

## ENVIRONMENTAL RESEARCH

### Air Quality Assessment, Emission Inventory & Source Apportionment Studies

A cost-effective approach for improving air quality in polluted areas involves (i) identification of emission sources; (ii) assessment of extent of contribution of these sources on ambient environment; (iii) prioritising the sources that need to be tackled; (iv) evaluate various options for controlling the sources with regard to feasibility and economic viability; and (v) formulation and implementation of most appropriate action plans. Source apportionment studies, which are primarily based on measurements and tracking down the sources through emission characteristics profiling, and receptor modelling, help in identifying the sources & extent of their contribution. The Auto Fuel Policy document of Government of India also recommended for carrying out source apportionment studies. Accordingly, source apportionment studies have been initiated in six major cities viz. (i) Delhi; (ii) Mumbai; (iii) Chennai; (iv) Bangalore; (v) Pune; and (vi) Kanpur. The scope for source apportionment studies includes preparation of emission inventories, monitoring of ambient air quality for various pollutants (SPM, PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, HC, VOC, etc.) at selected locations (07 – 10 locations covering different land use viz. residential, industrial, kerbside, background, etc.), chemical speciation of PM<sub>10</sub> & PM<sub>2.5</sub> as well as source emissions, application of dispersion & CMB8 models to assess the contribution from various sources, future projections and evaluation of various control options to develop cost-effective action plans. Besides, separate projects on development of emission factors for vehicles and Development of emission profiles for vehicular as well as non-vehicular sources have also been taken up, which would provide necessary inputs to source apportionment studies.

#### Source Apportionment Project and The Executing Institutes

Project	Institute
Source apportionment for Delhi	National Environmental Engineering Research Institute (NEERI), Zonal Laboratory, Delhi
Source apportionment for Bangalore	The Energy Research Institute (TERI)
Source apportionment for Pune	Automotive Research Association of India (ARAI)
Source apportionment for Mumbai	National Environmental Engineering Research Institute (NEERI), Zonal Laboratory, Mumbai

Project	Institute
	Laboratory, Mumbai
Source apportionment for Chennai	Indian Institute of Technology, Chennai
Source apportionment for Kanpur	Indian Institute of Technology, Kanpur
Emission factors for Vehicles	Automotive Research Association of India (ARAI), Pune
Source prioritising (vehicles)	Automotive Research Association of India (ARAI), Pune
Source prioritising (other sources)	Indian Institute of Technology, Mumbai

Documents on 'Conceptual Guidelines and Common methodology for Air Quality Monitoring, Emission Inventory & Source Apportionment Studies for Indian Cities' and 'Model Standard Operating Procedures (SOPs) for Sampling and Analysis' have been finalized and made available to the project executing agencies as well as placed on CPCB website for reference to others. Sites for ambient air quality monitoring have been finalized at all the six cities. Procurement of necessary equipment is completed. Trial ambient air quality monitoring conducted at Bangalore, Pune, Kanpur and Chennai and regular monitoring commenced at Bangalore. Primary surveys for preparing emission inventories are under progress. First set of emission factors, to be used in source apportionment studies, received from ARAI Pune has already been discussed by an Expert Group and is expected to be finalized soon. With regard to source profiling, test matrix for vehicular and source categories for non-vehicular sources have been finalized. Necessary SOPs for sampling & analysis are being prepared and database on Source profiling is under compilation.

Project is being monitored by Steering and Technical Committees, headed by the Secretary, Ministry of Environment & Forests and Chairman, Central Pollution Control Board respectively.

### **Co-incineration of high calorific value hazardous wastes in cement kiln**

It is estimated that 4.4 million tones of hazardous waste are generated in the country annually, out of which about 75,000 tones are incinerable. Destruction of high calorific value hazardous waste in cement kilns is a safe alternative to conventional disposal of hazardous waste in dedicated waste incinerators or landfills.

There are 250 cement works located in the European Union (EU), which, altogether are using around 3 million tones of hazardous waste as alternate fuel. This is over 10 percent of the fuel used and the figure is rising steadily across the EU with countries such as Germany leading the way. The other countries where hazardous waste is being co-incinerated in cement kiln are USA, Canada, Japan, Australia.

Central Pollution Control Board carried out trial runs for co-incineration of hazardous wastes in the cement kiln of M/s Rajashree Cement, Gulbarga and Gujarat Ambuja Cement Ltd., Kodinar, Lafarge India Ltd, Sonadih Cement Plant, Raipur, Grasim Industries Ltd., Reddipalayam, Tamilnadu. Intensive monitoring of stack emissions and ambient air quality along with the analysis of clinker quality was conducted at all the three cement plants. M/s SGS India Ltd, Gurgaon, carried out emission monitoring for dioxin and furan as per MOU between CPCB and GTZ while the other monitoring was conducted by M/s Vimta Lab, Hyderabad.

