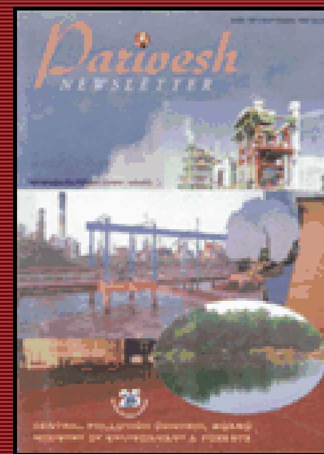
Parivesh

A News Letter from ENVIS Centre - Central Pollution Control Board

Editorial



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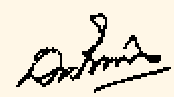
Technology is a useful tool for providing goods and services to the modern day society. Yet, technology is often perceived as the cause of pollution and wanton exploitation of natural endowments as experienced in the wake of industrialisation, urbanisation and motorisation. However, many of the problems which are attributed to technology can also be resolved through proper application and upgradation of available technologies. This is particularly evident in industrial activities which can reduce consumption of resources and minimise pollution, if not achieve "zero discharge", through technological innovations. In respect of various industrial operations, pollution control technologies have been developed and used while others need to adopt such technologies and look for newer technological interventions. To this end, industry, R & D institutions and regulatory bodies need to work in tandem.

In this issue of Parivesh, we present an overview of the available technologies and requirements for pollution control in a cross section of industry. The information, collated by my colleagues, is detailed in our technical publications entitled "Comprehensive Industry Documents Series (COINDS)".

We trust, dissemination of such information will promote awareness of pollution control requirements and stimulate initiatives for "Environmentally Sound Technologies (ESTs)".



Dilip Biswas
Chairman,

CPCB

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Technologies for Pollution Control Industry

INTRODUCTIONS

The advent of the industrial revolution has irreversibly impacted on the way people across the globe live their daily lives. The process of industrialisation has left none untouched, in some way or the other, though in varying measure. While it has influenced both, family and society, its impact on humankind's struggle against its environmental after-effects has been most profound.

The larger environmental repercussions of our industrial age have to do with the pollution that accompanies it. Pollution accompanies every outshoot of industrialisation, be it industrial production, generation of electric power or vehicular transport. It has also become a marked feature of the lifestyles that have come to mark the end of the twentieth century.

The varied sources and forms of pollution are only matched by the various technologies developed to control pollution, be it pollution generated from industries, vehicles, use of fuel in generation of power steam, liquid & solid wastes generated from municipal / residential areas. Indeed, the scientific community all over the world has been giving an extra thrust to researching and designing pollution control mechanisms.

The difference in pollution control technologies is obvious. Pollution control technologies in the industrial sector include modification in processes, plant practices, in-plant control measures and end-on systems to remove pollutants (including recovery and reuse). On the other hand, the wastes generated from municipal/residential areas (mainly sewage, municipal solid waste and bio-medical waste) have to be properly treated and disposed off. Of late, municipal wastes are also providing for fuel gases or fertiliser pellets. Concurrently, the approach to controlling pollution from vehicles includes improved fuel quality, improved engine design and control system (i.e. catalytic converter).

This edition of Parivesh deals with the pollution control technologies in practice in various industrial sectors and the requirements to meet the objective for maintaining the quality of air and water. For us at the Central Pollution Control Board (CPCB), this is also important as it falls well within our mandate of activities defined under the Air (Prevention & Control of Pollution) Act, 1981, and the Water (Prevention & Control of Pollution) Act, 1974.

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Industrial Sector

In keeping with the functions delegated to the CPCB under the Air (Prevention & Control of Pollution) Act, 1981, and the Water (Prevention & Control of Pollution) Act, 1974, CPCB undertook the national programme to control pollution by initiating preparation of Comprehensive Industry Documents, categorising important industrial sectors. These documents were expected to provide comprehensive information on the industries. They covered a number of industries, their production and location with details on receiving water body besides details on the raw material they used, the process they adopted to process them, in-plant control systems, pollution control system provided and the future requirement with cost implications, monitoring system etc.

These documents are also aimed at developing standards for effluents and emissions as Minimal National Standards that can be adopted uniformly throughout the country. The State Pollution Control Boards (SPCBs) can tighten the standards, wherever the local situation demands.

While implementing these standards, the status of technologies adopted by the industries and further requirements to meet the overall objective of pollution control have been assessed. The technology requirement for pollution control industry-wise has been presented in the following groups of industry categories:

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CHEMICAL INDUSTRIES

Fertiliser Industry

The fertiliser industry occupies a place of pride in the chemical industries sector. This industry can be classified into three categories, i.e. phosphatic fertiliser, nitrogenous fertiliser and complex fertiliser. The main pollutants from the phosphatic fertiliser plants are sulphur dioxide from the captive sulphuric acid plants and fluoride and particulate matter from the processing units (phosphate rock grinding, granulation & bagging sections). The scrubbing liquid for control of gaseous emission results in the generation of wastewater. Besides, there may be some wastewater (spillage/washings) generated from sulphuric acid plant.

The existing pollution control systems in these sectors and the scope for making them more efficient are tabulated below:

Phosphatic Fertiliser Plant :

Technologies/Current Practices	Requirements
The double conversion double absorption (DCDA) process has been recommended and adopted to minimise generation of SO_2 from sulphuric acid plants. Some plants have scrubbing system to control excessive SO_2 during start-up and shut-down of the plant.	Scrubbing systems with proper treatment for reuse / recovery of the scrubbing liquid should be provided by all the plants.
Scrubbing system (two or three stages) or venturi scrubbing system has been adopted to control fluoride emitted from acidulation of rock phosphate	Venturi scrubbers with reuse/recovery of scrubbing liquid or fluorine recovery plant need to be provided
Bag filters and cyclones have been provided for control of SPM.	Proper collection and disposal of collected particulate matter through cyclone, bag filters etc. Pneumatic systems can be used for collection and transportation of dust in large plants.
Neutralisation for acidic wastewater and fluoride and phosphate removal through chemical precipitation for fluoride & phosphate bearing effluent have been adopted.	Automatic feeding system for chemical dosing with pH indicator and alarm system need to be installed.

Nitrogenous Fertiliser Plant :

The pollutants from nitrogenous fertiliser plants are SO_2 & NOx from fuel burning in reformers, emission of ammonia from ammonia & urea plants, ammonia & oil bearing effluents from ammonia & urea plants, beside urea in effluent from urea plant, NOx from nitric acid plant and ammonia & nitrates in effluent from ammonium nitrate plants. The arsenic bearing effluent is also generated from the plants where Vetrocoke system of CO_2 absorption is followed. The cyanide bearing effluent is generated from ammonia plants where partial oxidation process is followed (having fuel oil as feed stock).

