Guide to Cleaner Production in Electroplating Sector

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Foreword

The electroplating industry has been playing a momentous role in development and growth of numerous metal manufacturing and other engineering industries. While electroplating operations is an essential and integral part of many engineering industries, there has also been a steady growth of independent and tiny - to medium-scale electroplating industries. The growth of these independent small-scale electroplating industries may be attributable to the growth of light and medium engineering industries which found it more convenient and economical to have their products metal plated by independent electroplaters.

In India, there are thousands of independent tiny to small scale units operating throughout the country both in organized and unorganized sector. The factors responsible for extensive pollution from these units include existence in very large number in a particular area, their sporadic distribution, small-scale operation, poor housekeeping, lack of space for installing waste treatment facility in view of their being located mostly in areas of high commercial activity or in a composite industrial complex and the high recurring costs of treatment of the waste water particularly for the tiny & small-scale units.

Cleaner production (CP) is considered to be one of the best suitable options for the electroplating industries. CP aims at reducing environmental and health risks, as well as improving efficient natural resource usage.

An effort has been made through preparation of this document for better management practices in electroplating industries. This document takes readers to overview of electroplating clusters in India with successful case studies in prevention & control of pollution, initiative of the Central Pollution Control Board, clean technology options and better waste management practices including zero liquid discharge.

This document has been prepared consequent to the recommendations of the National Task Force constituted by Central Pollution Control Board with an objective to control the extensive pollution caused by the electroplating sector.

Efforts of my colleagues Sh. U. N. Singh, Additional Director, Mrs. Pavithra L.J., Environmental Engineer and Mr. Ankush Tewani, Assistant Environmental Engineer under the supervision and guidance of Sh. J. S. Kamyotra, Member Secretary, in preparation of this document are gratefully acknowledged.

I hope, the document would be useful to the electroplating industries and the concerned regulatory agencies, consultancy organizations in prevention and control of pollution from this important industry.

(Ajay Tyagi)

April, 2013 **Chairman, CPCB**

Section One: Introduction

Electroplating/ Metal Finishing

Electroplating is defined as electro-deposition of an adherent metallic coating upon an electrode for the purpose of securing a surface with properties or dimensions different from those of the basis material."

Purpose of Plating

Metals are finished for many reasons. A finish may be defined as any final operation applied to the surface of a metal article in order to lend it properties not possessed by the article in its "unfinished" form. The purposes of electroplating an article are for:

- Appearance
- Protection
- Special surface properties, or
- Engineering or mechanical properties

Electroplating Industry in India

The Industry is widely spread out across the country. Certain states have large number of units concentrated in some towns / cities, such as:

- Andhra Pradesh – Hyderabad
- Delhi
- Gujarat- Ahmedabad
- Haryana- Faridabad
- Karnataka- Bangalore
- Maharashtra - Mumbai, Pune, Nashik
- Punjab - Ludhiana
- Tamil Nadu - Chennai, Madurai
- Uttar Pradesh - NOIDA

It is difficult to find out the distribution of production between the organized and small scale / tiny / unorganized sector. However, judging by the approximately 36% of the contribution is by the unorganized sector.

There are thousands of tiny/ small job-work electroplating units operating in various parts of the country. These units which are very small in nature are highly polluting and are unable to treat the waste generated due to unfavorable economy of scale. These units carry out crude plating practices thereby generating large quantity of waste.

Pollution Potential

All metal finishing processes tend to create pollution problems and to generate wastes to varying degrees. Of particular importance are those processes that use highly toxic or carcinogenic ingredients that are difficult to be destroyed or stabilized and disposed of in an environmentally sound manner. Some of these processes are:

- Cyanide based plating, especially zinc, copper, brass, bronze and silver plating
- Chromium plating and conversion coatings based on hexavalent chromium compounds
- Cadmium plating
- Lead and lead-tin plating

Cleaner Production

Cleaner Production (CP) is the application of preventive environmental strategies in the processing of products and services. CP aims at reducing environmental and health risks, as well as improving efficient natural resource usage.

Regulatory Overview

The Electroplating Industry is regulated under The Water (Prevention & Control of Pollution) Act, 1974 and The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008. The effluent from electroplating industry has to be complied with the new norms notified under Sr. no. 9, Schedule 1, of The Environment (Protection) Act, 1986 which includes additional parameters of Aluminum, Tin, Silver, Fluorides, Phosphates, Sulphides, Sulphates, Trichloroethane, & Trichloroethylene, and air emission standards in work zone area. Solid waste generated from the industry is required to be disposed off as per The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

Expert Committee constituted by the Central Pollution Control Board in order to explore the possibilities for phasing out usage of Cyanide in electroplating process, has **recommended to phase-out usage of cyanide in zinc and copper electroplating processes within a time period of three years.**

Cyanide and Chromium (VI) are the highly toxic chemicals used in the plating baths lethal to human. These chemicals are difficult to destroy/ destabilize and dispose in environmentally sound manner. Due to lack of awareness, these chemicals are handled carelessly by the labors in the plating industry. The National Task Force constituted by CPCB to study issues and thereby provide guidance on containment of pollution from electroplating sector suggested action plan for phase wise reduction of cyanide and hexavalent chromium in electroplating.

Section Two: Pollution Potential in Electroplating Sector

In comparison with other industries, the electroplating industry uses much less water, hence the volume of the waste water produced by this sector is also comparatively much smaller. Nevertheless, the waste water is highly toxic in nature because of the presence of metals such as **chromium**, highly dangerous **cyanides,** etc.

Cyanide

The use of cyanide in plating and stripping solutions stems from its ability to form weak complexes with metals typically used in plating. Metal deposits produced from cyanide plating solutions are finer grained than those plated from an acidic solution. In addition, cyanide-based plating solutions tend to be more tolerant of impurities than other solutions, offering preferred finishes over a wide range of conditions. Cyanide-based electroplating solutions usually operate at basic pH levels to avoid decomposition of the complexed cyanide and the formation of highly toxic hydrogen cyanide gas.

Acute inhalation exposure to 100 mg/m^3 or more hydrogen cyanide will cause death in humans. Chronic exposure to free cyanide in humans via inhalation results in effects to CNS. Cyanide ranks top in toxicity and free cyanide below 0.01 mg/l is toxic to fish and other living organisms while 0.25 - 1.0 mg/l kills the former in a few hours. The dose fatal, for animals and human beings is 9 mg / kg of the body weight.

Cyanide-bearing materials, solutions and waste streams require special handling and management. Residual cyanide in electroplating sludge has become an increasing concern for electroplaters as the amount of sludge produced is high, disposal options for cyanide-bearing sludge are limited and costs are high. The theoretical quantities of chemicals used and sludge produced in conventional treatment of cyanide bearing waste water is as follows:

Cyanide destruction:

To convert 1.0 kg of CN to N_2, and CO_2:
Chlorine (Cl_2) required = 6.83 kg
Caustic soda (NaOH) required = 6.16 kg
or
Bleaching powder ($CaOCl_2$) required = 12.22 kg

Sludge (from bleaching powder treatment): 1.O kg CN will theoretically produce 2 kg calcium carbonate ($CaCO_3$).

Chromium

Chromium coatings provide excellent wear resistance and corrosion protection, as well as a bright, highly reflective surface. Two main types of chromium coatings are used — decorative and hard chrome. Decorative coatings are applied primarily for appearance purposes, while hard chrome coatings are thicker layers of chromium used to give a part extra wear resistance. Decorative coatings is almost always applied over a bright nickel plated deposit, which in turn can be easily deposited on steel, aluminum, plastic, copper alloys and zinc die castings. Hard chrome plating is normally not applied over bright nickel plating, although in some cases, nickel or other deposits are applied first to enhance corrosion resistance.

Hexavalent Chromium – traditionally, chromium deposits are produced from an electrolyte containing hexavalent chromium ions. **Trivalent Chromium** – Decorative chromium plating is produced using because of lower toxicity aqueous solution that contains either hexavalent or trivalent chromium compounds. The trivalent chromium process is considered less toxic and more environmentally friendly and lower content of chromium in plating solution.

Chromium exposure can occur by ingestion, inhalation, and skin absorption. The form of chromium that is of major health concern in metals plating is hexavalent chromium, which is highly toxic due to its strong oxidation characteristics and high membrane permeability. Long-term exposure to hexavalent chromium can result in irritation of the nasal mucous membrane, including formation of ulcers, and has been associated with an increase in lung cancer. Hexavalent chromium is also mutagenic, and a carcinogen.

