Capacity Building for the Urban Environment:
A Comparitive Research, Training and Experience Exchange

Project Paper No. 7

An Approach to Pollution Prevention in the Electroplating Sector

by

Development Alternatives,
New Delhi
India

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Capacity Building for the Urban Environment: A Comparative Research, Training and Experience Exchange

A project implemented by the

Institute for Housing and Urban Development Studies (IHS), Rotterdam

In co-operation with the

Instituto de Desarrollo Urbano (CIUDAD), Lima
Institut Africain de Gestion Urbaine (IAGU), Dakar
Instituto para la Democracia Local (IPADEL), Lima
Human Settlements Management Institute (HSMI), New Delhi
Centro de Servicios para el Desarrollo Urbano (PROA), La Paz

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Introduction to the Project

Focus and Outline of the Project

Capacity Building for the Urban Environment is a comparative research, training and experience exchange project that was launched in October 1994 with the support of the Dutch government. It provides an inventory and review of the experiences of relevant bilateral and multilateral organisations and of Best Practices in urban environmental management. For the countries of India, Peru and Bolivia, it identifies, communicates and extends the application of Best Practices in environmental management for cities. In May 1995, the project was expanded to include Senegal/West Africa with the support of the Swiss government.

The focus of the project is on learning from experiences in urban environmental management at the city level and on developing strategies for capacity building in order to replicate and scale up the best of these experiences elsewhere. The overall co-ordination of the project is the responsibility of the Institute for Housing and Urban Development Studies in Rotterdam, while co-ordination in the participating countries is the responsibility of the following partner organisations:

- Human Settlements Management Institute (HSMI), New Delhi, India;
- Instituto para la Democracia Local (IPADEL), Lima, Peru;
- Instituto de Desarrollo Urbano (CIUDAD), Lima, Peru (since January 1997);
- Centro de Servicios para el Desarrollo Urbano, (PROA), La Paz, Bolivia, and
- Institut Africain de Gestion Urbaine, (IAGU), Dakar, Senegal.

Project Activities

Support to cities in the form of applied research and development activities in the area of urban environmental management has been, and continues to be, provided by the co-ordinating partner organisations through the following set of activities:

Research

Within the applied research programme undertaken in the project, Best Practices in urban environmental management in Bolivia, India, Peru and, to some extent, Senegal were identified, and their lessons and experiences reviewed. An analysis and review of the identified Best Practices then took place involving a large number of individual research groups and professionals. In a process of on-going monitoring and review, guidance and support were provided by IHS and its partner organisations. The results of both the individual studies of Best Practices and their review are being published in several books and papers in both English and Spanish. These and their publication dates are listed in the *Introduction to the Project Papers*, which follows this note.

Networking

In identifying the research priorities of the project, during the conduct of the research studies, and throughout the review of research findings, a structure was developed and utilised to ensure the participation of all interested and concerned individuals and institutions through a consultative process. Expert group meetings and consultative seminars were organised for this purpose.

Capacity Building Strategies

After the Best Practices research, analysis and review were completed for all countries, outline capacity building strategies were developed for each based on what was learned from these local experiences and practices. These strategies were developed through a broad-based consultation process involving a

large number of research institutions, individual professionals and academics, city representatives, NGOs and local representatives. They are currently being modified based on the outcome and findings of Habitat II, which was held in Istanbul in June 1996, and the emphasis has now shifted to applying a number of Best Practices to selected cities.

Best Practices Documentation

Concurrent to and co-ordinated with this project, IHS served as the secretariat of and contributed to the review of the Best Practices that were submitted to the United Nations Centre for Human Settlements (UNCHS) for the *Global Best Practice Initiative for Improving the Living Environment* in preparation for Habitat II. HSMI, PROA, IAGU and IPADEL were also involved and contributed to the national preparatory processes that took place in their own countries. An overview of the Best Practice submissions to UNCHS, as well as summaries of the additional case studies received by IHS, are being made available on the Internet through the IHS Home Page.

Databases

Two databases are also under preparation: an institutional database and a literature database. The institutional database is being developed in co-operation with the International Institute for Environment and Development (IIED) in London. It contains entries on relevant organisations, some of which are documented in extensive profiles, while others are included as shorter reference information entries. IHS is developing the second database, which provides references in the literature on experiences with urban environmental management.

Rotterdam Seminar

The Rotterdam Seminar, which took place in May 1996 during the two weeks preceding Habitat II, brought together all principal researchers, as well as city representatives and other professionals involved in the project for a period of intensive discussions. The seminar resulted in a document that provided a comparative analysis of practices and experiences in the field of urban environmental management. This analysis included the project process and network building, governance, job creation and poverty alleviation and gender. This was published as a book in February 1997 and is listed later in the *Introduction to the Project Papers*.

The Rotterdam seminar also discussed *city-level capacity building strategies* for the cities of Calcutta, India; Ilo, Peru; Santa Cruz, Bolivia and Dakar, Senegal. Experiences in *urban environmental management* were reviewed for the cities of Tilburg, The Netherlands and Nairobi, Kenya.

Habitat II

At Habitat II the project was presented in the Special Meeting on Implementing the Urban Environment, organised by UNEP and UNCHS, as well as in other fora.

Capacity Building Strategies for Peru, Bolivia, India and Senegal

The outline capacity building strategies which were developed in preparation for Habitat II (i.e., by CIUDAD, PROA, HSMI and IAGU with the support of IHS). They are being modified for implementation, which is expected to begin late in 1997.

Outline Training Program for Local Officials, CBO Workers, and other Partners for Peru, Bolivia and India

These training materials are to be developed over the next few months and will comprise curricula for short courses related to the most directly applicable Best Practices identified for each country in view of its national strategy for capacity building in urban environmental management.

The Development of a Medium-Term Capacity Building Strategy for Senegal and West Africa

This activity is in progress and addresses the building of individual and institutional capacities at the local level for urban environmental management in both Senegal and throughout West Africa.

Ed Frank, Project Manager

Rotterdam, February 1997

Introduction to the Project Papers

A number of publications have appeared under the Capacity Building for the Urban Environment project. These are listed below and can be ordered from IHS or its partner organisations respectively:

- *Capacity Building for the Urban Environment,* edited by David J. Edelman and Harry Mengers, summarises the research findings of the project and the conclusions of tile Rotterdam Seminar. It was published by the Institute for Housing and Urban Development Studies (IHS) in Rotterdam in February 1997;
- *Urban Environmental Management: The Indian Experience,* edited by B.N. Singh, Shipa Maitra and Rajiv Sharma, reviews the Indian experience in urban environmental management and presents all the Indian Best Practice of the project in detail. It was published by the Human Settlements Management Institute (HSMI) and (IHS) in New Delhi in May 1996;
- *Problems and Issues in Urban Environmental Management: Experiences of Ten Best Practices,* also edited by B.N. Singh, Shipa Maitra and Rajiv Sharma reports on the Indian Best Practices of the project in an abridged form. It was published by HSMI and IHS in New Delhi in May 1996, and
- *Ciudades para la Vida: Experiences exitosas y propuestas para la accion,* edited by Liliana Miranda Sara, presents the Best Practices and outline capacity building strategies for Peru and Bolivia for a Spanish speaking audience. It was published as Volume 6 in the Urban Management Series of the joint UNCHS/UNDP/World Bank Urban Management Programme in Quito in May 1996.

The objective of this series of *Project Papers,* then, is to bring to an English speaking, audience the results of the project research in Peru and Bolivia appearing in the Miranda book. In addition, the Indian research, while documented in English in the second and fourth references listed above, has not appeared as complete, individual studies. Consequently, a selection of these will also be chosen for this series. Finally, the first reference in the above list covers aspects of the research undertaken in all four countries of the project.

As a result, the selection of work appearing in the *Project Papers* includes the following:

Bolivia

- 'Urban and Environmental Reality Workshops' by Zoila Acebey;
- 'Urban Agriculture in Community Gardens' by Julio Prudencio Böhrt, and
- 'Institutional and Development Framework for Urban Environmental Management in Bolivia' edited by Gastón Mejía.

