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Biodegradation of chemical industry effluent by microbial consortia

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ABSTRACT

In the present study three bacterial species (Pseudomonas putida, Pseudomonas aeruginosa and Rhodococcus rhodochorus) were used in different combinations for the biotreatment of chemical industry effluent collected from Chennai under aerated conditions. The chemical oxygen demand (COD), biological oxygen demand (BOD), pH and dissolved oxygen (DO) of the chemical industry effluent was found to be very high than the permissible limits before treatment. After treatment one particular combination was capable of reducing the COD, BOD and DO of the effluent sample. Though there was no drastic change in the pH of the sample, it was not of great concern as the pH of the sample was well within the permissible limits for the discharge of the wastewater in natural sources after treatment.

Keywords: Microbial consortium, biodegradation, *Pseudomonas putida*, *P. aeruginosa* and *Rhodococcus rhodochorus*.

INTRODUCTION

Rapid growth of industries has not only enhanced the productivity but also resulted in release of toxic substances into the environment, creating health hazards. It has seriously affected normal operations of ecosystems, flora and fauna. In recent years, considerable attention has been paid to the industrial wastes, which are usually discharged on land or into different water bodies. This is likely to result in the degradation of environment [1]. In spite of the fact that aerobic biotreatment remains a preferred technology for the elimination of biodegradable pollutants from wastewaters, waste slurries, waste gas streams and seriously polluted environmental compartments, including soils, sediments, groundwater's and wastewater, remarkably little research concerning the dynamics of multiple pollutant degradation by microbial consortia has been conducted.

Until recently it has been common practice to classify biotreatment processes on the basis of the physical characteristics of the waste stream undergoing treatment. Essentially, wastewater streams containing soluble pollutants, polluted waste air streams and waste slurries have been examined on the basis of their different physical properties, rather than on the basis of the frequently common microbial mediated reactions responsible for their effective treatment. Biotreatment seeks to harness, control and accelerate reactions normally involved in natural self-purification, i.e., the reactions of the geobiochemical (or elemental) cycles for carbon, nitrogen, sulphur, etc.

Microorganisms can be present in biotreatment processes as discretely dispersed cells, as flocs or as biofilms. The latter two are by far the most common and both flocs and films can be considered as matrices of naturally immobilized cells. Environmental contamination by toxic xenobiotic chemicals has become a serious worldwide problem. Biological remedies for pollution reduction have received increasing attention since the 1980's. This increase in bioremediation applications has been fostered, in part, by our expanding knowledge of how these chemicals are metabolized by existing microbes, the isolation and utilization of new microbes and our ability to rationally design novel

metabolic capabilities using genetic engineering. Thus, users have increased our reparation of usable full bio-catalytic reactions for biotreatment applications.

However, certain microorganisms are able to survive in that environment because of their metabolic diversity mechanism to detoxify these chemicals. The process in which the microorganism converts the toxic or ecologically harmful materials into harmless molecules is known as bioremediation. Thus the microorganisms are capable of combating the pollutants.

Effluents from chemical industries contain various chemicals such as pthalic acid, fumaric acid, malic acid and benzoic acid, citric acid, thiourea etc. that discharge into natural water bodies. Certain microorganisms able to survive in this environment, develop mechanisms or detoxify these chemicals and (or) mineralized them. Conventional methods of wastewater treatment such as activated sludge or aerated lagoons are rather ineffective for biodegradation of wastewater, whereas indigenous microbial community seems to be most promising due to ability to degrade toxic compound and their intermediary metabolites [2].

Therefore the aim of the present study is to find out a suitable strain or consortia by continuous enrichment of the indigenous bacterial community and activated sludge for efficient degradation of the chemical industry effluent.

EXPERIMENTAL SECTION

The effluent samples were collected from the chemical industry, Chennai. The chemical composition of effluents was benzoic acid, 1.0%, pthalic acid 1.5%, malic acid 1.5%, fumaric acid 1%, citraconic acid 1.3%, thio urea 0.5% and acetic acid 0.01%. There are three strains of bacteria used in the present study, namely *Pseudomonas putida, Pseudomonas aeruginosa, Rhodococcus rhodochorus.* The bacteria cultures were obtained from PG and Research Dept. of Botany, Pachaiyappa's College, Chennai. These bacteria were cultured in a potato dextrose agar (PDA) at 35°C, respectively. The analysis of dissolved oxygen, pH, COD and BOD was done according to standard methods [3].

