# REDUCTION OF TOTAL CHROMIUM IN INDUSTRIAL EFFLUENT

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## ABSTRACT

*Chromium (Cr) is an environmentally significant metal used in various industrial processes Cr compounds enter natural waters mainly through the effluents from electroplating and tanning industries, from dyeing, from sanitary land fill leaching's and from water-cooling towers. It can also enter the drinking water distribution system from the corrosion inhibitors used in water pipes. Cr is the most commonly used tanning agent. Nearly 90% of all leather produced is tanned using Cr. The determination of trace of Cr in environmental samples is of great importance due to its toxicity. The two main oxidation states of Cr, Cr (III) and Cr (VI), present in natural waters, significantly differ in biological, geochemical and toxicological properties. Whereas Cr (III), over a narrow concentration range, is considered essential for mammals for the maintenance of glucose, lipid and protein metabolism and Cr (VI) is reported to have a toxic effect on humans. Cr (VI) is recognized as a serious health hazard for workers in Cr-plating plants and is a source of various cancer diseases. In view of the above, the determination of Cr at trace levels has received considerable attention. Sample pretreatment techniques which include analytic element separation and pre-concentration introduce additional laborious and time-consuming sample manipulation steps with contamination risk. Therefore, direct methods of determination of total element are preferable, if they are sufficiently sensitive.*

## INTRODUCTION

Waste water released from industries is a major concern for environmentalists these days. Industrial effluents contain various toxic metals, harmful gases and several organic and inorganic compounds. The discharge of these untreated toxic effluents has deteriorated the natural flora and fauna and poses a risk to human health.. The long-term consequences of exposure also cause fatal diseases like cancer, delayed nervous responses, mutagenic changes, neurological disorders etc. in humans. Industrial effluent containing chromium and aromatic compounds like phenol are discharged by the industrial processes of wood Preserving, metal finishing, petroleum refining, leather tanning and finishing, paint and ink Formulation, pulp and paper industry, textile Industry, pharmaceutical industry and automobile parts manufacturing industry. In order to remove these pollutants from the effluent, expensive chemical and physical processes like ionization, adsorption, and ion exchange, membrane filtration, chemical oxidation etc. are used. Most of these processes are high energy consuming, non-economic and release effluent waste water which is detrimental to the environment. Recently biotechnological processes have been reported as alternative expensive treatment methods. Biological methods are simple as well as eco-friendly and have the potential to completely reduce and degrade the pollutants under aerobic or anaerobic conditions at relatively low capital and operating cost. Very few researchers have initiated research work on degradation of phenol and chromium using mixed culture of different phenol reducing and chromium degrading microorganisms. Studied the simultaneous removal of the two pollutants by using a phenol degrading organism *Pseudomonas putrid*DMP-1 and a Cr (VI)reducing strain *Escherichia coli* ATCC 33456, with phenol as the sole added carbon and energy source. Nkhalambayausi-Chirwa and Wangalso observed the optimum Cr (VI) reduction at a phenol concentration of 200mgl-1 and an initial Cr (VI) concentration of 2mgl−1, while complete phenol degradation was observed in cultures only under low initial Cr (VI) concentrations (≤10mgl−1). Researchers have studied the simultaneous removal of Cr (VI) and phenol in a culture containing *Bacillus* sp. and *Pseudomonas putrid* Miguel CCTCC AB92019. All these treatment processes were carried on aqueous solution of phenol and chromium. Few literatures are available on treatment of industrial effluent containing chromium and phenol.

