

Industrial Waste Water Treatment Using an Attached Media

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Abstract - Majority of residential units and small-scale commercial operators in India dispose wastewater either onsite or into the public drainage systems, without paying any attention to the public health and environmental impacts. Need for high investments and the requirement for large operational space are the reasons often quoted against the installation of a proper wastewater treatment unit. In this present study emphasis has been given to evaluate removal prospects of organics and the nutrients by natural fibrous media, coconut coir as an attached media. The effects of vital factors such as organic loading rate (OLR) and hydraulic retention time (HRT) affecting the performance of reactor in terms of OM removal were investigated. It was found that the COD removal efficiency increased primarily with increase in OLR. However, after it reached to a constant value at OLR of about 1.33 kg COD/m³d, COD removal efficiency started to decrease significantly. The maximum COD removal was obtained at 1.33 Kg COD /m³ d and it was about 89.9%.

Key Words : Coir fibre, HRT, OLR, COD , FLR

1. INTRODUCTION

The increase in population density along with rapid industrialization creates threats to the environment. Water pollution has become a serious problem in our country. Treatment of domestic and industrial waste before their disposal into surface water was not given much importance until the recent past. This resulted in converting most of our rivers into super sewers. The ultimate goal of waste water treatment is the protection of environment in a manner commensurate with public health and socio-economic concern.

Nowadays biological wastewater treatment seems to be a most promising tool in treatment of industrial wastewater like waste water from essential oil industry. Essential oil industry is an oil producing industry which produce oil from nutmeg. Here the treatment is carried out using the concept of attached growth process with fibrous coir media used as a medium for growth of bacteria. Bacteria cling to the surface of media and utilizes the organic matter in wastewater in presence of diffused air (from diffusers) thus converting it to

biomass. Coir is a hard and tough organic fibre extracted from the husk of coconut. It is rich in cellulose and lignin, besides having high specific area and wetting ability – factors which are essential for bacterial adhesion in attached growth processes.

R. Vinod *et.al.* (2014) had studied two different fibrous packing materials in a packed bed reactor for sewage treatment. They took coffee husk blended with wooden chips and coconut coir in two reactors with packing densities 40 and 70 Kg/m³ as a media for microbial growth. In this study they observed that the best performance (highest percentage removal) was given by the reactor packed with coconut coir packing density 40 kg/m³ compared to other two reactors.

K V S Kudaligama *et.al.* in their paper, "Coir: a versatile raw material to produce stationary media for biological wastewater treatment systems" explained that several researchers are trying to develop coir as a practical medium in wastewater treatment systems and had tried to pack coconut coir as loose filled fibre, fine fibre cuts and coir fibre arranged in bottle brush like configuration. They gave the reason behind this as better attachment of bacteria on porous & rough surfaces of coir.

2. MATERIALS AND METHODOLOGY

2.1 Material

Coir is a hard and tough organic fibre extracted from the husk of coconut. It is an inexpensive fiber that is abundant in tropical regions. It has a lignin content of 45.84%, which makes it as the strongest of all known natural fibers, such as jute, flax, linen, cotton etc. The feasibility of using coir fiber as the attached medium for treatment of wastewater has not been studied extensively yet. Attached process employing coir fiber media exhibit high organic and nutrient removal rates, compared to suspended growth process.

2.2 Characteristics of industrial waste water

Table-1: Characteristics of waste water

| Sl. no | Parameters | Obtained value | Effluent standards |
|--------|----------------|----------------|--------------------|
| 1 | COD | 1888.3 mg/L | 250 mg/L |
| 2 | BOD | 1639.68 mg/ L | 30 mg/L |
| 3 | pH | 7-8 | 5.5-9 |
| 4 | Turbidity | 30 NTU | 10 NTU |
| 5 | Oil and Grease | 30 mg/L | 10 mg/L |

2.3 Start up and loading strategy

The reactor was set up at the Environmental engineering lab. A rectangular shaped tank built of acrylic with 1.2 m length, 0.3 m width and 0.4 m depth. Two air diffusers were provided at the bottom of the reactor with a constant aeration rate of 2.5 L/min per each in all the stages to supply oxygen to the microbial mass for biological activity and mixing the carriers.