### Studies of Hazardous Waste Co-incineration in Cement Units during 2006

Cement unit used for co-incineration study	Hazardous waste co-incinerated during the study
Gujarat Ambuja Cement Ltd., Kodinar	TDI tar
Lafarge India Ltd, Sonadih Cement Plant, Raipur	TDI tar
Grasim Industries Ltd., Reddipalayam, Tamilnadu	i) Tyre Chips, ii) Paint Sludge, iii) Refinery Sludge

Based on the findings of the study a policy on use of high calorific value hazardous waste as fuel in cement kiln was placed in 139<sup>th</sup> Board meeting held on November 17, 2006. The Central Board has approved the proposal for sending the findings of the study to MoEF for consideration of the policy on the matter. It was also decided that the proposal would be sent to SPCBs for their information and implementation in their respective State.

### Testing and Validation of BOD Biosensor

Biochemical Oxygen Demand (BOD) is the most important and commonly used parameter in water quality monitoring and monitoring of wastewater treatment plant. The BOD test requires considerable time, i.e. 3 days at 27° C or 5 days at 20° C as well as



consumes lot of energy. To overcome these constraints, attempts were made to carry out the test in short time through the technique using Biosensor probes. This technique involves selection of suitable microbial composition for using Biosensor so as to degrade wide range of effluents. In this endeavour, CPCB in collaboration with Institute of Genomics & Integrative Biology (IGIB), CSIR, Delhi has developed a BIO-SENSOR for rapid BOD test.

A Biosensor method have been used for trial analysis of several BOD samples in order to validate the method. Drain wastewater samples having BOD values from 23 mg/l to 52,267 mg/l showed a variation of -15.1 % to + 18.6% in the BOD values when tested with the developed sensor. A deviation of +10.6 % to -11.1 % was observed in case of industrial samples. A deviation of -18.9 % to + 8.3% was observed in case of slaughter house waste water having a BOD load varying from 36 mg/l to 3145 mg/l.

The validation studies indicated that these are possible to determine the BOD load of waste water collected from various sources with the help of the developed BOD biosensor. The deviation, however, seem to be within acceptable limits.

## **Treatment of Water and Wastewater through Recycled Alum Sludge**

Central Pollution Control Board has developed a renovated technology called “Sludge-Reagent-Product” (SRP) technology in the process of water treatment for drinking/domestic purpose through which 80 to 90% of chemical coagulant (alum) could be recovered from discarded alum-treated-sludge for recycling and reuse and alum chemical worth of Rs. 65 crore per year can be saved in the area of water treatment. Further the technology will take care of problems of disposal of huge volume of discarded alum chemical sludge. The patent on the technology entitled “An apparatus for treatment of Raw water” with a provisional number 535/DEL/2001. Construction work for a 0.5 mld pilot water treatment plant based on SRP technology at Bhagirathi Water Works in Delhi is under progress.

## **Pilot Study using Eco Bio Block (EBB) for Treatment of Wastewater in a Drain at Delhi.**

**‘Eco-Bio Block’ (EBB)** treatment is a technology using microorganisms embedded in a porous concrete block to treat wastewater, The “Eco-Bio-Block”, a Japanese invention and a patent product from a Japanese company with technology for cleaning polluted water sources such as wastewater drains, polluted rivers, ponds, lakes etc. The blocks are produced by mixing effective microbes with zeolites (volcanic porous stones), and alkaline cement. Once EBB is placed in water, the effective microbes would multiply and treat the wastes. There is no operational cost practically after initial capital investment. Since EBB is an online treatment technology, additional large land space is not required.



Considering possible advantages of the EBB treatment technology in Indian context as well as its national importance, NRC, MoEF directed CPCB to carry out the performance study of the EBB in laboratory. The laboratory scale study was carried out. Further it was decided to explore its feasibility of treating wastewater by a pilot project. The performance study is under progress.

### **Determination of Fish Toxicity in Electroplating Effluent Mixed with Sewage Wastewater**

The absence of separate transport system for industrial effluents and domestic wastewater leads to mixing of both in the transportation systems i.e. drains, pipelines etc. This not only creates problems for the waste receiving water bodies but also affect the performance of the sewage treatment plants, specially when toxic industrial wastewater get mixed with sewage. Considering this fact, the study has been undertaken to find out the impact of industrial toxic waste on sewage in terms of Fish toxicity. During the study electroplating wastewater samples have been collected from various electroplating process industrial units and each industrial sample was mixed in the laboratory with the sewage of known fish toxicity in the ratio of 75:25, 50:50 and 25:75. These synthetic samples alongwith individual original industrial wastewater sample have been tested for toxicity in terms of Toxicity Factor,  $T_F$  (minimum dilution in geometric scale of test sample with specified dilution water required for hundred percent fish survival under specified test condition). The study reflects additive effects in the toxicity after mixing of electroplating waste in the sewage.

