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Application of Bio technology in Treatment of Heavy Metal Contaminated Industrial Waste Water-A case study

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Abstract : Human life, as with all animals and plants life on this planet, is dependent upon water. Effluents from industries like; textile, leather, electroplating, dyes and pigment, metallurgical contain considerable amounts of toxic metal ions. These metal ions pose problems to the water environment as the industries often indulge in discharging waste water into underground and open drains or pit. The potential impacts from leaching operations on the environment are most likely to be experienced as changes to surface and groundwater quality. In this study an attempt has been made to utilize the microbes in treatment of industrial waste water collected from textile, electroplating industries. Studies have been carried out to specifically utilize the selected species of locally available microbial species in treatment of chromium contaminated industrial waste water. Waste water samples were collected from various industries subjected to characterization and compared analysis results. The waste water was subjected to bio remediation process to treat the waste water and the results have shown that the possibility of application Acidthiobacillus microbial community in effective treatment of chromium contaminated industrial waste water.
Keywords : Effluents. Treatment, Acidthiobacillus, chromium.

Introduction:

Water a necessity for life. This vital resource makes up 60 percent of the human body. A person can live no more than 4 to 5 days without water, and we rely on it for drinking, Cooking, bathing, washing clothes, growing food, recreation, industry, and mining, as well as generation of electric power. Water is a renewable resource (Stephen J. Vandas*et. al* 2002). Cr (VI) is toxic, carcinogenic and mutagenic metal ion to animals as well as humans and is associated with decreased plant growth and changes in plant morphology. It is one of the most strategic, critical & highly soluble metal pollutant having wide range of uses in the metals and chemical industries. Chromium exists in the environment in several diverse forms such as trivalent Cr (III) and hexavalent Cr (VI), of which hexavalent chromium Cr (VI) is a so-called carcinogen and a potential soil, surface water and ground water contaminant. Both human beings and animal community are being affected by the increased concentration of chromium metal in the water or soil environment. The main diseases includes, "gastrointestinal bleeding, tuberculosis, asthma, infertility, birth defects, and stillbirths" (Williams N, 1998). Potential health effects after exposure to chromium the chronic allergic contact dermatitis that it can lead to considerable health problems are studied (Malene Barre Hansen *et.al* 2002). Bioremediation is one of the most

promising technological approaches to the problem of hazardous waste. This process relies on microorganisms such as bacteria or fungi to transform hazardous chemicals into less toxic or nontoxic substances (Gulf Breeze*et.al* 1995). Biological reduction of Cr (VI) using indigenous microorganism offer a new cost-effective and environmentally compatible technology. Bioremediation is the use of living organisms, primarily microorganisms, to degrade the environmental contaminants into less toxic forms. Bio remediation technology is used to; degrade organic substances that are hazardous to living organisms and degrade the organic contaminants into inert products such that only harmless biological wastes are remained in the waste stream.***Acidithiobacillus*** is a genus of Proteobacteria. It is a Gram-negative organism with Size of 2.9 Mbp (2,885,038 bp***Acidithiobacillusferrooxidans*** is an autotrophic, acidophilic, mesophile occurring in single or occasionally in pairs or chains, depending on growth conditions. This bacteria is used in a mining technique called bioleaching whereby metals are extracted from their ores through oxidation. It is used in treating phenols and chromium content in waste water.

Process of bioremediation:

1. Microbes release enzymes to break down the contaminants into digestible pieces.
2. The contaminant of organic substances is ingest and digest as food along with other energy sources by the cell.

Materials and Methods:

The methodology followed in bio remediation process is as follows;

1. Prepare the standards as per the concentration of sample.
2. Add 100 ml of standard & samples to the respective screw cap bottles.
3. Add 1ml of inoculum to the sample and incubate all the screw cap bottles at 30 – 35^{o}C.
4. If required add small amount of peptone & sucrose as nutrient source.
5. Measure O D and compare the standards & sample at different time interval
6. Tabulate the results and plot a graph and compared.

Confirmation Tests:

As the micro-organism used was obtained from NCIM. To conform the micro-organism the following test were performed,

- Gram's staining.
- Hydrogen peroxide test (catalase test).
- Sulphur indole motility test.

Sulfur indole motility (sim) test:

- Sulphur bacteria act in a similar fashion to iron bacteria and are also commonly found in well-water systems. They also produce thick slime, usually colored black. The odors produced by them can be described as 'rotten eggs'. They are tested for in water samples.
- Biochemical test to aid in the identification of enteric bacteria.
- If the microorganism contains sulphur then it is said to belong to the group of ferrooxidans species.

Results:

The waste water collected from different industries was analyzed for various parameters the concentration values are as tabulated in Table. 1 & 2. The comparison of the different waste water samples based on their color are as shown in Table.1 The bioremediation values at different time interval of a chemically synthesized chromium sample were tabulated in Table.

