A Comparative Study of Reduction of Bod & Cod By Aeration And Biological Treatment of Benzathiazole Effluents

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Abstract- *Mercaptobenzothiazole (MBT) is an organic compound used as an accelerator and vulcanizer in rubber chemical industries. Industries synthesizing rubber chemicals release small, yet significant amount of above chemicals through their effluents. These pollutants enter food chain through water bodies and exhibit elevated levels of hazards such as carcinogenicity, cytotoxicity etc. Various procedures are employed to remove organic pollutants, most of which are chemical methods. Chemical methods are expensive, thus require to be replaced by biological remedial procedures. Microorganisms are found to play a key role in Bio-remediation.*

In the current study soil samples were collected from CETP regions of Dombivli, Boisar and Badlapur Industrial areas. Microorganisms were isolated from the soil samples and were studied for their ability to tolerate Mercaptobenzothiazole (MBT).

Microorganisms were selected based on its tolerance for the reduction of Mercaptobenzothiazoles. The reduction of physico-chemical parameters was confirmed by performing the COD, BOD and MBT content analysis by titration method. From the collected soil samples, 20 isolates were obtained. Out of these, three (3) isolates were found to tolerate Benzothizoles in effluent upto range of 0.1% to 0.8 %. Significant reduction of COD, BOD and MBT content was observed after the biological treatment of the sample for three days.

Efficient isolates were identified using Bergey's manual of determinative bacteriology. Isolates belonged to the following genera Bacillus ASMBT1, Bacillus ASMBT2 and Pseudomonas ASMBT3.

Keywords- Mercaptobenzothiazole , MBT, Bio- remediation, Micro-organisms etc.

I. INTRODUCTION

The biodegradation of many naturally occurring chemicals has been more investigated over the last few years. Several classes of substances with aromatic rings were tested for their biodegradability: Poly Chlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs), Halogenated hydrocarbons, Pesticides. (**De Wever et al 2001., Afzal et. al., 2012**). These types of pollutant are mixed with water to cause water pollution. Industries are used large amount of water for production process to form waste water.in industrial concern it is known as **"Effluent" (Maier et. al., 2000, Eswaramoorthi et. al.,2008**)

Release of such effluents into the water bodies has potential hazards on ecosystem due to its non-degradability. Mercaptobenzothiazole (MBT) belongs to family of benzothiazoles, they belong to one of the significant classes of organic polluting chemicals widely used in the rubber industry because of their desirable physical and chemical properties (**Gaja M. A.,1996, Rakkoed et. al.,1999**). They are used as vulcanization accelerators in the manufacture of rubber, corrosion inhibitors in antifreeze, photo sensitizers in photography and as pesticides. **(Brownlee et al., 1992 and 1981).** Thus is increasingly used in large quantities in many countries in the field of industrial processes.

Currently, organic pollutants in the industrial wastewater are treated by methods such as ozonation, chemical coagulation, reverse osmosis, membrane filtration methods, photochemical oxidation and electrochemical oxidation (**Margesin et.al., 2001**).One such method is Advanced oxidation processes (AOPs) which are emerging as a promising technology both as an alternative treatment to conventional wastewater treatment methods and enhancement of current biological treatment methods especially dealing with highly toxic and low biodegradable wastes **(Chamorro et al., 2001., Ailani et. al., 2013).**

The present study is intended to develop a microbial consortium for reduction of COD, BOD and MBT levels containing benzothiazole effluents. This work aims to isolate indigenous predominant adapted bacterial strains from the soils. To develop microbial consortium which possess the ability to reduce the COD, BOD and MBT content of the effluent. So, isolation and identification of microbes that can oxidize MBT to other compounds and its ability to reduce COD, BOD and MBT content by physical, chemical or biological methods. Present studies focuses on microbial degradation of MBT by use of either pure cultures or mixed cultures that can grow on benzothiazole as a sole source of carbon and nitrogen.