Bacterial biomass (harvested from both using centrifuge) and activated sludge were added in effluents for biodegradation, all that time effluent enriched with 1% jaggery, 0.5% urea and 0.25% Di-ammonium phosphate (DAP).

Effluent used for study:
Fumaric effluent:

COD	-	more than 100000 ppm
BOD	-	30000 ppm
pH	-	1.8 - 2.0
TDS	-	10000 pm

Fumaric effluent is not directly used for biodegradation, because of chemical oxygen demand (COD) were more. So, this effluent was diluted more than 5-10 times using raw waste. For neutralization of effluent lime powder were used (pH 6.5 - 7.0 ± 1).

Common protocol for experiment:
Concentrated effluent diluted up to 5 to 10 times using raw water and pH was raised up to 6.8 - 7.0 ± 1 then allow for settling and decant the supernatant. Approximate quantity of biomass or activated sludge was added in diluents effluent. Aerate the effluent up to experiment and (shaker 150 rpm). Every 24 hrs samples were analyzed for COD, BOD, pH temperature and D.O.

RESULTS

There is great concern about the deleterious effects of aromatic organic compounds in natural environment. Mixed bacterial community originating from sediment core contaminated with organic compounds in the chemical industry can degrade toxic compounds.

Biodegradation of industrial effluent by *Pseudomonas putida* showed 80 to 85% degradation in 5,000 to 10,000 ppm of effluent (Tables.1, 2). The time required for degradation compared more with 10,000 ppm to 5000 ppm of effluent.

During 0 hrs to 72 hrs 75 to 80% degradation was observed remaining 20 to 25% of degradation took more retention time due to feedback inhibition occurring in microbial enzymes belonging to the microbes used. By 0 day the COD values are higher (5617 and 10260 mg/L). When the effluent was treated with *Pseudomonas putida* there was a gradual reduction of COD from 24 hrs. At 120 hrs the COD concentration was 720 and 1165 mg/L by *Pseudomonas putida*. Similarly, the effluent was treated with *Pseudomonas putida* there was a gradual reduction of BOD from 24 hrs. In 0 day the BOD is higher (1874 and 5018 mg/L). At 120 hrs the BOD concentration was 185 and 725 mg/L by *Pseudomonas putida*.
The pH was maintained at around 6.5 to 8.0. The temperature was maintained at around 30ºC (0 to 168 hrs). Dissolved oxygen was observed in treating effluent (122 to 168 hrs).

Table.1 *Pseudomonas putida* biodegradation activity in 5000 ppm of effluent sample

S.No	Duration (hours)	1 g of *Pseudomonas putida* biomass = 100 ml at 5000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5617	0.00	1874	0.00	6.81	31.0	ND
2	24	2900	48.37	965	48.50	7.36	31.0	ND
3	48	1715	69.46	517	72.41	7.77	31.0	ND
4	72	1217	78.33	300	83.99	7.79	31.0	ND
5	96	890	84.15	222	88.15	7.91	31.0	ND
6	120	720	87.18	185	90.12	7.94	31.0	1.0

Table 2. *Pseudomonas putida* biodegradation activity in 10000 ppm of effluent sample

S.No	Duration (hours)	2.0 g of *Pseudomonas putida* + 100ml at 10000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10260	0.00	5018	0.00	6.5	29.0	ND
2	24	6900	32.74	2875	42.70	7.22	29.1	ND
3	48	3300	67.83	2100	58.15	7.46	30.0	ND
4	72	2115	79.38	1720	65.72	7.61	30.0	ND
5	96	1975	80.75	1190	76.28	7.77	29.5	ND
6	120	1660	83.82	914	81.78	7.79	29.8	ND
7	144	1220	88.2	761	84.83	7.86	29.8	0.88
8	168	1165	88.64	725	85.55	8.01	30.0	1.2

Table 3. *Pseudomonas aurignosa* biodegradation activity in 5000 ppm of effluent sample

S.No	Duration (hours)	1.0 g of *Pseudomonas auruginosa* + 100ml at 5000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5320	0.00	2261	0.00	6.80	30.0	ND
2	24	2710	49.0	1450	35.8	7.20	29.0	ND
3	48	1980	62.78	1120	50.46	7.38	29.0	ND
4	72	1230	76.87	820	63.73	7.51	30.0	ND
5	96	921	82.6	445	80.31	7.86	30.0	ND
6	120	465	91.25	160	89.1	7.91	30.5	0.8

