Research Paper

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Occurrence and Biodegradability Studies of Pharmaceuticals Effluent Containing 'Dimethyl formamide'

Environmental Science

KEYWORDS : Bacillus Subtilis, COD, Dimethylformamide (DMF), Degradation, MLSS, Turbidity & Soil Media

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ABSTRACT

The present study investigated the potential of the selected bacterium, a natural Bacillus Subtilis isolated from the soil which was found to be more useful in degrading the Dimethylformamide (DMF) based effluent generated in pharmaceuticals industries. On the assessment of physico-chemical parameters like pH, Turbidity, COD, MLSS and ammonia released during the degradation process. DMF degradation was estimated in the form of reduction in the COD. Continuous increase in turbidity and biomass was also observed during the treatability study. During study it is reported that 70-80% reduction in COD and 7-20% increase in MLSS was recorded, which indicates the degradation of DMF.

INTRODUCTION:

Industrialization is a key role to a nation's economy as it serves as a medium for development.The increasing demand of water and decrease in supply has made the treatment and reuse of industrial effluents an eye-catching option (Mashhood A. K. and Arsalan M. G., 2011). However, there are associated problems resulting from the introduction of industrial waste products into the environment and some sources of pollutants into the atmosphere. Industrial effluent generated from that industries posing high COD as well as high TDS which is a source of pollution which needs the proper treatment before discharge (Bisceglia and Roberts 2006). These effluents require a treated system in the form of "Effluent Treatment Plant" in which Bioreactors or Aeration Tanks are designed to reduce COD content in an effluent (Jim T. Yua, et.al, 2006).

Some times when a new form of effluent entered in to the Effluent Treatment Plant it gets disturbed and whole the system of ETP get fails too. For such types of the situations we have to generate an acclimatized bacterium which prevents shock loading to the bacteria's in aeration tanks. Acclimatized bacteria produced by using a seed culture either from domestic effluent or to be produced from organic matter deterioration in tanks with water in presence of air.

DMF is manufactured goods of the photochemical degradation of dimethylamine and trimethylamine. These both are frequently occurring natural substances and are also used in industrial applications. DMF does not occur naturally. There is little information regarding environmental levels or the exposure of the general population to DMF that is concentrations in the air in the range of 0.02-0.12mg/m^3 have been found in residential areas near industrial sites.

Compared with chemical/physical methods, biological processes have received more interest because of their cost effectiveness, lower sludge production and environmental friendliness (Mir Tariq A., et. al., 2012). Improvement in the ability of microorganisms to degrade a pollutant could be achieved through modification of the environment or the organisms. The ability of microorganisms to degrade and metabolize a wide variety of compounds has been recognized and exploited in various biotreatment processes (Boethling et.al, 2003). The biotreatment offers a cheaper and environmentally friendlier alternative for removal of pollutants in textile effluents(Bouwer, et.al, 1984).

In the present study an attempt has been made to isolate a bacterial strain, capable of degrading DMF and to identify and determine its efficiency of degradation by analyzing different parameters like pH, turbidity, biomass, CO_2 production and ammonia production.

MATERIAL AND METHODS:

Collection of Sample:

Soil sample collected in sterile screw cap bottles from the garden of university and the Dimethyl Formamide sample collected from a Pharmaceuticals industry using Dimethyl Formamide in their production.

Isolation of DMF Degrading Bacteria:

The collected soil samples were diluted in the proportion of 1:2, i.e. one part of soil and 2 parts of water in to the 100 lit of containers. The solution formed as soil solution is filtered and the filtrate is used as culture for this treatability study. This culture is analyzed for presence of Bacillus Subtilis bacteria. This species of bacteria's found in selected soil hence solution used as culture for degradation of DMF (Ladwani Kiran D., Ladwani K. D., et. al., 2012).

Identification of DMF Degrading Bacteria:

Different bacterial strains grown on agar plates, out of which one strain was selected i.e. Bacillus Subtilis found to be abundant in the media.

Degradation Efficiency:

The bacterial isolate was aerated for whole day then injected with different concentrations of DMF like 50 ppm, 100ppm, 150 ppm into the container of 100 lit. The container aerated and maintained the room temperature for a period of twelve days and the degradation was confirmed by analyzing the COD, pH, biomass, carbon dioxide and ammonia production (Rahman M.S., et. al., 2013). The above mentioned parameters were measured every 48 hours for 12 days.

pH:

The pH of the sample was determined from day first i.e. day 0 to continued i.e. 1, 3, 7, 9,11 and 12 days of aerated using pH meter.

Biomass Estimation:

The biodegraded samples were taken and centrifuged. The settled biomass was taken and the wet biomass was calculated. After drying it in a hot air oven, the dry biomass was determined.

Turbidity Estimation:
Turbidometric method was followed for confirming the increase in biomass by measuring the turbidity at 600nm.

Ammonia Estimation:
Decrease in pH and ammonia odor libration from container indicated Ammonia Estimation.