The experimental investigation was divided into three stages. The concentration of wastewater in the influent was varied depending upon the organic loading rate (OLR) conditions. In the first stage, the effect of organic loading rate (OLR) on the performance of reactor in terms of OM was examined. Three different OLRs of 0.88, 1.33, 2 kg COD/m³d were tested under the packing density of 40 Kg/m³. Also the removal efficiency of COD was investigated at three different hydraulic retention time and three different flow rates.

3. RESULTS AND DISCUSSIONS

Average COD removal efficiency increased from 79.5% to 89.9% with increasing OLR from 0.88 to 1.33 kg COD/m³d, respectively. It was found that the COD removal efficiency increased primarily with increase in OLR. However, after it reached to a constant value at OLR of about 1.33 kg COD/m³ d, COD removal efficiency started to decrease significantly. At 2 Kg COD / m³ d, the COD removal efficiency

was reduced to 73.35%. As the OLR increases HRT decreases and flow rate increases.

3.1 Effect of organic loading rate on the performance of reactor in terms of organic matter removal

Organic loading rate can be calculated on the basis of either variation in the reduction in the HRT. During this stage of the experiment, the initial OLR was set at 0.88 kg COD/m³ d HRT of 54 h and flow rate of 40L/d. The OLR was then increased gradually to 1.33 and 2 kg COD/m³.d.

The COD removal efficiency obtained for 0.88, 1.33 and 2 Kg COD/ m³ d were 79.5%, 89.9% and 73.35% respectively. The maximum removal was obtained at OLR 1.33 Kg COD/ m³ d. It was shown in the Chart 1.

It was reported that higher COD removal efficiency could be achieved at higher OLR in the aerobic reactor This indicates that a higher OLR could enhance the activity of aerobic microorganism. Although at the beginning of each phase, where OLR was increased, there was a corresponding decrease in COD removal efficiency, the system recovered shortly and adapted to the new conditions with time as it was expected. However, after it reached to a constant value at OLR of about 1.33 kg COD/m³.d, COD removal efficiency started to decrease significantly.

In this experiment, the attachment of high biomass hold up at OLR of 1.33 kg COD/m³d in addition to immobilization of microorganisms on the coir, contributed to such high removal efficiency. In this case, in which high concentration of biomass was attached to the coir surface, the greater part of the substrate can be consumed by the media. Nevertheless, more increase in OLR results in reduction of system efficiency. This point is called maximum loading capacity of a bioreactor and defined as the loading rate at which the removal rate does not increase with OLR. When the system passes maximum loading capacity, enhancement of OLR would results in reduction of removal rate. Hence, this point could vary in different systems.

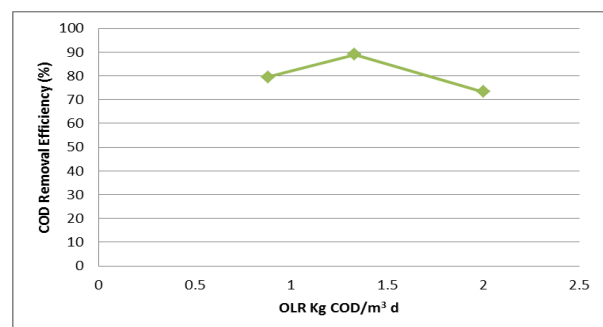


Chart-1: performance of reactor with OLR

3.2 Effect of HRT on the performance of reactor in terms of organic matter

Hydraulic retention time (HRT) is an important operational variable which can be easily controlled. It is average length of time a molecule of liquid remains in the reactor and can be defined as the volume of the reactor divided by the average influent flow rate. The HRT was changed by varying the flow rate in this phase of the experiment.