II. MATERIALS AND METHODS

Phase I: Characterization of Industrial Effluent

A] Sample Collection:
The effluent from organic rubber chemical industry situated in a suburban area of Mumbai was collected for study. The effluent collected after subsequent production batches of organic rubber chemicals. Such five effluent samples were collected.

B] Sample Characterization:
Every effluent sample was studied for physical, chemical and microbiological characterization. Physico- chemical parameters of the effluent were tasted as per the CPCB and MPCB Standards.

i) Physical Characterization of effluent
Color of the effluent was noted based on its visual appearance (**IS 3025, part 4**). Temperature of the effluent were measured by using thermometer. Odour of the effluent was used to indicate the presence of organic, phenolic and inorganic compounds (**IS 3025, part 5, 1983**).

ii) Chemical Characterization of effluent

1. **Estimation of pH of the effluent :**

It is the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. pH of the effluent samples was measured by using pH meter Electrometric method (**IS 3025, Part 11**).

2. **Evaluation of Chemical Oxygen Demand (COD) value of the effluent samples:**

Chemical Oxygen Demand (COD) is the oxygen required by the organic substances in water to oxidized them by a strong chemical oxidant. The COD usually refers to the laboratory dichromate oxidation procedure (**R.K Trivedi and P.K. Goel, 1984**).

3. **Estimation of BOD value of the effluent samples:**

Biological Oxygen Demand (BOD) is the amount of oxygen utilized by microorganisms in stabilizing the organic matter. The BOD value can be used as a measure of waste strength. BOD in general gives a qualitative index of the organic substances, which are degraded quickly in short period of time (**Trivedi and Goel 1986, Kulkarni and Nabar 2013., Kumlanghan et. al, 2008**).

4. **MBT content:**

2-Mercaptobenzothiathezole (MBT) was the constituents of some flotation collectors and there was need to determine MBT in rubber chemical effluent. MBT content in the effluent sample was analysis as per Indian Standards protocol. In this method, slightly modification was done (**Atagana, et. al., 1999b**). Weigh the 0.5 g of the effluent sample and transfer to a 500-ml dry conical flask. Add 30 ml chloroform solvent and mixed the sample. Add 200 ml water and 25-ml buffer solution (pH 4.95). and titrate against 0.1N standard iodine solution with the help of 5 drops of freshly prepared starch as a indicator. Magnetic stirrer was used for vigorously shaking of the test sample.

End point: Colorless – Pale yellow – permenant Blue (**IS 6918: 2000**)

5. **Consortium preparation:**

Consortium was prepared by using three isolates ASMBT 1, ASMBT 2 and ASMBT 3. those isolates have high tolerance capacity of MBT they are selected for consortium preparation with the help of proper nutrient supply. after consortium was prepared then they are used for effluent treatment and check for the reduction of COD and BOD value of effluent (**De Wever.,1998, Besse et. al., 2001, Ramasany, R.,2012**)

Results:

Five different batches of the effluent were analyzed for its physico chemical characters.

Result presented in table no.1 shows, the effluent used in the study was alkaline in nature which was clear from the pH (11.21 to 11.74). After physical treatment i.e. aeration, the pH decreased slightly change (11.00 to 11.50). But changes in the pH are not significant i.e. no remarkable reduction in pH values was observed. The effluent treated with biological consortium showed significant reduction in pH values of (9.58 to 10.20).

Table No 1: Results of pH reduction after effluent treatment with aeration & biological treatment

		Raw Effluent	After Aeration	Treatment with Microbial consortium
Batch no.	**Colour**	**pH**		
1.	Yellow	11.74	11.50	9.90
2.	Yellow	11.21	11.00	9.58
3.	Pale yellow	11.48	11.28	10.07
4.	Yellow	11.51	11.21	10.20
5.	Yellow	11.50	11.35	9.85
CPCB	colourless	7.0-9.0		

The color of the effluent from different batches was variable (Yellow to Pale yellow). The COD and BOD levels were in the range of 120000 to 125000mg/L and 1300 to 2540mg/L respectively. MBT content of the effluent was found to be in the range of 0.38 to 0.68%. After subjecting the effluent to aeration significant decrease in the mean values difference of COD (35,840 mg/L), BOD (1094 mg/L) were observed compared to the untreated sample and no change reduction was observed in MBT content and color.