Technologies/Current Practices	**Requirements**
API separator for oil removal	Oil removed is to be properly stored and transported for reuse/recovery
The technologies adopted for effluent are (i) air stripping, (ii) stream stripping with recovery of ammonia for ammonia bearing effluents from ammonia and urea plants, and (iii) hydrolyser stripper for urea bearing effluent.	High-pressure hydrolyser strippers with recovery of ammonia and condensate. Retrofitting of hydrolyser stripper in old plants.
Nitrification and denitrification system for ammonia, urea and nitrate bearing effluent	For proper operation of the denitrification system, availability of carbon source has to be ensured.
Cyanide treatment by alkaline chlorination	Cyanide destruction by thermal/ oxidation system.
Arsenic bearing effluent is evaporated or chemically treated. The sludge generated is either stored or encapsulated	Few plants which are still having Vetrocoke system of CO_2 absorption using arsenic as medium, should change over to the non-arsenic system

Complex Fertiliser Plant :

The pollutants from complex fertiliser plants could be generated from nitrogenous or phosphatic fertiliser plants, or both, depending upon the captive units. Generally, fluoride and suspended particulate matter are generated in emission through stacks and effluent generated can be recycled due to negative water balance in the process.

Technologies/Current Practices	**Requirements**
Venturi scrubbing system for fluoride control in emission from phosphoric acid and complex fertiliser plants	Fluoride recovery plant where phosphoric acid is produced
Treatment of fluoride and phosphate bearing effluent	Improved treatment using alum where receiving environment cannot accept Fluoride above 2 mg/l
Recycle and reuse of effluent from NPK and DAP plants	Zero discharge should be aimed from the complex fertiliser plants

Phosphogypsum generated from phosphoric acid plant is generally stacked and partly used for mixing in cement and for making gypsum board	Technology (such as to produce ammonium sulphate) to use entire phosphogypsum generated from phosphoric acid production

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Bulk Drug Manufacturing Industry

Environmental pollution control in bulk-drug manufacturing industry requires high skilled manpower due to its nature of pollutants. In general, it has been observed that the final product's purity is of major concern to the industry. Thus, the rejects (unreacted/ converted portion of raw materials) contribute to the major pollution load from the industry. The industry involves several batch reactors to get required product and each reaction yields different kinds of pollutants depending upon particular reactants and process. There are number of streams with different characteristics which emanate from the various sections of the industry, requiring segregation and corresponding treatment instead of the conventional end-of-pipe treatment system for combined effluent. The air pollution potential is also significant, though quantity of air pollutants may not be much. However, the toxic emissions (fugitive and channelised) are required to be properly collected and treated. The solid waste generated from the industry falls under hazardous categories, thus the compliance as per hazardous waste management rules is required.

Technologies/Current Practices	**Requirements**
Wastewater treatment Collection of all the streams and providing collective treatment (end-of-the-pipe treatment) as follows: • Collection tanks - For separation of carbon black (usually used for the colour removal of the final product). • Oil & Grease trap - conventional separator • Equalisation tank • Neutralisation • Primary clarification • Biological treatment (mostly activated sludge process and lagoons) • Secondary clarifier	Wastewater treatment • In-plant pollution control measures • Process optimisation/modifications to avoid untreatable pollutants generation • Segregation of effluent streams and characterisation for separate treatment as necessary is shown on next page. • Salt recovery from high TDS (inorganic) containing streams through forced evaporation system. • Efficient solvent recovery systems.
Air Pollution Control Systems • Scrubbers for point source emissions • Cyclone to control emission • Suitable stack height for appropriate dispersion	Air Pollution Control Systems • Properly designed chlorine storage facility with automatic control equipment • Collection of fugitive emissions from the processing sections and loading/unloading sections through hoods & ducts and providing control equipment such as absorption/ adsorption

	systems • Multi-cyclones or bag filters for control of emissions from boilers • Continuous monitoring equipment/ sensors to be provided
Solid/ hazardous waste management • Empty drums are sold to third party for reuse. • Process residues are stored in drums • ETP primary sludge is sent sludge drying beds • Oil & grease is collected & burnt in boilers	Solid/hazardous waste management • The process residues and other hazardous wastes generated in the industry should be stored/treated/ disposed as per the Hazardous Waste Management & Handling Rules , 1989 • Proper incineration of organic residues, instead of burning in boiler, which leads to air pollution problem • Detoxification of empty drums/bags etc, before selling and to maintain good manifest system.

Combination	**Quality of Effluent**	**Treatment Options**
1	Waste is not easily bio-degradable but toxic	1. Thermal decomposition (based on calorific value) 2. Chemical oxidation by hydrogen peroxide, ozone etc. 3. Evaporation + Secure land-fill
2	May be toxic; not suitable for biological treatment; mostly inorganic	1. Chemical treatment (recovery, precipitation etc.) 2. Evaporation + Secure land-fill of evaporated

	salts	residue
3	Highly organic effluent fully biodegradable	1. Anaerobic + Aerobic treatment 2. If quantity is less, incineration (based on calorific value) + Secure land-fill of incineration ash
4	Only inorganic salts, no need for biological treatment	1. Solar evaporation 2. Forced evaporation (after separation of volatile organic matter) 3. Reverse osmosis
5	Highly organic effluent, may not be easily biodegradable	1. Thermal decomposition 2. Chemical oxidation by hydrogen peroxide or ozone or sodium, hypochlorite etc. 3. Chemical + biological treatment
6	Highly inorganic effluent, not suitable for biological treatment	1. Chemical recovery 2. Chemical oxidation + biological treatment
7	Organic effluent, fully biodegradable	Anaerobic + aerobic treatment
8	Low organic and low inorganic effluent	Recycle and reuse (after preliminary treatment)

Combination Exercise for Treatment of Individual Effluent Streams in Bulk-Drug Industry

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Pesticides Industries

Pesticides manufacturing involves various toxic chemicals as raw materials and a number of unit operations to get required technical grade product. In a unit process, due to impurities in raw materials, variations in operational parameters of the reactor vessels and thermodynamic limitations, 100% conversion of raw materials into products is impracticable. Hence, excess chemicals are fed into the reactor to get the required efficiency and quantity of final product. The unconverted reactants from each unit process generate wastes in the form of effluents, emissions and solids.