### **Study on Environmental Contamination with Polychlorinated Dioxins**

Polychlorinated dibenzo-p-dioxin (PCDD) and poly-chlorinated dibenzofuran (PCDF) are inadvertently formed by a host of industrial activities in which chlorine based compounds are exposed to high heat in the presence of organic material. These are highly stable and known carcinogenic. The exposure to these contaminants results in adverse health effects in human and animals like liver

necrosis, and neurobehavioral changes, skin lesions, reproductive etc.

Central Pollution Control Board has undertaken a study in association with the National Environmental Engineering Research Institute (NEERI), Nagpur, to assess the presence of said chemicals in wastewater, solid waste from Pulp & paper mills, PVC industries, incinerators, and crematorium. The quantitative and qualitative identification of 2,3,7,8-TCDD (tetrachloro dibenzo-p-dioxins), dioxin congeners and precursors contamination were studied for the samples collected from pulp and paper industries.

### 2,3,7,8 - TCDD contamination in Pulp & Paper waste

Industry / Type of Bleaching	Sampling location	2,3,7,8-TCDD
Industry I (1st set) / Chlorine & Chlorine dioxide bleaching	Final treated effluent	0.12 ngL <sup>-1</sup>
Industry I (2nd set) / Chlorine & Chlorine dioxide bleaching	Primary Clarifier Effluent	0.10 ngL <sup>-1</sup>
-DO-	Final Treated Effluent	0.06 ngL <sup>-1</sup>
Industry II / Elemental Chlorine bleaching	Bleached pulp	0.01 ngg <sup>-1</sup>

There are units in which in spite of elemental chlorine being used for bleaching, there was no report of 2,3,7,8 TCDD, however, dioxins & furan congeners presents at both inlet and outlet of ETP, ETP sludge and ash from boiler.

In units using both elemental chlorine and chlorine dioxide for bleaching, occasional peak of PCBs are there, but TCDD, dioxins & furan congeners were absent. It was also observed that there is no presence of chlorinated compounds in case of exclusively chlorine dioxide bleaching. It means chlorine dioxide bleaching is safer than elemental chlorine bleaching.

### Ionic Composition of PM<sub>10</sub> in Delhi

Major constituents of urban dust are Carbons (elemental and Organic), Ions, elements (earth metals, heavy metals, transitional metals), Sulphur, Phosphorous and some SVOCs and other organics adhered to the particulate. Both background and secondarily formed ions interact in atmosphere to get stabilised forming different salts. Suspended fine particulate matter provides proper nucleus for these formations, which finally get deposited on earth or remain suspended in air depending upon the buoyancy of particular salt. Ion analysis is a part of chemical characterisation of particulate matter in ambient air and suggest

about predominant ionic composition and potential of secondary aerosol formation in a given micrometeorological condition. CPCB carried out an Ion analysis study for characterisation of PM<sub>10</sub> at seven stations in Delhi to generate baseline data which could serve as reference data of ions for source apportionment studies awarded to NEERI. Four to six PM<sub>10</sub> filter papers in each month for all the location were taken for analysis of 7 anions and 5 cations. Total 373 filter papers were considered for anion and cation analysis in this study. The filters are extracted in water and analyzed by Metrohm Ion Chromatograph using suitable columns and eluent. Anions were analysed using Metrohm A Supp 5 column and ion exchange technique with suppressor. Cations were analysed using Metrohm C – 2 250 column and without suppressor.

Statistical Analysis using ANOVA technique shows that except in case of fluoride all the ions vary both among the stations and months during the year 2005. This indicates differences in pollution sources, their impact and prevailing micrometeorological conditions.

Overall Correlation between SO<sub>2</sub> and SO<sub>4</sub> suggest poor agreement. As the self-life of gas phase NO<sub>2</sub> in atmosphere is more, the values are always few folds higher than sum of NO<sub>2</sub> and NO<sub>3</sub> ions. The correlation among total anions and cations considering the whole data set for Delhi was found good. This study was restricted to soluble fractions of major anions and cations excluding Al and SiO<sub>3</sub> due to use of GF filters.