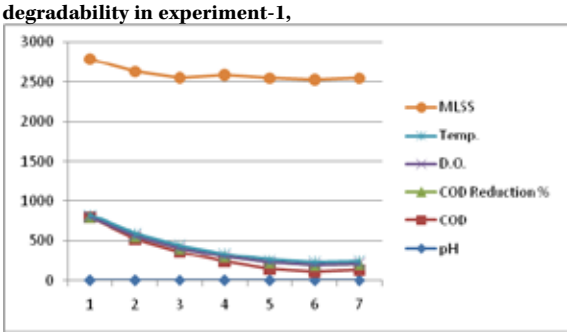
RESULTS AND DISCUSSION:
The study reveals shows degradation in effluent in terms of COD which is studied 3 times in a different concentration:

Experiment -1
Experiment No. 1 shows that DMF degradation of 50 ppm concentrate effluent was taken for study. Carboy drum is taken as a Aeration tank with 100 liters capacity in which 60% of volume of soil culture were added and 30% DMF effluent having concentration of 50 ppm also added to same carboy drum. There after whole content mixed thoroughly and kept for aeration. The initial COD found 786 mg/lit., where aeration given at low speed to maintain the temperature of container near about 28^{0}C with a culture concentration of 1966 mg/lit to degrade the COD in the effluent. Samples drawn on the day '0' i.e.after set up installed and continued to every alternate day from day '1st' upto day '11th'. In the following table, the study reveals shows that there is 87.53 % of reduction in the form of COD and 17.24% growth in the form of culture are found in the effluent within 9 days.

Table No. 1

No. of Days	pH	COD	COD Reduction %	D.O.	Temp.	MLSS	MLSS Rise %
0	8.22	786	-	2.3	28.2	1966	-
1	8.17	512	34.86	2.7	28.4	2042	3.866
3	8.1	346	55.98	3.3	28.8	2110	7.325
5	8.02	224	71.5	3.2	28.7	2250	14.446
7	7.98	135	82.82	3.4	28.3	2286	16.278
9	7.94	98	87.53	3.7	28.2	2298	16.887
11	7.91	119	81.04	3.9	28.5	2305	17.243

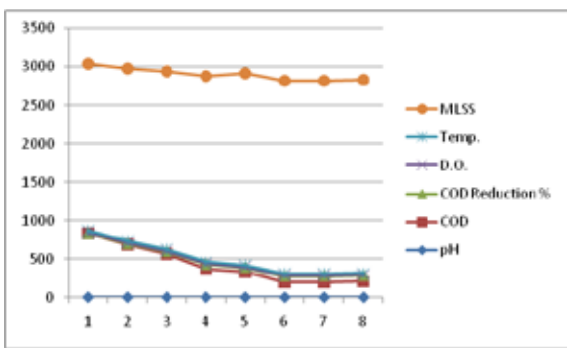
Graph No. 1: The graphical representation shows the COD degradability in experiment-1,



Experiment No – 2
Experiment No.2 set for high ppm dose of DMF i.e. 100ppm. As concentration of DMF is more the COD of aeration tank should be more than that of first experiment i.e. Initial COD of this set up is 829 mg/lit. on day '0'. This aerator also get aerated at low speed to maintain the temperature of container near about 280C with a culture concentration of 2169 mg/lit to degrade the COD in the effluent. Samples drawn on the day '0' and continued to every alternate day from day '1st' upto day '11th'. In the following table, the study reveals shows that there is 76.60 % of reduction in the form of COD and 15.72% growth in the form of culture are found in the effluent within 9 days.

Table No. 2

No. of Days	pH	COD	COD Reduction %	D.O.	Temp.	MLSS	MLSS Rise %
0	8.8	829	-	2.8	28.2	2169	-
1	8.43	678	18.21	2.6	28.7	2242	3.366
3	8.57	557	32.81	2.9	28.6	2314	6.685
5	8.2	368	55.61	3.1	28.9	2420	11.572
7	7.86	325	60.8	3.2	28.9	2486	14.615
9	7.8	194	76.6	3.3	29.1	2508	15.629
11	7.78	199	76	3.1	29.1	2505	15.491
12	7.82	202	75.63	2.9	29.2	2510	15.722



Graph No. 2: The graphical representation shows the COD degradability in experiment-2

Experiment No – 3
Experiment No 3 set for high dose of DMF 150ppm . AS due to the higher concentration of DMF, the initial COD of aeration tank was more i.e. COD of intial as day zero '0' is 1142 mg/lit. Samples drawn on the day '0' and continued to every alternate day from day '1st' upto day '11th'. In the following table, the study reveals shows that there is 80.33 % of reduction in the form of COD and 21.82% growth in the form of culture are found in the effluent in 11 days.

Table No. 3

No. of Days	pH	COD	COD Reduction %	D.O.	Temp.	MLSS	MLSS Rise %
0	7.69	1142	-	2.3	27.8	2213	-
1	7.64	868	16.7	2.7	28.1	2442	10.348
3	7.6	547	37.91	3.1	28.1	2598	17.397
5	7.51	402	61.42	3.2	28.1	2650	19.747
7	7.47	290	72.17	3.4	28.4	2686	21.374
9	7.22	205	75.91	3.7	28.5	2698	21.916
11	7.19	134	80.33	3.9	28.6	2680	21.103
12	7	152	78.41	3.6	28.6	2696	21.826

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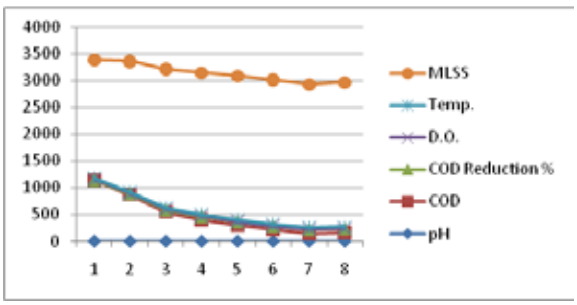
Graph No. 3: The graphical representation shows the COD degradability in experiment-3



CONCLUSION:

It is concluded that soil bioculture is helpful to degrade DMF effluent of pharmaceuticals which are an alternative source for the existing bioculture prepared from domestic sewage. This technique also can used to acclimatization of the culture with an newer effluents to which soil bioculture get acclimatized and after that they can use as a substituent's in aeration tanks for those new effluents qualities.

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