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Biofertilizer production from gas refinery wastewater

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ABSTRACT

In this study the wastewater treatment of a gas refinery was investigated by using an aerobic trickle bed filter bioreactor. Using a methanothrophic bacterium was the only difference of this experiment from the common aerobic wastewater treatment processes. In addition to reach the standards of wastewater treatments the other goal of using this special bacterium was the production of a bacterial biomass which can be used as a biofertilizer. The optimization of major effective parameters such as inoculum size, ammonium sulfate, sodium hydrogen phosphate and methanol concentration and hydraulic and retention time was carried out by using the simple experiment design method of one variable at the time in a trickle bed bioreactor. The results of this study showed that the maximum biofertilizer production of 0.45 g/lit was obtainable in the optimum conditions including inoculum size of 0.27g/lit, ammonium sulfate concentrations of 0.25g/lit, sodium hydrogen phosphate concentration of 0.1g/lit, methanol concentration of 0.1g/lit, hydraulic time of 1.6 minutes and retention time of 24 hours.

Keywords: Biofertilizer, Methanothrophic bacteria, Wastewater treatment

Introduction

Nowadays industrial wastewaters are threating our health a safety. Among the plenty of industrial wastewaters are produced daily and emitted to the environment, gas refinery wastewater contains some chemical and petrochemical pollutants that can be harmful on our health and environment. The main chemical pollutants in a gas refinery wastewater are nitrogen containing hydrocarbons which can be harmful for human and animal life. These chemical pollutants commonly release to the wastewater when the plant in under overhaul conditions. Based on the contents and conditions of Wastewater, the management units select some suitable method to reach the international standards of wastewater treating. In some gas refineries the common aerobic and anaerobic activated sludge method is used to treat the wastewater. The total sluggish biomass produced in these refineries is repose to landfill. Using a methanothrophic bacterium that can utilize the nitrogen containing hydrocarbons pollutants in wastewater not only can help to reach the standards of wastewater treating but also can produce a bacterial biomass which can be used as a biofertilizer [1]. Among many type of methanothrophic bacteria, the type X has the potential to be used as a biofertilizer [2]. Production and selling This new fertilizer not only can reduce the prices of wastewater treatment in gas refineries but also initiates an environmentally the friendly and cheap process for fertilizer production [3].

Experimental

Bioreactor characteristics

A bench scale 72-liter trickle bed filter bioreactor with dimensions of 60cm length, 20cm width and 60cm height was made from glass an equipped with a pump and an external recycling loop for agitation an aeration. The duty of this loop and its pump was maintaining a wastewater flow rate of 0.17lit/s from the button of the bioreactor to the sprayers which are installed at the top of the bed. The average diameter size of stone marble filling the bioreactor was around 4cm [4].

Bacterium preparation

The bacterium was used in this study is belonging to the type X of methanothrophic bacteria and prepared from Islamic Azad university of Dezful branch culture collection. A methanol and nitrate based medium was used for biomass production to be used as inoculum in experiments [5].

Wastewater characteristics

The input wastewater effluent characteristics is shown in table1.

Table1. The Input wastewater effluent characteristics

The parameters	Amount
pH	8.8
BOD(ppm)	310
COD(ppm)	650
TDS(ppm)	3436
EC	3880

Optimization of effective parameters

The simple method of one variable at the time was used to determine the optimum conditions of treating the wastewater by methanothrophic bacterium to achieve the maximum bacterial biomass production in conjunction with obtaining wastewater management standards. The height level of the stone bed or the hydraulic time was the first parameter was investigated in this experiments. The height level of the bed was changed from 10cm to 50cm while the other parameters were constant at the base amounts of 0.01 g/lit for methanol concentration, 0.01g/lit for sodium hydrogen phosphate concentration, 0.01g/lit for ammonium sulfate concentration, 0.05g/lit for inoculum size and 48 hours for retention time [6]. After investigation of the hydraulic time, other variables such as the inoculum size, ammonium sulfate concentration,

sodium hydrogen phosphate concentration, methanol concentration and retention time were investigated. When the optimum amount of a variable was determined, this optimum amount was used for optimization of other parameters. After determining all optimum conditions, the procedure was repeated by changing the base amount with the optimum amount until the optimum amount did not changed.

Results and discussions

The results of determining the optimum amount for height level of the bed was shown in table2. As can be seen increasing the amount of bed height reduces the remaining BOD and COD of the treated wastewater up to the bed height of 50cm. Based on the recycling flow rate this height is equivalent to hydraulic time of 1.6 minutes. So the optimum hydraulic time is 1.6 minutes.

Table2. Results of optimizing height level of the bed

Height level of the bed	BOD(ppm)	COD(ppm)
10	120	288
20	103	256
30	92	248
40	83	232
50	80	230

The results of determining the optimum amount of inoculum size was shown in table3. As can be seen in table3 increasing the inoculum size increases the biomass production up to inoculum size of .0.27g/lit. So the optimum inoculum size is 0.27g/lit.

Table3. Results of optimizing inoculum size

Inoculum size(g/lit)	Final biomass concentration(g/lit)
0.05	1.6
0.135	3.2
0.270	4.5

The results of determining the nitrogen and phosphorus substrates for cell growth was shown in table4 and table5. As can be seen, increasing the concentration of ammonium sulfate and sodium hydrogen phosphate decreases the BOD and COD in treated wastewater respectively up to ammonium sulfate concentration of 0.25g/lit and sodium hydrogen phosphate concentration of 0.1g/lit. So the optimum amount of nitrogen substrate is 0.25g/lit and phosphorus substrate is 0.1 g/lit.

Table4. Results of optimizing ammonium sulfate concentration

Ammonium sulfate (g/lit)	BOD(ppm)	COD(ppm)
0.01	65	123
0.05	53	111
0.10	44	93
0.25	42	83
0.50	38	83

Table5. Results of optimizing sodium hydrogen phosphate concentration

Sodium hydrogen phosphate (g/lit)	BOD (ppm)	COD (ppm)
0.01	38	73
0.05	36	70
0.10	33	68
0.50	33	65

The results of investigating methanol concentration effects on wastewater treatment was shown in table6. As can be seen in table6 increasing the methanol concentration decreases the BOD and COD of the treated wastewater up to the methanol concentration of 0.1 g/lit. So the optimum amount of methanol concentration is 0.1 g/lit.

Table6. Results of optimizing methanol concentration

Methanol(g/lit)	BOD (ppm)	COD (ppm)
0.01	38	58
0.05	36	53
0.10	33	51
0.50	33	50

The results of investigating the effects of biological retention time of the fermentation process in the bioreactor was shown in table7. As can be seen increasing the retention time decreases the BOD and COD of the treated wastewater water up to the retention time of 24hours. So the optimum retention time of the fermentation is 24hours.

Table7. Results of optimizing the biological retention time

Time(hour)	BOD (ppm)	COD (ppm)
4	294	589
8	243	481
12	175	382
16	90	187
20	54	113
24	38	75

Conclusion

The results of this study determined that methanothrophic bacteria have the ability to consume industrial pollutants in gas refineries wastewater and can reduce the pollutants to the standard level of pouring the treated wastewater to the rivers. The optimum conditions of using a methanothrophic bacterium to treat a gas refinery wastewater investigated by using the simple method of one variable at the time. According to the results the maximum biofertilizer bacterial biomass of 0.45g/lit was obtained at hydraulic time of 1.6minutes, inoculum size of 0.27g/lit, ammonium sulfate concentration of 0.25g/lit, sodium hydrogen phosphate concentration of 0.1g/lit, methanol concentration of 0.1 g/lit and biological retention time of 24hours.

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