Technologies/Current Practices	**Requirements**
<u>Wastewater Treatment</u> • pH correction • Solar evaporation ponds for high TDS/inorganic effluent • Incinerator for high organic waste	<u>Wastewater Treatment</u> • In-plant pollution control measures • Process optimisation/automation to avoid discarded products, and to reduce pollutants generation • Segregation of streams and providing treatment as follows: • Inorganic streams - recovery of salts through forced evaporation or membrane separation • Highly organic streams (toxic effluents) which cannot be treated biologically are to be chemically treated or incinerated, depending on calorific value.

	• medium organic streams are to be biologically treated (preferably extended aeration). • Efficient solvent recovery systems. • Identification of compatible streams for neutralisation to avoid chemical closing and formation of additional total dissolved solids concentrations. • Homogenisation of effluent, before feeding into biological systems • Usage of pure oxygen, ozonation, chemical wherever necessary.
Air Pollution Scrubbers	Air Pollution • Stack gas scrubbing and /or carbon adsorption (for toxic organics) and baghouses (for particulate removal) are applicable and effective technologies for minimizing the release of significant pollutants to air combustion devices (Incinerator) should be used to destroy toxic organics. Combustion devices should be operated at temperature above 1100^{o}C with a residence time of atleast 0.5 second to achieve acceptable destruction efficiency of toxics. • Handling of mercaptans needs special attention in terms of proper collection, and incineration. • Open flaring of any gas should be avoided. Instead, incinerator (with pollution control equipment) needs to be provided. • All the fugitive emissions from various sources need to be collected through ducts & hoods and treated (may be alongwith channelised emissions). • Continuous monitoring equipment in the stack and minimum height of the stacks needs to be ensured. • The boilers should be provided with multicyclones or bag filters depending on size and local conditions.
Solid/Hazardous Waste Management • Incineration	Solid/Hazardous Waste Management • Proper handling of hazardous waste as per the Hazardous Waste Management & Handling Rules, 1989 need to be followed. • The waste should be incinerated or disposed at authorised secured land fills identified by the State Government with the prior authorisation from the local regulatory authorities and should follow the guidelines framed under the Rules.

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Oil refinery

In a refinery, crude oil is processed in Crude Distillation Unit, consisting of atmospheric distillation and vacuum distillation columns. In addition, various chemical conversion processes viz. catalytic cracking, hydrocracking, thermal cracking, viz., breaking, etc.; purification processes viz. hydrodesulphurisation, desalting, sulphur recovery, etc.; and utilities & auxiliary facilities viz. water, power, steam, hydrocarbon slop treatment, etc. are also in use in refineries.

Various unit processes in the refining of petroleum oil cause significant amount of air and water pollution and also generate solid wastes. The type and quantum of the pollutants, generated from an oil refinery, will depend on type of crude and processes in use. The major pollutants emanated are emissions of Oxides of Sulphur (SOx) and Hydrocarbons (HC); liquid effluent containing oil, phenol, sulphide with significant concentration of BOD and COD; and solid waste including oily sludge.

The available pollution control technologies and the requirements are tabulated hereunder:

Technologies/Current Practices	**Requirements**
Effluent treatment comprising primary (physico-chemical), secondary (biological) and tertiary (e.g. activated carbon) systems.	Possibilities (implant measures) for reducing water consumption and effluent generation; and better management practices for reuse/recycle of the treated effluent.
To minimise emissions of SOx, Sulphur Recovery Units (SRU) based on Claus/modified Claus process, are installed. Besides this, scrubbers are also installed for controlling the emissions.	Super Claus process with greater sulphur removal efficiencies and SCOT process for off-gas treatment. Catalytic cracking units should be provided with particulate removal devices.
To minimise fugitive emissions of HC, floating and fixed roof tanks are provided for storage of lighter products and crude oil respectively.	Better practices are needed for maintenance of flanges/valves, handling and transport of material etc., to reduce the fugitive emissions. Steam injection in flaring stacks to reduce particulate emission, vapour recovery system to be installed to control losses of volatile organic compounds (VOC's) from storage tanks and loading areas and it should achieve 90-100% recovery.
Part of the oil is recovered from oily sludge and the sludge is disposed off through a secured landfill.	Technology is required for minimising the generation of oily sludge and proper handling of oily sludge and more efficient recovery of oil from sludge using improved adsorbent.

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Dyes and Dye Intermediates

Dyes and Dye Intermediates industry is an important sector of the Indian Chemical Industry. This sector has grown at a very fast pace after independence and nearly half of its production is being exported today. A remarkable feature of the Indian dyestuff industry is the co-existence of units in the small, medium and large sectors, actively involved in the manufacture of dyestuffs and their intermediates. The pollution that accompanies this industry in its nature and extents, particularly, because of the non-biodegradable nature of the dyes as well as due to the presence of acid/ alkali/ toxic trace metals/ carcinogenic aromatic amines in the effluents. In addition to effluent, gaseous emissions such as SO_2, NOx, NH_3 & HCl and solid wastes in the form of iron sludge, gypsum and sludge from treatment facilities are generated.

The available pollution control systems and the requirements are tabulated below:

Technologies/Current Practices	Requirements
Effluent treatment comprising primary (physico-chemical) and secondary (biological) systems are in practice. Some of the units have also provided tertiary treatment and incinerators for non-biodegradable waste.	Possibilities for adaptation of cleaner process options for reducing the water consumption and effluent generation; better management practices for segregation and reuse/ recycle of the treated effluent; effective utilisation of raw materials; improvement in efficiency of process; and recovery of by-products. The effluent generated from manufacturing of some of the dyes and intermediates such as H-acid is not biodegradable, which requires process change.
Gaseous emissions such as SOx, NOx, HCl and NH_3 are generally scrubbed.	Properly designed scrubber with recovery reuse of scrubbed liquid is required.
Gypsum, iron sludge and sludge from ETP are generated as solid waste. The gypsum and iron sludge can be used in the cement and pigment industries. The sludge is either disposed off on land/secured landfill or sent to other user industries.	Cleaner process technologies e.g. catalytic hydrogenation, use of spent acid after nitration for acidification of fusion mass, which can eliminate generation of iron and gypsum sludge.