Effluent treatment with biological consortium was performed in two stages. Effluent was incubated with biological consortium for about two days (24hr and 48hr). After incubation, COD and BOD values of the effluent reduced to significant amount. The consortium was prepared by MBT tolerance organisms ASMBT 1, ASMBT 2 and ASMBT 3. They are pooled into nutritional medium and matt growth of organisms was observed. The resultant consortium was directly used for the treatment of thiazole based effluent.

The sample was subjected to biological treatment for 24 to 48 hr for comparing the change in the values of COD and BOD. After 24 hr of the biological treatment, considerable reduction in the COD is 55.48% and BOD is 92.32% was observed. Results are presented in table no 2.

Table no 2 : Results of COD,BOD & MBT Content of the effluent after aeration and biological tratment

	COD (mg/lit.)			BOD (mg/lit.)			MBT content		
Batch no	**Raw Effluent**	**After Aeration**	**Treatment with Microbial consortium**	**Raw Effluent**	**After Aeration**	**Treatment with Microbial consortium**	**Raw Effluent**	**After Aeration**	**Treatment with Microbial consortium**
1.	1,24,000	87,200	32,000	2540	1000	92	0.68%	0.67%	0.35%
2.	1,20,000	85,000	31,800	1300	720	86	0.45%	0.45%	0.15%
3.	1,22,000	82,600	30,200	1500	800	75	0.45%	0.43%	0.12%
4.	1,25,000	89,200	34,400	2100	800	98	0.40%	0.39%	0.18%
5.	1,20,000	87,800	32,600	2200	850	82	0.38%	0.37%	0.12%
CPCB Std.	250-300			100			----		

Further % reduction in the values of COD is 73.64% and BOD is 95.48% was observed after 48 hr of treatment. The average reduction of MBT concentration upto 59.74%. The results are presented in figure no 1.

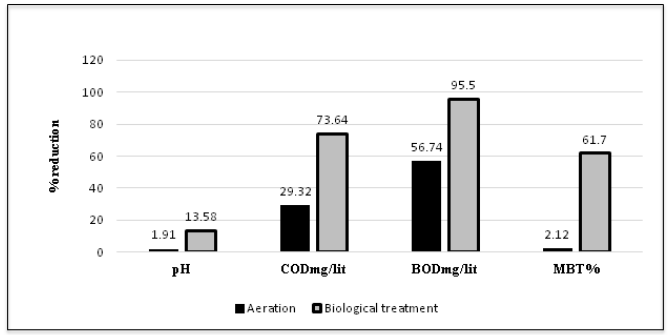

Figure no 1: Comparison of Percentage reduction of Parameters

III. CONCLUSION

Enormous amount of water is used in rubber chemical processing industry in chemical processes including obsolete process technology, poor recycling and reuse practices and poor wastewater treatment. Advanced aeration and biological processes for the treatment of rubber chemical effluents are promising methods for purification aimed at reuse of rubber chemical wastewaters, resulting in direct environmental and economic benefits. These methods provide complete removal of volatile organic compounds and reduce organic and inorganic matter from the wastewater loads from above mentioned industry. Initial experiments involved the use of biological consortium prepared in laboratory that is used for treatment of effluent from a large chemical factory complex which manufactures MBT and MBT-based rubber additives. This study demonstrates that MBT can be removed from solution in the presence of both aeration and biological consortium. This removal is unlikely to be due to adsorption. But MBT can be removed by using biological method and significant amount of reduction in pH, COD, BOD and MBT content of the effluent. It is very easy, cost effective and pollution free environment method as compared to aeration method. No evidence for degradation of MBT is seen but MBT is utilized by microbes as a sole carbon source. Clearly further research is required to understand mechanisms for MBT degradation in effluent treatment plants.

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