Peru

- 'Defence and Conservation of the Natural Swamp Area Pantanos de Villa, Lima' by Arnold Millet Luna, Eduardo Calvo, Elsie Guerrero Bedoya and Manuel Glave;
- 'Consultation in Urban Environmental Management: The Case of Ilo' by José Luis López Follegatti, Walter Melgar Paz and Doris Balvín Díaz;
- 'Promotion of Employment, Health and the Environment, Lima' by César Zela Fierro and Cecilia Castro Nureña
- 'Environmental Sanitation and Infrastructure: The Case of the Marginal Urban Areas of the Southern Cone of Lima' by Silvia Meléndez Kohatsu, Víctor Carrasco Cortez and Ana Granados Soldevilla, and
- 'Inter-institutional Consultation and Urban Environmental Management in San Marcos Cajamarca' by Marina Irigoyen and Russeles Machuca.

India

- 'Power to the People: The Local Government Context' by the Times Research Foundation;
- 'Carrying Capacity Based Regional Planning' by the National Institute of Urban Affairs;
- 'NGOs/Civic Societies and Urban Environmental Advocacy' by Development Associates;
- 'Integrated Low-Cost Sanitation: Indian Experience' by Sulabh International Institute of Technical Research and Training;
- 'City-Wide "Best Practices" in Solid Waste Management in Collection, Transportation and Disposal' by HSMI/WMC of UIFW;
- 'Environmental and Health Improvement in Jajmau Area, Kanpur: Lessons and Experiences for Wider Replication' by Ministry of Environment and Forests;
- 'An Approach to Pollution Prevention in Electroplating Sector' by Development Alternatives;
- 'Integrated Study on Wetlands Conservation and Urban Growth: A Case of Calcutta's Wetlands' by Institute of Wetlands Management and Ecological Design;
- 'Sustainable Urban Development: A Case of Navi Mumbai (New Bombay)' by City & Industrial Development Corporation;
- 'Community Based Sanitation and Environmental Improvement Programme: Experiences of Indore, Baroda and Ahmedabad' by Shri Himanshu Parikh, and
- 'Institutional and Development Framework for Urban Environmental Management in India' by HSMI.

It should be emphasised here that the nineteen *Project Papers* in this series reflect the views of their authors only and have been edited to varying degrees. Initial English language editing was done by, among others, B.N. Singh, S. Maitra and R. Sharma for India and by D.J. Edelman for Peru and Bolivia. In fairness to both the authors and the publishers, they should, therefore, be characterised as working papers rather than full academic papers.

David J. Edelman, Series Editor
Rotterdam, February 1997

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INTRODUCTION

The process of rapid industrialisation often results in the release of hazardous wastes and emissions into the environment, thus affecting the quality of life of the surrounding people.

With the increasing demand for non-corrosive, aesthetic looking consumer items, there has been a tremendous growth in electroplating units. The growth of these units is mainly urban oriented owing to the inherent advantages associated with it.

The unplanned growth of these units and the thoughtless dumping of hazardous chemical residues on to the land and water courses has been a cause of major environmental concern especially in urban areas.

In Delhi, besides causing local land and environmental problems, a significant part of the pollution load to the River Yamuna is contributed by small scale electroplating units.

While the local governments are responsible for improving the local environmental conditions, they are inadequately equipped to confront the environmental problems in a professional way owing to constraints of resources, institutional constraints, legal impediments and insufficient human resource.

On the issue of urban environmental quality improvement, the Rio conference (1992) on environment and development has recommended 'capacity building for human settlements' as one of the prime solutions to achieve sustainable development by national governments.

Even in the forthcoming Second United Nations Conference on Human Settlements, the Habitat II, scheduled to be held in Istanbul, Turkey, the focus will be primarily on the issue of sustainable human settlements development in an urbanising world. Attempts will be made in this meeting to identify and compare the 'best practices' in the field of environmental quality improvement in human settlements regionally and globally.

OBJECTIVES OF THE RESEARCH STUDY

* To consolidate examples of good practices in electroplating that have an impact on urban environmental quality.
* To identify key strategies to be adopted for capacity building at the local level.

The area of focus for the study is Delhi and is limited to the more prevalent operations such as nickel-chrome and zinc-cyanide plating. However, to consolidate best practices, case studies from other areas such as Madras, Parwanoo (Himachal Pradesh) have also been taken up for this study.

AN OVERVIEW OF THE ELECTROPLATING SECTOR

SMALL SCALE INDUSTRIES : THE INDIAN SCENARIO

Ranked one among the top fifteen industrial economies of the world, industrial pollution in India is shared equally by large scale enterprises (LSEs) and small and medium enterprises (SMEs). While two thirds of the goods and services of the national economy are provided by SMEs, maximum resource wastage and pollution load to the environment is also contributed by this sector.

The Government of India's thrust has been towards the promotion of SMEs through fiscal incentives and policy measures. One such measure was to allot 836 product categories for production exclusively by SMEs and reserve 409 items for 100 per cent or partial purchase by government stores from SMEs.

In spite of all these measures, the growth trend of SMEs is not up to the expectation and is in fact facing gradual decline, as industrial sickness is on the rise. In the wake of global competition and the changing market scenario in recent years, it makes a good business proposition to improve the productivity and efficiency and competitive edge of small enterprises through cleaner production.

The Government of India offers subsidies for installing pollution control equipments through their various schemes.

DELHI

Delhi and its surroundings have often attracted varying types of small and medium sized units. The advantages of operating in and around Delhi are enormous. To quote some of these features: better access to markets, transportation facilities, assured business centres, tax relaxations and incentives among others. There are about 9000 small and medium industries operating in Delhi. The types of units vary from soft industries such as the electronic industry to highly polluting ones such as textile dyeing, electroplating, rolling and pickling units.

The urban environmental quality of Delhi is facing equal threat from the burgeoning population as well as industrial growth, especially the small scale industries.

ELECTROPLATING SCENARIO IN DELHI REGION

The growth of the electroplating sector has direct correlation with the rapid industrialisation process. The growth of this sector is largely urban oriented as it mostly operates as a service sector to big enterprises.

The electroplating sector can mainly be categorised into three types. (i) Captive type : where electroplating is an ancillary operation in large scale production units such as cycle part manufacturers, automobile part manufacturers and such others. (ii) Feeder type: where electroplating is usually a medium scale operation. These units provide services to fixed clients, usually the big companies. (iii) Job type : These types of units are usually small scale operations and the day to day operations vary quite drastically.

It is estimated that there are about 3000 electroplating units both authorised and unauthorised units operating in the eight industrial pockets of Delhi. The industries are represented by industrial associations within an estate. Most of them are small scale job platers and are characterised by the following features:

* Generally family owned enterprises, employing unskilled and untrained manpower;
* Insufficient work place resulting in inadequate operational facilities and poor house-keeping;
* Inadequate water supply and improper drainage system;
* Frequent variations in the daily production schedule;
* Unaware of the benefits of waste minimisation and pollution prevention measures.
* Unaware and ignorant of the consequences of pollution on the environment and people, including the work force.

SCENARIO OF THE STUDY AREA

Of the eight industrial pockets of Delhi, four pockets of West Delhi were chosen for the study: (a) Naraina, (b) Anand Parbat, (c) Mayapuri, and (d) Wazirpur. The most common electroplating operations in these regions are nickel-chrome (Ni-Cr) and zinc-cyanide (Zn-CN) plating. Table 7.1 shows the total number of electroplating units in these four industrial pockets.

Table 7.1: Electroplating Units in the Study Area

Industrial Area Units	No. of Zn-CN Units*	No. of Ni-Cr
Naraina	20	18
Anand Parbat	28	38
Mayapuri	18	27
Wazirpur	15	26

* *This number does not represent a minimum of 100 very small household units in these areas. (Source : Industrial associations).*

Of these four industrial areas, Anand Parbat Industrial Area is not located in a confirmed industrial zone. A large number of Ni-Cr and Zn-CN plating units are operating in this area and are located in the midst of a thickly populated residential area, thus posing greater environmental threat to the surrounding people. All the units are small scale job platers and they do not have adequate space nor do they have technical or financial capability to install and maintain individual waste treatment and disposal facilities.

In the absence of any organised sewerage system in this area, all these units discharge their waste water containing heavy metals into open storm water drains, which are finally connected to a domestic sewer.

The situation in the other industrial areas is more or less the same, except for the fact that they are situated in authorised industrial areas and not in the middle of the residential areas.

In a recent drive to contain pollution, the Supreme Court has ordered 3000 small scale units in Delhi in various industrial areas to close down owing to lack of pollution control measures. While some units are ready to shift to Haryana, most of them are still trying to adopt suitable pollution control measures. But the progress is very poor.