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Caustic Soda Industry

There are 40 units manufacturing caustic soda in India with an installed capacity of 2.27 million tonnes per annum, and the actual production in the year 1998 has been about 1.49 million tonnes. 34% of the capacity is based on the mercury cell process, and 66% on the membrane process. The major environmental problems posed by this industrial sector is from the mercury cell process and although this metal is not supposed to get consumed as per the chemistry of the production, it gets entrapped into the circulating brine solution and all the product and bye-product streams. This leads to contamination of the water, wastewater, air and solid wastes generated from the production activities. Also, since the quantity of mercury involved in the production is very large, its leakage, spillage and even evaporation of the spilled mercury are observed to be very common and require proper and timely attention. A limit of 0.01 mg/l has been prescribed for the levels of mercury in the effluent alongwith a limitation of a maximum of 10 cum effluent per tonne of product. The CPCB experience gathered through visits and in-depth studies of the mercury cell based chlor-alkali plants confirm that a major part of mercury escaping into the environment is due to the lack of good housekeeping practices specially in the cell house and related activities. It has also to be noted here that the efficiency of any of the control measures which mostly involve the end-of-pipe treatment technology, can be affected by the lack of attention in attending the mercury leakage/ spillage or even floor washings in the cell room. Special attention needs to be given to all the mercury cell-based chlor-alkali plants looking at the manner in which the return brine from the electrolysis cells is treated soon after the power failures. This is because the mercury concentration in the return brine after power failures may go upto even 200 mg/l as against a concentration of about 7 mg/l in the brine in the normal running of the plant. There has been a practice of adding Sodium Sulphide to the brine after power failures for avoiding the chlorine nuisance but this addition of Sodium Sulphide results into a bigger nuisance as the high level of mercury present in the brine gets precipitated as Mercury Sulphide and the subsequent brine sludge from the clarifier may contain upto over 1000 mg/kg of mercury [Chemical Age of India 35 (9):1984]. The escape of mercury in the brine sludge in a single power failure can be as much as 10 times the loss in the sludge produced in a day under the normal running of the plant.

The commissioning/expansion of caustic soda units based on mercury cell process has already been banned by the Government and the existing mercury cell based plants are also in the process of switching over to the membrane process. However, there is no mandatory target existing for this conversion and the mercury cell based units need to take proper attention for their mercury bearing wastes including the disposal of the brine sludge. The pollution control measures, existing as well as waiting to be incorporated, are given below.

Technologies/Current Practices	**Requirements**
Caustic Soda production through Mercury Cell as well as Membrane Cell Process	Conversion of Mercury Cells into Membrane Cells in a phased manner
Addition of sodium sulphide to the brine to avoid chlorine nuisance after power failures	Stand-by Power supply for dechlorination of the return brine in the existing mercury cell pants after power failures, instead of adding sodium sulphide to eliminate chlorine. This dechlorinated brine should be stored and recycled directly to the cells in a controlled manner to ensure conversion of the high amount of the dissolved mercury back into the elemental mercury.
Rejection of the cell cleaning water as effluent for treatment with final effluent	Collection of the washings immediately after the start of the cell cleaning operation and recycle of the washings into the brine system.
Floor Washings with fresh water	Collection of the wastewater from cell house in a amply dimensioned sedimentation tank, providing a pump with nipple and hose pipe arrangements in the discharge line and use of this collected water for floor washings as well as its recycle into the brine system as and when possible with the help of same pumping arrangements (Chemical Age of India 37 (11) : 1986). Also, the floor should be preferably swept and the wet washings should be avoided as far as possible.
The collection and washing of the solid wastes generated from the cell house for mercury recovery	The solid wastes resulting from the cell room should be heated in a closed system and the mercury should be recovered through condensation (indirect cooling).
Scrubbing of the uncondensed gases from the HCl production system.	The hydrogen gas should be treated at source with the help of activated carbon adsorption technique (Chemical Age of India 37 (12):1986). This will eliminate the involvement of the mercury in the HCl production system. The hydrogen produced can also be used for hydrogenation of the oils and the mercury free HCl produced from this hydrogen will be useful even for the food and pharmaceuticals sector.
Utilisation of excess chlorine with caustic soda or lime slurry	The production of caustic soda should be optimised on the basis of the demand, and the chlorine neutralisation should be minimised as far as possible. If at all required, the use of caustic soda or lime slurry should be made on the basis of the use of resulting Calcium hypochlorite or Sodium hypochlorite.
Disposal of sludge cake from the brine recovery drum filter into authorised landfills	Each of the mercury cell chlor- alkali plant need to study the level of excess chlorine which can be maintained in

	the circulating brine of the production system as the presence of chlorine in brine avoids precipitation of mercury into the brine sludge. Also, the disposal of brine sludge should be made in a secured landfill with proper arrangements for the collection and recycle of the leachate.
Sodium sulphide precipitation, filtration followed by ion exchange or activated carbon adsorption method of the mercury from the final effluent	The mercury bearing streams should be segregated at the source itself in the plant and recycled into the brine system. This will result into minimisation of mercury input load to the final treatment system, and the steps like precipitation, ion exchange etc. can be decided by individual plants depending upon the level of mercury control that can be achieved at source.

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AGRO-BASED INDUSTRIES

Textile Industry

The textile industry encompasses a range of industrial units, which use a wide variety of natural and synthetic fibres to produce fabrics. The textile industry can be broadly classified in two groups, namely cotton industry and woollen industry.

The effluent generated from textile industry contains various dyes, chemicals, auxiliary chemicals, sizing materials etc. The effluent is usually treated by physico-chemical treatment followed by biological treatment process. However, such treatment systems are not effective for removal of colour, dissolved solids, trace metals etc. In-plant control measures such as process change, recovery/reuse of chemicals, chemical substitutes can significantly reduce pollution from this sector. There are described below:

(a) Process Change/ Recovery

Area	Technologies/Current Practices	Requirements
Sizing	Starch is most commonly used as sizing material for cotton textiles. During sizing, the starch eliminates the possibility of its recovery. It also contributes high BOD.	Recovery of Sizing material: The other types of sizing material, such as carboxymethyl cellulose (CWC), polyvinyl acetate (PVA) are comparatively more expensive but are recoverable.
Mercerising	Mercerising waste contains about 4% caustic. Few textile industries have provision for its recovery.	Recovery of Caustic: Spent caustic from mercerising as well as other units can be recovered and reused either by membrane separation technology or by most commonly used evaporation method.
Dyeing	The textile industry uses various types of dyes to impart the desired quality in the fabrics, which generates coloured effluent. No specific treatment is given before it is discharged.	Reuse of dye bath: Instead of discharging the exhausted dyebath, it can be reconstituted by adding appropriate amount of make-up dyes and auxiliary chemicals. The reconstituted dyebath can be reused for dyeing successive batches.
Printing	The conventional printing involves colour paste application to fabric and subsequent dye fixation. After this, all chemicals other than the dye need to be removed from fabric. This increases effluent generation.	Transfer Printing: The transfer printing transfers dyestuff, previously printed on paper, on the fabric. Only the dyestuff and other chemicals are transferred on the fabric thus eliminating the after-washing.
Wastewater Treatment	The wastewater is treated by physico-chemical and/or biological treatment process. Some industry	Recycling of Treated Wastewater: The effluent can be further treated by activated carbon adsorption process or other

	uses filtration alongwith physico-chemical treatment to reuse the specific effluent streams.	advanced treatment process so that the treated effluent can be recycled/reused.