## STUDIES ON TEXTILE POLLUTION

Textile and Clothing (T&C) is one of the largest and oldest industries present globally (Giraffe, 2002). However, the textile industry is considered to be one of the biggest threats to the environment. The various processes carried out in the textile industries produce large amounts of gas, liquid and solid wastes. The textile industry uses a variety of chemicals and a large amount of water for all of its manufacturing steps. About 200 L of water are used to produce 1 kg of textile. In the year 2012, Paul et al. selected six textile industries in East region of Solapur city for analyzing the major pollution indicator parameters namely BOD, COD, TDS, sulphide, sulphate, chloride, hardness, alkalinity, calcium and magnesium. They reported unto 1548 ppm COD, 7072 ppm TDS, 79 ppm sulfide, 2750 ppm chloride and 912 ppm sulphate for different textile units of Solapur. As per the report by Rathore (2012), around 49 MLD (Million Litres/Day) of combined effluent from more than 800 texile dyeing and printing industries with domestic sewage is being discharged in Bandi river at Pali. The physicochemical parameters Cl-SO42-, NO3,

suspended solids, chemical oxygen demand and biological oxygen demand assessed in the combine effluent were higher than the recommended standards for discharge of industrial effluent by BIS. The overall pollution load in Bandi River in terms of chemical oxygen demand, biological oxygen demand, suspended solids and total alkalinity is 57,520 kg/ day 38,160 kg/day, 61,950 kg/day and 74570 kg/day respectively. Therefore, the pollution load estimated clearly illustrates the environmental degradation in the study area to a great extent. In addition to this, Pali city is one of the critically polluted areas identified by CPCB in 1998. These textiles and dying industries discharge their treated and untreated residual wastes directly into the Bandi river that flows from east to west. Due to this discharge, the river water acquired an organic, pungent smell, dark color, high alkaline pH, very low dissolved oxygen, high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and high amounts of total suspended / dissolved and volatile solids (TDS)(Bhadra, 2013). The study by Dutta and Singh (2014) revealed that the groundwater samples of Pail, industrial area has shown alkaline nature and chemical parameters – COD, BOD, total dissolve solids electrical conductivity, chloride and Cr have exceeded the maximum discharge limits laid down by Bureau of Indian Standards , rendering wells in the area unfit for drinking and even for irrigation. The soil in this area has also become hard and infertile.

**PRECIPITATION OF TOATAL CHROMIUM FROM TEXTILE INDUSTRY**

The removal of Cr from textile industry wastewater by chemical precipitation using ferric chloride was investigated in the present study. The ferric chloride was able to precipitate out Cr as well as coloring matter from the wastewater. The precipitation was found to be highly dependent on both pH and dose of iron salt used. The Cr removal was effective under highly alkaline conditions above pH 10 and the color removal was effective in the pH range of 3.0-6.0. The chemical precipitation performed at pH 12, using ferric chloride dose of 2.5 g/l, was able to reduce 98% of phenols and 80% of color from the textile industry. The experiments showed the Cr reduction from 564 mg/l to a dischargeable level of 2mg/l after treatment with ferric chloride at pH 12. The study claims that the ferric chloride can be used effectively to remove phenols from textile industry.

**SIMULTANEOUS REDUCTION OF CHROMIUM FROM TEXTILE INDUSTRY**

Simultaneous removal of Cr (VI) from textile industry effluent was achieved with the help of two indigenous microorganisms *Pseudomonas putida* (MTCC 1194) and *Escherichia coli* (NCIM 5051). The metabolites, energy and electrons produced during the phenol degradation by *Pseudomonas putida* are utilized by *Escherichia coli* for the reduction of Cr (VI). Simultaneous Cr (VI) degradation is studied at constant Cr (VI) concentration (5 mg l−1). The bioreactor results shows 5 ppm of Cr (VI) takes (10–12) hours respectively for their complete degradation when present in aqueous solution containing both chromium, But in case of textile industry effluent it takes (16–18) hours respectively for their complete degradation indicating the inhibitory effect of organic and inorganic pollutants along with other heavy metals present in the textile industry effluent. The effluent analyzed post treatment confirmed the reduction of chromium concentrations along with other contaminants to their permissible limits. So the studied indigenous organisms can be very well applied for the treatment of effluents containing the multiple contaminants such as phenol and chromium.

