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# Chromium distribution seasonwise in effluent samples sourced from electroplating industries of Bangalore city, India

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**Abstract.** Heavy metal contamination has been recognized as a major environmental concern in India over the last few decades. Industrialization in India gained a momentum with the introduction of few years developmental plan in the early 50's. The main heavy metal pollutants of concern include lead, mercury, chromium, uranium, selenium, zinc, arsenic, cadmium, nickel, copper, gold and silver. These toxic heavy metals may be derived from mining operations, refining ores, sludge disposed, fly ash from incinerators, processing of radioactive materials, metal plating or due to the manufacture of electrical equipments, paints, alloys, batteries, pesticides or preservatives. Many of these heavy metals are not biodegradable, hence persist long in environment and there is need to develop a remediation technique, which should be efficient, economical and rapidly deployable in environment. As an initial procedure, it becomes necessary to analyze the heavy metals and to compare it to the standard limit recommended by 1S:3307(1977). In the present study samples from electroplating industries of Bangalore were analyzed for chromium contamination and have been reported with reference to seasonal variations.

**Keywords:** Heavy metals, chromium, industrial effluents, Bangalore industrial areas, seasonal variations.

## 1. Introduction

Heavy metal contamination is one of the major environment problems and the contaminants generally are due to industrialization, urbanization, population growth and unconscious attitude towards the environment. The most commonly occurring metals are lead, chromium, arsenic, zinc, cadmium, copper and mercury. Presence of these metals in ground water and soils may cause a significant threat to human health and ecological systems (K. Sundar, 2010). In India, the environment pollution has become a cause of concern at various levels. In India, due to lack of sewage treatment plants, generally untreated effluents are released either on agricultural land for irrigation or disposed off in nearby water bodies which either threw accumulation in soil or entering through food chain or through occupational source causes significant health concern. (Vijendra Singh, 2006). Electroplating is the most commonly adopted metal finishing process, these result in the generation of heavy metal pollutants, which are toxic and non biodegradable. Hexavalent chromium (Cr (VI)) emanating from chrome plating is carcinogenic to human. Chromium has been considered as one of the top 16$^{th}$ toxic pollutants and because of its carcinogenic teratogenic characteristics on human life, it has become a serious health concern. Extensive exposure to chromium is known to cause various health effects such as skin rashes, stomach upset, ulcers, respiratory problems, weakened immune system, kidney and liver damage, alternation of genetic material, lung cancer and also death.

World health organization recommended the maximum allowable concentration of 0.05mg/L in drinking water for chromium VI. It is same with Indian Standard Institution. With reference to Central pollution control board, the allowable chromium concentration in effluents is 2.0-5.0 mg/L

Bangalore is located at a latitude of 12 º 58′ N and longitude of 77 º 35′ E at an altitude of 921m above mean sea level (Shivashankara etal, 1999).Sampling area identified is the peenya industrial complex established in early 1970's is the biggest and one of the oldest industrial estates in the whole of southeast Asia, located at the northern part of the Bangalore city, Karnataka, India. The area spread over 40 sq kms comprising about 4000 small scale industries and few medium scale industries is one of the biggest industrial areas in the country as well as in Southeast Asia.

With reference to the updated official list of registered factories of 2008 under Karnataka state factories act obtained from the office of dept of boilers and factories, Karmika Bhavana, Bangalore. Peenya industrial area hosts maximum industries, majority of them are electroplating industries. 52 registered factories of electroplating industries are considered for study based on the number of employees, they have been categorized into 3 groups >50,<50 and >100, 10% of each category will all together make up to 5 no's.Hence 5 factories are selected. Thus it becomes necessary to analyse the concentration of heavy metals especially chromium in this study from selected electroplating at Bangalore, Karnataka (India).With the help of advanced techniques like atomic absorption spectrophotometer studies. With respect to 4 seasons of a year (08-09) obtained from met office, Bangalore [Winter season (Jan-Feb), Pre monsoon (Mar-May), Southwest monsoon ( June-Sep ), Northwest monsoon (Oct-Dec)].

