerobic biofilm principle. The biofilm carriers that are made from polyethylene provide a protected surface area for the biofilm and optimal conditions for the bacterial culture to grow. It's mean that less spaced are required by bacteria to grow compared to other biological systems and far less control. The only control points for this system are nutrient levels and DO (Dissolved Oxygen) level. It is widely used as facilities to remove BOD/COD from wastewater treatment streams and for nitrogen removal.

1. 4 Market

According to Business Communications Company (BCC), Inc., all bioreactors market was valued at \$275 million in 1997 and expected to increase to \$380 million in 2002 which mean 6. 6% of average annual growth rate (AAGR).

Below is the table of estimated of total U. S bioreactor market size and growth of 1997 and 2002 in Million U. S Dollar.

From here we can conclude that bioreactor market will increased from year to year because of the request from all sector to use the bioreactor in their field.

MEMBRANE BIOREACTOR

1. 1 Background Studies

Membrane bioreactor (MBR) is process that combined membrane process like microfiltration or ultrafiltration process with a suspended growth bioreactor. It is use all over the world widely in industrial wastewater treatment. MBR process could produce outflow of high quality enough to be discharged to be discharged to coastal, brackish or surface waterways when being used with domestic wastewater.

The advantages of MBR process is small footprint, east retrofit and upgrade of old wastewater treatment plants. There are two MBR configuration exist which is internal part where the membrane are plunged in and integral to the biological reactor and the other part is external or downstream part where membranes are separate unit process requiring an intermediate pumping step.

The MBR had been pushed to become an established process for the wastewater treatment after the recent technical innovation and significant membrane cost reduction. It has been estimated that the current MBR market to value around US\$216 million in 2006 and to rise to US\$363 million by 2010 which become evidence that the MBR process is now become the number one option for the treatment and reuse of wastewater treatment.

1. 2 History

As soon as ultrafiltration and microfiltration membranes were available, the MBR process was introduces around the late 1960s. Dorr-Oliver Inc. was the one that responsible in introducing the original process and combined the use of an activated sludge bioreactor with a cross flow membrane filtration loop. Even though the idea was great, it was hard to use the process due to <https://assignbuster.com/use-of-bioreactors-in-sewage-treatment/>

the high cost of membranes, low economic value of the product and the potential rapid loss of performance due to membrane fouling.

With the idea from Yamamoto and colleagues to submerge the membranes in the bioreactor, the breakthrough for the MBR came at 1989. Before that, the separation device located external to the reactor and relied on high Trans membrane pressure to maintain filtration but with the idea from Yamamoto, the membrane directly plunged into the bioreactor, submerged MBR systems preferred to side stream configuration. To produce mixing and limit fouling, the submerged configuration relies on coarse bubble aeration and the energy demand of it can be up to 2 orders of magnitude lower than the side stream system. It also operates at lower flux which leads to demand more membrane area. Aeration is considered as the major parameter on process performances both hydraulic and biological in submerged configurations and it maintains solids in suspension, scours the membrane surface and provides oxygen to biomass which lead to better biodegradability and cell synthesis.

The acceptance of modest fluxes and the idea to use two-phase bubbly flow to control fouling were the other important steps in the recent MBR development. From the mid-90s, encouraged by the lower operating cost obtained with submerged configuration along with the steady decrease in the membrane cost, an exponential increase had been seen in MBR plant installations. Since then, MBR design and operation have been improved further by introduced and incorporated into larger plants. The recent trend, which made MBR to operate in lower solid retention times around 10-20 days, made them more manageable mixed liquor suspended solids (MLSS)

<https://assignbuster.com/use-of-bioreactors-in-sewage-treatment/>

levels around 10-15 g/L. With this new operating state, the oxygen transfer and the pumping cost in MBR have decrease and overall maintenance has been simplified.

MEMBRANE BIOREACTOR IN SEWAGE TREATMENT

Introduction

Environment of city have been one of the important thing for the citizen. Nowadays, we can see people tend to pay more and more attention to the environment. The sewage treatment is very important especially for city with high population. The sequencing batch reactor (SBR) is a traditional sewage treatment method which combines the biology reactor and the secondary settling tank, and the sludge separation is finished by the gravity action in the gravity action in the secondary settling tank. The separation efficiency depends on the settleability of the sludge which mean the better settleability is, the higher the separating efficiency will be but in practical application, the settleability of the sludge is hard to control which lead to unstable treatment effect. So, people tend to change to membrane bioreactor (MBR) which is a sewage treatment technique using membrane separating process instead of the secondary settling tank. It can avoid the problem of hard control of the settleability and can displace the secondary settling tank which means it surpassed the SBR sewage treatment technique and the membrane separating technique.