In Anand Parbat area, the land has been acquired by the Municipal Corporation of Delhi for developing the area and all these industrial units will be asked to shift out from there.

No firm action has been taken so far to close down the units, as the socio-economic and political links are very sensitive in this sector.

TECHNICAL DESCRIPTION OF ELECTROPLATING OPERATION

Electroplating process

Metal finishing is an activity which is introduced early in the

Inside view of an Electroplating unit.

process of industrialization. *Electroplating is the process of coating a layer of one metal on another metal or conducting a metal by electrolysis.*

It contributes significantly towards offering a good pleasing and decorative finish, rendering objects non-corrosive and re-building worn metal surfaces in engineering applications at affordable prices without placing too large a demand on skilled labour or sophisticated equipment.

However, for many processes the consumption of water and chemicals involved in them can be astoundingly high, and constitute, unless reasonably controlled, a major threat to the health of people and the environment.

The plating operation is mainly carried out in three process steps:

a. Pre-treatment

b. Electroplating

c. After-treatment

A general process flow diagram is given in Annex-I

a. Pre-treatment

Pre-treatment of work pieces is done to remove dust, scales, oil and grease and to make the surface receptive to the final coating. The process steps are :

* Polishing: buffing and belt sanding to prepare even surfaces.

* Water rinsing:to remove dust

* Degreasing :vapour degreasing in advanced scale of operations

* Acid dip:to remove rust, oil and grease by strong acid or strong caustic solutions.

b. Electroplating

After pre-treatment the work pieces are dipped into an electrolytic cell, usually containing a salt solution of the metal to be plated. An electrolytic cell contains two electrodes, namely, an anode and a cathode. The two electrodes are connected to a low potential, direct current electric power source. The work piece to be plated acts as a cathode and the metal used for plating acts as the anode. During the plating process the anode will be dissolved and coated on the cathode. The plating process can be classified as :

* Acidic process:Nickel, Chromium, Copper, Zinc, Cobalt etc.

* Basic process:Copper, Brass, Silver, Zinc, Cadmium, Gold, Cyanide etc.

It is very important to maintain the required conditions of temperature, pH and concentrations of the bath chemicals for various plating operations.

c. After-treatment

After-treatment involves passivation, lacquering, polishing, final rinsing and drying.

Passifying - A Surface Hardening Process

A zinc layer is passified by applying a thin layer of chromium as a visual enhancement and extra protection against corrosion. Blue - passifying is the application of a very thin passifying layer, yellow - passification is the application of a slightly thicker layer.

Rinsing

Rinsing takes place between various baths to avoid drag-in and contamination of the next bath. Rinsing also prevents surface staining caused by drying out as a result of crystallization.

Rinsing is usually done in two ways:

a. **Still rinsing baths :** The still rinse baths (also referred to as economy tanks) are tanks filled with water in which the workpiece is immersed. Over a period of time, the contamination level of this rinse water increases. It is therefore essential to be renewed periodically.

b. **Running water baths :** The running water baths are tanks in which the rinsing water circulates. This water is replenished on a continual basis and thus the level of contamination remains low. A filtration and water-softening unit (ion exchange) is incorporated in the circulation system.

Drying

Drying is conducted in a centrifuge or by circulating hot air in the area.

SOURCE OF POLLUTION

Metals and chemicals are the basis of the metal finishing industry. The thoughtless use, release or dumping of chemical residues and effluents can affect a wide range of environmental species, as well as cause serious human health effects. Most processes which involve the use of chemicals should be examined for their propensity to cause pollution. Loss of chemicals can occur from rinsing operations, from spills, or the discarding of spent solutions. In a few instances the products from the industry may be of environmental concern as for example, objects plated with cadmium.

The main sources of wastes are :

a. **Drag out losses :** Drag out is the loss of bath liquids while transferring the workpiece from one bath to another. The costly concentrated chemicals used in the plating baths are lost in the rinse water or on the floor.

b. **Concentrated liquid wastes :** Pre-treatment and plating bath solutions need to be replaced when the quality deteriorates because of contamination by dissolved metals and insoluble salts. Rinse water baths need to be replaced with fresh rinse owing to build up of concentrations. All these :

* spent acid baths
* spent alkali baths
* spent passivation dip baths
* rinse waters
* spent plating baths

will be dumped into drains, creating environmental hazards.

c. **Water treatment :** Waste resulting from water treatment, for example, neutralisation, de-watering, detoxification and treatment.

d. **Solid waste :** Sludge generated during plating operations, for example, Zinc-Cyanide bath, residues and sludge generated after treatment.

e. **Air pollution :** Buffing of articles, fumes generated from the baths cause air pollution, resulting in occupational health hazards for the work-force.

ENVIRONMENTAL IMPACTS

Corrosive chemicals such as acids and alkalis used in the pre-treatment process have the capacity to eat away the tissues and materials they come in contact with.

When the presence of heavy metals such as nickel, chromium and zinc exceeds the toxic limits in a particular environmental medium can gradually accumulate in the body and shows its effects only some years after exposure has begun. Toxic properties include carcinogenicity (cancer causing), nervous disorders and mutagenecity (mutations in the genetic code).

Pollutants from electroplating operations can find their environmental path-ways into soil, air, water, food material, plant and animal tissues. Metals tend to get absorbed easily on surfaces like soil or sediments. Cases were reported that metal finishing wastes damaged natural eco-systems by contaminating the drinking water, destroying the fisheries and its products.

Air pollution problems are encountered owing to the acid mists and toxic fumes generated when cyanide wastes come in contact with acidic effluents because of unmindful dumping of wastes into the sewer lines. Occupational health risks are inevitable for shop-floor personnel if proper precautions are not followed while operating with acids and toxic heavy metals.

Solutions to Minimise Occupational and Environmental Risks

A. For Minimising Occupational Health Risks

Some of the precautions to be taken are:

* Good housekeeping practices and proper care while handling toxic heavy metals.
* Use of proper protection devices such as hand gloves, nose masks, shoes, goggles etc.
* Use of less hazardous alternate chemicals
* Provision of exhaust systems and ventilation
* Improvisation of skills in various operations

B. FOR Minimising Environmental Risks

* Good housekeeping measures to minimise loss of chemicals.

* Pre-treatment of hazardous effluents to make them non-hazardous.

* Neutralisation of highly acidic or basic effluents before disposal into the sewers.

* Proper lining of the sewage pipelines to protect ground water from contamination.

OVERVIEW OF LEGISLATIVE FRAMEWORK

Small scale industries do not require any license. Even registration with the state directorate of industries is voluntary. Registration, however, helps in many ways.

Registration with state directorates of industries helps a unit to obtain all facilities and assistance from government. Registration of small scale units is done in two stages :

* Provisional Registration

* Permanent Registration

Provisional registration enables the units to apply for and obtain facilities such as allotment of factory sheds/plots in industrial estates, water and power connections, liberalised financial assistance, machinery on hire-purchase and so forth from central/ state government organisations such as National Small Industries Corporation and State Small Industries Corporations.

In Delhi, a unit then has to obtain a license from the Municipal Corporation of Delhi (MCD) and can then apply for electricity and water facilities. A registered unit can get infrastructure facilities from Delhi Small Industrial Development Corporation (DSIDC).

Concerned Industry Associations will mediate to get all know-how and assistance for small scale industries registered with them. All environmental regulations are equally applicable to small industries also. In case of non-compliance of environmental regulations central/state machinery can intervene in accordance with law. Delhi Pollution Control Committee (DPCC) has the authority to ask the industry to close down and cancel/confiscate their licenses etc.

Environmental Legislation

Environmental legislation, including the Water Pollution Act of 1974 and Air Pollution Act of 1981 gave central and state pollution control boards, authority to regulate the activities of industry in relation to the environment. In 1986, a comprehensive Environmental Protection Act was passed by Parliament giving the government wide ranging powers for both pre-emptive and ameliorative action.

The role of the Central Pollution Control Board (CPCB) is to identify the polluting sector and advise government and industry on pollution control measures and it even has the power to close down the industry in case of non-compliance with environmental regulations. CPCB is an apex body for all state and union territory pollution control committees. However, the ultimate powers are vested with the Supreme Court of India.

