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TREATMENT OF DAIRY WASTEWATER USING ROTATING BIOLOGICAL CONTACTOR

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Absract: Wastewater is conventionally treated either by suspended growth system, attached growth system or combination of attached and suspended growth process. Various wastewater technologies working on principle of attached growth process are used nowadays for treatment of waste such as Trickling filters, Rotating Biological contactor, Packed Bed Reactor etc. The Rotating Biological Contactor (RBC) process is one of the more efficient fixed film wastewater treatment technologies. The rotating biological contactor process offers the specific advantages of a biofilm system in treatment of wastewater for removal of soluble organic substances. It is a unique adaptation of the moving-medium biofilm system which facilitates easy and effective oxygen transfer. Media in the form of several large flat or corrugated discs with biofilm attached to the surface is mounted on a common shaft partially submerged in the wastewater and rotated through contoured tanks in which wastewater flows on a continuous basis. As such, it is well-suited for secondary and/or advanced treatment in municipal or industrial applications. The effect of type of media, size of media, thickness of media, void ratio, detention time, flow rate, introduction of oxygen etc. on the performance of reactor in terms of increased efficiency will be noticed. This project is about treatment of dairy waster using rotating biological contactor to reduce biological oxygen demand respectively.

Keywords: Rotating biological contactor, Dairy wastewater, Biofilm, Biological oxygen demand.

1. INTRODUCTION

Rotating biological contactor is an aerobic and anaerobic fixed film biological treatment. This treatment is widely used as secondary treatment of industrial and domestic wastewater. In this system the disc portion is partly submerged in wastewater and partly exposed in atmosphere. The rotation of the system leads to continuous growth of microorganisms and the formation of biological slime layer on the surface of the discs known as biofilm is developed on the rotating disc. The constant rotation of the disc causes mixing of the liquid. During submergence organic matter is removed

While during emersion aeration of the culture is accomplished. Oxygen is transferred to the thin film of liquid that remains attached to the discs when they rise above the liquid surface increasing its dissolved oxygen content.

The Rotating Biological Contactor (RBC) was introduced, on the basis that the Dissolved Oxygen (DO) in the reactor did not have significance on treatment efficiency because adequate amount of oxygen could be supplied during the air exposure cycle required for metabolism of microorganism. In rotating disc shaft assembly is mounted into a tank with the shaft slightly above the surface of the liquid. Approximately 40 % of the disc surface is submerged in the waste and the remaining disc surface is exposed to the atmosphere. The rotation of the discs also mixes the liquid keeping the detached biomass in suspension and maintaining a uniform dissolved oxygen concentration. Although the exact composition of the microbial population on a disc depends upon the type of wastewater being treated and the relative position of the disc in the reactor.

Fig1: FABRICATION OF RBC

A continuous sloughing off from the discs when the innermost microorganisms lose their ability to adhere to the rotating surface and sloughed biofilm have good settling characteristics. Sloughed biofilm and suspended solids are washed out of the contactor as the wastewater flows through the unit. They are later removed from the effluent during secondary clarification. Rotating biological contactor requires low power because the only power required for rotation is needed in overcoming the drag friction of discs in the liquid. RBC has a better shock load, because of the short residence time and the shock does not kill the whole biomass and recovery is fairly rapid. RBC have more process stability with load variations since the microorganisms in a fixed film system are attached to a media, they cannot wash out with increasing flow rate. Also fixed film systems generally have a greater mass of microorganisms, making them better able to handle increasing organic load. Recycling of solids is not required as the microorganisms are not washed off. RBC requires low energy, short hydraulic retention time and low operating cost. It has excellent process control and is capable of handling a wide range of flows and organic concentration.In general, a biofilm system offers the following advantages:

1) High biomass packing density and reactor compactness due to a large specific surface area. 2) Short contact periods and co -habitation of aerobic and anoxic micro-organisms within the same ecosystem. 3) Reduced sludge bulking and better sludge thickening qualities. 4) Lower sensitivity and better recovery from shock loadings. 5) Low energy requirements and more economy in operation and maintenance. 6) Low sludge production and superior process control. 7) Simple in operation and maintenance.

2. MATERIALS AND METHODS

FABRICATION

The samples were collected from the dairy industry. The various products like paneer, cheese, butter, milk cream etc. are produced in it. A lab-scale three stage RBC was fabricated with an acrylic plastic transparent sheet thickness of 8 mm. The working volume of RBC were 50 L respectively. The reactor was semicircular in shape having outer diameter of 20 cm and length of each stage was 60 cm. Each stage had 4 discs with 24 cm diameter. The discs were mounted on a shaft of PVC pipe, geared with a rotational speed of 5 to 10 rpm by an electric motor. The shaft passed through the center of each disc and was mounted on the bearing attached to the ends of the wastewater container and the submergence of the discs was 40 percent.