(b) Chemical substitute

Area/Process	Chemical in Use	Substitute Required
Sizing/Process	Conventional Starch based size	Synthetic wrap sizes (PVA) Acrylates)
Desizing	Enzymes	Acids
Soaping	Conventional Soap	Synthetic Detergents
Good Scouring	Soda Ash	Sodium Acetate
Disperse Dyeing & Pigment Printing	Acetic Acid	Ammonium Sulphate
Printing	Gum	Emulsion
Oxidation of vat dye	Acetic Acid	Sodium Bicarbonate
Screen Printing machines	Conventional Gums	Permanent Adhesives
Finishing starch based	Temporary Finishes	Durable Finishes
Dyeing	Two stages dye (Disperse, vat. etc.)	Single stage dyes (Tindigosol)
Dyeing	Solvent Pthalogen blue	All aqueous Pthalogen blue
Dacron Dyeing	Conventional Carriers	Monochlorobenzene
Dye bath	Acetic acid	Formic Acid
Lubricants used in textile machinery	Carding oils anti-state lube	Non-ionic emulsifiers

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Tanneries

Tanning is an integral part of leather making process, which converts the raw hides and skins to finished leather, which is used for manufacturing various leather goods.

Tanning industries can be classified into two categories with respect to the kind of tanning practised: vegetable or EI tanning and chrome tanning. Further these processes can be classified into different processes each depending upon the level of tanning a particular industry adopts.

For vegetable tanning:

(a) Raw hide to vegetable tanned semi-finished leather

(b) Vegetable tanned semi-finished leather into finished leather.

For Chrome tanning:

(a) Raw hide to chrome tanned semifinished leather

(b) Raw hide to finished leather by chrome tanning

(c) Chrome tanned leather into finished leather.

In India, mostly chrome tanning is practised.

The effluent generated from tanning process contains very high TDS, chromium (where chrome tanning is practised), high BOD & COD. So far, the practice to reduce TDS in effluent has been to segregate soak liquor and to minimise the total volume by solar evaporation. The chromium can be reduced by two ways i.e. chemical precipitation or chrome recovery. The biological treatment (anaerobic followed by aerobic) is practised to reduce BOD & COD.

The technologies available and the requirements are described below:

Technologies/Current Practices	**Requirements**
(I) CHROME RECOVERY Adoption of chrome recovery in case of raw hide to finished processes especially is practised by some of the medium and large-scale tanneries. It comprises collection of spent chrome liquor after basification and recovery of chrome from the same. This results in substantial saving besides reducing the concentration of chrome in the trade effluent. The supernatant liquor after recovery of chrome can be used for soaking. The recovered chrome can be used alongwith regular basic chrome sulphate for chrome tanning.	Large and medium units should provide individual chrome recovery system barring those which are practising semi-chrome finished to finished leather. The small-scale units need to adopt the chrome recovery system in a group of 4 to 5 units.
(ii) SOAKING **(a) Reuse of main soak for dirt soak** Soaking consists of dirt soak and main soak. The main soak is retained and used for dirt soak for the	**(a) Addition of soaking enzymes** Soaking enzymes @ 0.4% of w/s wt. can be added to achieve uniform and thorough soaking.

next batch.	
(b) Drum soaking instead of pit soaking Drum soaking instead of pits soaking which reduces the water consumption besides bringing down the soaking time from 12 hrs. To 3 hrs.	**(a) Reuse of dirt soak** Possibilities of collection of dirt soak liquor and adding polyelectrolyte to flocculate and settle the suspended solids need to be explored. Soak liquor after treatment and filtration can be reused partially in liming/deliming washes and picking. Modern plants are providing these facilities.
(iii) LIMING **(a) Substitution of paste lime by 85% pure calcium oxide (CaO)** This can bring down the quantity of consumption of powered lime to one third of its original quantity. It can also reduce the frequency of cleaning the primary settling containing the lime sludge. **(b) Provision of slight slope in the pasting area** By providing a slight slope in the pasting area, the excess liming paste can be effectively collected and used, which is otherwise washed away in the drain by lime yard workers. **(c) Reuse of relime liquor** 50% of relime liquor can be retained and reused for liming of subsequent batches. This also reduces water consumption. Other than optimisation of chemical consumption in this section, fleshing can be used for production of high-grade protein. This, if achieved, will solve the problem of solid waste disposal from the liming section.	**(a) Use of Liming Enzymes** Use of liming enzymes @ 0.4% can reduce Sodium Sulphide (Na_2S) Consumption by 40%. Use of soaking and liming enzymes can improve liming quality resulting in cleaner and flatter pelts. The marginal increase in cost is more than offset by increase in yield achieved in Wet Blue as well as reduction in Na_2S consumption. At higher enzyme levels, hair can be shaved off without burning which can be screened and used as a fertiliser. Some tanneries are practising; however, others should be encouraged to do so.
(iv) DELIMING Efforts can be made to reduce water consumption in this section by implementing the following measures:	Proper deliming agents need to be identified.

a. Use of deliming agents. b. Use of first delimes wash for liming.	
(v) PICKLING **Use of drained float for next batch** Normally after desired pH is obtained in pickling, 1/3rd float is drained to ensure better chrome exhaustion at lower floats. This liquor can be collected and used for next batch to reduce consumption of salt and acids.	Such facilities need to be installed in selected units for demonstration purposes.

Technologies for waste minimization in tanneries

Manual/mechanical desalting prior to soaking

- Reducing hydraulic load in soaking
- Counter current recycling of soak liquors
- Lime-free Beam house operations
- Enzyme assisted less-sulfide unhairing
- Recycling of lime liquor/washings
- Ammonia-free deliming process
- Salt-less picking
- Pickle-free chrome tanning
- Closed loop pickle-chrome recycling methods involving high exhaust chrome tanning
- Less chrome and chrome-free tanning methods
- Full chrome tanning methods
- Use of Eco-benign post tanning auxiliaries
- Optimization of float volumes in processing
- Formaldehyde-free finishing techniques
- Use of newer finish application systems
- Use of Roller Coater for improved transfer efficiency
- Split finishing

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Distillery

The main source of pollution from distilleries is the spentwash, which is produced as a result of fermentation and distillation of the molasses. The spentwash is acidic in character having very high BOD (40,000 - 50,000 mg/l) and COD (10,000-125,000 mg/l). The different treatment technologies for treatment of distillery effluent have been adopted depending upon the availability of land; filler material for compost and mode of disposal of treated effluent. The existing technologies and technologies required are given below:

Technologies/Current Practices	Requirements
Bio-methanation followed by Secondary Biological treatment system Large number of industries have provided the system wherein methane gas produced can be used into boilers which saves the fuel to the tune of 60%, besides removing BOD in the order of 80-90%. The secondary biological treatment such as activated sludge process or extended aeration system after bio-methanation brings down the BOD in the range of 300-500 mg/l. The final effluent after mixing with the other wastewater can be used on land for irrigation.	Two stage secondary biological treatment system is needed preferably using diffused aeration system for better efficiency and saving in power. The treated effluent when utilised on land for irrigation should meet the requirement of TDS by mixing with the irrigation water from other sources.
Composting In this process, press mud generated from sugar mill is utilised to produce compost by mixing distillery effluent. Both anaerobic and aerobic composting systems are practised. In some plants composting with treated effluent treated through bio-methanation plant is also practised. This system can achieve zero effluent if the press mud quantity matches with the effluent generated.	Adequate capacity of composting facility is needed and the compost quality is required to be checked periodically. There should be adequate holding capacity of effluent so that at no time effluent finds way into the drain or in the ground water. Ground water monitoring is also necessary to ensure that there is no seepage from the composting site.
Incineration Following drying of spentwash and using dried material in the boiler for steam generation.	Use of the spent wash alongwith baggasse/biomass for generation of power.

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Pulp & Paper Industry

The pulp & paper industries can be classified into three-category i.e. large-scale pulp & paper mills, agro based pulp & paper mills and waste paper based mills having installed capacity of 4.25 million tonnes. Environmental problems associated with pulp & paper industries vary with the size and category of the mill. Although all the large-scale pulp & paper mills have adequate treatment systems but still some of the problems like colour in the effluent and solid waste disposal problem still persists. The colour problem is basically due to spillage of black liquor during its handling which ultimately joins the effluent stream. The effluent that emanates from the bleaching section of the mill also contributes the colour. The toxicity is another problem, which is mainly due to use of elemental chlorine during the bleaching.

In small scale agro-based pulp and paper mills, major cause of pollution is discharge of black liquor which is otherwise taken to chemical recovery plant by large scale pulp and paper mills. The absence of chemical recovery plant in small-scale pulp & paper mills is due to their smaller size and high cost involved in its installation.

In waste paper based mills, zero discharge is possible through recycling of wastewater after suitable treatment. But due to poor waste treatment and old fibre recovery technologies, the industries are unable to recycle the effluent.

In the following table, the present practices adopted by the pulp and paper mills alongwith the technology requirements are outlined.

Technologies/Current Practices	Requirements
Use of elemental chlorine in bleaching of pulp which is resulting in generation of toxic effluent containing chloro compounds of lignin. It results in generation of AOX, which is highly toxic and carcinogenic.	Bleaching techniques, which avoid the use of elemental chlorine, should be adopted. Use of chlorine dioxide and use of oxygen at alkali extraction stage should be preferred. It reduces generation of AOX by about 70%. The use of oxygen/ozone as bleaching agents makes the effluent recyclable from this section with no colour
Use of kraft pulping process for delignification of wood/bamboo raw material in large-scale mills.	Use of modern pulping process like RDH pulping, Oxygen delignification should be practised. These processes produce pulp of low kappa number and high brightness, which require low bleach chemicals. Low steam requirement with high pulping yield are the attempted benefits.
Land disposal of lime sludge by the mills having chemical recovery plant	Most of the large-scale mills dispose lime sludge on land. Lime kiln should be used for recalcination of lime sludge so that it can be reused in the process.
Discharge of black liquor by the small scale agro-based pulp & paper mills	Chemical Recovery Plant (CRP) is required to be installed by such mills. The black liquor can be taken to CRP for recovery of pulping chemicals. Some agro-based pulp & paper mills have installed CRP and running it successfully. The installation of CRP by all units is necessary to control pollution and colour.
Removal of colour through lignin precipitation by adding poly-electrolyte	For the industry where chemical recovery is not feasible economically and problem of colour persists, the removal of lignin through precipitation and its conversion into useful and marketable product e.g. binders should be practised.
Use of obsolete technologies like conical save-all etc. as fibre recovery system	Dissolved air floatation based fibre recovery systems and micro-filters. Use of micro-filters improves the recycling of wastewater significantly.

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MINING INDUSTRIES

Aluminium Industry

The manufacture of aluminium involves two important stages (i) refining bauxite to aluminium oxide (alumina) by the Bayer process and (ii) reducing alumina in Hall-Heroult electrolytic cells to the aluminium metal.

In Bayer process the bauxite material is crushed and digested in a heated caustic solution. The solution is then filtered to remove insoluble residue (red mud) and the pregnant liquor is cooled so that precipitation of aluminium oxide occurs. The precipitated material is removed from the process stream by filtration and calcined to produce aluminium oxide.

In the Hall-Heroult process, aluminium oxide is dissolved in an electrolytic bath composed mainly of cryolite, sodium aluminium fluoride and aluminium fluoride. The electrolytic cells consist of open steel vessels, that are lined with carbon. The carbon lining serves as the cathode for electrical conductance. Consumable carbon anodes (Soderberg or prebaked type) are used to provide a carbon source to react with the oxygen liberated in the electrolysis.

The major pollutants/wastes generated are (i) red mud (solid waste) from refining of bauxite; (ii) fluoride emission (air pollutant) and spent pot lining (solid waste) from electrolytic stage. The red mud is highly alkaline and hence needs special precaution while disposing to avoid pollution of surface as well ground water resources. The specific generation of red mud in our country is 1.16 – 1.4 T/T of alumina production. The total generation of red mud in India is about 2 million TPA.

The specific generation rate for spent pot lining in our country varies from 43 to 62 Kg per tonne of aluminium produced. The spent pot lining carbon portion contains 4-8% leachable fluoride as well 0.01-0.025% leachable cyanide, requiring handling and management as per Hazardous Wastes (Management & Handling) Rules, 1989.

The existing pollution control/waste management systems and the requirements are tabulated below :

Existing Management System	Requirements
Red Mud : a) Wet disposal : In this method, washed red mud slurry containing 10 – 30% solids is pumped to the pond. b) Dry disposal : In this method, the red mud disposed contains 30 – 50% moisture and also known as thickened tailing disposal	Dry disposal in secured land fill, as dry disposal requires much less space (1/3 to 1/5 of Wet disposal) and less seepage is expected.
Spent Pot Lining :	

a) Flouride recovery followed by use as fuel. b) Disposal in secured landfill to avoid leakage of fluoride and cyanide.	a) Fluoride recovery followed by reuse for carbon portion (Impact of such reuses need to be investigated). b) Disposal in secured landfill for refractory portion.
Fluoride emission : a) Dry scrubbing (using alumina): By this most of the fluoride is recycled into the system. b) Wet scrubbing. This causes water pollution. The treatment of water pollutants results in generation of solid waste (calcium fluoride).	Dry scrubbing, as this helps in recycling fluoride and also there is no water pollution.