While it is true that the Government of India has moved relatively quickly on environmental legislation, it has not been successful enough in enforcing the regulations owing to lack of enforcement machinery and also because of many loopholes in the law itself.

METHODOLOGY OF RESEARCH

The methodological activity framework followed is shown below:

* Selected study areas in specific industrial locations in Delhi.

* Established contacts with industry associations and electroplaters of Mayapuri, Naraina and Anand Parbat industrial areas.

* Visited a few electroplating units where 'best practices' for pollution prevention are adapted (names cannot be provided as promised to entrepreneur to maintain secrecy of the units).

* Assessed the current practices followed by a majority of nickel-chrome and zinc platers in the project study area.

* From the literature survey, identified pollution prevention opportunities in electroplating operations.

* Surveyed some of the units in the study area to identify scope for implementing pollution prevention practices.

* Interviewed leading chemical suppliers, electroplaters (ex : Grower & Weil Company, Plate Well Company etc.) and other consultants (such as National Productivity Council) who were the key players in educating entrepreneurs regarding the potential benefits of pollution prevention techniques. Their views were taken as a basis in formulating strategy recommendations.

* Gathered information regarding the efforts made by pollution control authorities (CPCB, Delhi Pollution Control Committee) in preventing pollution from these units.

* Selected two units in Anand Parbat Industrial Area as cases of followers of 'good practices' amongst the surveyed units in the study area. One unit was selected from Parwanoo as this unit gives insights into

the importance of quality management in achieving environmental performance and examined one more case study from Madras as suggested by National Productivity Council (NPC) and Ministry of Environment and Forests (MoEF).

* Identified and analysed the potentials and constraints involved in adoption of pollution prevention techniques by a large number of entrepreneurs for improving the surrounding urban environmental quality. This analysis formed a basis in formulating a strategy for capacity building for improving urban environmental quality with reference to pollution from electroplating operations.

IMPACT AREAS AND ASSESSMENT

This section illustrates the good practices followed for pollution prevention in some electroplating units of Madras, Delhi and Parwanoo. Since none of the units surveyed in Delhi has qualified as best examples, some demonstrated cases of pollution prevention were chosen from Madras.

However, two representative units (best among the surveyed units) in Delhi were studied to understand the pollution prevention potential. The financial feasibility of those initiatives were studied by conducting trial runs of the prevention measures in the concerned units.

The case study in Parwanoo was chosen to understand the impact at a different scale of operation and when quality management aspects are involved. A detailed description of each of these units is provided in the following paragraphs.

CASE I : NICKEL-CHROME UNIT (MADRAS BASED)

Unit I studied in Madras is a small scale job plater and employs about 15 male workers and 3 female workers. They do plating for automobile parts. Besides undertaking job works, this unit also provides services to the large automobile manufacturers on a regular basis. The shapes of the articles vary from big cylindrical to small plates and spikes.

The main plating operations include nickel-chromium plating.

Upon realising the fact that they were losing 55 per cent of nickel and 71 per cent of chromium, the input chemicals, at various stages of the plating operation, the unit agreed to take part in the pollution prevention demonstration exercise.

Pollution prevention measures

Table 7.2 shows the nature of the measures taken and the resultant financial and environmental benefits achieved by Unit I.

TABLE 7.2 : POLLUTION PREVENTION MEASURES AND THEIR IMPACT

Measures taken	Nature of the measures	Reason for adopting measures	Environmental/ occupational implications	Financial investments (Rs.)	Monthly savings (Rs.)
Use of fume suppressants in chrome plating	Cleaner production	To reduce air pollution	Reduced exposure to toxic fumes	400/-	Air pollution reduced
Provision of exhaust fans in the chrome plating area	Cleaner production	To reduce air pollution	Reduced exposure to toxic fumes	Nominal	-
Drag out reduction				Nominal	8,500
- conversion of nickel rinse 1 into dragout collection	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs		
- Lower nickel concentration in plating bath	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs		

Table 2 continued

Measures taken	Nature of the measures	Reason for adopting measures	Environmental/ occupational implications	Financial investments (Rs.)	Monthly savings (Rs.)
- Better component drainage through slow jerking after nickel plating	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs		
- Provision of drain boards between plating and rinse tanks	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs		
- Provision of hangers over chrome drag out to reduce carry over	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs	500	1,500
PVC coating of jigs and fixtures	Change in practice	To reduce chemical loss and pollution	Reduced environmental treatment costs	4,000	5,500
Improved bath life extension measures					
- Use of DM* water	Process control measure	To improve productivity and quality	Reduced rate of accumulation of pollutants	Nominal	2,500
- Bath condition maintenance by regular checking	Process control measure	To improve productivity and quality	Reduced rate of accumulation of pollutants	Nominal	
- Continuous filtration of bath chemicals	Process control measure	To improve productivity and quality	Reduced rate of accumulation of pollutants	Nominal	
Total savings				4,900	18,000

* DM : Demineralised water;

NPC has demonstrated potential for pollution prevention through various simple in-house measures in Unit-1. These measures have resulted in savings of Rs. 2,16,000 per annum, which is about 18 per cent of their total production cost. The pay back period is also very short. Besides the measures taken (see Table 7.2), the unit was following some good practices on its own such as :

* avoiding losses in energy by keeping the rectifier closer to the plating units and the busbars with fewer joints;

* storing the spent acids in plastic containers for off-site recycling by some customers; and,

* using magnets to fish out dropped articles in the plating bath thus avoiding unnecessary losses owing to coating on the dropped articles.

Using all these measures, they were able to cut down 50 per cent of the pollution load to the environment.

Some short-term and long-term measures suggested by NPC were not implemented because of the following reasons:

* second drag out tank installation was not implemented owing to lack of space.

* change over to the thyristor control in rectifiers instead of dimmer control owing to lack of reliable suppliers.

* provision of treatment facilities because of financial and space constraints.

CASES II & III : NICKEL-CHROME AND ZINC-CYANIDE UNITS (DELHI BASED)

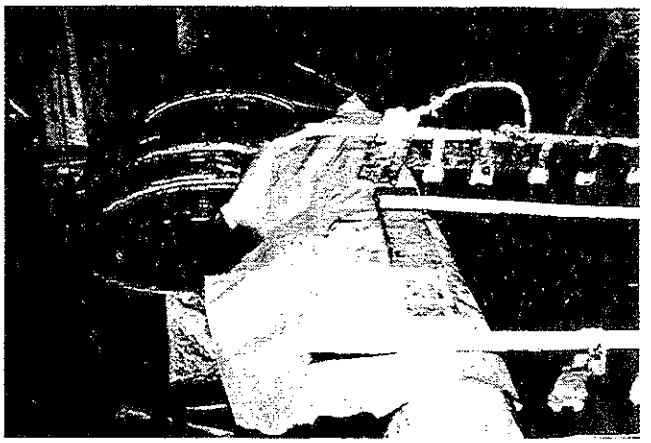
In all the four industrial estates of the study area surveyed, there were no units that followed any good practices. Most of these units are job platers and are unaware of the benefits of pollution prevention measures.

However, from among these units one representative unit each for nickel chrome and zinc cyanide plating operations in Anand Parbat Industrial Area was selected. The criteria for selection of these units, are based on the initiatives they have taken in adopting some measures though not quite up to the mark, for reducing losses. Some trial runs were conducted for preventive measures that are economically viable.

Unit 2 is a nickel-chrome plating unit and Unit 3 is a zinc-cyanide plating unit in Anand Parbat Industrial Area.

Unit II : Nickel-Chrome

Unit II is a family owned enterprise and does rack plating and



Plastic Drain Board Drag out Recovery Process adopted by some has not been proved very successful.

employs about 18 people – four in the buffing section, eight in the polishing unit and six electroplaters. Two or three women are employed in the polishing section to do light jobs.

Pollution prevention measures

Though this unit has initiated two prevention measures by installing a still rinse bath and a drag out collection tank on their own, they are highly inefficient, continuing to lose valuable chemicals.

For air pollution reduction they add fume suppressants to the chromic acid bath. The unit has installed a powerful exhaust system behind the buffing machine.

Unit III : Zinc-Cyanide

This unit does both rack and barrel plating employing about five workers. The production process takes place on a land area of 30 sq.m. Small metal strips, bolts and small iron pieces are plated on job order basis. No women workers are engaged in this unit.