FIG 2: RBC UNIT

METHOD

The samples collected before and after treatment were analyzed for pH, TSS, BOD5 and COD by using standards methods.The samples were collected from the dairy industry. The barrel was used as a primary settling tank. In order to make sure that the large solids had settled to the bottom of the barrel, samples were not taken until two hours after collection. Before the beginning of data collection, the RBC was allowed to run for three weeks to make sure that micro organism's growth on the discs was well established and the system had reached a steady state. After those three weeks, the first stage was covered by a layer of light brown biofilm and the effluent was quite clear. Actual observations were taken after three weeks i.e. after formation of biofilm.

Thus, the microbial film grows on the plastic that is in initially contact with the nutrients of the wastewater phase and the oxygen in the atmosphere would then perform its metabolism. Hence, the organic compounds in the wastewater would serve as the nutrients for the microbes to digestand grow. In this study the combination of different shafts will also be studied which will be rotated at different RPM (rotation per minute) to study the effect of speed on the proposed model. Study will also be carried out on the effect of submergence of paddles in the domestic waste water. The various effluent parameters such as BOD, COD, pH, TS, TSS, and TDS etc. will be studied in order to decide the feasibility of treatment process for domestic wastewater.

CHARACTERISTICS OF DAIRY WASTEWATER PROCESS DESIGN AND NUTRIENT REMOVAL PERFORMANCE

PARAMETERS	VALUE
pH	8.3
TDS(mg/l)	5458.4
EC(µs/cm)	8640
SALINITY (ppm)	4.5
DO(mg/l)	5.2
BOD(mg/l)	14.2
COD(mg/l)	24.6
TA(mg/l)	480.5
TH(mg/l)	398.4

ORGANIC SUBSTRATE REMOVAL:

The critical hydraulic retention time for removal of carbonaceous substrate in RBCs is about 3-4 hours and studies have revealed that further increase in retention has little effect on improvement in performances. For a given system, as the applied loading rate increases, the removal efficiency decreases. Under normal operating conditions, carbonaceous substrate is mainly removed in initial stages of the RBC.

NITRIFICATION:

The oxidation of ammonia is an important feature in assessing the performance of a biological reactor. Heterotrophic bacterias offer strong competition to nitrifiers in the initial stages with high BOD concentrations. So the maximum nitrification rate occurs when the soluble BOD load reduces sufficiently. Studies suggest that full nitrification can only be achieved when the organic loading rate is less than 5gBOD/(m2.day). The recommended initial BOD5 loading rate as per ATV-DVWK standard is 8-10g/(m2.d). Therefore, nitrification always occurs prominently in the later stages of RBC set-up. The highest nitrification rate depends upon oxygen concentration in the boundary layer and dissolved oxygen concentration in the bulk liquid, which should not be oxygen limited. Also concentration of ammoniacal Nitrogen should not go below 3-5 mg/l in the bulk liquid for best results bulk liquid for best results.

DENITRIFICATION:

The usage of RBC systems for denitrification is not very widespread. Laboratory scale studies indicate that for an influent NO3-N concentration of 50mg/l, the maximum denitrification rate is 15.2gNO3-N/m2.day at a rotational speed of 2rpm [13].In case of liquid temperature going below 13°C, temperature correction factors need to be taken into account.

RESULT

The method use for wastewater treatment should be economical, simple in operation and easy to maintain. RBC is one of the efficient treatment having BOD and COD removal efficiency ranging from 60 to 70%. Performance of RBC unit can be improved by various techniques like by combination of shafts and increasing submergence level.

PARAMETERS	VALUE
pH	7.42
TDS(mg/l)	883
EC(µs/cm)	1.38
SALINITY (ppm)	4.5
DO(mg/l)	0.2
BOD(mg/l)	128
COD(mg/l)	59
CARBONATE(mg/l)	NIL
NITRITE(mg/l)	NIL
PHOSPHATE(mg/l)	0.06

3. CONCLUSION

Rotating biological contactor is very effectively used for treatment of wastewater of very high organic loading. Mostly now days the RBC is used for aerobic treatment process for removal of organic concentration, also anaerobic RBC is used for Denitrification process. Under variations of nutrient and hydraulic loading rates in influent, RBCs can sustain such fluctuations within a tolerable range and perform efficiently. Although this is valid for most biofilm systems, RBCs may provide an economical advantage. The tolerable limit for such performance depends upon system configuration and temperature which can be determined from simulations.

The mechanical design of an RBC is not simply selecting the best material to performance particular function based on stress levels, but is more concerned with the corrosion (chemical and biological) and fatigue behaviour of the various materials chosen at low speeds of loading. Failure to understand these requirements is probably why so many failures have been experienced after the unit has been in operation only a few months or years of service. With a thorough understanding of the mechanisms of mechanical failure, a new approach to RBC design will reduce the occurrence of mechanical failure and ensure that effluent consent standards are maintained continuously. Thus, rotating biological contactor was fabricated with the dimensions of 300x300x500mm for treating dairy wastewater including diffused bubble aerator thus provide better aeration for the process thus enhancing removal of constituents in the final result.

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