Table 4. *Pseudomonas aurignosa* biodegradation activity in 10000 ppm of effluent sample

S.No	Duration (hours)	2.0 g of *Pseudomonas aurignosa* + 100ml at 10000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10681	0.00	5210	0.00	6.81	30.0	ND
2	24	5580	47.75	2630	49.52	7.12	30.0	ND
3	48	3320	68.9	1570	69.8	7.38	30.6	ND
4	72	1920	82.0	1122	78.46	7.78	30.3	ND
5	96	1300	87.8	980	81.0	7.86	31.5	ND
6	120	1040	90.26	912	82.49	7.86	30.5	ND
7	144	1015	90.49	880	83.1	7.88	29.5	0.5
8	168	918	91.40	820	84.26	7.96	30.0	1.2

In the present study *Pseudomonas auruginosa* showed 80 to 85% degradation in 5000 ppm to 10000 ppm of effluent samples (Tables.3, 4). During 0 hrs to 72 hrs 80% of biodegradation was observed, remaining 5 to 10% degradation took more retention time due to feedback inhibition occurring microbial enzymes belonging to the microbes used. The hydrogen ion concentration was maintained at around 6.5 to 8.0 pH. During 0 hrs to 168 hrs almost temperature was maintained at around 30ºC. In treated effluent sample dissolved oxygen were observed (1.5 ppm) but untreated effluent sample dissolved oxygen was not below detectable amount. The mild colour reduction was also observed in treating sample. In 0 day the COD values are higher (5320 & 10681 mg/L). When the effluent was treated with *Pseudomonas*

auruginosa there was a gradual reduction of COD from 24 hrs. At 168 hrs the COD concentration was 465 & 918 mg/L by *Pseudomonas auruginosa.* Similarly, the effluent was treated with *Pseudomonas auruginosa* there was a gradual reduction of BOD from 24 hrs. In 0 day the BOD is higher (2261 & 5210 mg/L). At 168 hrs the BOD concentration was 160 & 820 mg/L by *Pseudomonas auruginosa.*

Table 5. *Rhodococcus rhodochorus* biodegradation activity in 5000 ppm of effluent sample

S.No	Duration (hours)	1.0 g of *Rhodococcus rhodochorus* + 100ml at 5000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5017	0.00	2753	0.00	6.8	30.0	ND
2	24	1770	64.71	1060	61.49	32.4	29.0	ND
3	48	1753	65.05	1040	62.22	7.50	31.0	ND
4	72	1420	71.69	885	67.85	7.73	30.5	ND
5	96	879	82.40	651	76.3	7.96	30.0	ND
6	120	627	87.50	625	77.29	7.99	30.7	0.5

Table 6. *Rhodococcus rhodochorus* biodegradation activity in 10000 ppm of effluent sample

S.No	Duration (hours)	2.0 g of *Rhodococcus rhodochorus* + 100ml at 10000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10017	0.00	5386	0.00	6.80	30.5	ND
2	24	6440	35.7	2913	45.97	7.01	30.5	ND
3	48	2900	71.04	1820	66.20	7.28	30.0	ND
4	72	2680	73.2	1260	76.1	7.33	29.6	ND
5	96	1640	83.6	960	82.17	7.54	30.2	ND
6	120	1525	84.77	830	84.5	7.77	30.7	ND
7	144	1380	86.2	780	85.51	7.78	29.7	0.5
8	168	1200	88.02	730	86.44	7.90	30.0	1.0

Table 7. Consortium biomass (*Pseudomonas pudita* + *P. aeruginosa* & *Rhodococcus Rhodochorus*) biodegradation activity in 5000 ppm of effluent sample

S.No	Duration (hours)	1.0 g of *Consortium* of cells + 100ml at 5000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5418	0.00	2820	0.00	6.89	30.0	ND
2	24	2265	58.0	1770	37.23	7.26	29.0	ND
3	48	1990	63.2	1225	56.56	7.33	30.4	ND
4	72	845	84.3	482	82.9	7.71	30.0	ND
5	96	400	92.61	230	91.84	7.94	29.5	0.5
6	120	265	95.10	92	96.73	8.21	30.0	1.0

Table 8. Consortium biomass (*Pseudomonas pudita* + *P. aeruginosa* & *Rhodococcus Rhodochorus*) biodegradation activity in 10000 ppm of effluent sample