Typical of any zinc-cyanide unit, the rinse water and the effluent from this unit contains highly hazardous cyanide pollutants.

Pollution prevention measures

This unit has implemented two preventive measures

a. Installed two still rinse baths and makes up the main plating bath losses using the still rinse bath contents.

b. Uses perforated basket to collect drag out from barrel plating operation. However, these two facilities are not being used in a proper way.

To understand the scope for further improvement, trial runs for the following three simple, inexpensive pollution prevention techniques were conducted in both the units (Nos. II & III) and financial benefits were also estimated. These techniques are:

a. Hanging technique

b. Eco-rinse technique

c. A combination of hanging and eco-rinse techniques

A description of the above techniques is provided in Annex-II

Savings owing to pollution prevention measures

Tables 7.3, 7.4, 7.5, & 7.6 summarise the findings regarding the potential benefits of using the above techniques.

Table 7.3 : Nickel Plating

Number of pieces plated per day : 400

Cost of plating bath (Rs./ litre) : 69.20

Options	Drag-out saved litre/day	Savings Rs/day	Savings Rs/year	Waste reduction kgs./year
Hanging techchnique	4	276.80	79,718	461
Eco-rinse	2.4	166.08	47,831	276
Hanging & Eco rinse (or still rinse)	4.4	304.48	87,690	507

Source : Unit level trial runs

Table 7.4 : Chrome Plating

Number of pieces plated per day : 400

Cost of plating bath (Rs/litre) : Rs. 27.74

Options	Drag-out saved litre/day	Savings Rs/day	Savings Rs/year	Waste reduction kgs./year
Hanging techchnique	4	110.96	31,956	276
Eco-rinse	2.4	66.58	19,174	166
Hanging & Eco rinse (or still rinse)	4.4	122.06	35,152	304

Source : Unit level trial runs

Table 7.5 : Zinc Plating (rack)

Number of pieces plated per day: 2,200

Cost of plating bath (Rs/litre): Rs. 25.77

Options	Drag-out saved litre/day	Savings Rs/day	Savings Rs/year	Waste reduction kgs./year
Hanging techchnique	1.7	43.81	12,617	98
Eco-rinse	1.5	26.29	7,570	59
Hanging & Eco rinse (or still rinse)	1.87	48.19	13,879	108

Source : Unit level trial runs

Table 7.6 : Zinc Plating (barrel)

Number of batches per day: 12

Weight of pieces per batch: 30 kg

Cost of plating bath (Rs/litre): Rs. 25.77

Options	Drag-out saved litre/day	Savings Rs/day	Savings Rs/year	Waste reduction kgs./year
Hanging techchnique	0.78	20.10	5,789	45
Eco-rinse	0.47	12.11	3,488	27
Hanging & Eco rinse (or still rinse)	0.86	22.16	6,383	50

Source : Unit level trial runs

Hanging Technique

Though the above techniques are highly promising ones, they are worker dependent techniques and are not very popular among the electroplating units because of the following reasons :

a. Lack of knowledge of these techniques.

b. Lack of space.

c. Inadequate control over workforce for adopting the techniques.

CASE IV : NICKEL-ZINC UNIT (PARWANOO BASED)

Unit IV based in Parwanoo is a medium scale feeder unit which plates a standard product, watch components. Nickel and zinc plating are part of precious metal plating. Quality maintenance is the main drive behind achieving pollution reduction. The general process flow is similar to the nickel and zinc plating operations described earlier.

Some of the good practices adopted are as follows :

* High power exhaust for dust collection in buffing section.

* Maintenance of plating bath chemistry by using deionised water, continuous filtration of bath solutions, periodical testing in the laboratory, rinse water recycling.

* Drag-out reduction by eco-rinsing.

* Continuous R&D on jigs and fixtures shape to reduce rejection rate of articles plated.

* Better stirring of bath chemicals for even plating.

* Hi-power exhaust in solvent degreasing area.

* Judicial use of water using spray rinsing.

* Final effluent treatment before disposal.

* Less distance between rectifier and plating baths.

These are some of the best practices followed in Unit IV. Unfortunately the financial aspects of these measures were not made available in this unit.

In the next section, an analysis of the issues such as replicability, positive and negative factors in the implementation of good practices and aspects such as measures to be taken for sustainability are discussed. These are summarised in Annex. III.

ANALYSIS OF THE RESEARCH FINDINGS

GENDER ISSUES

The number of women employed in electroplating operations is highly negligible. The production process demands experienced labourers on a regular basis, since most of these units operate on a day to day job order basis. Therefore men are preferred in the plating sector.

In all the units surveyed, women and children are employed only for works such as assembling the articles for plating, final cleaning and packaging. Since these are considered lighter jobs women are offered less remuneration. For example a person in the plating line would be getting something like Rs.1,500 per month whereas, women in a final polishing and packaging section would get about Rs.900 per month.

As far as occupational health risks are concerned, it is only the men who are at risk compared to women. With regard to general pollution problems such as ground water pollution, bioaccumulation through contaminated food, can impact women's health as equally as men's health. Besides these effects, women's reproductive health is also susceptible. An unborn baby can contract the ailments if the mother's health is affected by heavy metal contamination.

Applicability of Good Practices - An Analysis

In the study area, two types of operational conditions were observed: those which were operating in authorised locations (Naraina, Mayapuri and Wazirpur) and those which were operating in unauthorised locations (Anand Parbat Industrial Area) in the midst of congested residential localities. In both cases, the growth of these units was quite unplanned, thus hampering any kind of centralised treatment facilities that can otherwise be installed.

The Indian electroplating sector is dominated by small and medium enterprises which execute mostly job plating for large scale industries such as automobile industries. To avoid pollution problems large industries prefer to get such services from these small units. However, in the wake of the increasing emphasis on TQM (Total Quality Management), the large scale units are going in for their own captive operations.

Waste minimisation and pollution prevention practices have been well understood and demonstrated for the electroplating sector world-wide. But in a developing country, there are a good number of barriers rather than potentials for implementation especially in the small scale sector.

Approach adopted for waste minimisation

In the study area, the waste minimisation and pollution prevention measures were taken by the industry as part of the dem-

onstration exercises conducted by the technical consultants (of NPC) for the Ministry of Environment sponsored project.

An analysis of the approach indicates that the demonstration exercises were taken up to motivate the entrepreneurs and to test the financial and environment viability of such initiatives. While such an approach was essential to bring in the required change, in the absence of a systematic approach for wider dissemination, the impact seems to be limited to units where demonstration exercises were conducted.

Analysis of the barriers for replication

Of the several options identified for pollution prevention, the Madras units have implemented only a few source reduction measures such as:

a. Process bath maintenance

b. Material substitution

c. Drag out reduction and recovery

d. Improved rinsing techniques

e. Improved housekeeping measures

f. Energy conservation measures.

Some of the other options such as heavy metal recovery techniques, replacement of cyanide baths with acid baths and suchlike were not adopted, as these units were not ready to make such high financial investments.

From the analysis of the waste minimisation efforts displayed by all the four case study units, the following conclusions can be drawn.

A majority of the initiatives are:

a. Aimed at reducing about 50 per cent pollution load

b. Easy to operate, low investment options with less pay back period

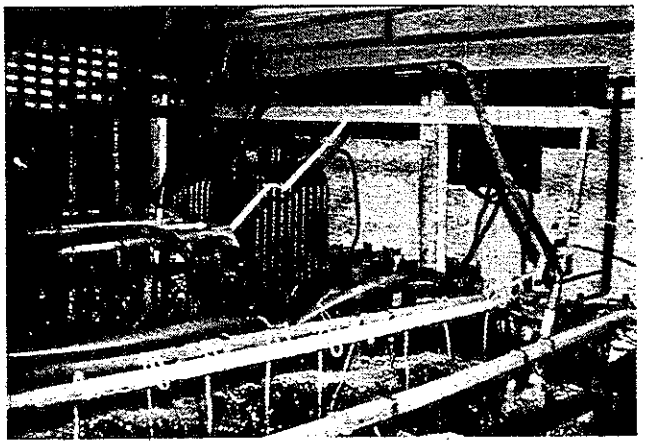
c. Having high potential for financial savings

d. Not aimed at recovering or treatment of chemicals.