Hexavalent chromium ions in waste streams are highly toxic even in very low concentrations and need to be almost completely removed from the waste waters before they are discharged into a stream, sewer or on land. The most common way of treatment involves reduction to trivalent state, Cr **(III),** and subsequent precipitation with an alkali.

The theoretical quantities of chemicals used and sludge produced in conventional treatment of hexavalent chromium bearing waste water is as follows:

Chromium removal

i) **Using ferrous sulphate** ($FeS0_4.7H_2O$)

Chemicals

1 kg Cr requires 16.03 kg ferrous sulphate ($FeS0_4.7H_2O$)

1 kg Cr requires 6.01 kg sulphuric acid (66'Be')

1 kg Cr requires 9.48 kg lime (90%) for precipitation of metallic sulphates.

Sludge

1 kg Cr produces 6.09 kg ferric hydroxide, $Fe(OH)_3$.

1 kg Cr produces 17.443 kg calcium sulphate, $CaS0_4$ (not all sludge)

1 kg Cr produces 1.98 kg chromium hydroxide, Cr $(OH)_3$.

ii) **Using sodium metabisulphite** ($Na_2S_20_5$)

Chemicals

1 kg Cr requires 2.81 kg sodium metabisulphite (97.5%)

1 kg Cr requires 1.52 kg sulphuric acid (66OBe’)

1 kg Cr requires 2.38 kg lime (90%).

Sludge

1 kg lime, as $Ca(OH)_2$, produces 1.84 kg $CaS0_4$ (not **all** sludge)

1 kg chromium, as Cr, produces 1.98 kg $Cr(OH)_3$.

Waste Generation and Waste Handling

The electrochemical operation is typically performed in chemical baths that are followed by rinsing operations. The major concern in the electroplating units are spent process baths and rinse water effluent containing heavy metals and other toxic and nontoxic chemicals. This waste is typically treated by method of neutralization and precipitation, in the process generating solid waste that are regulated by The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008. The disposal options for sludge are limited and cost is high.

Section Three: Status of Electroplating Clusters

General

Electroplating operations form part of large scale manufacturing plants (e.g. automobile, cycle, engineering and numerous other industries) or performed as job-work by small and tiny units. They are spread across the entire country with significant concentration in several states like Tamil Nadu, Maharashtra, Gujarat, Punjab, Haryana, part of U.P., Karnataka, Andhra Pradesh, and West Bengal. The Task Force constituted by Central Pollution Control Board with the objective to identify specific problems/ issues of this sector and suggest a suitable approach in solving the problem visited some of the electroplating clusters in order to review the status. The status of these clusters is given below.

Tamil Nadu

There are 400 registered electroplating units in the state located in Thiruvallur, Kancheepuram, Krishnagiri, Madurai and Coimbatore. These units are mainly operating in small scale sector and 90% of them are carrying out zinc, nickel and chromium plating. The units continue to use cyanide and chromium (VI) based plating.

Madurai: There are 80 electroplating units located in a mixed residential area in Madurai. Presently 58 units are under operation. These units are tiny and small in nature with inadequate space to provide Effluent Treatment Plant. The untreated wastewater is discharged into public sewer. Mostly Zinc, Chromium and Nickel plating is practiced and cyanide plating is not in use.

 

 

Eco Electroplaters Park (Madurai): The Electroplaters have planned to develop an Eco-Electroplaters Park. The park is planned for relocation of 80 electroplating units, with CETP for waste water treatment including an effluent recycling system. Total 27 acres of land has been acquired for development of Park at D. Karaisalkulam with CETP. MoEF has given EIA clearance, subsequently TNPCB has given consent to establish. Due to non-availability of funds, the shed and CETP construction work has been delayed.

Initiatives undertaken by Tamil Nadu SPCB

Based on the recommendations of Expert Committee (CPCB), TNPCB is not giving Consent to cyanide based plating units except Cadmium and gold plating units. For medium and large scale plating units, implementation of effluent recycling system is insisted.

Key Issues

- Majority of units are small scale where expertise and finance is a constraint
- Space constraints
- Large scale units outsource the plating work, to reduce pollution output
- Operating in residential area with inadequate space for pollution control measures
- Madurai plating units operating without treatment facility

Maharashtra

Major auto manufacturers and engineering units are located in Pune, Nasik and Aurangabad. The Electroplating activity is generally outsourced resulting in unplanned growth of these units. There are about 167 registered plating units in these 3 regions. More than 500 units operating are not registered. Pollution control from these 500 units is a major challenge. 90% of these units are small scale. A separate division “Clean Technology division” in MPCB is working on implementation of waste minimization activities in plating units.

Pune: Pune has organized electroplating cluster of total 65 electroplating units with total effluent discharge of 700 m^3/ day. Plating is mainly done for automobile parts and defense applications. All the plating units have individual effluent treatment plant and treated effluent is discharged on land (gardening). Hazardous waste is sent to Ranjangaon MIDC TSDF. Common effluent treatment plant (CETP) is being planned in order to collect and treat effluent from individual plating units. Maharashtra Industrial Development Corporation (MIDC) has allotted land for CETP at Pimpri Chinchwad MIDC.

Board Initiatives: The following directions were issued by the Maharashtra Pollution Control Board on to the electroplating units for compliance:

- Existing electroplating units in non-CETP areas to implement segregation of metal bearing effluent for treatment and recovery within 6 months with a suitable Bank Guarantee.
- Large units to implement metal recovery, with possible recycle of effluent.
- Existing electroplating units connected to CETP, should meet CETP inlet standards. If the CETP is not functioning properly then the electroplating units in that

area shall also comply non-CETP norms for individual electroplating units.

- New electroplating units are allowed only with metal waste recovery and recycling of the effluent.

Directions have been issued to large automobile industries to declare the names of their vendors providing plated parts and, also to ensure that these units have provided necessary pollution control systems and have valid consent from the Board.

Key Issues

- Outsourcing by Corporate sectors resulting in unplanned growth of plating units
- Demand from customers for chrome and cyanide based plating
- Majority of units are small scale where expertise and finance is a constraint
- Space constraint

Gujarat

There are 400 plating units covered under Consent mechanism. Small units operates in about 10-25 m^2 area. The Production capacity varies from 10-200 M^2 of plated surface area per day. Most of the units are operating in residential area with poor industrial infrastructure facilities. The CETPs catering to electroplating units are inadequate. In Jamnagar most of the cyanide based zinc plating units have shifted to acidic zinc plating

Board Initiatives: Waste Minimization Programme was launched in Jamnagar under Forest & Environment Department (GoG), which was assisted by GPCB. As a result of this Programme, the total acidic effluents from the units got reduced from 500-1000 lit/day to 100-200 lit/day depending on the size of the units

Rajkot: There are 3000 registered industrial units in Rajkot out of which 200 are electroplating units. These are tiny and small scale units. They are the service industry doing plating on automotive parts. There are two CETPs exclusively for the treatment of effluent of these Electroplating units. The effluent is sent to CETP through tankers. Sludge from CETP is sent to TSDF at Naroda.

Key Issues

- Very tiny units having no space for treating effluent
- CETP yet to come up in Jamnagar
- Operating in residential area with poor industrial infrastructure facilities
- Majority of units are small scale where expertise and finance is a constraint

Jamnagar: There are about 150-170 electroplating units in Jamnagar carrying out mainly zinc, nickel and chrome plating. They are tiny units having no space for treating effluent. The Jamnagar Electroplaters Association is planning for construction of a CETP.

Punjab (Ludhiana)

There are about 1000 electroplating units in Ludhiana connected to Common Effluent Treatment Plant. The effluent is conveyed through tankers to CETP. About 200 electroplating units are located in residential areas. The Association has made a submission to the State Government for land allocation for relocating the units operating in residential areas.

Key Issues

- Operating in residential area with poor industrial infrastructure facilities
- Majority of units are small scale where expertise and finance is a constraint

Major Issues of Electroplating Units

- Unplanned growth, majorly contributed by outsourcing of electroplating work by corporate sectors (Engineering, Automobile, etc).

- Majority of units are tiny and small scale where finance is a constraint. The scale of operation of the unit is unfavourable to bear treatment cost of effluent.

- Very poor working practices due to unskilled and untrained manpower, insufficient working space and improper layout leading to wastage of chemicals, water and increased volume of effluent thereby increasing cost of treatment.