### Ionic Profile of Respirable Particulate Matter (PM<sub>10</sub>) at Agra

A study on Ionic Profile of Respirable Particulate Matter (PM<sub>10</sub>) in Agra was under taken during 2006 under which important ions (Na<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, SO<sub>4</sub><sup>-</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, K<sup>+</sup>, Ca<sup>++</sup>, Mg<sup>++</sup> and F<sup>-</sup>) were analysed. Of these SO<sub>4</sub><sup>-</sup> and NO<sub>3</sub><sup>-</sup> are particularly related to anthropogenic / industrial sources. Concentration of various ions analysed in RSPM samples collected at four monitoring station at Agra are presented below.

Station	Mean RSPM	Concentration of ions in RSPM samples									Total A (Anions)	Total B (Cations)	Analyzed ions as % of RSPM
		F <sup>-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>	Na <sup>+</sup>	NH <sub>4</sub> <sup>+</sup>	K <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>			
Tajmahal	170	0.5	2.6	6.2	3.2	4.7	4.3	2.6	6.4	1.4	12.5	19.4	18.8 %
Itmad-ud-daulah	224	1.2	9.1	10.1	7.5	10.4	10.2	5	4.9	1.8	27.9	32.2	27.0 %

Nunhai	256	0.9	21.5	13.2	10.3	23	27.5	14.5	2	1.5	45.9	68.4	44.6 %
Rambagh	247	0.5	9.6	8.5	6.1	7.3	12	5.2	6.7	1.4	24.8	32.6	23.2 %

Note: All values of average concentration are represented in  $\mu\text{g}/\text{m}^3$  except otherwise stated