S.No	Duration (hours)	2.0 g of *Rhodococcus rhodochorus* + 100ml at 10000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10444	0.00	5116	0.00	6.63	30.2	ND
2	24	4975	52.36	2130	58.36	7.27	30.0	ND
3	48	2527	75.8	1422	72.2	7.32	30.5	ND
4	72	1930	81.52	930	81.82	7.59	30.5	ND
5	96	1040	90.0	516	89.9	7.88	31.5	ND
6	120	860	91.76	310	93.9	8.0	30.1	ND
7	144	570	94.54	230	95.5	8.21	30.0	0.5
8	168	308	97.05	97	98.10	8.30	30.0	1.0

Table 9. Activated sludge *biodegradation* activity in 5000 ppm of effluent sample

S.No	Duration (hours)	1.0 g of Activated sludge + 100ml at 5000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5237	0.00	2915	0.00	6.81	30.0	ND
2	24	2962	43.44	1780	39.3	7.34	31.0	ND
3	48	1820	65.24	920	68.43	7.48	30.0	ND
4	72	824	84.2	422	85.6	7.59	30.0	ND
5	96	690	86.82	290	90.0	7.79	29.5	0.5
6	120	310	94.0	110	96.22	7.86	30.0	1.0

Table 10. Activated sludge biodegradation activity in 10000 ppm of effluent sample

S.No	Duration (hours)	2.0 g of Activated sludge + 100ml at 10000 ppm effluent						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10355	0.00	5628	0.00	6.39	30.0	ND
2	24	5920	42.82	2821	49.8	7.11	30.0	ND
3	48	2620	65.0	1970	64.99	7.28	30.1	ND
4	72	2080	79.9	1000	82.23	7.36	30.5	ND
5	96	1540	85.1	786	86.0	7.59	30.0	ND
6	120	630	93.91	280	95.02	7.77	30.0	ND
7	144	440	95.7	260	95.38	7.98	30.0	1.0
8	168	280	97.29	140	97.51	8.21	30.0	1.0

Table 11.Without addition of any biomass or activated sludge biodegradation activity in 5000 ppm of effluent sample (Control)

S.No	Duration (hours)	100 ml at 5000 ppm effluent + Without addition of any biomass						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	5449	0.00	2320	0.00	6.50	30.0	ND
2	24	5421	0.51	2270	2.15	6.81	31.0	ND
3	48	5090	6.58	2083	10.2	6.88	30.0	ND
4	72	4970	8.71	1990	14.22	7.01	30.0	ND
5	96	4931	9.50	1971	15.04	7.11	29.5	ND
6	120	4900	10.07	1960	15.51	7.09	30.0	ND

Table 12. Without addition of any biomass or activated sludge biodegradation activity in 10000 ppm of effluent sample (Control)

S.No	Duration (hours)	100 ml at 10000 ppm effluent + Without addition of any biomass						
		COD ppm	% R	BOD ppm	% R	pH	Temp ºC	D.O ppm
1	0	10281	0.00	5162	0.00	6.82	30.0	ND
2	24	9920	3.51	5150	0.23	6.88	30.0	ND
3	48	9730	5.35	5000	3.13	6.91	30.0	ND
4	72	9404	8.52	4920	4.68	7.07	29.5	ND
5	96	9265	9.82	4875	5.56	7.11	30.0	ND
6	120	9240	9.88	4800	7.01	7.16	30.0	ND
7	144	9032	12.14	4710	8.75	7.18	30.0	ND
8	168	8955	12.89	4685	9.24	7.23	30.0	ND

Biodegradation by *Rhodococcus ridiculous* showed 80 to 85% degradation in 5000 to 10000 ppm in the effluent samples (Tables 5, 6). The hydrogen ion concentration was maintained at around 6.5 to 8.5 pH and then the temperature was maintained at around 30ºC. Dissolved oxygen was detected at 5000 ppm and 10000 ppm of treated effluents. The mild colour reduction was also observed in treated effluent samples. In 0 day the COD values are higher (5017 & 10017 mg/L). When the effluent was treated with *Rhodococcus rhodochorus* there was a gradual reduction of COD from 24 hrs. At 168 hrs the COD concentration was 627 & 1200 mg/L by *Rhodococcus rhodochorus.* Similarly, the effluent was treated with *Rhodococcus rhodochorus* there was a gradual reduction of BOD from 24 hrs. In 0-day the BOD is higher (2753 & 5386 mg/L). At 168 hrs the BOD concentration was 625 & 730 mg/L by *Rhodococcus rhodochorus.*