In short, the barriers for replication of these initiatives can be listed as given below :

i. Attitudinal problems

The common fear amongst small scale entrepreneurs is that any additional investment towards pollution reduction would be a financial burden to them. Besides this, the "Why me" attitude



Drag out Recovery by hanging is an improvement to earlier method

also is hampering any positive initiative in this direction. As long as the profits they can generate are substantial, environmental problems will not be a major priority.

ii. Lack of awareness

The opportunity to get information on pollution prevention and waste minimisation techniques and their benefits is very minimal for a small-scale entrepreneur. Even if available, it would be mostly general information. Though seminars and workshops provide such opportunities, these are not attended by small scale entrepreneurs. So far no special efforts have been made to address this problem.

iii. Policy and regulatory barriers

In the absence of pollution control taxes, it is not an attractive proposition to recover chemicals. Especially in the case of chrome recovery, the entrepreneurs are finding it cheaper to buy chromic acid at a rate of Rs. 120 per kg than recovering it. While taking policy decisions on excise duties, levies and so forth, these factors should be given due consideration.

Irrespective of the variations in the type and nature of plating operations, the discharge standards to be met are fixed (Annex-IV). In order to promote pollution prevention practices standards have to be based on the nature of pollutants generated and the limit for heavy metal load and wastewater generation should be based on the unit area plated.

iv. Financial constraints

Most of the small scale enterprises run on lower profit margins and the regularity of cash flow is quite uncertain. The change over to cyanide free baths, installation of heavy metal recovery system and demineralised water generation system etc. were not adopted by the units owing to financial problems.

v. Information and technology barriers

Ion exchange systems for heavy metal recovery is one of the

viable solutions for heavy metal pollution problems. However because of lack of information on the availability of such systems as per the need of the entrepreneurs, these ion-exchange systems are not popular in the electroplating sector. No attempt has been made so far to utilise the potential of this technology either for individual use or for collective use.

Very little information is available to the small scale entrepreneurs on alternative, less hazardous chemicals for substitution and their availability in the market.

vi. Lack of trained workforce

The workforce employed in these units are mostly untrained and ignorant of health impacts arising out of improper handling of chemicals, spillages and emissions. For any waste minimisation programme to be successful, training and motivation of workforce is essential.

vii. Lack of quality control

The use of demineralised water reduces the plating bath contamination process and improves the quality of plating. Unfortunately in small scale job operations demineralised water plant installation is expensive and therefore quality maintenance is very minimal.

Besides this, there are no cost effective monitoring equipments available to maintain the plating bath composition. Therefore, it is essential to promote quality plating in these units by providing the quality control equipment / devices at an affordable price.

In India, most of the demonstration studies are striving to achieve 50 per cent load reduction to environment by following simple prevention techniques. Removal of the remaining 50 per cent load through recovery (through ion exchange), recycle (through reverse osmosis, electrodialysis techniques) and treatment is highly cost prohibitive and needs a great deal of articulation to design alternative means of achieving a pollution free environment. One such initiative was attempted by Anand Parbat Industrial Area. The story goes as follows :

Electroplating units have started coming up in Anand Parbat area since 1940. Besides electroplating, anodisation, printing, painting, solvent extraction are also housed in the congested lanes of Anand Parbat Area. Since the 1980s, as environmental regulations started becoming stringent, the electroplating units were constantly disturbed by being served with notice to vacate or by stoppage of electrical supply.

Being situated in an unauthorised area, the entrepreneurs take a more pro-active role when compared to their counterparts in the authorised areas. Since the late 1980s efforts are on to get a Common Effluent Treatment Plant (CETP) constructed in that area so that they can continue to stay there.

Acording to Mr. Tandon, the President of the Anand Parbat Industry Association, the electroplaters have got together to get the treatment plant design made by a renowned research organisation in central India. A technical feasibility study was also sponsored by them for the same and funds earmarked for the CETP.

In spite of all these efforts, the proposal has not made any progress so far because of bureaucratic procedures and delays.

The other side of the story is that a common effluent treatment plant operation is not a feasible option for that area as it will be located very far away from the units owing to lack of space. Many uncertainties are involved in that operation and the regulatory authorities are not very keen to approve the proposal nor are they in a position to offer alternative suggestions for moving out to a new location.

In the wake of the recent Supreme Court decision, it is highly unlikely that government approves any such initiative. But at the same time displacement of so many enterprises and dislocation of hundreds of livelihoods is not desirable. One has to wait and see whether there will be a major turn in the story. Till that point, pollution prevention is the immediate solution that electroplaters have to adopt.

From the above analysis it is very clear that the barriers for replication or for wider acceptability for pollution prevention measures have to be overcome by making strategic choices on all fronts such as technology, awareness, public pressure, regulatory mechanisms, training, skill development, quality management, resource utilisation and R&D.

FORMULATION OF NATIONAL STRATEGY

CURRENT EFFORTS

Traditionally environmental problems in small scale industries are largely dealt with by the command and control principle. But this mechanism has failed miserably as it is physically impossible to have control over such vast numbers with wide variations in operational practices and geographic distribution.

Of late, the government is taking a more cooperative approach in dealing with these units. The government sponsored demonstration programme for pollution prevention (the DESIRE programme) and the initiation of Waste Minimisation Circles (just like quality circles) are a few such initiatives in this direction.

In spite of all these efforts, the change is quite slow and the desired multiplier effect has not yet been achieved owing to the inherent constraints associated with small scale units.

At the national and state levels, there is a great need for a clear and explicit policy statement to promote cleaner production. This must be complemented by the required legislation, institutions for monitoring and agencies for implementation.

RECOMMENDATIONS

Regulatory measures

a. Licenses : Since the pollution load generated per unit production is quite high in small scale units compared to medium and large ones, no new units should be encouraged to come up in the small scale sector.

b. Standards : To support the above measure, the discharge standards need to be modified to load based standards thus allowing individual units to take up measures as per their production capacity. Specified limits have to be fixed for unit production, and these should be based on easily verifiable and monitorable environmental targets.

c. Incentives : Incentives should be granted to only those units whose resource consumption and waste generation factors are below certain specified levels.

d. .Financial schemes : Preferential financial assistance should be given to proposals that give priority to waste minimisation measures rather than for end-of-the-pipe pollution control proposals.

o Pricing policy : Prices of essential resources such as water, chemicals need to be hiked to a level that justifies waste minimisation and recovery of chemicals and resources becomes more economical than investing in fresh materials.

Institutional support

It is essential to strengthen the capabilities of existing institutions working in the area of waste minimisation for the small scale sector. It is also essential to create more institutions which can provide requisite support. Primarily the role players could be chosen from :

* Academic institutions
* Private consultants
* NGOs (technically capable)
* Advocacy groups

Technology development

Technical and research institutions have to be brought in to identify, develop, evaluate and advocate suitable low-cost, indigenous technologies, techniques and devices for operational requirements, monitoring, process change and treatment requirements.

Training and skill development

The most urgent need is to promote systematic technical education and develop a cadre of professionals to implement cleaner production methods. Skill development institutions for small scale industries have to be promoted.

Access to information and awareness

The two major hurdles quite often raised by professionals in waste minimisation programmes are i) Attitudinal problems ii) Lack of awareness about benefits of waste minimisation. Adequate measures should be taken to break these two barriers by making information more easily accessible and through more demonstrative examples. Again more role players should be brought in for quick results.

Pressure from stakeholders

Large industries, the general public and consumers being the main stakeholders, voluntary compliance in the units can be brought in by them by insisting on quality and environmental performance.

NATIONAL STRATEGY

As was already mentioned, the DESIRE Programme (of NPC) and the Waste Minimisation Circles Programme (of Ministry of Environment) have been able to achieve some success, but still limited to the units where it was demonstrated.

Neither of the programmes could bring in the required stimuli to initiate voluntary action amongst the industry circles. The failure could be attributed largely to the fact that both the programmes have major emphasis on demonstration rather than on dissemination and materialisation of benefits into clear-cut categories that are environmental (including regulatory) and financial.

Provision has not been made for effective dissemination through audio-visuals and on-the-job-training programmes. Accessibility to demonstrated units was not very encouraging. Spokespersons for Waste Minimization and Pollution Prevention programme have to be created from within that sector, whose words hold more value than a consultant's.

To promote pollution prevention practices on a wider scale, a model strategy can be formulated as given below.