# 2. Materials and methods:

## 2.1. Sample collection

Sampling was carried out for one year from Dec 2009 –Nov 2010, covering all the four seasons. Hence a total of 4 seasonal samples from 5 industries i.e 5x4=20 samples in triplicates were collected and analysed for chromium concentration.

The effluent samples of around 1000ml volume from outlets of electroplating industries were collected in autoclaved linear polyethylene containers of 1L capacity with polyethylene cap, labeled properly. The samples were preserved immediately by acidifying with conc . nitric acid(1.5ml conc/L sample)and stored at 4˚ C for further analysis.

## 2.2. Instrumentation and chromium analysis

**Digestion with nitric acid**: The 50 ml volumes of the effluent samples in evaporating dishes were taken and acidified with conc. Nitric acid. Further 5 ml of conc. Nitric acid was added and evaporated to 10 ml. Then it was transferred to a 125ml conical flask. 5ml of conc nitric acid and 10ml $HClO_4$ (70%), per chloric acid (70%) were added and heated gently till white dense fumes of $HClO_4$ appear. The digested samples were cooled at room temp, filtered through whatman no.41 or sintered glass crucible and finally the volume was made upto 100ml with distilled water. Then this solution was further boiled to remove oxides of N and Cl. The solution was then used for the analysis of chromium heavy metal using AAS by flame using air acetylene gas.

**NOTE:** Following precautions have to be taken while performing the experiment:

1. The sample has to be treated with nitric acid.
2. Digestion was done carefully as the chemicals may explode.
3. Per chloric acid has to be added to cold solutions.
4. Fuming has to be done in hood.

**Analysis of chromium by Atomic Absorption Spectrophotometry:** Atomic absorption spectrophotometer provides accurate quantitative analyses for metals in water, sediments, soils or rocks. Atomic absorption units have 4 basic parts:Interchangeable lamps that emit light with element, specific wavelengths, a sample aspirators, aflame or furnace apparatus for volatizing the sample and a photon detecter. In order to analyze for any given element, a lamp is chosen that produces a wavelength of light that is absorbed by that element. Sample solutions are aspirated into the flame. If any ions of the given element are present in the flame, they will absorb light produced by the lamp before it reaches the detector. The amount of light absorbed depends on the amount of the element present in the sample.

**Apparatus:** Absorbance values for unknown samples are compared to calibration curves prepared by running known samples. The atomic absorption spectrophotometer, is chemito AA201, with glass flow meters with the following operating parameters and working range.

**Atomic Absorption working conditions:**

| OPERATING PARAMETERS | | WORKING RANGE |
|---|---|---|
| Instrument | Chemito AA201 | |
| Wavelength | 357.9 nm<br>425.4 nm | 2-8 ppm<br>10-40 ppm |
| Light source | Hollow cathode lamp | |
| Flame type | Air –Acetylene flame<br>Reducing(rich yellow) | |

**Procedure:**

A) Optimization:

1. Switch on the instrument .Put Cu lamp into lamp holder. Give 4mA lamp current, choose wavelength 324.7nm & select band width to 0.5nm.
2. Focus the lamp correctly by adjusting the circular patch of lamp exactly at the center of lens (on monochromator side). This can be done by adjusting horizontal & vertical movement of the lamp.
3. Increase PMT volts so that energy meter needle goes into green region.
4. Adjust wavelength for maximum deflection of needle and also cross check the lamp focusing by vertical & horizontal adjustment knobs for maximum deflection of needle.
5. Connect the drain tube with loop formation and fill the loop of tube with water .Also confirm that capillary tube is connected to the nebuliser assembly.
6. When instrument is stabilized switch on the air compressor and turn AIR/N20 valve to air side on pneumatic front panel.
7. After lighting the flame, make it blue by i Wipe off the water if accumulated on the burner head and ignite the flame with gas lighter by switching on the fuel ON/OFF switch.
8. Take std.5 ppm Cu .First aspirate distilled water and make zero absorbance by pressing zero key. Then aspirate 5 ppm Cu std.For std. 5 ppm Cu absorbance should be >0.700.
9. Check for zero absorbance by aspirating distilled water and if zero is shifted make absorbance

After doing all these checks one should get absorbance value around 0.700.This is optimization of the instrument. After optimization, the parameters like burner height, fuel, and nebuliser and bead adjustment should not be changed.