MBR is a sewage treatment method with high efficiency and broad application. It has the advantages of high sludge concentration, good water out quality, low sludge production and compact conformation compared to <https://assignbuster.com/use-of-bioreactors-in-sewage-treatment/>

the traditional SBR methods. Even though this technique is successfully applied in the sewage treatment system, it still has the problem like causing membrane fouling, huge cost of energy and the sludge is likely to lose, in which the membrane fouling is the foremost factor. It also may lead to the destroy of the sludge separating function which mean the system running has to depend on replacing the membrane groupware that will lead to increase of the cost of the reactor and interrupt the running period. In order to obtain a long-time and stable running effect, the membrane fouling must be solved and the modeling method of membrane fouling is an effective method to describe and predict the membrane fouling.

Below, one modeling method of membrane fouling will be reviewed which is the method based on Radial Basic Function Neuron Network (RBFNN).

MEMBRANE FOULING FACTOR OF MBR

2. 21 Membrane Fouling

Membrane fouling is a condition when the membrane flux becomes decrease and the separating capability of the membrane become low. This is happened when the solid particle and colloid particle or the solute big numerator in the sewage will generate some physics and chemistry action with the membrane or the adsorption in the membrane aperture. This will result in diminish or jam of the membrane aperture and will lead to enhance of the resistance of breaking through of water of the membrane which impede the dissolution and diffusing on the membrane surface. The effect factor of membrane fouling is numerous and complicated but the main factor

are the property of the membrane, the operating condition and the quality of the mixed sludge fluid.

2. 22 Related Membrane Properties

The membrane properties that related with the membrane fouling are the membrane material, the size of the membrane aperture, membrane placement mode, the porosity, the electric charge quality, the coarseness and the super hydrophobic properties. The flux of inorganic membrane is bigger than the organism membrane according to the preceding research but the huge cost of inorganic membrane limited its application in the membrane biology reactor. Under the same running condition, the different membrane material and different membrane aperture in the membrane biology reactor have different fouling trend and generally, the membrane with aperture distributing in the range of 0. 05-0. 2 micrometer (μm) has the biggest flux.

2. 23 The Operating Condition

The operating conditions of the membrane reactor mainly includes the entered-water quality, the sludge age, the sludge burden, the aeration gas quantity, the structure of the reactor, the operating pressure, temperature and the pumping time. When the reactor with heavy burden worked more than 40 day, it pump stress mount fast, the membrane flux decrease quickly which lead the membrane cant resume even cleanout. On the other hand, the reactor with low burden still has variation after 120 day running. The aeration concentration influences the membrane stress when the sludge concentration is high.

2. 23 Influences from the Operating Pressure (TMP)

The influence mainly embodies in the thickness and density of polluted layer. Filtrate resistance will increase when the gelatin layer of the membrane exterior become denser which lead to reduce of membrane flux. High TMP will increase the membrane flux but also increase the operation stress which mean increasing in operation cost.

2. 24 Mixed Sludge Fluid

The properties of sludge mixed fluid is the sludge concentration, the size of sludge granule, the electric charge in surface of sludge, the colloid particle in the mixed fluid and the deliquescent organism. The increase of sludge concentration always goes with the variance of mixed-fluid viscosity, dissolutive organism and inertia materials which will impact the membrane flux. If the sludge concentration is high, it lay on the membrane surface and form a thick sludge layer that make the filtrate resistance increase and membrane flux decrease but if the concentration is low, the adsorption ability and soluble organic compound degrader will decrease that will lead to decrease of membrane flux.

RADIAL BASIC FUNCTION NETWORK (RBFN)

2. 24 Characteristic parameters

Radial Basic Function Network is composed of three layers which are input layer, hidden layer and output layer. The input layer point transmit input signal to reach hidden layer, hidden layers point are described by the Gauss kernel function and output layer point are describes by the linear function.

<https://assignbuster.com/use-of-bioreactors-in-sewage-treatment/>

The first task of detection the membrane fouling degree of MBR is to collect sample data. The characteristics parameters that correlate with membrane fouling degree of MBR must be extracting to collect the sample. We can collect multi characteristics but all of them cannot be the input vector of sample because among them, some single characteristic parameter can't possess the direct significant and it is possible they correlative with each other which will create the redundancy of information so we need to select the key parameters. The key parameter which is some minority attribute which selected from the obtained multitude parameters and have the most affiliations and most sensitive response with membrane fouling degree. The key parameters that have the biggest degree of correlation with the membrane fouling degree will be choose as the input neuron of RBFN.