- Adoption of old traditional manual method of plating practices resulting in no control over process, chemicals, etc. in turn causing variation in the generation of quantity and quality of waste streams.

- Operating in non-confirming areas with inadequate space for pollution control measures, having greater pollution potential and affecting the residents.

- Non adoption of cleaner technology options, waste minimization techniques, reduction and recycling practices which makes effluent treatment easier and cheaper, results in saving of chemicals.

- Low awareness and inadequate attention towards handling toxic chemical and hazardous waste resulting in its poor management.

- Although proven cyanide free plating and Cr(VI) free Passivation chemicals are available customers demand for chrome and cyanide based plating.

Section Four: Recommendations of the National Task Force for Pollution Control in Electroplating Sector

Central Pollution Control Board with an objective to control the extensive pollution caused by the electroplating sector constituted a National Level Task Force under the Chairmanship of Prof. J.M. Dave. The terms of reference of this Task Force included identification of specific problems/ issues of electroplating sector and best available solution to these, identification of clean technologies/ waste minimization measures, and, providing guidance on implementation of environmental discharge standards in both organized and unorganized sectors and on development of action plan for phase wise reduction of cyanide and hexavalent chromium. The Task Force was constituted with tenure of two years. The office order for constitution of the Task Force is annexed **at Annexure I.**

Six meetings were convened including three meetings and the visit to the electroplating clusters at Pune, Rajkot and Ludhiana.

The First meeting of the National Task Force was held on October 21, 2008 (Delhi) wherein the objectives of constitution of the Task force was briefed and the overall scenario of electroplating sector in terms of pollution potential, issues and existing legislation was discussed. It was decided that SPCBs representative will present the problems/ issues that need to be addressed for pollution control in electroplating units in the respective states and also suggest approach for solving it, for taking decision by the Task Force. Minutes annexed at **Annexure II**.

The Second meeting of the National Task Force was held on June 17, 2009 (Madurai). Representatives of various SPCBs informed the status of electroplating units/ clusters, initiatives taken for control of pollution from the sector, and the suggestions for improvement in pollution control were discussed. The Task Force team also visited Electroplaters Park site and some of the existing plating units in Madurai, Minutes annexed at **Annexure III**.

The next three meetings were convened in Pune, Rajkot and Ludhiana by the sub-committee. Electroplating units and their Association presented National Task Force their views/ experiences/ initiatives taken for pollution control to which were deliberated. The Task Force team also visited electroplating units in these regions and the CETP for their effluent treatment, Minutes annexed at **Annexure IV to VI**.

On the basis of studying the issues & problems of the sector through visits and meetings with the associations & entrepreneurs and considering the initiatives already taken by some SPCBs, the final recommendations were made by Task Force for implementation by SPCBs/ CPCB during the Third Meeting held on June 15, 2010, chaired by Prof. J.M Dave:

1. Usage of cyanide in electroplating should be phased out, except for cadmium, gold and silver plating, within a time frame of two years.

   (Action: SPCBs)

2. The usage of hexavalent chromium should be phased out in electroplating within a time frame of two years.

   (Action: SPCBs)

3. Cadmium based plating units should have closed-loop system for recycling of cadmium bearing waste water through suitable recycling technologies such as reverse osmosis, Ion exchange, etc.

   (Action: SPCBs)

4. Existing medium and large units should implement zero discharge for Cr(VI) and other metal bearing waste within time frame of two years.

   (Action: SPCBs)

5. The new medium and large units should be allowed only with zero discharge for Cr(VI) and other metal bearing waste.

   (Action: SPCBs)

6. The new small and tiny units (water consumption including recycling water less than 5000 lt/day) should be allowed to come only in industrial clusters having common effluent treatment facility with sufficient treatment capacity to take additional effluent load.

   (Action: SPCBs)

7. Engineering units which outsource electroplating work to vendors should submit contract agreement to the State Pollution Control Boards informing name of the vendors and vendor's consent and compliance status report should be submitted yearly to the State Board by the outsourcing unit.

(Action: SPCBs)

8. Electroplaters Associations should assess the feasibility of implementing the ZERO Liquid Discharge (ZLD) in CETPs on similar lines as being implemented in CETP at Ludhiana. The SPCBs should play a promotional role in providing guidance to the Associations for implementing ZLD.

(Action: Industrial Association/ SPCBs)

9. The SPCBs should take initiatives to relocate the electroplating units operating in non-conforming areas to industrial park with common treatment facilities.

(Action: SPCBs)

10. The Tamil Nadu Pollution Control Board (TNPCB) should take action on priority either to relocate electroplating units in Madurai to proposed Electroplating Park or to ensure treatment of wastewater at their current locations before discharge to drains until they are relocated to Park.

(Action TNPCB/ Madurai Electroplaters Association)

11. Interaction meeting for electroplaters and technology providers should be organized by CPCB/ SPCBs

(Action: SPCBs/CPCB)

12. The SPCBs may examine the feasibility of constituting Technical cell for major polluting SSIs to provide assistance and create awareness on CT/WMM in these sectors.

(Action: SPCBs)

13. Technical Reports be prepared and published by CPCBs to guide SPCBs in implementing CTs/ WMMs

(Action: CPCB)

14. CPCB may be associated with SPCBs in implementing these recommendations whenever required.

(Action: CPCB/ SPCBs)

Section Five: Cleaner Technologies Options

Non-Cyanide Plating Processes

Zinc, copper, cadmium, silver, gold, brass and nickel are commonly plated using cyanide solutions. Although cyanide solutions are extremely toxic, their use has become widespread due to their intrinsic cleaning ability and effectiveness in keeping metals in solution during the plating process. Motivation for eliminating cyanide solutions stem from cyanide's toxicity, potential liability, public distrust, increasing regulation and rising waste treatment and disposal costs.

Listing of alternative solutions for the various cyanide placing solutions, along witch their advantages and disadvantages, are given in **table II. Zinc and, Copper cyanide solutions are the most commonly replaced and promising alternatives are available.** Alternatives for cyanide silver, cadmium, nickel and gold are currently limited in application.

Pollution Prevention Benefits

Non-cyanide plating solutions **eliminate** cyanide from rinse water **and sludge generated during waste treatment of the rinse water.** Non-cyanide baths contain one-half to one-quarter as much copper as full strength processes, **resulting in lower sludge volume generation rates.** The sludge from waste treatment of cyanide bearing rinse water can be particularly difficult to dispose of because of residual cyanide content. By eliminating cyanide from the rinse water, compliance with cyanide regulations in wastewater discharges is ensured. Rinse water from non-cyanide plating only requires pH adjustment to precipitate metal as the hydroxide. This avoids the use of chemicals such as chlorine and sodium hypochlorite.

Non-Cyanide Zinc Plating

Zinc plating is utilized by industries for many different reasons. It is a soft, ductile deposit offering excellent corrosion-resistance. Three main types of zinc plating being done today are: (i) cyanide zinc, (ii) acid chloride zinc, and (iii) alkaline cyanide-free zinc. With the never-ending environmental pressures that are being placed on industry, there is a worldwide push to move away from cyanide zinc and into cyanide-free zinc plating.

Alkaline cyanide free Zinc Plating

Alkaline cyanide free zinc deposits have very unique characteristics that lend themselves well as a base coating for paint and powder applications.

Operating Features

- The operating characteristics of an alkaline noncyanide system depend to a great extent on the propriety additives and brightening agents used in the bath.
- Table: composition of alkaline non-cyanide zinc baths

Constituent	Range (g/l)
Preparation	
Zinc Oxide	7.5-21
Sodium Hydroxide	65-90
Proprietary additive	3-5
Analysts	
Zinc Metal	6.0-17.0
Sodium Hydroxide	75-112

Operating conditions: Temperature, 21 to 35 °C (69 to 94 °F) range; cathode current density, 2.0 to 4.0 A/dm^2 (20 to 40 A/ft^2); bath voltages, 12 to 18 barrel.

- Alkaline noncyanide baths are inexpensive to prepare and maintain, and they produce bright deposits and cyanide-free effluents.
- An alkaline noncyanide zinc bath with a zinc metal content of 7.5 to 12 g/L (1.0 to 1.6 oz/gal) used at 3 A/dm^2 (30 A/ft^2) produces an acceptably bright deposit at efficiencies of approximately 80%.

