Evaluation of the efficiency of rotating bio-disk system in domestic wastewater treatment

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ABSTRACT

Due to the crisis of water shortage, the importance of wastewater treatment and reuse of wastewater, today the application of advanced methods of wastewater treatment has been considered. Therefore, in the present study, a rotating bio-disk system has been used to treat municipal wastewater. To conduct the research, a laboratory-scale reactor unit made of Plexiglas with 35 discs was used, and initially the system used a 20-liter tank in a completely anaerobic manner to increase the reactor efficiency. The aerobic sludge of the wastewater treatment plant of the slaughterhouse has been used for the initial inoculation of the reactor and sugar, urea and potash fertilizer have been used to feed the reactor. The study lasted 96 days in three periods. During the study, the COD level increased from 575 mg/l.d to 1250 mg/l.d. The reactor temperature is in the mesophilic and psychrophilic temperature range for two periods. The results showed that the thickness of the biofilm on the surface of the disks is 2 mm and the pH changes are in the range of 9 to 7. COD removal efficiency during the second period is between 19.13-48% and during the third period is between 50-92%. During the study of the hydraulic retention time factor and the change in the rotation speed of the disk, the highest efficiency was obtained at 93% in 24 hours and 92% at 12 rpm, respectively. Experiment with real wastewater has an efficiency of 80%, which is 12% different from the efficiency of laboratory wastewater.

KEYWORDS

Bioremediation, rotating bio-disk system, domestic wastewater, real wastewater.

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1. Introduction

Due to the increasing population growth, increasing water needs and the existence of dry and low water conditions in most parts of the country, protection of limited water resources against pollution and reuse of treated wastewater, is a fundamental solution to meet current water needs. It will be the future[1]. Home and municipal wastewater treatment methods include physical, chemical and biological methods (aerobic and anaerobic methods). The removal process by physical and chemical processes is costly and for this reason, biological methods are receiving more attention today[2]. Among the various methods of bioremediation, the rotating bioreactor is a type of wastewater treatment that uses sticky growth for the activity of microorganisms and bacteria for intermediate and advanced levels.

In the present study, a conventional rotating biological disk system has been used to treat domestic (municipal) wastewater. In the research process, the effective factors of organic loading, hydraulic retention time, disk rotation speed, determining the BOD5 / COD ratio and comparing the rate of COD removal in the actual wastewater sample compared to the laboratory sample have been investigated. An important point in the research is the use of a 20-liter tank in a completely anaerobic manner similar to the operation of the septic tank to uniform flow, sedimentation of suspended solids and overall increase in reactor efficiency, which has the mentioned advantages over using a simple reactor.

2. materials and methods

The laboratory-scale reactor is made of Plexiglas and scratched plastic disc with a diameter of 12 cm and a thickness of 5.4 mm with a volume of 6 liters for use in research. 35 discs with a distance of 1 cm are mounted on a horizontal shaft and rotate in the sewer at a speed of 6-12 rpm. The driving force for the rotation of the discs is provided by connecting to a wiper motor with a dimmer to adjust the rotation speed. Three valves are installed on the body of the device as inlet, outlet and sludge discharge, respectively. At the beginning of the device, a 20-liter tank that was placed above the reactor was used to streamline the flow, settle the suspended solids and increase the reactor efficiency overall.

In order to inoculate the reactor, the aerobic sludge of the wastewater treatment plant (activated sludge method) of the chicken slaughterhouse in the secondary treatment section was used. Sugar, urea and potash fertilizer with a ratio of C: N: P equal to 18:10:18 have also been used to feed the RBC reactor. It should be noted that throughout the research period, the ratio of 100 to 5 to 1 for carbon to nitrogen to phosphorus was adjusted by adding urea and potash fertilizer in synthetic wastewater, respectively[3].