A model strategy for pollution prevention

Traditionally environmental consultants are experts in providing expensive end-of-the-pipe solutions by suggesting retrofitting technologies and practices. The business potential for environmental management through waste minimisation and pollution prevention practices have not been explored by these

consultants. Therefore state-of-the-art technologies and materials available in the market are also based on end-of-the-pipe solutions.

So far it has been amply displayed through demonstration exercises that pollution prevention initiatives are environmentally and economically viable. The next strategic step should therefore be to evolve the policies, environmental consultancy services, R&D programmes for technology and material development driven by a pollution prevention approach.

The basic assumption behind this proposed model strategy is that if the business potential for prevention based environmental management consultancy services is realised, it can trigger off the market demand for indigenous technologies and alternative less hazardous materials which can cumulatively help promote cleaner production. The proposed model strategy has a five pronged approach, the details of which are provided in the following paragraphs.

The apex body to execute such programmes should be either Central or State Pollution Control Boards preferably in association with the Ministry of Environment.

Demonstration of cleaner production practices

Demonstration units should be established preferably that operate under the control of municipal governments or industrial development corporations or small scale industrial training centres. The advantage is that these units are more easily accessible for on the job training and would be willing to share information with other units.

Dissemination of technical package

Training programmes and workshops should be organised to disseminate technical packages on best practices for pollution prevention in the electroplating sector to practising environmental consultants, technical organisations, technical NGOs, academic institutions and other interested groups. These groups may further disseminate the knowledge or help the entrepreneur implement them.

Here the dissemination of technical packages to these consultants plays a key role in :

a. Providing the cleaner production initiatives a business like approach

b. Making this approach successful

c. Driving the environmental technology and material supply market to cleaner production requirements.

Conducting skill development programmes

Regional training centres should be opened to improve skills of floor personnel to implement pollution prevention practices. These could be set up in Industrial Training Institutes or in Small Scale Industrial Training Centres.

Policy interventions

At the regulatory level, pollution prevention initiatives should be encouraged by providing permits, licenses, soft loans and awards, differential standards for polluting and non-polluting units and such other measures.

Development and dissemination of training modules

Audio-visual based awareness and training modules should be evolved for various role players, especially entrepreneurs. These programmes should be updated on a regular basis. Wider publicity through the media should be promoted to reach small scale units. On-the-job training facilities, data-banks on the latest R&D for technology improvement and material substitution should be made accessible to small scale units.

It is anticipated that by adopting the above model, a cadre of professionals can be trained to undertake pollution prevention initiatives in companies, thus triggering off a chain reaction on all fronts such as technology, material development and ultimately achieve the multiplying effect.

Conclusions

Traditionally, electroplating operations, especially small scale operations, are an important source of pollution on account of the metals, chemicals and processes they involve. The most useful approach for pollution control in electroplating operations is:

a. Avoidance of waste generation and reduction whenever possible.

b. Recovery and recycling of waste streams.

c. And finally, treatment and disposal as a last step.

Since the benefits of such an approach were not well understood, the pollution control strategy in India is so far largely dependent on end-of-the-pipe solutions, that too, only when pressurised for regulatory compliance.

A few efforts made by environmental agencies in the past and in recent times have resulted in a handful of demonstrative cases which were centred around simple waste avoidance and reduction measures. However, only those measures which gain good financial returns were practised in a sustained way. This clearly shows that economic feasibility of a "good practice" gains weightage over a solution which gains only environmental benefits.

This may not be true of some motivated entrepreneurs, but then they seem to be handicapped with lack of proper information, technical guidance and consultancy services, or sometimes because of bureaucratic hurdles.

An analysis of the pollution demonstration exercise carried out by NPC clearly shows that 50 per cent pollution load can be avoided straightaway by following simple drag out reduction measures such as hanging technique, drag out board installation, eco-rinse techniques, coating of jigs and fixtures and a few energy conservation measures.

Even these simple measures to reduce 50 per cent pollution load are not being replicated widely, not to talk of the remaining 50 per cent pollution load which can be avoided only by using expensive recovery and recycling techniques such as reverse osmosis, electro-dialysis etc. The most promising technique for recovery being the ion-exchange technique, the information regarding its applicability, cost-benefits and so on, are generally not made available to the entrepreneurs.

The barriers for the adoption of waste prevention measures seem to be multi-pronged, ranging from attitudinal barriers to lack of such entities as awareness, information, space and workers' cooperation, indigenous inexpensive technologies, adequate regulatory and public pressure, and low cost of resources.

To overcome these barriers, the strategies to be followed should take into account all those influencing parameters and should aim to promote voluntary action amongst the entrepreneurs. Besides setting up demonstration units, the strategy should include the dissemination of the technical packages to environmental consultants. The business like approach of these consultants is expected to boost the demand for other support services for cleaner production.

Simultaneously, the strategy should be to conduct skill development programmes for the workforce, make policy interventions in favour of cleaner production and finally to make available the information to a wider audience through seminars, workshops, audio-visuals and print media and databanks.

Until these barriers are overcome, the main effort should be to reduce 50 per cent pollution load through simple measures and then to progressively move towards achieving 100 per cent results through recovery and treatment practices.

Capacity building through training and institutional strengthening is considered to be the potential gateway to enter into this pollution prevention game.

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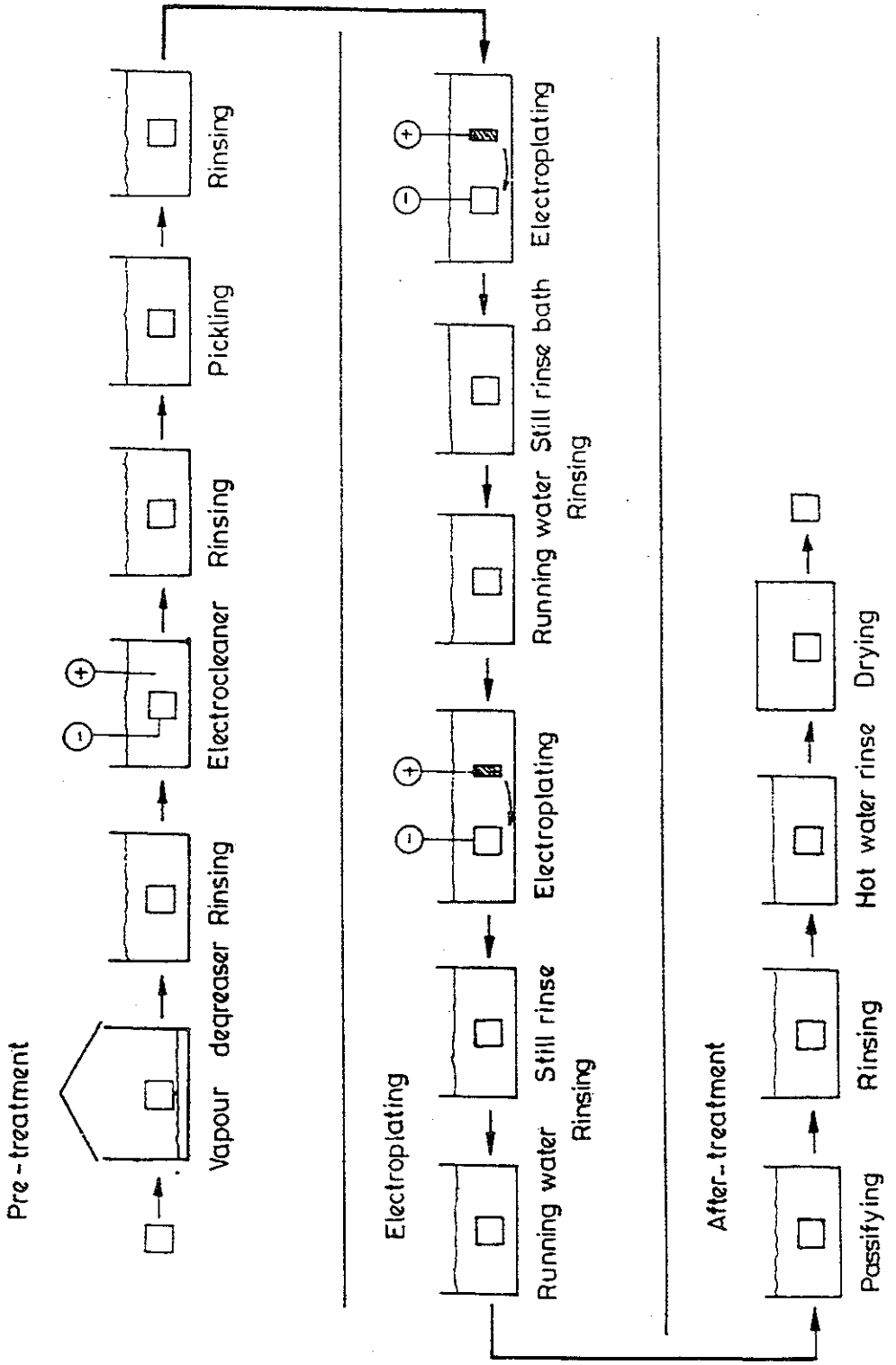
General Process Flow of Electroplating