Table II**: Cyanide Electroplating Solution Alternatives**

Alternative Solution	**Advantages**	**Limitations**	**Application potential**
Alkaline zinc	▪ Good coverage in low-current density areas ▪ Bright deposits ▪ Throwing power similar to cyanide solutions ▪ Use of existing tanks ▪ Allows for gradual phase-out of cyanide solutions ▪ Chemical costs similar to cyanide solutions	▪ Loss of intrinsic ability of cyanide ▪ Harder to plate on cast iron and carbonitnded steel. ▪ Generally requires additional filtration	▪ Firms using solution must compensate for loss of intrinsic cleaning ability of cyanide and control post-blistering problems
Acid zinc	▪ Faster deposition speed than alkaline zinc solutions ▪ Yield bright deposits that level surface irregularities. ▪ Plate readily on cast iron and cabrbonitnded steel. ▪ Less prone to post-blistering than alkaline zinc solutions ▪ Less sensitive to make-up water than alkaline zinc solutions. ▪ Better able to accept chromate sealers than alkaline zinc solutions.	▪ Loss of intrinsic cleaning ability of cyanide. ▪ Corrosive nature of solutions may require modifications to plating equipment. ▪ Higher maintenance costs. ▪ Additional cooling and filtration equipment may be necessary ▪ Cannot be gradually phased in. ▪ Poor throwing power in low-current density areas. ▪ Make-up water may require iron removal.	▪ Promising for firms willing to provide necessary modifications and investments in their lines.
Acid sulfate copper	▪ Superior leveling and brightness.	▪ Corrosivity of solution is hard on plating equipment.	▪ Promising; has been used since 1950 and accepted

	▪ Pretreatment is relatively easy and inexpensive. ▪ Make –up costs are inexpensive. ▪ High plating current densities are possible. ▪ High line speeds are possible ▪ Only bright copper works well on plastic.	▪ Hard to recover dragout. ▪ Poor macro-throwing power. ▪ Solution may attack base metal ▪ Additional cooling equipment may be necessary. ▪ Acid-resistant ventilation systems may be necessary	in a wide variety of plating applications
Pyrophosphate copper	▪ Excellent throwing power. ▪ Does not attack base metal or plating equipment ▪ Dragout recovery is possible. ▪ Pretreatment is relatively easy ▪ Excellent subsequent plating adhesion. ▪ Anode bags are not needed. ▪ High deposition of metals.	▪ High initial solution costs. ▪ May require longer plating times ▪ Steel and zinc parts require copper cyanide strike. ▪ May contain significant amounts of ammonia that may pose pretreatment problems. ▪ Life of solutions is limited.	▪ Promising; Provided the loss of the intrinsic cleaning ability of cyanide is compensated for and production speed can be lowered to compensate for the longer plating time required.
Alkaline Copper	▪ Works well on steel, brass, white metal, zinc die cast and zincates aluminum surfaces. ▪ Good throwing power. ▪ Good coverage capability	▪ Additional cleaning and process controls may be necessary.	Less promising – more difficult and expensive to operate
Copper fluoroborate	▪ Can accommodate higher line speeds. ▪ More soluble than sulfuric acid.	▪ May be more expensive to operate and difficult to control.	Less promising –more difficult and expensive to operate

Electroless nickel phosphorous	▪ Eliminates need for a copper strike on zinc parts. ▪ Improved coverage capability. ▪ Improved corrosion protection of zinc substrates. ▪ Lower reject rates	▪ Plating process much more complex.	Limited application- tested as an alternative to cooper /nickel plating on zinc die casts.
Ammonium silver		▪ Bath generates ammonium hydroxide, which poses and exposure concern for line operations. ▪ Limited information is available on solution.	Not promising due to worker health and safety concerns.
Halide silver	▪ Very stable and easy to operate.	▪ Light –sensitive solution. ▪ Initial cost high for electronic and decorative applications. Solution is toxic.	Limited applications since solutions is fairly unstable
Methanesultonate-potassume iodide silver	▪ Yields fine –grained structured deposits similar to cyanide solutions.	▪ Not yet developed on a commercial scale.	Only tested on a laboratory scale no tests in commercial setting have been performed.
Amino- or thio-complex silver		▪ Readiness of thiosulfate ions to be oxidized. ▪ Low current density areas may be discolored. ▪ Limited information is available on solution.	Not promising. At one time the solution was widely marketed, but has since been withdrawn.
No free cyanide	▪ Developed specifically for electronics industry.		Limited test application. Developed for high speed

silver	▪ Good contract properties. ▪ Less susceptible to tarnishing. ▪ Silver can be precipitated as AgCN and reused. ▪ Neutral pH and no free cyanide allows for free rinsing.		electronics plating
Cadmium chloride		▪ Limited information is available on solution.	Not promising. Cadmium plating likely to be phased out due to the toxicity of cadmium.
Cadmium sulfate	▪ Can produce deposits up to 0.02 inches with good adhesion and density properties.		Not promising. Cadmium plating likely to be phased out due to the toxicity of cadmium
Cadmium fluoborate		▪ Limited information is available on solution.	Not promising. Cadmium plating likely to be phased out due to the toxicity of cadmium
Cadmium perchlorate		▪ Limited information is available on solution.	Not promising. Cadmium plating likely to be phased out due to the toxicity of cadmium.
Gold sulfite	▪ Excellent throwing power. ▪ Can plate on complex parts. ▪ Performs as well as gold cyanide solutions.	▪ Solutions are less stable, therefore require more monitoring and control.	More research is required for electronic application
Cobalt	▪ Works well on slide-wear	▪ Deposits are brittle and shock	More research is required

hardened (no free cyanide)gold	applications.	may cause cracking. ▪ Limited information is available on solution.	for electronic application

Source: Alternatives to the Use of Cyanide Solutions in Electroplating, July 1992, Braun lntertec Environmental, Inc. Mendota Heights, Minnesota.

- However, if the metal content is allowed to drop 2 g/l (0.26 oz/gal), efficiency drops to below 60% at this current density.
- Raising the metal content much above 17 g/l (2.3 oz/gal) produces dull gray deposits, lower-current-density plating areas, and poor distribution; however, additives have been developed to address this problem.
- Increasing sodium hydroxide concentration increases efficiency. However, excessively high concentrations will cause metal buildup on sharp-cornered edges.

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- Alkaline Non-Cyanide Zinc Plating by PAvco, Inc, Cleveland, OH

Acid Chloride Zinc Plating

There are three primary types of acid zinc plating baths: (i) ammonium chloride, (ii) potassium chloride and (iii) mixed chloride/ potassium chloride.

The **ammonium chloride** bath is most forgiving of the three major types of acid zinc plating because of its wide operating parameters. The primary drawback of this system is the high level of ammonia, which can cause problems in wastewater treatment. Ammonia acts as a chelator, and if the rinse waters are not segregated from other waste streams, removal of metals to acceptable levels using standard water treatment practices can be difficult and expensive. Ammonia is also regulated in many communities.

Potassium chloride zinc plating solutions are attractive because they contain no ammonia. The disadvantages of this system are a greater tendency to burn on extreme edges and higher operating costs. The potassium bath also requires the use of relatively expensive boric acid to buffer the solution and prevent burning in the high-current-density areas, functions performed by the ammonium chloride in the other systems.

Mixed ammonium chloride/potassium chloride zinc plating. This bath combines the best of the ammonia and ammonia-free baths. Because potassium chloride is less expensive than ammonium chloride, the maintenance costs of the mixed bath are lower than the ammonia bath, and it does not require boric acid. The ammonia levels in the rinse waters are low enough that it does not significantly interfere with wastewater treatment, even if plating nickel and copper in the same plant with mixed waste streams. If level of ammonia is higher, special waste treatment equipment will be required, and the non-ammonia bath is most likely the best choice.

Operating features:-

	Ammonia g/l	**Potassium g/l**	**Mixed g/l**
Zinc Metal	11 to 37.5	22.5 to 37.5	11 to 37.5
Ammonium Chloride	120 to 180l	0	30 to 60
Potassium Chloride	0	187 to 224.6	120 to180
Boric Acid	0	22.5 to 37.5	0
pH	5 to 6	4.5 to 5.5	5 to 6
Temperature	65 to 105F	65 to 115F	65 to120F

References: Acid Chloride Zinc Plating by Steven Erwin and Mike Flanigan, Benchmark Products, Inc., Indianapolis, Indiana

Alkaline non-cyanide zinc is reported to have good throwing power, so it is a better substitute than acid zinc for parts that require good throwing/covering power.