Biodegradation studies were carried out using consortium biomass (*Pseudomonas putida, Pseudomonas aeruginosa* and *Rhodococcus rhodochorus*) showed 90 to 97% biodegradation in 5000 to 10000 ppm of effluent sample (Tables.7, 8). During 0 hrs to 72 hrs effluents biodegradation was observed when compared to 96 hrs to 168 hrs. The pH was maintained around 6.5 to 8.2. pH and temperature were also maintained at around 30ºC. Consortium biomass treated effluent samples had high dissolved oxygen (Tables 7, 8) when compared to individual biomass treated effluent samples. Effluent colour reduction up to 95% was also observed in treated effluent. In 0 day the COD values are higher (5418 & 10444 mg/L). When the effluent was treated with consortium biomass there was a gradual reduction of COD from 24 hrs. At 168 hrs the COD concentration was 265 & 308 mg/L by consortium biomass. Similarly, the effluent was treated with consortium biomass there was a gradual reduction of BOD from 24 hrs. In 0 day the BOD is higher (2820 & 5116 mg/L). At 168 hrs the BOD concentration was 92 & 97 mg/L by consortium biomass.

Biodegradation using activated sludge showed 90 to 97% degradation in 5000 to 10000 ppm of effluent (Tables.9, 10). During 0 hrs to 72 hrs biodegradation was very effective. Almost pH was maintained at around 6.5 to 8.2. Increased dissolved oxygen, noted in aerated effluent samples taken after 96 to 168 hrs. Colour reduction was also observed in the treated effluent samples. In 0 day the COD is higher (5237 & 10355 mg/L). When the effluent was treated with activated sludge there was a gradual reduction of COD from 24 hrs. At 168 hrs the COD concentration was 310 & 280 mg/L by

activated sludge. Similarly, the effluent was treated with activated sludge there was a gradual reduction of BOD from 24 hrs. In 0 day the BOD is higher (2915 & 5628 mg/L). At 168 hrs the BOD concentration was 110 & 140 mg/L by activated sludge.

Without the addition of any biomass or activated sludge added effluent degradation was very poor (Tables.1, 12). The pH was maintained at around 6.0 to 7.1 pH. Dissolved oxygen was not detected 0 to 168 hrs in the aerated effluent samples. Colour reduction also very poor in aerated sample. In 0 day the COD values are higher (5449 & 10281 mg/L). When the effluent was treated without addition of any biomass or activated sludge there was a gradual reduction of COD from 24 hrs. At 168 hrs the COD concentration was 4900 & 8955 mg/L by without addition of any biomass or activated sludge. Similarly, the effluent was treated with without addition of any biomass or activated sludge there was a gradual reduction of BOD from 24 hrs. In 0-day the BOD values are higher (2320 & 5162 mg/L). At 168 hrs the BOD concentration was 1960 & 4685 mg/L by without addition of any biomass or activated sludge.

The result revealed that the higher reduction of COD and BOD was observed in different bacterial strains and consortia. Experiments regarding genetic characterization and extra cellular enzyme formation during the degradation process are underway in our laboratories.

DISCUSSION

In the present study effluent generated due to production of following compounds (Benzoic acid, pthalic acid, malic acid, fumaric acid, citoconic acid and nucleic acid) were used as sample for biodegradation. The above samples were enriched with 1% jeggery, 0.5% urea and 0.25% Di-ammonium phosphate and inoculated with *Psedomonas putida, P. aeruginosa, Rhodococcus rhodochorus,* consortium biomass and activated sludge for adding degradation. Proper agitation was provided (Shaker 135 rpm).

In the present study, biodegradation showed 80-85% degradation in 5000 ppm and 10000 ppm in the effluent samples. During (0-hrs to 72 hrs 75 to 85% biodegradation activity was observed remaining 5-10% degradation took more retention time due to feedback inhibition occurring in microbial enzymes belonging to the microbes used. Schwien and Schimidt [4] have reported on biodegradation of benzoic acid, pthalic acid, fluorobenzoate and chlorobenzoate using *Psedomonas putida.*

In the present study of biodegradation by *Psedomonas putida* showed 85 - 90% degradation and retention time was 168 hrs. Reduction of retention time from 900 hrs to 160 hrs decreased effluent treatment expenditure. From this study and based on various studies, it was found that pH control within range of 7.0 - 8.0 could increase the process efficiency [5]. Base pH boundary 7.8 - 8.5 had the strongest effect on naphthalene degradation. pH can affect microbial activity and therefore investigations into the effect of enzyme activity, transport processes and the nutrient solubility were made.