## MATERIALS & METHODS

**BIOCHEMICAL ANALYSIS**

IDENTIFICATION OF *E.COLI*

- Firstly serial dilution was performed upto 5 folds, with both the samples, i.e, sewage water and textile effluent
- LB agar was taken as the media for the growth of *E.Coli*, and 120 ml media was prepared for 6 petri-plates
- The apparatus along with the prepared media was autoclaved at 121 degree celsius
- Then the media was poured into the petri-plates, 20ml of media in each plate in sterile conditions
- After the media got dried off, 200ul of the diluted sewage water sample from $4^{th}$ and $5^{th}$ was poured in each of the 3 plates and 200ul of diluted textile effluent from $4^{th}$ and $5^{th}$ was poured into the other 3 plates and was properly spread with the L-rod in sterile conditions
- Then the plates were wrapped with tapes and kept for overnight incubation at 37 degree celsius
- Then next day, cell cultures were observed in the 6 plates
- For confirmation of *E.Coli sp.* MacConkey's agar was prepared as a selective media for the growth of *E.Coli* under sterile conditions.
- From the mother cultures in the plates, a small loop of the culture was taken by sterile loop, and was streaked on MacConkey's agar.
- Observed cultures was of *E.Coli sp.*

**IDENTIFICATION OF *Salmonella***

- Firstly serial dilution was performed upto 5 folds, with both the samples, i.e, sewage water and textile effluent
- Deoxycholate citrate agar (DCA) was taken as the selective media for the specific growth of *salmonella sp*. and 120 ml media was prepared for 6 petri-plates
- The apparatus along with the prepared media was autoclaved at 121 degree celsius
- Then the media was poured into the petri-plates, 20ml of media in each plate in sterile conditions
- After the media got dried off, 200ul of the diluted sewage water sample was poured in each of the 3 plates and 200ul of diluted textile effluent was poured into the 3 plates and was properly spread with the L-rod in sterile conditions
- Then the plates were wrapped with tapes and kept for overnight incubation at 37 degree Celsius
- Then next day, *salmonella* cultures were observed in the 6 plates
- The culture was confirmed to be *salmonella* as the media used was selective media for non lactose fermenting bacteria *salmonella sp.*
- Observed cultures was of *salmonella sp.*