Non-cyanide Copper Plating

Copper Plating is the base building block in plating chrome-plated bumpers to printed circuit boards. There are four types of copper plating (i) acid copper, (ii) alkaline cyanide copper (iii) alkaline non-cyanide copper and (iv) electroless copper.

Alkaline non-cyanide copper processes include copper Pyrophosphate chemistries and propriety alkaline non-cyanide copper chemistries. Some of the pyrophosphate baths use ammonium hydroxide as a brightener. The result of using ammonia is waste treatment challenges. Pyrophosphate chemistry limitations include adhesion concerns on some substrate and a breakdown product called orthophosphate. At 40-60 g/lt of orthophosphate, the plating bath will have to be diluted or dumped.

A non-cyanide alkaline copper plating bath has been developed. The bath will plate directly on iron and steel, brass and copper, zincated aluminum diecast zinc, stainless steel and white metal castings in both rack and barrel operations.

Operating Features:

- The process consists of a liquid concentrate which contains copper and all the chemistry required in the process.
- The liquid concentrate is used at a volume of 40 to 60% in D.I. or soft water to charge the bath initially. Thereafter, only one primary addition agent, the electrolyte is used to maintain the bath as the copper is dissolved from anodes.
- In addition, there is a high current density booster additive.
- A bath charged at 40% by volume will have a copper concentration of 7.5 g/l. The bath can be operated successfully at this level of copper, but

there are instances where a faster plating speed is desired in which the anodes are dissolved until a concentration of 11 to 15 g/l of copper is reached.

- It is very important that the electrolyte additive be added on a daily basis while copper anodes are being dissolved.
- Once the preferred level of copper is determined for a particular installation, the anode area and anode current density required to maintain optimum copper concentration in the bath are determined.
- The pH of the bath is monitored and will increase as the bath is sed. When the pH exceeds 10, it is reduced by adding dilute sulfuric acid.

Bath Operation:-

Constituent	**Range**
Copper Metal**(g/l)**	7.5 to 15
pH	9 to 10
Temperature	37.8 to 65.5
Anode Current Density	100 to 150 A/dm^2 (10-15 ASF)
Voltage, Rack	1-6
Voltage Barrel	12-18
Agitation	Vigorous air
Filtration	Continuous with carbon pack
Copper Anodes	OFHC CDA 101
Anode Baskets	Titanium
Heating	Stainless steel and Titanium elements
Tank	Plastic or lined steel
Ventilation	None required

- Plating on to zincated aluminum surface needs proper pre-plate cycle.

Applications

The alkaline non-cyanide copper plating bath will plate directly on iron and steel, brass and copper, zincated aluminum diecast zinc, stainless steel and white metal castings in both rack and barrel operations. It is being used successfully as a strike prior to bright nickel plating, tin plating, solder plating and acid copper plating. In addition it has been used as a finish in itself for hardware and lamp fixture parts which are usually antiques or oxidized.

It is an electrolytic process similar to its cyanide based counterpart. Operating conditions and procedures are similar and existing equipment usually will suffice when converting from a cyanide based process to a non-cyanide process. Cyanide free copper plating can be applied as a strike (thin deposit) or as a heavy plate

References:

- Guide To Cleaner technologies, Alternative Metal Finishes, Office of Research and Development, Unites States Environmental Protection Agency, Sept 1994
- Alkaline Cyanide-Free Copper Process for Functional and Decorative Plating, by Eric Olander, Electrochemical Products Inc., New Berlin, WI.
- A noncyanide Alkaline Bath for Industrial Copper Plating, by S. M. Mayanna and B. N. Maruthi, Dept. of Postgraduate Studies in Chemistry, Central College, Bangalore, University, March 1996.

Hexavalant Chrome free Passivation (Chromating)

One of the many uses of chromium in the electroplating industry is for conversion coatings for corrosion protection or to improve adhesion of subsequent organic coatings. The form of chromium used for treatment is hexavalent chromium which is carcinogenic and highly toxic.

New passivation systems based on trivalent chrome can replace the current hexavalent processes with the same or, if needed, a much higher coating weight. Depending on the coating weight, the corrosion protection can be similar or even higher.

The new passivation coatings are harder, more scratch resistance and contain less water compared to the old hexavalent chrome passivation coatings. Because of the lower water content, these new coatings are more heat resistant. Unlike the hexavalent chromate coatings which are colored, the trivalent passivation coatings are colorless but have an iridescent appearance changing from colorless to green depending on the thickness. The application of a colorless topcoat to these trivalent coatings gives back the original appearance of the zinc coating.

These trivalent chrome passivation systems are well established in conventional barrel, rack and continuous tube plating operations for the replacement of hexavalent chromates. These new systems are tested for both hot dip and electrogalvanized steel in many instances.

Operating Parameters:-

Parameters	**Unit**	**Range**	**Optimum**
Trivalent chrome	ml/lt	125-175	150
pH	--	1.82.0	1.8
Temperature	℃	55-80	35
Dipping time	Sec	30-90	60
Solution movement	Mild Air/ Mechanical Movement		

Note: pH value adjusted with Nitric Acid or Sodium hydroxide.

International Restrictions on Hexavalent Chromium

The toxicity and carcinogenity associated with Cr (VI) has resulted in ranging environmental legislations to reduce its use. The European Union’s End of Life Vehicles Directive allows only 2 g hexavalent chrome per vehicle.

In addition, Restriction of Hazardous Substances Directive (ROHS Regulations) of EU limits the amount of hexavalent chromium to 0.1% (weight/weight) in waste electronic devices so that those metals never find their way into landfills or elsewhere, where they can eventually be released into the environment. It has also been implemented by China, Japan, Korea and California(USA).

Section Six: Recovery and Zero Liquid Discharge

General

One approach to waste reduction is to recover process materials for reuse. Adoption of proper handling and recycling methods will help in the optimization of the use of various raw materials. The recovered materials can be used again, thus reducing their consumption. The two basic type of recoveries applicable for electroplating industry are:

- Metal recovery
- Water Recovery

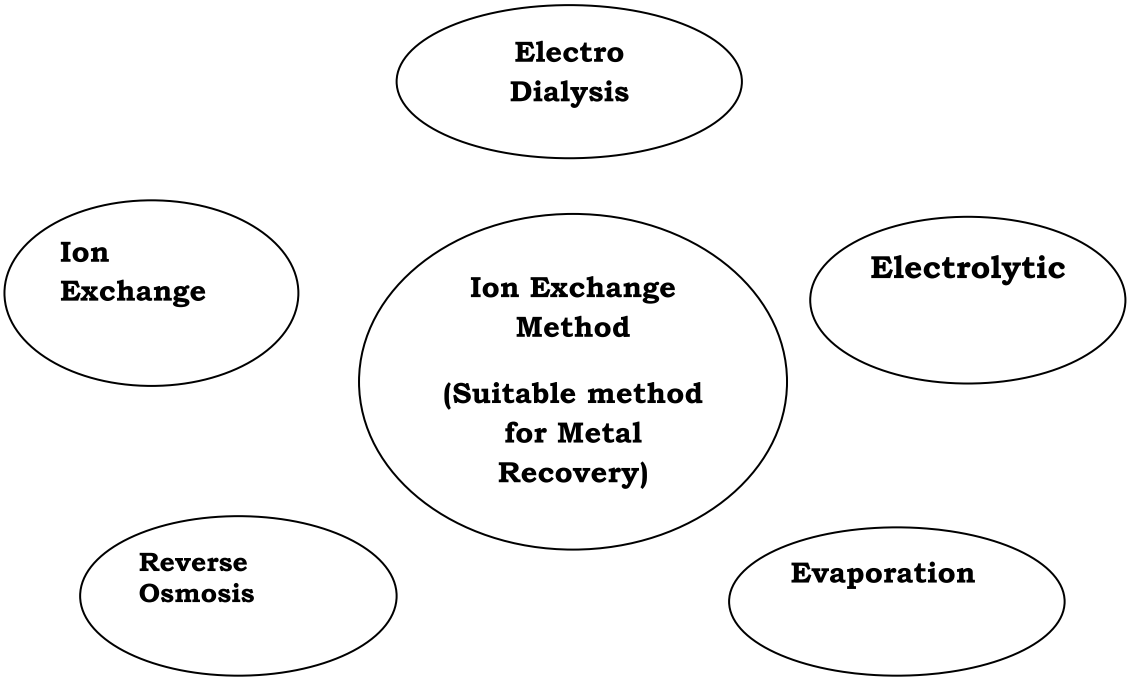
The recovery can be either only water or only metal or both metal and water together. It depends on the technology or system adopted.