Increased dissolved oxygen was noted in aerated effluent samples at 120 to 169 hrs. The temperature was maintained at around 30ºC. The mild colour reduction was also observed in effluent samples.

Biodegradation of industrial effluent *Pseudomonas aeruginosa* 85 to 90% degradation in 5000 ppm to 10,000 ppm of effluent samples. During 0 to 72 hrs 80% of biodegradation was observed, remaining 5 to 10% degradation took more retention time due to feedback inhibition occurring in microbial enzyme belong microbes used. pH was maintained in around 6.5 to 8.0. During the 0-hrs almost temperature was maintained at around 30ºC. In treated effluent samples dissolved oxygen was observed (1.5 ppm but untreated effluent samples dissolved oxygen was not below detectable amount.

Biodegradation by *Rhodococcus rhodochorus* showed 85 to 90% degradation at 5000 to 10000 ppm in the effluent samples. Another strain of *Rhodococcus erythropolis* showed 2% degradation in n-tetradecane containing di-benzothiophene in the effluent [6]. pH ion concentration was maintained at around 6.5 to 8.0 and temperature was maintained at around 30ºC. Dissolved oxygen was detected at 5000 ppm and 10000 ppm of treated effluents. The mild colour reduction was also observed.

Biodegradation studies using consortium biomass (*Pseudomonas putida, Pseudomonas aeruginosa* and *Rhodococcus rhodochorus*) showed 90 to 97% biodegradation in 5000 to 10000 ppm of effluent samples. Many authors opined mixed culture with the addition of nontoxic surfactant enhanced the biodegradation of poly aromatic hydrocarbons [7]. In the present study without the addition of nontoxic surfactant gave very effective biodegradation of effluent samples. During 0

to 72 hrs effective biodegradation was observed when compared to 96 to 168 hrs. pH was maintained at around 6.5 to 8.2 pH and temperature was maintained at around 30ºC.

Consortium biomass treated effluent samples had high dissolved oxygen compared to individual biomass treated effluent. Colour reduction up to 95% was also observed in treated effluent samples when compared to individual biomass treated samples.

Biodegradation using activated sludge showed 92 to 97% degradation in 5000 to 10000 ppm of effluent samples. In the previous study activated sludge was used to treat all kinds of effluent to achieve biodegradation [8, 9]. During 0 to 72 hrs biodegradation was very effective. Almost pH was maintained at around 6.5 to 8.2. Increase dissolved oxygen was noted in aerated effluent samples taken after 96 to 168% hrs. Colour reduction was also observed in treated effluent samples.
In addition, bacteria are able to change and adapt themselves to changes in environmental condition such as a change from anoxic to aerobic condition. In either anoxic or aerobic condition, bacterium Pseudomonas heterotrophy is able to use fumaric acid as the aromatic compounds indicator and as a source of carbon [10]. Change of bacterium metabolism from anoxic to aerobic helps it produce the required enzymes in shorter time. Among anoxic/aerobic advantages, it can be referred to lower utilization cost, less biomass production during anoxic process, and finally less slime decomposition. Lower cost of this method in aromatic hydrocarbons removal is very beneficial. In nature, aromatic compounds decomposition is influenced by environmental parameters such as pH, temperature degree, and amount of injected bacterium [11].

This preliminary study indicates that these microorganisms can be successfully used in biodegradation process for the reduction of BOD, COD in the chemical industry effluent. This lab scale study is being extended to the bench top bioreactor so that it can further be scaled up to the industrial level.

CONCLUSION

Wastewater from chemical industry contains a variety of polluting substances. Physical, chemical and physico-chemical methods are available to treat these type of effluents, but they are expensive and do not provide satisfactory results. The biological treatment methods are cheap and offer the best alternative to treat the chemical industry effluent. In the present study, an attempt has been made to reduce the colour and pollution load of COD. BOD, pH and dissolved oxygen of the chemical industry effluent by biological methods. The findings in the present study could serve as an important base for developing economic as well as biological system using microorganisms for providing reusable clean water for industrial as well as for agricultural use.

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