### Measurement of Benzene Soluble Organic Fraction in FPM (PM<sub>2.5</sub>) at Agra

As a part of the Fine Particulate Matter (FPM or PM<sub>2.5</sub>) characterizations program, measurement of Benzene Soluble Organic Fraction (BSOF) in PM<sub>2.5</sub> at Agra is in progress since January 2006, wherein 4-6 selected representative samples of PM<sub>2.5</sub> monitored at Tajmahal by an indigenous manual sampler manual monitoring). The PM<sub>2.5</sub> ranged between 13  $\mu\text{g}/\text{m}^3$  to 232  $\mu\text{g}/\text{m}^3$  out of which organic fraction ranged from 5  $\mu\text{g}/\text{m}^3$  to 208  $\mu\text{g}/\text{m}^3$  between January to October 2006.

### Groundwater Remediation in Kanpur

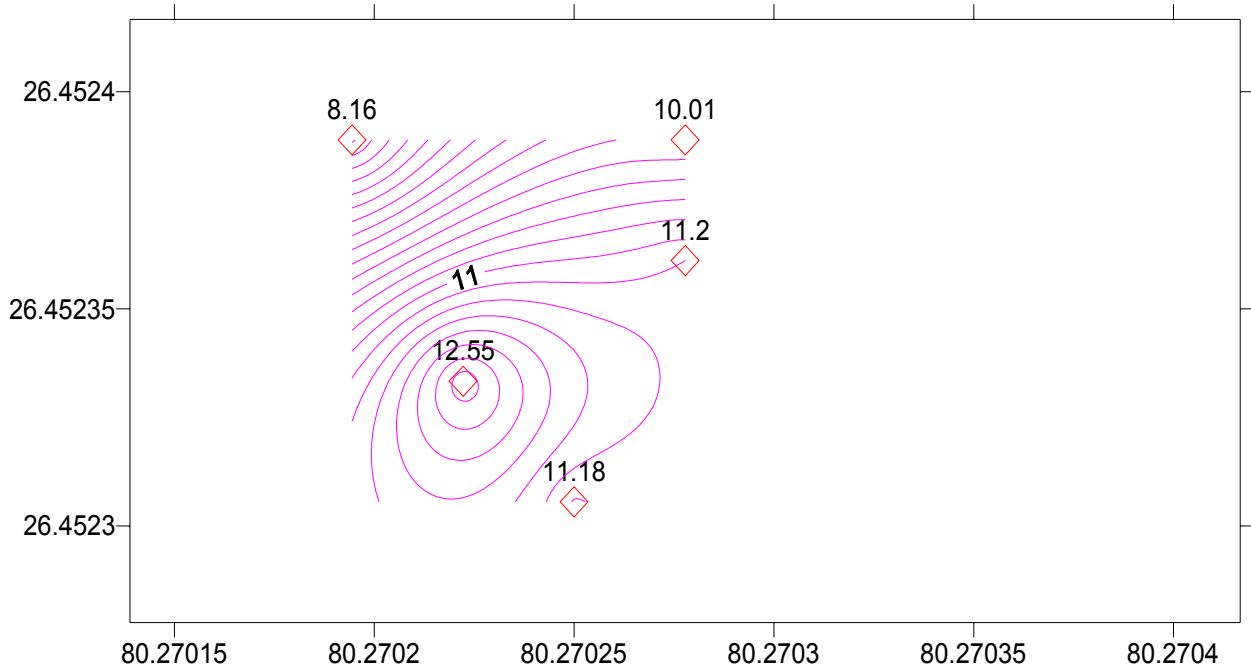
The 2<sup>nd</sup> year studies under collaborative project on Groundwater Remediation in Kanpur were completed with execution of all the identified works. Having completed the investigation and preparation of conceptual model for transport of hexavalent Chromium in groundwater, a Pilot Study on Anaerobic Bio-Remediation of groundwater was executed in the study area. The study, technically supported by GZA-Geoenvironment Inc. USA and Ecocycle, Japan, stressed on *in-situ* bio-remediation by stimulation of native soil-microbes. The stimulation was achieved by injecting measured doses of 'bio-stimulant' which dispersed in the groundwater. Anaerobic conditions resulting due to Microbial Stimulation, transformed the hexavalent chromium to innocuous trivalent chromium which, by virtue of being insoluble in groundwater, was retained (filtered) by soil matrix. The results of Pilot study have been highly encouraging and efforts for full-scale remediation are under way.