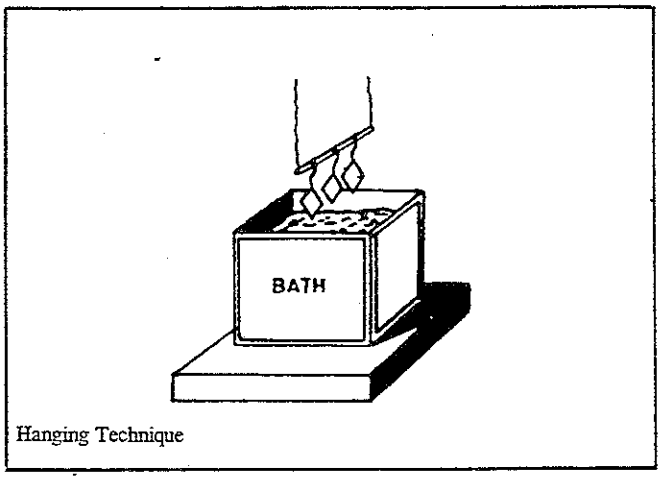


Hanging technique

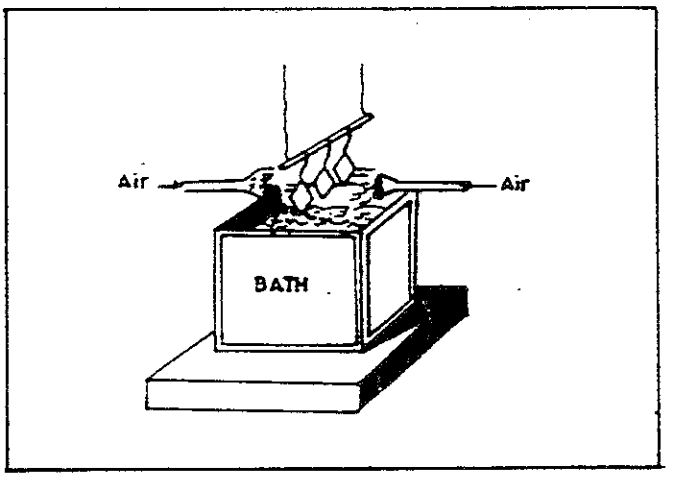
Rack plating : The rack with workpieces should be placed above the plating tank or drag-out tank for dripping.

Barrel plating : The workpieces should be placed long enough in a perforated basket for dripping. In all cases, sufficient dripping (at least 20 seconds) should be allowed.

The hanging (dripping) technique reduces the drag-out by 83 percent. Less chemicals would be discharged through the rinse water and less waste water would need to be treated. Only then will the consumption of chemicals decrease.



Hanging Technique

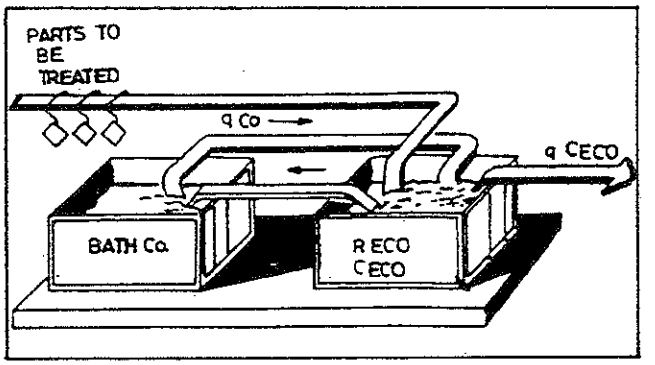


Spray Rinsing

Eco rinse technique

ECO (ie. "economical rinse") rinses are still rinses in which the workpieces are immersed in the rinse tank before and after treatment in the plating bath. Drag-out is lowered to 50 per cent because the same quantity of liquid is transferred to the treatment bath (by the untreated pieces).

Advantages are equal to the hanging technique. By implementing the eco rinse technique, treatment costs can be saved and the consumption of bath chemicals decreases.



Eco-rinse Technique

POTENTIALS AND BARRIERS FOR REPLICATION OF WASTE MINIMISATION PRACTICES

1. Drag-out reduction measures

a. **Conversion of Ist rinse tanks intodrag-out tanks**

- managers need to be convinced of the benefits
- dependent on workers using it.
- in case of zinc plating savings through recovery are not so attractive when comparfed to buying new chemicals.
- investment is nominal.
- high financial returns in case of nickel.
- many entrepreneurs try to avoid it as it is an additional process step.
- replicability is less due to space restrictionand lack of understanding of the benefits.

b. **Hanging Techniques**

In spite of having potential for replicability this technique is not becoming popular due to:

- additional space requirement.
- varying shapes of articles doesn't permit a fixed system of hanging.
- dependent on worker's involvement/motivation.
- mechanised techniques not affordable.
- indigenous methods not developed adequately for different needs.
- requires motivation.
- lack of awareness.

c. **Spray Rinse Technique**

- easy to operate.
- high impact in pollution load reduction.
- main hurdle is non-availability of suitable devices.
- lack of awareness among entrepreneurs.

d. **Eco-Rinse Technique**

- extra process step for workers.
- depends on how motivated the workers are.
- lack of awareness is another hurdle.
- high potential for reducing loss of chemicals.
- high potential for reducing loss of chemicals.
- low investment costs.

2. **PVC coating of Jigs & fixtures**

- unaware of losses through jigs and fixtures.
- need to be adapted as per the individual requirements.
- motivated work-force can contribute significantly.
- not a common practice.

3. **Use of Fume Suppressants and Exhaust Fan in Chrome Plating**

- not aware of health hazards involved.
- misconception that it would cost them extra money.
- dependent on management's priorities for wealth or health.
- less motivation from chemical supplier.
- use of polypropylene balls to cover the surface of the bath liquids is not yet popular in India.

4. **Improved Bath Life Extension Measures**

a. **Use of demineralised water in critical areas**

- change in practice not a welcome suggestion.
- central supply facilities are not available.
- not so popular practice.
- not aware of the repercussions of not using demineralised water for plating and rinsing operations.

- quality maintensnace is not a pre-requisite in many small scale units.
- cost benefits are not known.
- do not want to invest in.
- no incentives from regulatory authorities.

b. **Bath chemistry maintenance**

- no in-house laboratories for regular monitoring.
- not aware of extent of losses.
- non-availability of easy to use testing procedures, devices
- dependent on outside laboratories.
- quality not a priority.
- unskilled work force.

5. **Use of Alternate Non-hazardous Chemicals**

- involves capital investments for switch over to cyanide free plating.
- apprehensions about quality of plating.
- CN based plating easy to operate.
- uninformed of energy savings.
- environmental improvement least priority.
- resistance to change

STANDARDS FOR ELECTROPLATING SECTOR ENVIRONMENTAL PROTECTION ACT - 1986

Industry	Parameter	Standards
Electroplating industries		Concentration not to exceed milligrams per litre (except for pH and temperature
	pH	6.0 to 9.0
	Temperature	Shall not exceed 5°C above the ambient temperature of the receiving body
	Oil and Grease	10
	Suspended Solids	100
	Cyanides (as CN)	0.2
	Ammonical Nitrogen (as N)	50
	Total Residual Chloride (as Cl)	1.0
	Cadmium (as Cd)	2.0
	Nickel (as Ni)	3.0
	Zinc (as Zn)	5.0
	Hexavalent Chromium (as Cr)	0.1
	Total Chromium (as Cr)	2.0
	Copper (as Cu)	3.0
	Lead (as Pb)	0.1
	Iron (as Fe)	3.0
	Total Metal	10.0