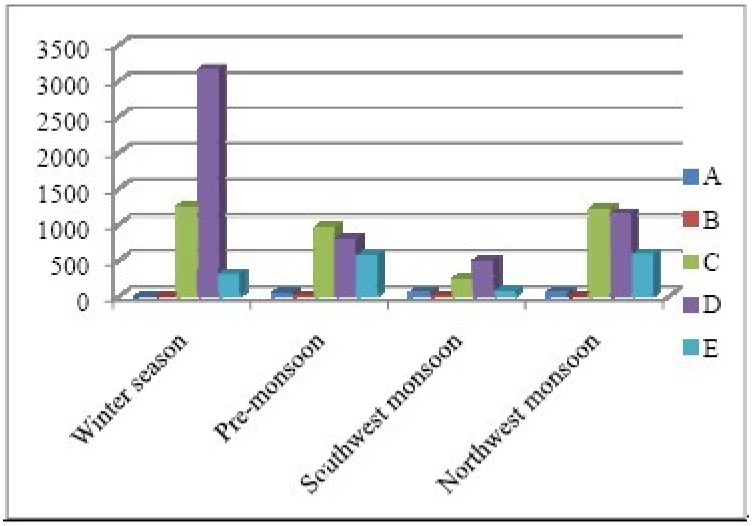
B) Repeatability checks: After getting absorbance >0.700 take repeated sets of absorbance and zero for 10 times. Calculate co efficient of variation as mentioned in test report and it should be <0.5%.

C) Linearity test: For linearity test take 1 to 5 ppm Cu standard solutions. Aspirate these standard solutions, take 3 repeats of each. Plot graph of absorbance Vs concentration, it should be straight line passing through origin.

## 3. Results and discussion:

Industrialization means more effluent release into the environment. It becomes mandatory on part of the industry to release the effluent treated by physico – chemical treatment or by biological means. However, such treatment systems are not effective for removal of color, dissolved solids; trace elements etc. and thus the effluents are directly discharged into drains, public sewers, rivers, etc. Thus effluents containing heavy metals when released into the agricultural land for irrigation purpose, the heavy metal gets accumulated in soil and it in turn is available to plants and gets into plant material and then the food chain follows then to humans and thus heavy metals are hazardous to human health. Graph 1 represents the chromium concentration in ppm on X axis against seasons on Y axis of one year in all the 5 industries-A,B,C,D,E. The Minimal National Standards (MINAS) with reference to Central Pollution control Board in Electroplating effluents is 2.0 mg/lt.

Graph 1: Heavy metal chromium concentrations in industrial effluents of electroplating industries of Bangalore city.




A, B, C, D, E –Industry code

In the present study, chromium concentration in the industrial effluent was considerably low or BDL (Below detection level) in industry B , while the chromium concentration was high in Industry A,C ,E and D with reference to all the 4 seasons. The concentration of chromium was quite high which varied between 239 to 3156 ppm in industry D and C and moderate in Industry A and E which varied between 50.5 to 585.6 ppm. It is interesting to note that the Cr concentration is all time high during winter season and low during southwest monsoon among the five industries.

Overall findings indicated that industrial effluents of the major industrial areas of Bangalore city have elevated levels of chromium and it is suggested that the industries should give importance to release of effluent with prior treatment with reference to the standards. However experiments are underway to isolate the potential chromium tolerant strains of bacteria and utilize them for bioremedial purpose.

## 4. Acknowledgments

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