#### Hexavalent Chromium - Pre and Post Injection Status (conc. in mg/l)

Well	Pre-Injection Status	Post Injection Status				
		Days after injection				
		07	14	60	78	106
IW	10.01	*	*	ND	ND	ND
SMW	8.16	*	0.56	ND	ND	ND
DW-I	11.2	0.34	0.06	ND	ND	ND

DW-II	12.55	0.23	ND	ND	ND	0.67
PM	11.8	1.17	0.32	ND	ND	ND

**Graphical depiction of CR(VI) \* status Cr(VI) before Injection**

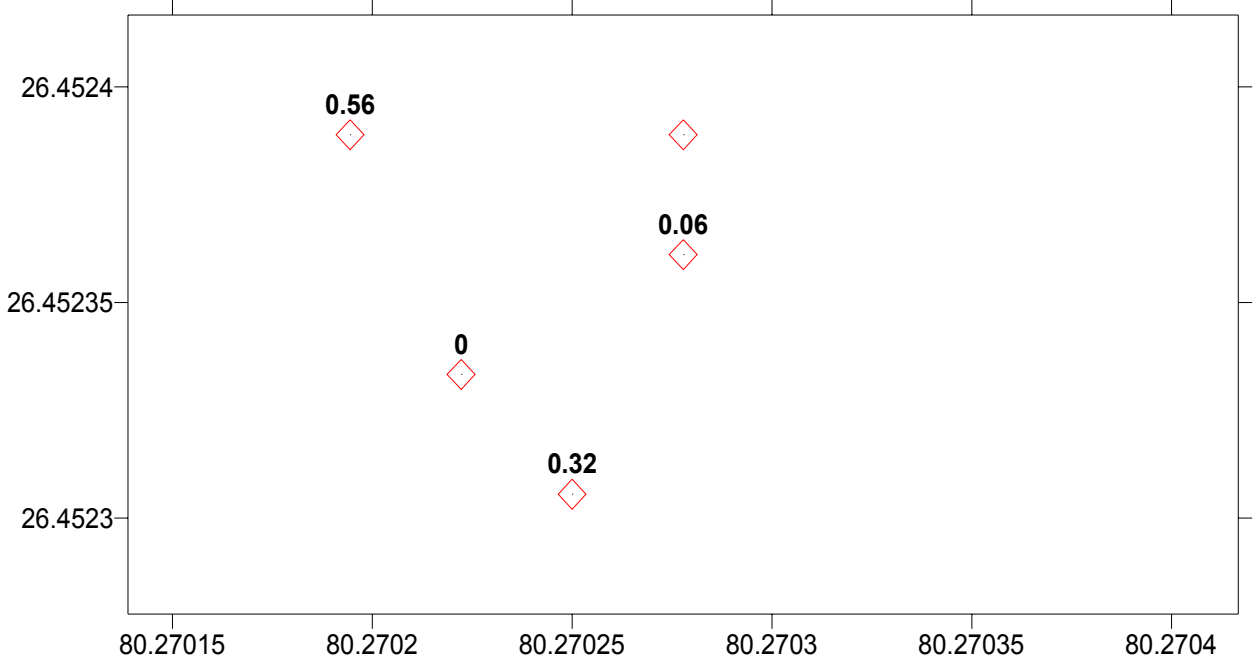
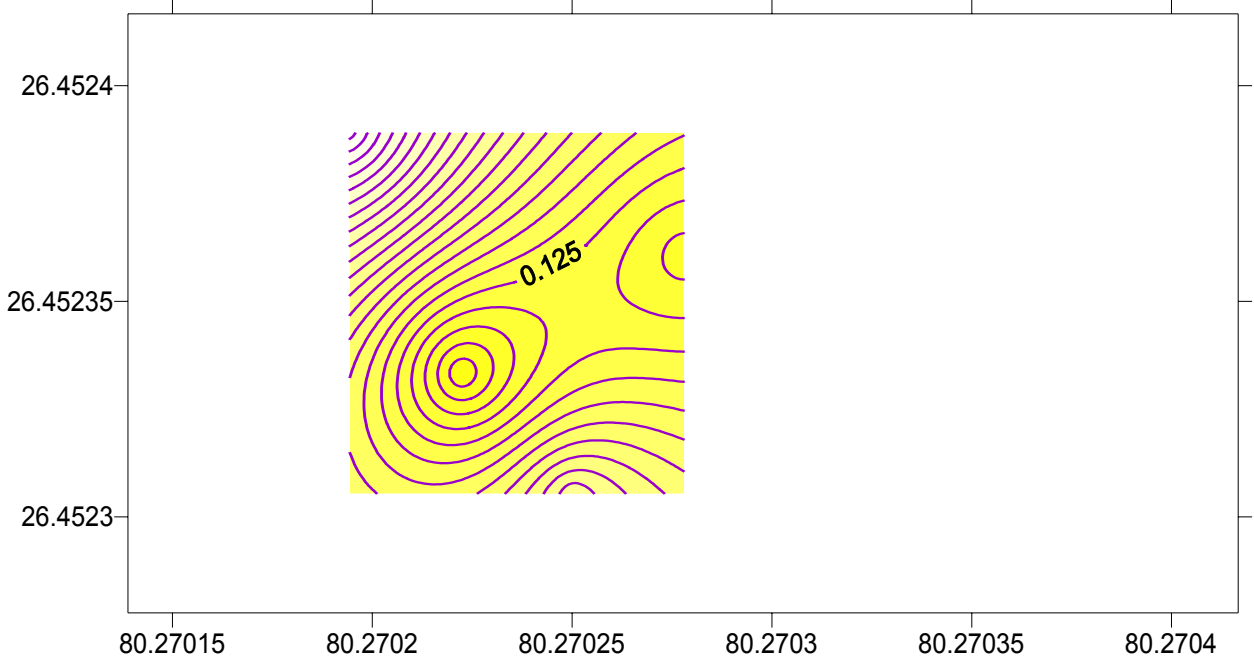