**EFFECTIVE MICROORANISMS**

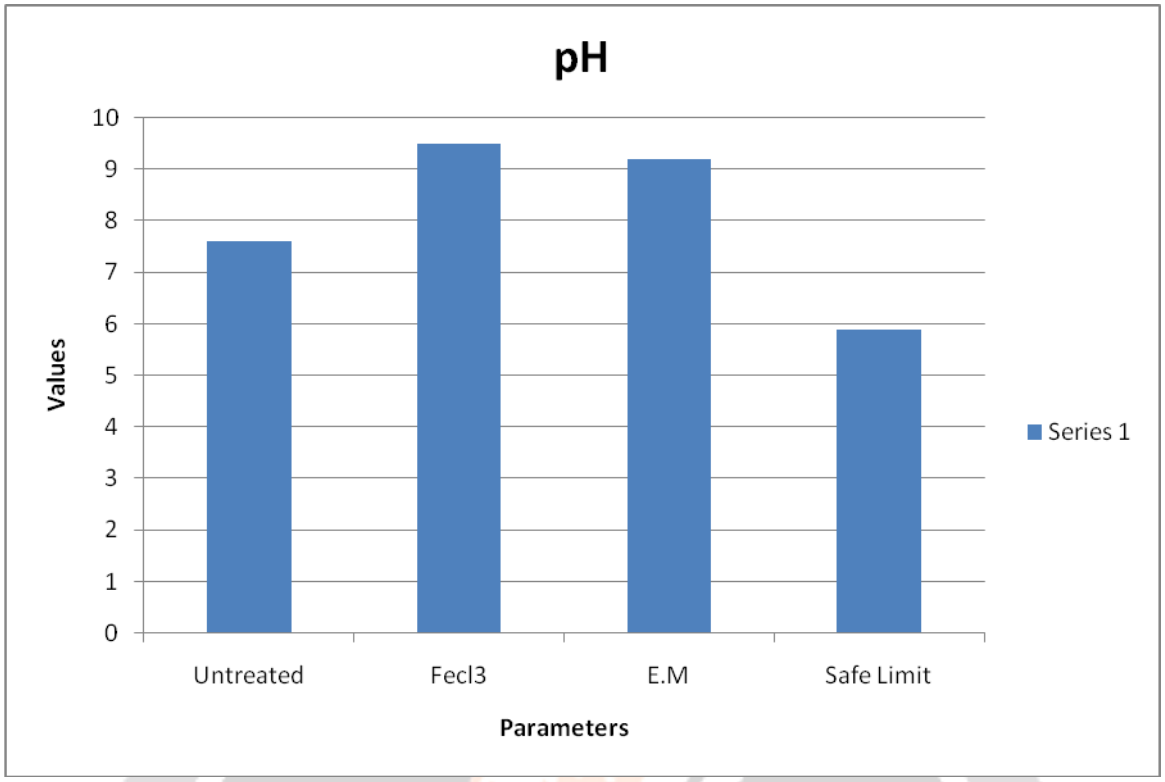

EM (Effective Microorganisms): predominantly anaerobic organisms blended in commercial agricultural amendments, medicines, and nutritional supplements. These blends are reported to include:
Lactic Acid Bacteria – curd, yogurt, cheese etc.,
Yeast Antinomies - breads, beers, wines, etc.,
Photosynthetic bacteria - green seaweed and in any soil particle.
EM Technology supports sustainable practices in farming and to improve and support human health and hygiene, compost and waste management.

**RESULTS AND DISCUSSIONS**

**4.1 TABULATION**

| **PARAMETERS** | **UNTREATED** | **TREATED** | | **SAFE LIMIT** | **PROCEDURE** |
|---|---|---|---|---|---|
| | | **$Fecl_3$** | **EM** | | |
| Ph @ 25°C | 7.62 | 9.5 | 9.2 | 5.5 – 9 | Ls 3025 Part 11 (Reaff.2012) |
| Oil & Grease | 35.0 Mg/L | BDL | BDL | 10 Mg/L | Ls 3025 Part 39 (Reaff.2009) |
| Biochemical Oxygen Demand @ 27°C for 3 days | 220Mg/L | 68 Mg/L | 15 Mg/L | 30 Mg/L | Ls 3025 Part 44 (Reaff.2003) |
| Chemical Oxygen Demand | 1816 Mg/L | 317 Mg/L | 124 Mg/L | 250 Mg/L | Ls 3025 Part 58 (Reaff.2012) |
| Sulphates as $SO_4$ | 2680 Mg/L | 1580 Mg/L | 820 Mg/L | 1000 Mg/L | Ls 3025 Part24 (Reaff.2009) |
| Total Chromium as Cr | 564 Mg/L | 120 Mg/L | 15 Mg/L | 2.0 Mg/L | APHA 22no Edition 3111 B |