Recovery Techniques

Materials used in metal finishing processes can be effectively recovered using following available technologies.

- Evaporation
- Reverse Osmosis
- Ion Exchange
- Electrodialysis
- Electrolytic Recovery

However considering advantages and disadvantages of the available technologies and the case studies, Ion Exchange technology is found to be the suitable method for metal recovery for electroplating industry.



Recovery Options

The options for recycle/ reclaim water and metal in a plating industry are:

Option1. **Water Recovery through Reverse Osmosis after precipitation system**
Option2. **Metal recovery by ion exchange**
Option3. **Zero Liquid Discharge - Recovery through Ion Exchange & Reverse Osmosis**

Option 1: Water Recovery through Reverse Osmosis after precipitation system

The waste water from plating and cleaning operations is first treated by conventional treatment method neutralization cum precipitation. The conventionally treated effluent is passed through filtration systems such as Activated Carbon Filter, Cation & Anion exchanger, Cartridge filter, etc and subsequently passed through Reverse Osmosis. The permeate from RO is recycled within the process. The reject from RO is taken to evaporation systems either solar stills, Multiple Effect Evaporator, etc. the schematic diagram of the system is given in figure I.

Option 2: Metal recovery by ion exchange

The rinse water from first rinse tank is passed through recovery system i.e., Ion Exchange unit. There should be separate recovery system for each metal to be recovered. The metal ions in solution are removed by a chemical substitution reaction with an ion exchange resin. Metal cations exchange sites with sodium or hydrogen ions and anions (such as chromate) with hydroxyl ions. The exchange resin can generally be regenerated with an acid or alkaline solution and reused. When a cation exchange resin is regenerated, it produces a metal salt. For example, copper is removed from an ion exchange resin by passing sulfuric acid over the resin, producing copper sulfate. This salt can be added directly into the plating bath. The metal free water is reused in plating bath / rinse tank top up. The schematic diagram of the system is given in figure II.

The cleaning wastewater and the resin regenerant are treated by conventional treatment method, neutralization cum precipitation.

Option 3: Zero Liquid Discharge - Recovery through Ion Exchange & Reverse Osmosis

The rinse water from first rinse tank is passed through recovery system i.e., Ion Exchange unit. There should be separate recovery system for each metal to be recovered. The metal concentrate regenerated from the resin is used in the plating bath. The metal free water is reused in the rinsing tank or taken to storage tank for further use in plating bath preparation, top-up solution make-up, etc. The cleaning wastewater and the resin regenerant are treated by neutralization cum precipitation. The treated effluent is passed through pre-filtration systems (Activated Carbon Filter, Cation & Anion exchanger, Cartridge filter, etc) and subsequently passed through Reverse Osmosis. The permeate from RO is recycled within the process. The reject from RO is taken to evaporation systems either solar stills, Multiple Effect Evaporator, etc. the schematic diagram of the system is given in figure III.

Requirements of Recovery

Waste Segregation: Recovery should begin with segregation. Segregation of waste streams is essential for most recycling and resource recovery technologies. To reuse a waste material for another process, recover valuable chemicals from a waste stream, or recycle rinse water, the waste stream must be kept separate from other wastes that will disturb the reuse or recycling process. Therefore, implementation of recycling and resource recovery technologies will typically require process piping modifications and additional holding tanks to provide appropriate material segregation.

Deionized Water: Using deionized water to prepare plating bath solutions is an effective way of preventing waste generation. Some groundwater and surface water contains high concentrations of calcium, magnesium, chloride and other soluble contaminants that may build up in process baths. By using deionized water, build-up of these contaminants can be easily controlled. Technologies such as reverse osmosis and ion exchange can be used to effectively remove soluble contaminants in incoming water.