**Total Chromium - Pre and Post Injection Status (conc. in mg/l)**

Well	Pre-Injection Status	Post Injection Status				
		Days after injection				
		07	14	60	78	106
IW	12.88	*	*	0.19	0.08	0.12
SMW	16.39	*	0.86	0.47	0.87	0.57
DW-I	15.28	10.16	1.68	7.78	0.4	0.2
DW-II	19.49	9.09	7.79	3.3	2.71	2.87
PM	14.94	10.66	0.46	1.44	0.9	0.28

IW : Injection Well ; DW1/DW2 /piezometer : Monitoring wells, ND: Not Detectable

**Graphical depiction of CR(VI) \* status Cr(VI) 15 days Injection**

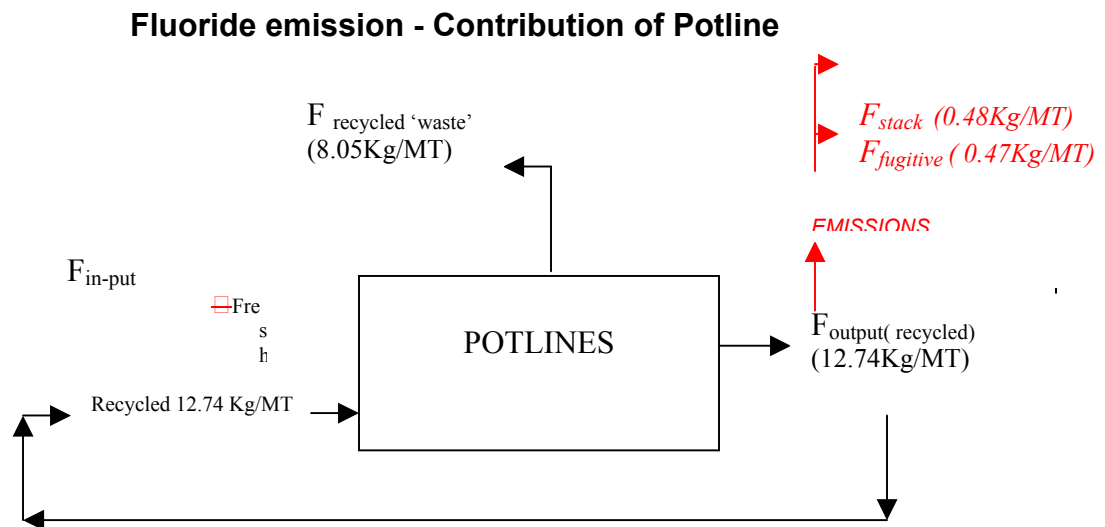


\*Contours plotted based on Cr(VI) conc. in mg/l  
Note : The mark  indicates geographically aligned location of wells

## Fluoride Balance of Hindalco, Renukoot

The study to examine fluoride distribution and identify main points emission/discharge revealed that fluoride emission to the environment of Renukoot is mainly contributed (98 %) by Pot-Lines. A major component of total fluoride emission is through 'fugitive' emissions (50 %). Based on fluoride balance in the plant, the total estimated emission of fluoride is about 0.96 Kg/ MT of aluminum produced. However, the measured fluoride emission from Pot Lines was 0.752 Kg/MT. This discrepancy may be due to the fact not all stacks were monitored and the measurements may not be fully representative of actual emission. Fluoride emission from Anode Baking process and Boilers were insignificant.

A significant observation in this study has been the fluoride content of (raw) red-mud which is observed to possess 0.12 % fluoride. The provenance of this fluoride content needs further investigation



## Monitoring of Air Micro-Flora at Selected Locations of Lucknow City

The Bacteria, Moulds and Yeast present in the air are termed as air micro-flora. The air micro flora can travel to long distances due its microscopic size and remain in the atmosphere for longer periods and can also settle down at distances from the source of origin. These micro floras can also cause deleterious effects to the human being directly or indirectly. The micro flora belonging to fungi group have been monitored at different locations of the

Lucknow city and attempts have been made to quantify various species of fungi at various locations.

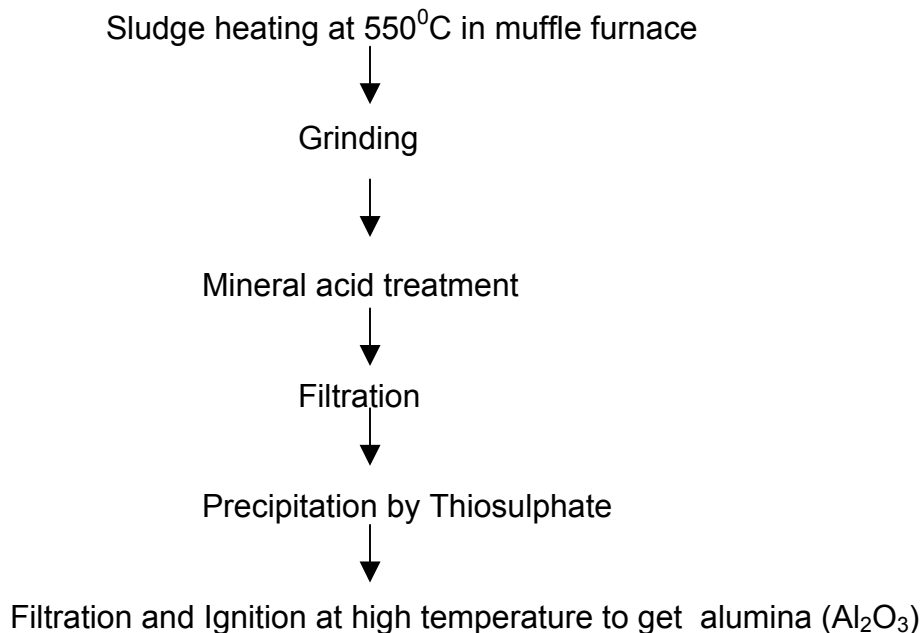
### Major Genera of Fungi at Certain Locations Monitored in the 1<sup>st</sup> Phase of Study

