

FEASIBILITY STUDY OF EFFLUENTS CONTAINING PHENOLS : RECOVERY THROUGH RESIN COLUMNS AND BIO-DEGRADATION BIOLOGICAL PROCESS

****Bandela N.N. **Deshpande D.M.**

Phenols are widely used chemicals in manufacturing of various products. There is continuous increase in the consumption of phenols. This heavy consumption of phenols leads to increase in the concentration of the phenols in effluent. Hence treatment of effluent containing phenols is very difficult and economically not feasible task. This heavy concentration of phenols restricts the biodegradation capacity of the bioreactors. Hence for complete biodegradation of these phenols, it is essential to increase capacity or size of the bioreactors. This affects by increase in the overall treatment cost. So rather than biodegradation one can recover these phenols from the effluent by using resins. The phenols from the effluent get adsorb on the resins. As phenols are soluble in methanol resins can be regenerated by using methanol. By distillation we can again recover the methanol and phenols. In the present investigation it was found that there was substantial reduction of phenols from 6000 mg/l to 400 mg/l with 12 bed volume of effluent. When the same effluent is again passed through the second resin column we get concentration of phenols below 100 mg/l in the effluent. This effluent can than be easily treated in the bioreactor. This will not only help to conserve the natural resource but also help in reduction in emission of green house gas, carbon dioxide.

Introduction—Phenols are widely used in the manufacturing of various chemicals like pesticides, herbicides, biocides, dyes etc. The effluent generated from these industries is heavily contaminated with phenols. Hence different routes are used for the removal and recovery of phenols from the waste water. This includes oxidation, biodegradation and recovery by resins. The oxidation method requires external addition of chemicals to the effluent stream, for the oxidation of phenols. These chemicals are very expensive and effluent requires further treatment for removal of these added oxidizing chemicals. In the biodegradation method phenols are biodegraded with the help of activated sludge. In this method the microorganism in the activated sludge process

degrade the phenols to form carbon dioxide and water. But the process requires high energy and economically not feasible when there is high concentration of phenol in waste water. To overcome this problem one can recover the phenols from the effluent. The phenols are recovered by using adsorption technique. This method not only recovers the phenols but also reduces CO₂ emissions from the bioreactors there by contributing to the reductions in global warming process. It also curtails the over all operation cost of bioreactor.

Material and Methods—The laboratory experiment was carried out by using cationic resin in two separate glass column of 0.5 meter in length with half inch in diameter. Each column is open at the top with cock at the bottom. 200 ml of resin is packed in each glass column. The effluent of 6000 mg/l of phenols concentration was fed from the top at the rate 6 ml / minutes. The elute was collected in a glass beaker of capacity 2 liter from first column and was again passed through second resin column. A composite sample of elute from first and second column was analyzed on Gas Chromatography.

Results and Discussion—Resins are having capacity to adsorb phenols on its surface. The maximum adsorption can be achieved by regulating the rate of elution. The initial concentration of phenols in the effluent was 6000 mg/l with COD 18000 mg/l, were reduced to 400 mg/l with COD 4600 mg/l. This concentration of phenols can also be further reduced below 100 mg/l by passing through similar second resin column. This will help in lowering down the initial concentration and effluent treatment cost required for biological treatment.

The biological treatment of phenols requires higher capacity of bioreactors which ultimately results in huge energy consumption for aeration. For e.g. treatment of 25 KL of phenolic effluent (6000 mg/l of phenols) and 18000 mg/l of COD, 450 KL capacity { (10 Meter (L) X 10 Meter (W) X 4.5 Meter (H) } of bioreactor is required. This will acquire 100 square meter of land and will require 20 HP motor for the aeration system. This consumes 358 KW per day. The

***.**Department of Environmental Science, Dr. Babasaheb Ambedkar Marathwada University Aurangabad**

result and overall cost benefit analysis of the treatment plant before and after recovery of the phenols is shown in **Table 1**. From the table it is very much clear that there is heavy difference of Rs.23, 50,000 if the effluent is biologically treated after recovery of the phenols. Recovery will also reduce

the electrical energy consumption from 358 KW to 180 KW per day. The recovery and recycling of phenols will save Rs. 30,40,000 per annum shown in **Table No.2**. The payback period for equipments like Resins and columns, required for recovery of phenols is 08 months.

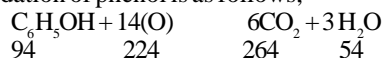
TABLE 1: Comparative statement of installation cost of bioreactors before and after recovery of phenols

PARAMETER	BEFORE TREATMENT	AFTER TREATMENT
Initial And Final Effluent Characteristic (For Treatment of 25 KL effluent / Day)		
Phenols mg/l	6,000	400
Phenols in Kg	150	10
COD mg/l	18,000	4,600
COD in Kg	450	115
Required Bioreactor Capacity in KL	450	125
Construction Cost In Rs. (6.66 Rs/L)	30,00,000	8,50,000
Membrane Cost	3,50,000	1,25,000
Blower Cost	1,50,000	75,000
Total Cost	35,00,000 (A)	10,50,000 (B)
Cost Saving	(A – B) 23,50,000	

TABLE 2 : Cost Benefit analysis of phenols recovery from 25KL of effluent

Total Resin Required For Recovery	2000 lit
Resin Cost In Rs. (A)	14,00,000
Column Installation Cost (B)	6,00,000
Total Cost 20,00,000	
Quantity Of Phenols Recovered / Day in Kgs.	140
Phenols Cost./kg (Rs)	100
Total Phenols Cost / Day (Rs.)	14,000
Total Phenols Cost / Month (Rs)	4,20,000
Total Phenols Cost / Year (Rs) (C)	50,40,000
Saving in Phenols Cost { C – (A+B) }	30,40,000
Pay Back Period.	08 Months.

Conclusion—The phenols compounds can be recovered efficiently by using resin column. The cost saving in initial investment of set up of bioreactors in ETP is 23, 50,000. The Yearly cost saving from phenols recovery is Rs.30, 40,000 with 8 months payback period. The reaction that takes place for the complete oxidation of phenol is as follows,



From above reaction It is clear that 94 kg of phenols evolves 264 kg of CO₂. By using resin column we can recover 140 kg of phenols / day. Ultimately we can save 51.1 MT of phenols per annum. Thus, it results into reduction of CO₂ emissions in atmosphere by 143.51 MT/year. It will not only save the cost, the natural resource, but also help in reduction of green house gas emission, the carbon dioxide. Recovery of phenols by resin column is therefore economically feasible and eco friendly method.

References -

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