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Steel Industry

Iron and Steel is one of the largest sectors of industries in India. Though the production of steel is vital for the economic growth but its production is a major source of pollution. The production of steel causes water, air and noise pollution and generation of solid wastes including hazardous waste. The main units of steel industry causing pollution are coke oven and by-product plant, steel melting shop, sintering plant, blast furnace, refractory material plant and captive thermal power plant.

The existing pollution control systems and the needs are tabulated below:

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Coke Oven by-product Plant

Technologies/Current Practices	Requirements
Coke Oven In coke ovens the volatile materials released during cooking flows from the oven to the by-product plants where ammonia, benzol, xylene, toluene, tar,	- Land based pushing and charging emission control with dust extraction system - Automation for process operations

pitch and tar acids are recovered. The operations are associated with fugitive and stack emissions. The PAH compounds released during cooking operation as fugitive emissions are carcinogenic in nature. The technologies available to control the pollution are - HPLA system - Hydraulic door and door frame cleaner - Doors with double knife edge and rope sealing - Water sealed AP caps - Screw feeder	- Self sealing air cooled doors - Possibility of coke dry quenching needs to be tried out • Effluent treatment plant to treat cyanide, phenol, ammonia, COD etc. - Hazardous waste (tar sludge and ETP sludge) handling and disposal following Hazardous Waste Handling, Rules; or, tar sludge / ETP sludge charging alongwith the coal fines in the coke ovens
Sintering Plant - ESP / bag filter / wet scrubber for process emissions - ESP / bag filter / wet scrubber for work zone environment	- ESP / bag filters with higher efficiency of removal for process emissions.
Thermal Power Plant - ESP for the emissions	- Proper management and utilisation of fly ash
Steel Melting Shop - ESP/ bag filter wet scrubber for the process emissions - Effluent treatment comprising settling unit and re-circulation system for the treated effluent	- Proper operation and maintenance of air emission control and effluent treatment systems.
Blast Furnace - ESP / bag filter / wet scrubber for air emissions	- Proper operation and maintenance of ESP / bag filter / wet scrubber for air emissions - BF slag utilisation
Lime / dolomite plant - ESP bag filter / multiclones for	- Effective operation and maintenance of ESP / bag filter / multiclones for process and work zone dust emissions

process and work zone dust emissions	
Mills - Oil & Grease traps and settling tanks for waste water treatment	- API separators and settling tanks for wastewater treatment
Raw material handling units - Enclosures and water sprinkling system	- Improvements in the systems for controlling fugitive emissions.

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Cement Plant

The Cement plants can be classified into three categories i.e. Wet process kiln , semi-dry process kiln and dry process kiln. Cement industry contributes air pollution mainly in the form of particulate matter. The major sources of dus generation in the cement plants are : limestone crusher, raw mill, kiln, clinker cooler, coal mill, cement mill and packing plant.

The existing pollution control systems and the requirements are tabulated as follows:

Technologies/Current Practices	**Requirements**
Out of the three processes, wet process kiln is the most energy intensive. Most of the cements have switched over to dry process.	Wet process kilns be converted to dry process kilns.
Multi-cyclones/ESPs/Bag filters to control particulate matter generated from various sections of the cement industry.	Recommended dust collectors for different sections are : Lime Stone Crusher - Bag Filter Raw Mill - Bag filter/ESP Kiln - Bag Filter/ESP Clinker Cooler - ESP/Bag filter with heat exchanger Coal Mill - Bag Filter/ESP Cement Mill - Bag Filter/ESP Packing Plant - Bag Filter

The Cement industry has potential to utilise the industrial solid waste like flyash and slag as a raw material to produce flyash pozzolana cement, & slag cement. On the one hand, this technology of reuse of waste material will conserve natural resources of limestone and on the other hand it will solve the problem associated with disposal of waste material. It is to be borne in mind that quality-wise flyash pozzolana cement and slag cement is as good as ordinary Portland cement. Use of flyash, slag and other compatible waste material should be encouraged for utilisation in cement manufacturing.

The dust collected in pollution control devices is a valuable material. The pay back period of ESP and fabric filter for a 3000 TPD cement plant is 10 and 13 months respectively.

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THERMAL POWER PLANTS

Thermal Power Plants can be classified based on the type of fuel used. The main categories of the power plants are coal/lignite based; gas/Naphtha/oil based and Nuclear power plants.

Coal/lignite based thermal power plants

Particulate matter, sulphurdioxide and oxides of nitrogen are the main pollutants emitted form these plants which lead to air pollution. The suspended solids, oil and grease are main pollutants in effluent generated besides higher temperature in cooling water discharge.

The pollution control systems in practice and the requirements are tabulated below :

Technologies/Current Practices	Requirements
- Electrostatic Precipitators have been provided to control the emission of particulate matter **with** appropriate stack height for adequate dispersion of gaseous pollutants.	**-** High efficiency ESPs with EPIC controller should be provided. Further, based on background concentration or future development of power generation in cluster areas, space provision for installation of flue Gas Desulphurisation (FGD) system and DeNOx system, for control of SO_2 and NOx emissions are needed so that the same control be provided where needed. For controlling smaller particulate emissions from stacks i.e. PM10/PM2.5, bag filters may be used as ESP would not trap small particles efficiently. Bag filters may also be used in combination with mechanical collectors or ESPs.
- To reduce ash content in coal, use of beneficiated coal has been made mandatory w.e.f June 2001.	- Fluidised Bed combustion (FBC)/CFBC technology for the solid fuel containing higher ash and sulphur. **-** Integrated Coal Gasification combined cycle (IGCC) technology should be tried.
- Wet ash disposal system (lean phase) has been adopted. Some of the plants have dry ash disposal/collection system vis-a-vis wet disposal in ash pond with wastewater recycling system.	• Dense Phase wet ash disposal system. Ash pond wastewater should by recycled hundred percent by the new plants. • To promote utilisation of flyash, provision for dry collection and storage (Silos) should be made an

	integral part of the ash management system.
- Once through cooling system is in practice in some plants. However, new plants have provided cooling towers (which discharge less quantity of hot water) **.**	- In water scarce areas and in locations where power plants are sited near lakes/reservoir, cooling towers should be provided.

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Gas/Naphtha based Thermal Power plants

Oxides of nitrogen and noise are the main pollutants from these plants. In combined cycle power plants, cooling water discharge at high temperature is a problem for the recipient water bodies.