Table 1:

Sl No.	Test Parameter	Sample A mg/ml	Sample B mg/ml	Sample C mg/ml	Sample D mg/ml	Sample E mg/ml	Sample F mg/ml
1.	Color	Creamish brown	Greenish	Greenish	Greyish	Slight Yellow	Greyish
2.	pH	7.77	2.24	2.24	6.70	7.61	8.35
3.	Temperature (^oC)	26	27	27	26	30	27
4.	Turbidity in NTU	800.o	20.3	20.3	43.3	4.9	182.8
5.	Conductivity (mohms/cm)	400.0	Acidic	Acidic	1500.0	2100.0	2000.0
6.	COD	4528.8	1065.6	444.0	399.2	133.0	355.0
7.	BOD (ppm)	2.56	2.8	1.9	2.4	1.87	2
8.	Total hardness (ppm of $CaCO_3$)	972.2	-	1354.8	-	1115.744	896.97
9.	Zinc (as Zn)	2.0	0.3	0.05	0.1	0.1	0.05
10.	Lead (as Pb)	1.09	-	0.15	-	0.05	0.021
11.	Hexavalent Chromium (as Cr^{6+})	1.5	0.87	0.29	1.9	0.58	0.54
12.	Total Chromium (as Cr)	1.2	0.9	2.0	0.5	2.0	0.5

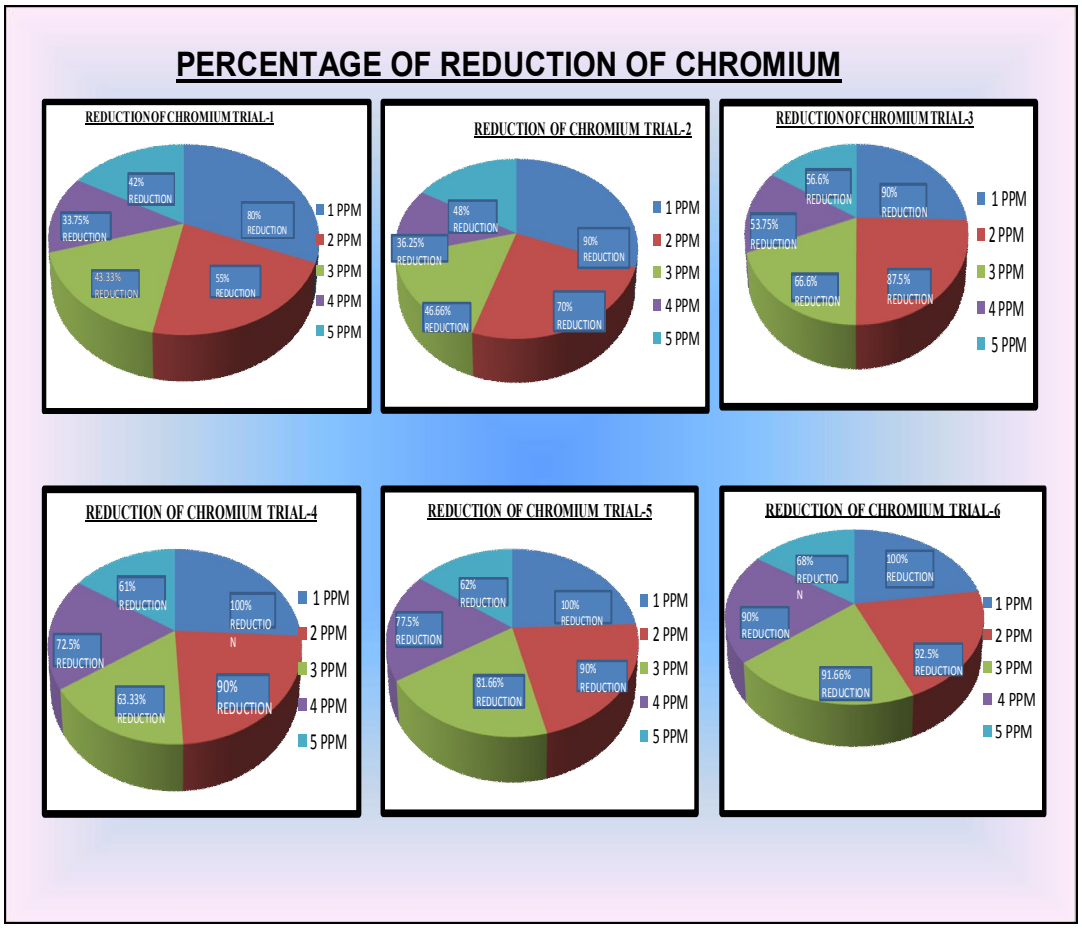

Table 2:

Sl No.	Standard Concentration In Ppm	Standard Absorbance In Nm	Sample Absorbance In Nm	Sample Concentration In ppm	% Of Chromium Degradation
The absorbance value and % of chromium degradation in trial -1					
1.	1	0.137	0.025	0.2	80
2.	2	0.264	0.12	0.9	55
3.	3	0.364	O.223	1.7	43.33
4.	4	0.473	0.35	2.65	33.75
5.	5	0.557	0.383	2.9	42
The absorbance value and % of chromium degradation in trial -2					
Sl No.	**Standard Concentration In ppm**	**Standard Absorbance In Nm**	**Sample Absorbance In Nm**	**Sample Concentration In ppm**	**% Of Chromium Degradation**
1	1	0.134	0.011	0.1	90
2	2	0.254	0.074	0.6	70
3	3	0.366	0.189	1.6	46.66
4	4	0.487	0.310	2.55	36.25
5	5	0.571	0.317	2.6	48

Conclusions:

- Chromium concentration is found to be high in the waste water of some of the waste water samples.
- Though the concentration of other metals are also present in high level they are not asharmful as when compared to chromium.
- Though there are many microorganisms used for degradation of waste water we have used *acidthiobacillusferrooxidans*for our experiment.
- The results for 6 different time interval were analyzed and found that the chromium content was degraded 80-100%.
- If the degradation procedure was continued then there could be further degradation of chromium.
- When compared to chemical method of analysis the biological method is more convenient and also consumes less time. So biological method of remediation could be recommended

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