There was a considerable reduction in wastewater analytical parameters, most notably in total chromium level. However safe limit can be achieved with further increase in treatment time.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Untreated
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E.M
Safe Limit
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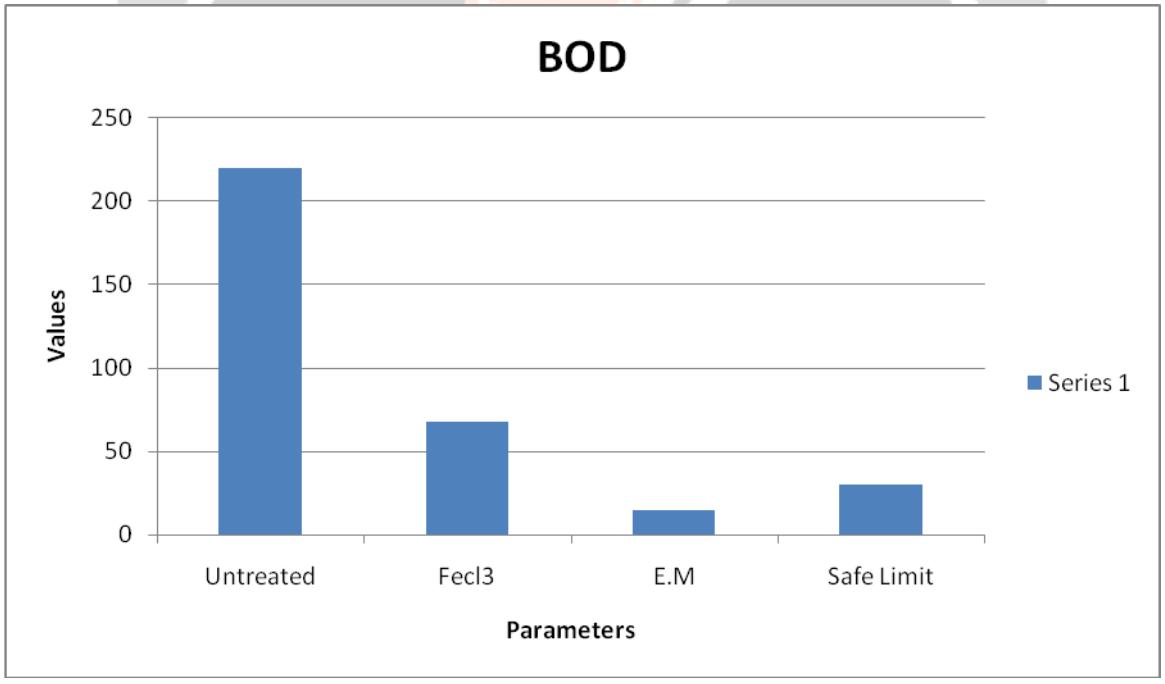