S. No.	Area category	Monitoring Location	Specific sampling location	Genera identified
1	Tourist places/ places of archaeological importance	Imam Bada	Lawn situated in front of main building	Fusarium, Aspergillus, Curvularia, Alternaria, Fusoma
		Shahid Smarak	Close to monument	Fusarium, Aspergillus
2	Commercial	Alam Bag	At fruit market	Fusarium, Aspergillus, Alternaria
		Hazarat Ganj	Main market	Fusarium, Aspergillus, Biosphora
3	Parks	Children Park	Near main entrance	Fusarium, Aspergillus
		Ram Manohar Lohia Park	Lawn inside park	Fusarium, Geotrichum
4	Hospitals	Civil Hospital	Near main gate	Alternaria, Dreschslera, Fusoma
		K.G. Medical University Hospital	Near entrance to the main building	Fusarium, Alternaria
		Vivekanand Polyclinic	Lawn out side main building	Fusarium, Aspergillus, Alternaria, Penicillium
5	Bus Stand	Quasar Bag	At main parking area	Aspergillus, Alternaria, Bipolaris

### Recovery of Alumina from the Sludge of Pulp and Paper Industries

The sludge generated by various pulp and paper industries have been collected and processed for the recovery of Alumina in the form of Aluminum hydroxide by

using various chemical methods and work is under progress. The flow chart used for the recovery is as under:



Since this method is a costly method for the separation of Alumina from the sludge. Therefore, other methods are being tested for the recovery of the Alumina.

### **Optimization of Mercuric Sulphate in COD Estimation**

In the optimization of mercuric sulphate in COD estimation, various exercises have been conducted in the laboratory by using different quantity of mercuric sulphate in the synthetic sample of Sodium Chloride containing 1000 ppm, 500 ppm, 200 ppm 100 ppm and 50 ppm chloride concentration and same exercise have been conducted without using mercuric sulphate because the purpose of using mercuric sulphate is to mask the chloride interferences present in the water samples coming from various sources.

The chloride interferences can also be overcome by the silver sulphate which is being used along with concentrated sulphuric acid by precipitating the chloride in the form of silver halide and other halide if present. The same concentration have to be applied in the synthetic sample prepared by glutamic acid to assess the impact of COD (Inorganic COD) contributed by chloride present in the sample. The work is under progress.

## Development and Standardization of Methodology for Analysis of Trihalomethanes (THMs) in Environmental Samples

The Central Pollution Control Board has been undertaking the study on Development & Standardization of Methodology for THM in Environmental Samples. Under the study, samples from seven Delhi Jal Board Water Treatment Plants were collected for six rounds of sampling between November, 2004 to September, 2006 from inlet (raw water) and outlet (finished / final water / treated water) for fifteen locations as detailed below:

The infrastructural facilities for analysis of THMs has been developed and standardized at CPCB's Trace Organic Laboratory. US-EPA Method No. 551 was adopted for processing and analysis of samples using Varian Gas Chromatograph.

S. No.	Location	S. No.	Location
1.	Haiderpur Water Works - Raw	9.	Chandrawal Water Works I - Treated
2.	Haiderpur Water Works - Treated	10.	Chandrawal Water Works II - Raw
3.	Wazirabad Water Works - Raw	11.	Chandrawal Water Works II - Treated
4.	Wazirabad Water Works - Treated	12.	Okhla Water Works - Raw
5.	Bhagirathi Water Works Yamuna - Raw	13.	Okhla Water Works - Treated
6.	Bhagirathi Water Works Ganga - Raw	14.	Nangloi Water Works - Raw
7.	Bhagirathi Water Works - Treated	15.	Nangloi Water Works - Treated
8.	Chandrawal Water Works I - Raw		

The samples drawn during the six rounds of samplings were analyzed for four Trihalomethanes individually. The Trihalomethanes were also analyzed at ten consumer supply locations (Tap water). The level of Total Trihalomethane as well as its individual compounds in treated water of Delhi have been found within guideline value of World Health Organization (WHO). The total THMs limit for all the samples (all the locations and all the rounds) were also found to be within limits of USEPA, European Union and Environment Canada.

## **Establishment of Methodology for Extractable Organic Halides (EOX) in Soil and Sludge**

The majority of organic halogens in the chemical compounds are of anthropogenic origin. The major sources of organic halogens (OX) in the environment are pulp & paper industries, textile unit, Halogenated pesticide/insecticide industries, potable water treatment, PVC plastic industries etc. The analysis of organic halogens may be performed individually by GC, HPLC etc. but their individual analysis is not only time consuming but also cost-prohibitive. Therefore, increasing need has been realized for analysis of organic halogens as summary parameters consisting steps for separation, adsorption, pyrolysis and titration.

The methodology for analysis of adsorbable organic halides (AOX) has been standardized and presently being used for analysis of liquid environmental samples. It has been realized that the methodology must be extended for other matrix such as soil, sludge and sediment samples through extraction techniques (EOX). The project is undertaken with the following objectives to:

- Develop infrastructure facilities for measurement of extractable organic halides (EOX)
- Standardize procedure for extraction of field samples.
- Standardize the methodology using extracted field samples.