The study lasted 96 days in three periods. The first period for 30 days includes the design and construction of the reactor, the second period for 30 days including commissioning, adaptation of microorganisms to existing conditions, biofilm formation, pH and temperature measurements and the initial study of COD removal changes and the third period for 36 days including measurement pH and temperature, study of COD removal efficiency, study of effective factors of changes in organic load, hydraulic retention time, changes in disk rotation speed, determination of BOD5/COD ratio and finally study of COD removal rate of real wastewater. During two periods, the COD increased from 575 mg/l.d to 1250 mg/l.d. The reactor temperature was in the range of mesophilic (25-25 ° C) and psychrophilic (> 25 ° C) during two periods. All experiments are performed according to the methods mentioned in the book of standard methods[4].

3. Results and Discussion

About a week after the start of loading, the formation of biofilm has begun. The amount of COD was measured during the second period of once a week to check the stability and correctness of the system performance. The COD removal efficiency during the second period was between 19.13-48%.

The output COD is measured every day during the third period. COD removal efficiency during the third period is under the rate of increase of COD up to 1250 mg/l.d and rotation speed of 8 revolutions per minute is equal to 50-92%. Due to the fact that the temperature in the above period was in the mesophilic range and increased, the rate of removal has increased. The most important physical factors affecting the overall removal efficiency of the RBC system are oxygen transfer rate and temperature[5]. The pH changes in the present study were in the range of 7 to 9.

1.3. Biofilm formation process

Microbial growth and distribution of biofilms were observed under a microscope during research periods to ensure the correctness of the purification process. The biofilm formed on the discs was measured at the end of the third period using a caliper with a thickness of 2 mm. The thickness of the biofilm is controlled by the shear force[6]. The thickness of the biofilm increases with the concentration of the substrate and decreases with the shear forces of the surface[7]. The appropriate thickness should be about 2 mm. If the surface of the

biofilm is too thick, it may cause excessive anaerobic conditions, resulting in an unpleasant odor. Endogenous metabolism may even occur, which destroys the adhesion of the biofilms and may cause them to separate from the discs[3].

2.3. Investigating the effect of effective factors on removal efficiency

In order to investigate the increase of COD removal efficiency in the present study, the effective factors of hydraulic retention time, changes in disk rotation speed and determination of BOD5/COD ratio were evaluated, which are explained below.

- ✓ Check hydraulic retention time

In order to investigate the effect of retention time on system removal efficiency, at times of COD, 1250 mg/l.d and rotation speed of 8 rpm, times of 6, 12, 18 and 24 hours were evaluated. The highest removal efficiency occurred at a residence time of 24 hours equal to 93%.

- ✓ Investigating the effect of disk rotation speed

In order to investigate the effect of disk rotation speed on system removal efficiency, under COD, 1250 mg/l.d, removal efficiency was evaluated at 5 different speeds of 6, 8, 10, 12 and 14 rpm. The process of COD removal efficiency increases by increasing the rotation speed to 12 revolutions per minute and is equal to 92%. Then, by increasing the speed to 14 rpm, the removal efficiency decreases and causes the biofilm to be removed from the surface of the discs.

- ✓ Determine the BOD5 / COD ratio

During the study period, the BOD5 value was measured twice by the BOD reactor to obtain the BOD5/COD ratio. The results were 0.58 and 0.52 under COD, 1250 mg/l.d and 8 rpm.

3.3. Experiments on real sewage

In the present study, at the end of the third period, the experiment was performed on a real sample of municipal wastewater with an input COD of 710.5 mg / l, which was taken from the part after sowing. The final results are listed below the input COD and the rotation speed of 8 rpm was 80%. With a difference of 12% in the COD removal efficiency of the system with synthetic wastewater and real wastewater, it can be concluded that due to the fact that the composition of municipal wastewater with synthetic wastewater is different and it takes time to adapt microorganisms in the system to new wastewater. The difference is significant.

4. Conclusions

The results of the research confirm the possibility of biological treatment of domestic wastewater by a rotating biological disk system. The best biological removal of domestic wastewater at the input COD of 1250 mg / l.d was achieved after a residence time of 24 hours and a rotation speed of 10 revolutions per minute of 92%. During the research, the trend of pH changes was in the appropriate range of 7 to 9 and the temperature changes were in the temperature range of mesophilic and psychrophilic.

5. References

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