Series 1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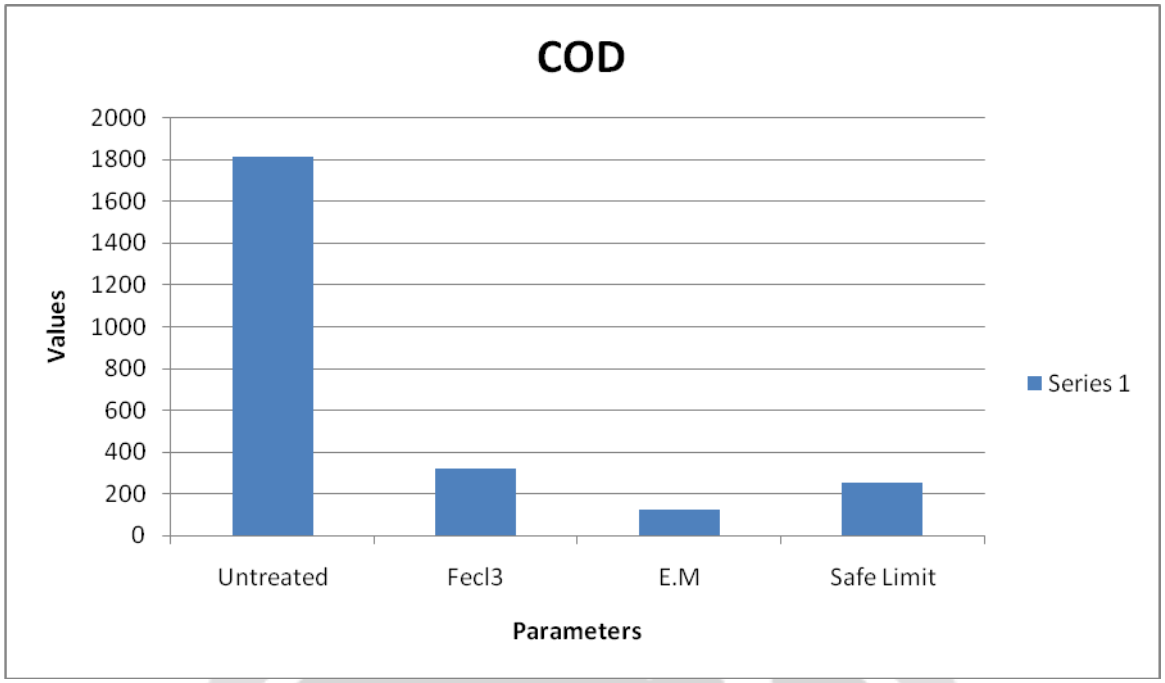
Safe Limit
Parameters
Series 1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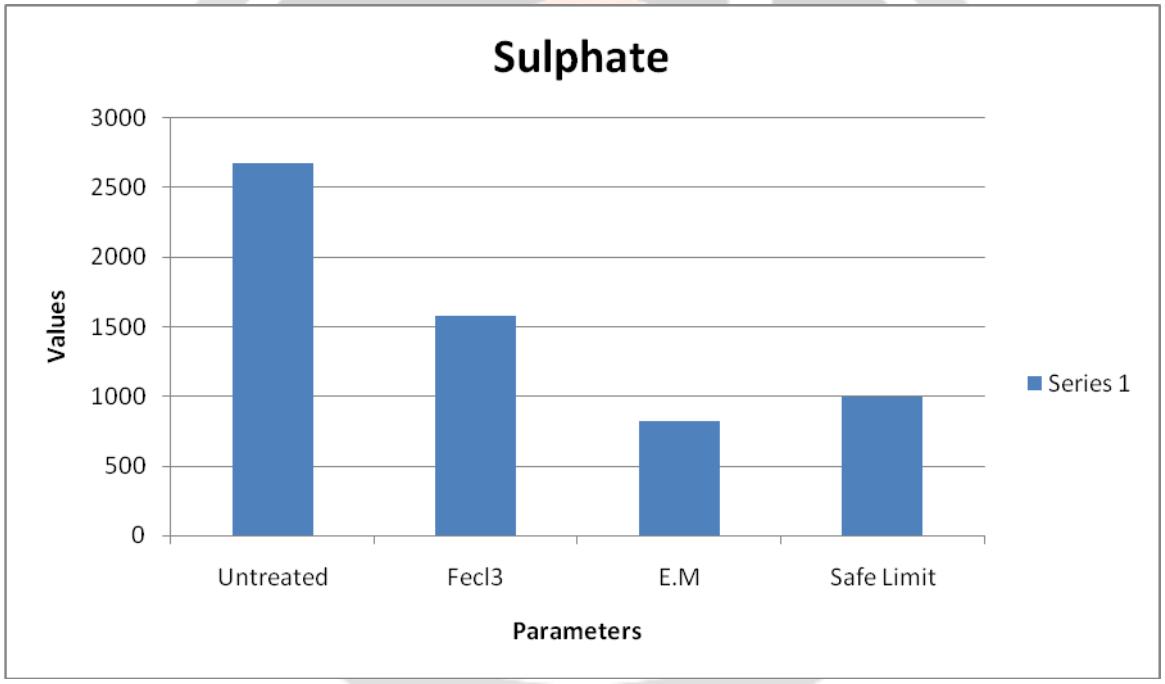
Series 1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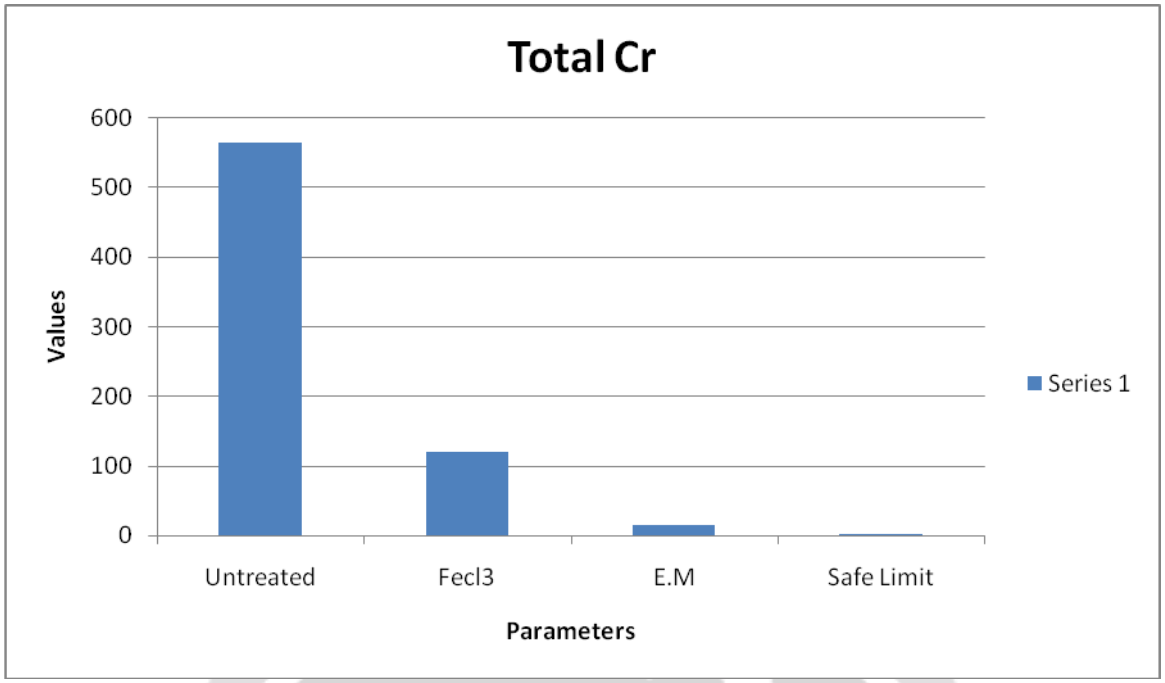
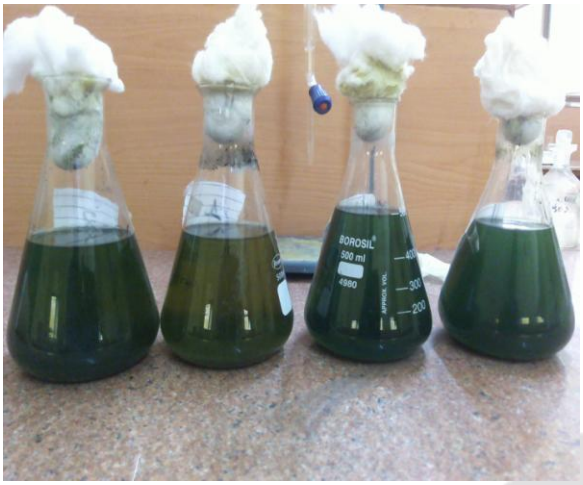



Biochemical analysis after $Fecl_3$, E.M treatment

Deoxycholate Citrate Agar

Maconkey's Agar

**Untreated Textile Effluent**




**FeCl3 Precipitation**


**EM Treatment**

**Decolourization of Textile Effluent**


## CONCLUSION

Total chromium and Pathological Contents of textile effulent were considerably reduced by aeration, $Fecl_3$ precipitation and Effective Microbial treatment. This test can be repealed for other chromium containing effluents in different permutations and combinations.

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