In terms of COD removal, although the HRT was decreased, reactor conditions were became stabilized shortly within the first few days of each cycle and high removal efficiency was achieved after the stabilization days. The COD removal efficiency obtained for hydraulic retention time of 54 h was 79.5%. For 36 hrs it was 89.9% and 73.35% for 24 h. It was shown in the chart 2.

COD removal increased slightly with augmentation of HRT and the highest removal efficiency was obtained at the HRT of 36 h. This high COD removal was attributed to the reactor advantage that can completely retain biomass presents in the mixed liquor to produce a high quality effluent. In addition, the removal of organic pollutants was a co-function of microbial metabolism. So after reaching maximum value it begins to reduce. It is the reason for reduction in COD at 24 h.

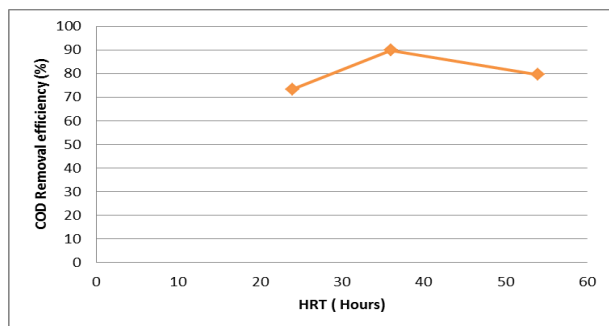


Chart-2: performance of reactor with HRT

3.3 Effect of flow rate on the performance of reactor in terms of organic matter removal

Both OLR and HRT are the functions of flow rate. As flow rate increases OLR increases and HRT decreases. The COD removal efficiency obtained for 40L/d was 79.5%. For 60 L/d it was 89.9% and 73.35% for 90 L/d. The maximum removal was obtained at flow rate of 60 L/d. It was shown in the chart 3.

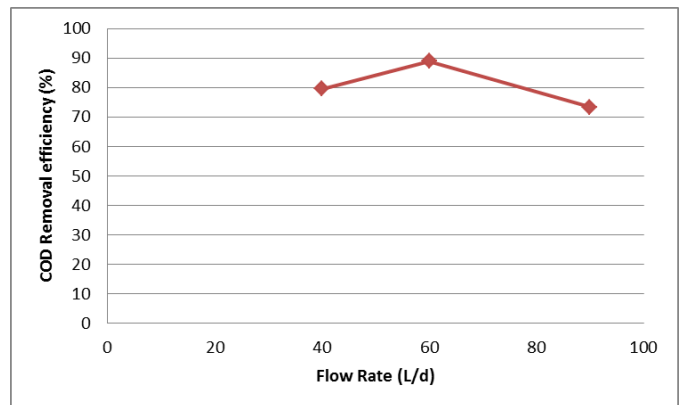


Chart- 3: performance of reactor with flow rate

4 CONCLUSION

The waste water treatment using coconut coir as an attached media is a very cost effective and eco-friendly option for the removal of organic matters (OM) from wastewater. This particular research work analysed the removal of OM from the industrial wastewater using the same reactor. Effects of vital factors such as organic loading rate (OLR) and hydraulic retention time(HRT)affecting the performance of reactor in terms of OM removal were investigated.

It was found that the COD removal efficiency increased primarily with increase in OLR. However, after it reached to a constant value at OLR of about 1.33 kg COD/m³d, COD removal efficiency started to decrease significantly. The maximum COD removal was obtained at 1.33 Kg COD /m³ d and it was about 89.9%. As the OLR increases HRT decreases and flow rate increases. The optimum flow rate was 40 L/d and optimum HRT obtained was 36 h.

The utility of coir fiber as an attached media for the treatment of wastewater, loaded with biodegradable matter, has been successfully established in this research. This would certainly result in expanding the engineering application for coir fiber, which are presently used more extensively in geotechnical engineering and water management projects. The laboratory results obtained from this study have given the necessary information to design and evaluate the long-term performance of a field-scale, reactive sewer unit.

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