The available and required pollution control measures in such plants are tabulated below:

Technologies/Current Practices	**Requirements**
- Low NOx burner and steam injection for control of oxides of nitrogen.	High efficiency catalysts based fuel gas denitrification (selective catalytic reduction, SCR) system.
- Turbines in acoustic enclosures (in door) to control noise.	Low noise and low vibration turbines.
- Once through cooling system	

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READER'S COLUMN

I am glad to see the amount of work you are doing to generate awareness of our present environmental problems. I hope your warnings will not fall on deaf ears.

M S Swaminathan

Chairman, M.S.Swaminathan Research Foundation, Chennai

In general, bio-mapping is important for understanding the state of environment. …….I wish you success in developing and using this methodology effectively.

M G K Menon

Chairman, High Power Committee on Hazardous Waste, Delhi

The studies on the stretch of the River Jamuna from Delhi to Etawah and the presentation of the results in the form of a map is an interesting and valuable initiative. The water quality parameters and even the biological organisms resident will undoubtedly vary with the season, the rate of flow of fresh water, rain and the quantities and types of discharges from human habitation along the stretch and the inputs from colonies upstream of Delhi.

S Varadarajan

INSA, New Delhi

The Newsletter (March, 1999) is very informative and well brought out. I enjoyed going through it.

R.A.Mashelkar

Director General, CSIR

I find them (issues of Parivesh) most interesting and informative.

S.Z.Qasim

Vice Chairman, Society for Indian Ocean Studies, New Delhi

I am delighted to see your latest Newsletter (March, 1999) containing interesting results of bio-mapping of riverine system in our country, adding another dimension to water quality monitoring. I congratulate you on your leadership in an extraordinarily vital area to the nation's health and development.

V Ramalingaswami

National Research Professor, AIIMS, New Delhi

I find these Newsletters very interesting.

Tarun das

Director General, CII

Permit me to sincerely congratulate you and your team at CPCB for the excellent pioneering research (on bio-mapping of rivers) you are undertaking, which will definitely benefit the ecosystem.

P.Murari

Adviser to President, FICCI

Biomonitoring, undoubtely holds promise as a novel approach to water quality monitoring. I take this opportunity to wish every success to you and your team at CPCB in its future endeavours.

Amit Mitra

Secretary-General, FICCI

We are all aware of the varied activities of CPCB and I am happy that such activities (Bio-mapping of rivers) are now being widely publicised through excellently brought brochures.

Rajat Nandi

SIAM, New Delhi

I take this opportunity to congratulate you and your colleagues in having taken the initiative and completed such a study (Bio-mapping of rivers) on a subject of topical interest. I do hope the Board would take up similar work in other rivers as well.

K.Rajendran Nair

E.O. & A.S., DoPT, New Delhi

Congratulations for your successful work on the bio-mapping of rivers. It is an endeavor to monitor two environmental issues (water quality and biodiversity) with a single set of parameters. We believe that this innovative study will motivate future studies and invent more accurate relationships between water quality and living organisms.

Surendra Shrestha

Regional Coordinator, UNEP/EAP-AP

The findings of the study as undertaken by your organisation are indeed very interesting and useful for understanding the relationship between the water quality and the living organisms.

Ketut K Ardiantha

Counsellor, Embassy of Indonesia, New Delhi

In my opinion it is a commendable work carried out in the field of bio-monitoring in the Yamuna river and the methodology that could be adopted for bio-mapping of Indian rivers. I am sure you will create greater awareness among institutions and public at large on issues relating to water quality and its impact on living organisms.

L.Lakshminarayan

In-charge, Technology Management, APCTT

I have shared (Parivesh, March, 1999) with my colleagues in the subjects of hydrology, water quality and GIS.

Egbert Pelinck

Director General, ICIMOD, Nepal

I am very much impressed about the data based analysis to polymer demand in India, per capita consumption of plastcs etc.(Parivesh, Sept, 98). ……………We have a fear that in future the plastc would be an alarming problem. Kindly give more information related to this.

M.David Mansingh

Secretary, SHWET, Trichy

Both these publications (Parivesh, Dec 98 and June 1999) are attractive besides being informative and educative. ………………..Your opening remarks (Editorials) and other matters with facts and figures have added grace to the said publication.

J R Jindal,

Special Executive Magistrate I Class, Delhi

There is lot of valuable information regarding Auto emission norms (Parivesh, June 1999). Kindly accept ou complements for this wonderful and useful issue.

K R Joshi

Advisor, AIILSG, Mumbai

Kindly accept my thanks for an excellent issue (Parivesh, June 1999)

Rajeev Talwar, IAS,

Secretary, Environment and Chairman, DPCC, Delhi

It (Parivesh, June 1999) provides a wealth of information and would be very useful for our students.

Principal

Bhavan's Vidya Mandir, Kochi

The issue (Parivesh, Dec. 1999) has detailed information of CPCB activities in different States in India. We welcome with appreciation, the setting up of Environmental Surveillance Squad, to monitor the pollution related issues deliberately ignored by many agencies, causing hazardous health and difficulties to people. We trust, the central notion will have greater effect on the management and monitor of pollution control and environment, in the country.

M G S Remu

Director, CPD, Bangalore

The subjects ‘Bio-mapping of rivers' and ‘Auto emission' covered by Parivesh is really a source of information on the deteriorating environment conditions of our country. Our students will definitely find it interesting and informative to go through its leaflets.

Vinay Kumar

Principal, DPS Vasant Kunj, New Delhi

It (Parivesh, June 1999) will add boost for the Tamil Nadu Pollution Control Board Library users.

G. Rengasamy

M.S., TNPCB, Chennai

I enjoyed going through the newsletters (Parivesh, March & June, 1999) and also shared these with my staff. We wish to compliment you and your associates for their research and efforts in finding out a new method of bio-mapping to check the water quality by the presence of living organism which will now be adopted for checking the quality of water in all the rivers of the country. Neatly printed with elegant layout and striking pictures the newsletters indeed look very impressive.

Vinod K. Bhola

Manager, Rotary International, New Delhi

It is an excellent concept, but even better to see was its detailed implementation programme……….Encouraged by your Bio-mapping of Rivers, we are putting together a zero order draft of a proposal to the Ministry of Environment and Forests to fund such a study all along the coast of India.

E. Desa

Director, National Institute of Oceanography, Goa

These (Parivesh Newsletters) are indeed worthy of the cause being pursued so vigorously by the Central Pollution Control Board.

B.B. Tandon

Secretary, Ministry of Personnel, Public Grievances and Pensions, New Delhi

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