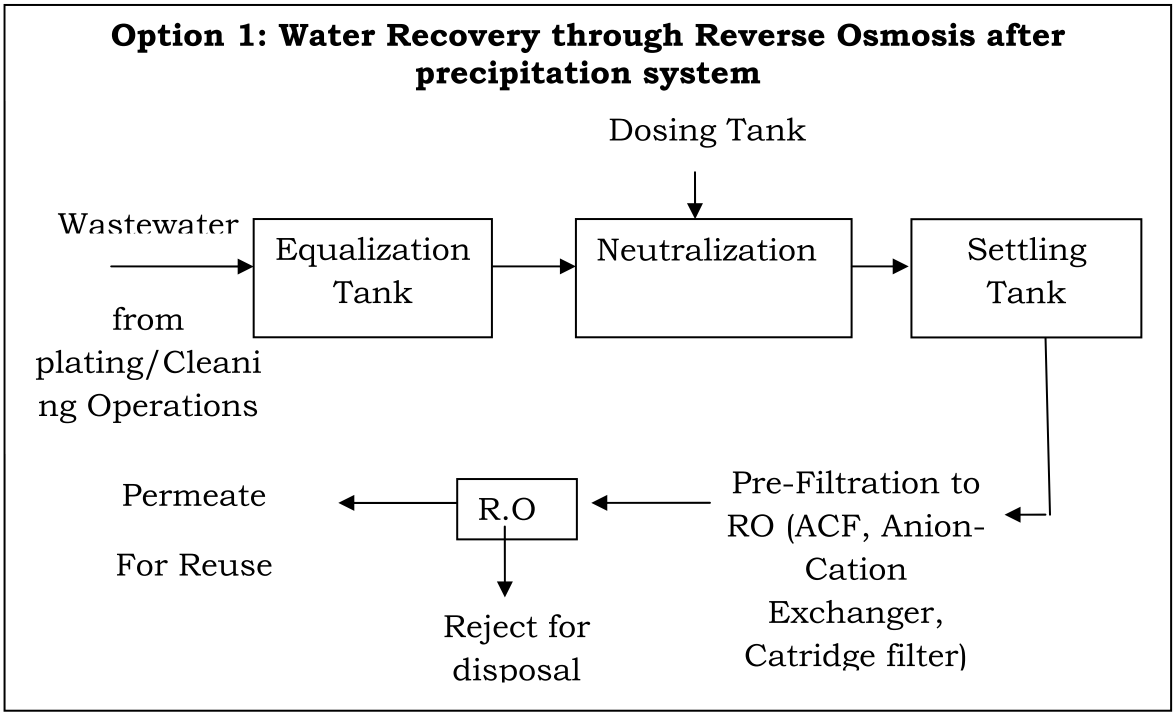


Figure I

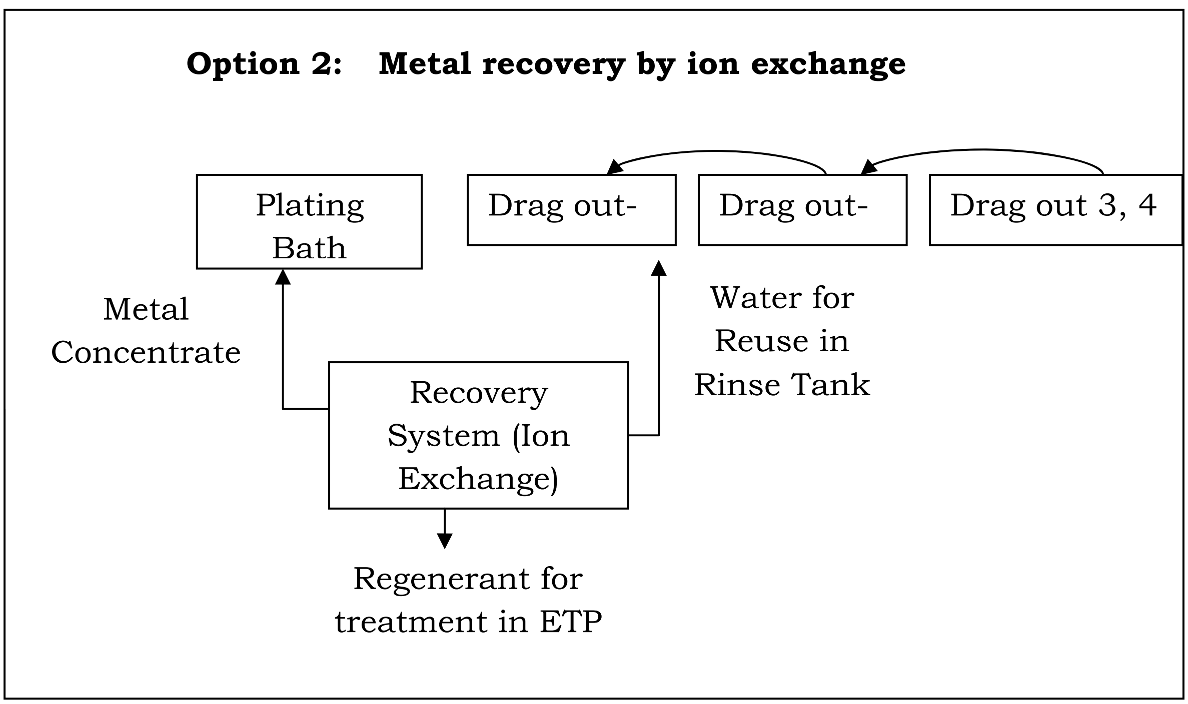
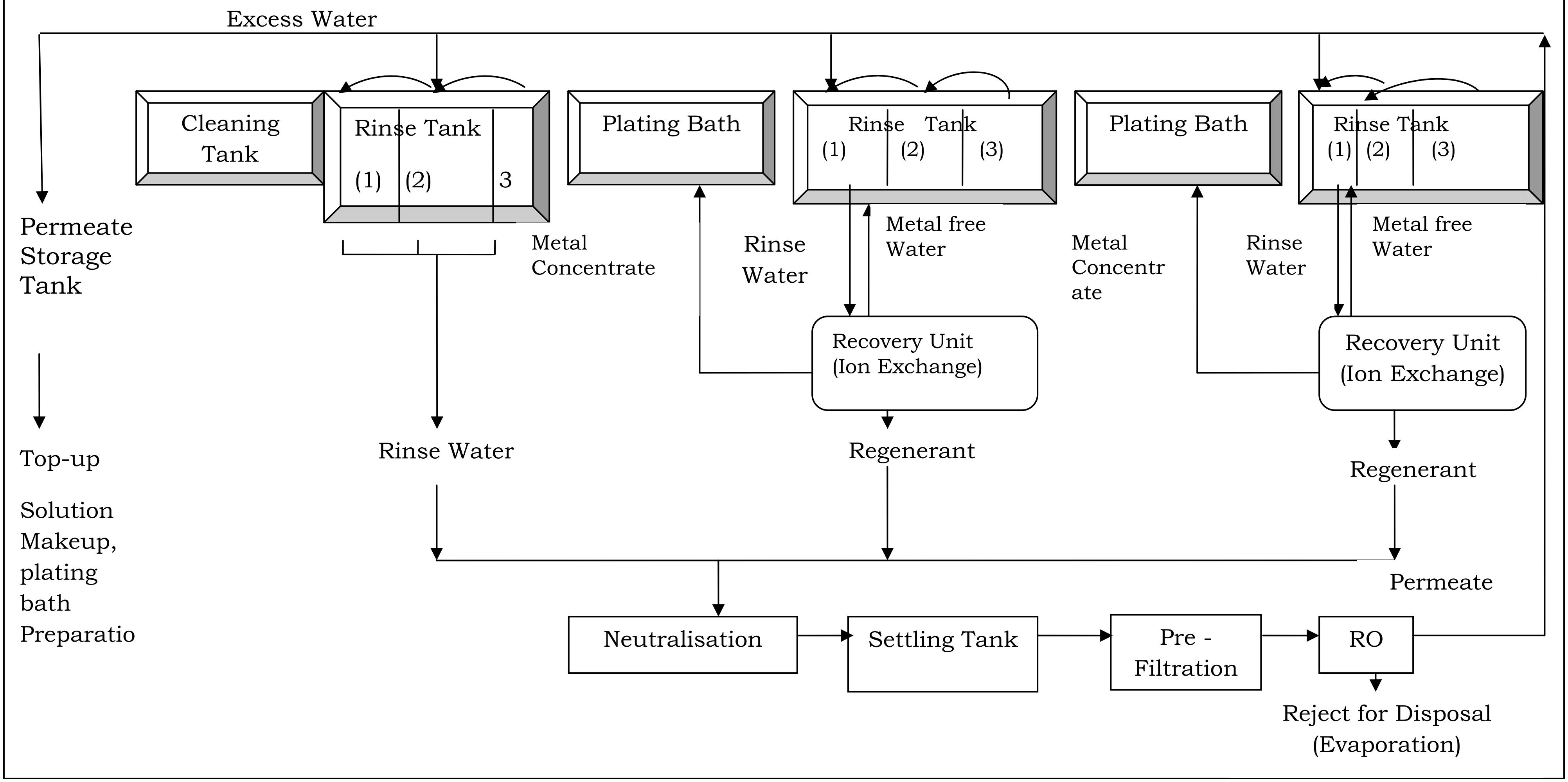


Figure II

Option 3: ZLD Scheme for Electroplating Industry



Plating Technologies

Ro reject disposal options

The options for disposal of are as below

- Multiple Effect Evaporators
- Solar stills
- Mixing with domestic sewage with sufficient dilution

Multiple Effect Evaporators: It is an apparatus efficiently using the heat from steam to evaporate water. In a multiple-effect evaporator, water is boiled in a sequence of vessels, each held at a lower pressure than the last. Because the boiling point of water decreases as pressure decreases, the vapor boiled off in one vessel can be used to heat the next, and only the first vessel (at the highest pressure) requires an external source of heat. The system has been installed in Common Effluent treatment Plant at Ludhiana.

Solar Stills: The simple solar still consists of a blackened basin containing the saline water over which a transparent, air tight covering that completely encloses the space above the bottom. The cover, usually glass is sloped towards a collection trough. Solar energy passing through the transparent cover is absorbed by the water and the basin linear and thereby heats the water causing evaporation, as the transparent cover will be cooler than the water surface enclosure. The humid air contact with the cool cover result in condensation of some of water vapour underneath the surface of the glass cover. This condensate slides down the slope, flows along the trough and drains out through the outlet pipe.

Mixing with Domestic Sewage: RO reject may be mixed with treated domestic sewage in order to bring down dissolved solids concentration. However the concentration of heavy metal in the reject has to be checked and sufficient dilution should be ensured.

Section Seven: Success Stories in Pollution Control in Plating Industries

General

Some of the success stories in pollution control in electroplating industries found during visit of the Task Force to the electroplating clusters are given below.

Metal Recovery in National Electroplater Ludhiana, Punjab

The unit carries out nickel, chrome and zinc plating on automobile parts. The plating capacity of the unit is about 1.5 lakh Sq. ft., the entire operation of cleaning and plating is automated. Chrome and Nickel are being recovered through Ion Exchange process as chromic acid and nickel sulphate respectively with a recovery rate of 15-20 kg of nickel and chromium per day. The recovery is being practised by the unit for the last 15 year.

Cyanide free Alkaline Zinc process is being used. The effluent generated from degreasing and membrane regeneration is treated in settling tank and subsequently passed through Reverse Osmosis. The RO permeate is recycled in the process and reject sent to ETP.

The economics of recovery is given in table – I.

Zero Liquid Discharge (ZLD in CETP, Ludhiana

The designed capacity of the CETP is 200 m^3/day but it is getting only about 150 m^3/day effluent. 582 electroplating units are members of the CETP. The components of CETP comprise of (i) Storage tank (ii) Equalization tank (iii) Tube settler (iv) Bioreactor (v) Clarifier (vi) Reverse Osmosis (viii) Multiple Effect Evaporator. The CETP is equipped with a water recovery system through RO. The part of the permeate from RO is reused by dyeing units located nearby to CETP and the rest used in CETP boiler & for irrigation within the premises. The reject is evaporated in Multiple Effect Evaporator and salt generated is stored in interim sludge storage facility within the CETP premises along with sludge from chemical treatment. The sludge finally is disposed off in TSDF at Nimbua. The CETP management charges 60 paisa per litre of wastewater from member units. The schematic diagram of Zero Liquid discharge in practice in CETP is given in figure - I

Table-I **Cost Economics of Metal Recovery in National Industries, Ludhiana**

NICKEL RECOVERY PLANT (ECONOMIC EVALUATION)

Cost of Nickel Recovery unit	:	Rs 350000 (3.5Lakhs)
Capacity of Recovery unit	:	To recover 30 Kg Nickel Sulphate per regeneration from rinse water (waste stream)

OPERATIONAL COST PER REGENERATION (In Rs)

Sulphuric Acid 15 kg @ Rs 6 per Kg	:	90
Soda ash 20 Kg @ Rs 22 per Kg	:	440
Electricity 36 units @ Rs 4.50 per unit	:	162
Labour	:	150
Total cost	**:**	**842**
Number of regeneration in one month	:	15
Number of regenerations per year	:	180
Operational cost per year (180X842)	:	151560
Depriciation 15% on (3.5Lakh)	:	52500
Interest 12% on (3.5 Lakh)	:	42000
Maintenance cost 5%	:	17500
TOTAL ANNUAL OPERATIONAL COST (In Rs)	**:**	**263560**
Nickel Sulphate recovered per regeneration	:	30 Kg
Nickel Sulphate recovered per year (30X180)	:	5400 Kg
Cost of Nickel Sulphate recovered @ Rs 350 per Kg		1890000
Daily saving of water 5000 litres (Water consumption is nil for rinsing)		
Annual savings of 1500000 litres of water @ 1paise per litre	:	Rs 15000
Annual saving on conventional ETP @ 5 paise per litre treatment cost for 15 Lakh litres	:	Rs 75000
Annual saving on 5 ton sludge reduction	:	Rs 25000
Total annual savings	**:**	**2005000**
Net annual savings (2005000-263560)	**:**	**1741440**
Payback period 350000X12/ 1741440	**:**	**2.41 Months (3 Months approx.)**

Source: National Industries, Ludhiana, Punjab

CHROME RECOVERY PLANT (ECONOMIC EVALUATION IN RUPEES)

Water requirement for Chrome rinse stream	:	10000 Litres per day
Cost of Chrome Recovery unit	:	6 Lakh
Capacity of Chrome recovery unit	:	To Recover 15 kg of

Chromic acid per regeneration from rinse water (waste stream)

Operational cost per regeneration (In Rs)

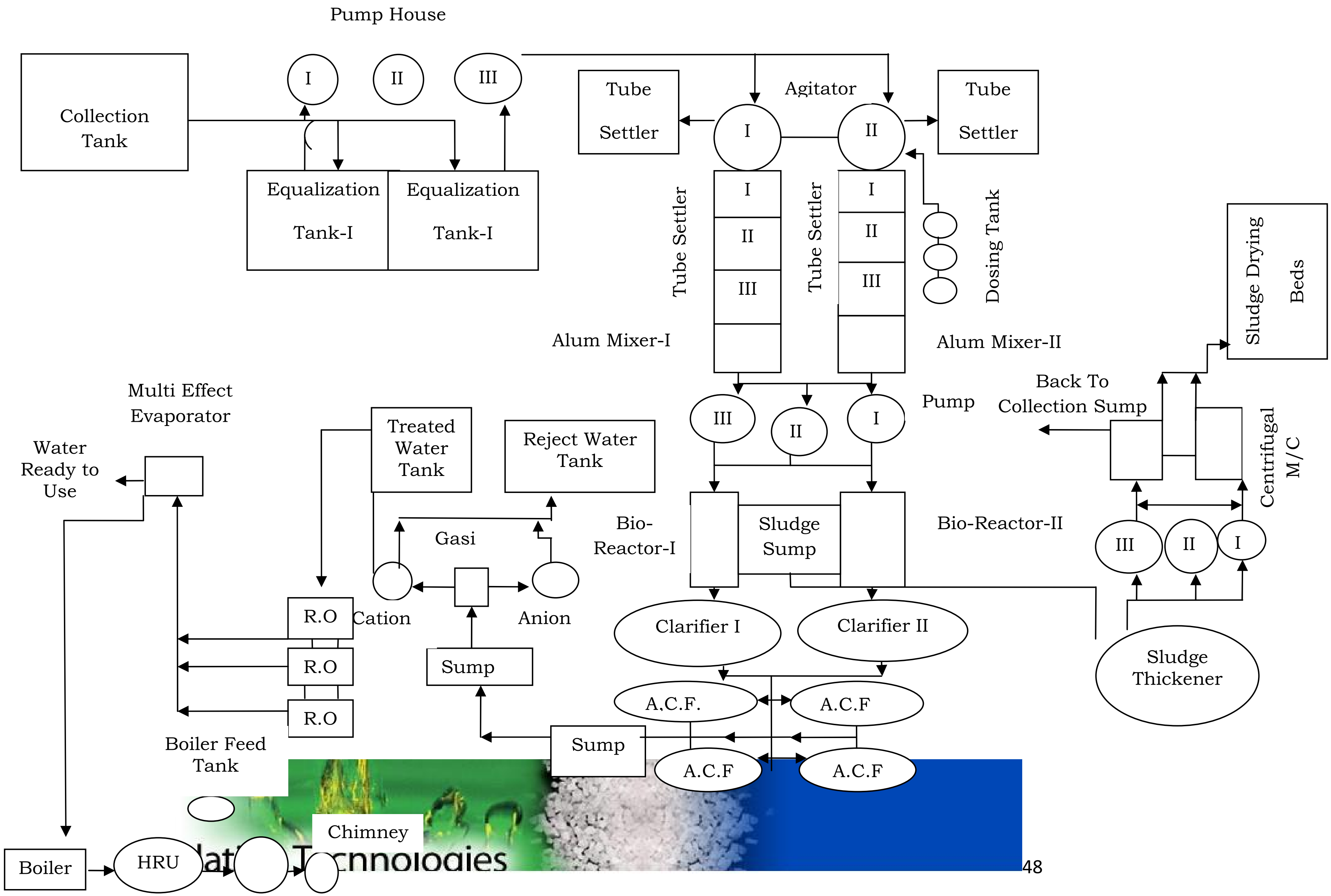
1.Sulphuric Acid 30 Kg @ Rs 6 per Kg	:	180
2.Sodium Hydroxide 15 Kg @ Rs 32 per Kg	:	480
3.Electricity 36 units @ Rs 4.50 per unit	:	162
4.Labour @ Rs 150 per day	:	150
Total cost	**:**	**972**
Number of regenerations per month	:	15
Number of regenerations per year (15X12)	:	180
Operational cost per year (180X972)	:	174960
Depriciation 15% on (6lakh)	:	90000
Interest 12% on (6Lakh)	:	72000
Maintenance cost 5%	:	30000
Total operational cost per year	**:**	**366960**
Chromic Acid recovered per regeneration	:	15 Kg
Chromic acid recovered per year 15*180	:	2700 Kg
Cost of Chromic Acid @ Rs 250 per kg	:	675000
Daily saving of water (Water consumption is nil for rinsing)	:	10000 Litres
Annual saving of 3000000 litres of water @ 1 paise per litre	:	30000
Annual saving on conventional ETP @ 10 paise per litre as treatment cost for 30 Lakh litres	**:**	**300000**

NOTE: The treatment cost and sludge volumes of Chrome effluent is higher than nickel or simple acid & alkali neutralization.

Annual saving on 10 tons of sludge disposal	**:**	**50000**
total annual saving	**:**	**1005000**
Net annual saving (100500-366960)	**:**	**638040**
Payback period 600000X12/638040	**:**	**11.28 months (One year safely)**

Source: National Industries, Ludhiana, Punjab

Figure I: **FLOW CHART OF C.E.T.P., Ludhiana**



Energy Conservation by M/s Ashok Iron & Steel Works, Rajkot, Gujarat

Installation of **hot water generator** for supply of hot water for plating baths resulting in 60 % cost saving in electricity. The energy consumption has reduced from 72 KVA to 28 KVA. This has resulted in substantial saving in cost and energy.

Trivalent Chrome Based Passivation by ECHJAY Pvt. Industries Ltd., Rajkot, Gujarat

The unit mainly manufactures cast iron components for heavy industries and automobiles. It is carrying out trivalent chromium based passivation on the components. Demineralised water is being used for both process and rinsing enabling reuse of rinse water for more number of rinses.

Measures Undertaken by State Boards in Pollution Control

Maharashtra SPCB:

- Directions to Large Scale units to implement metal recovery, with possible recycle of effluent.

- Directions to large industries outsourcing electroplating work, to declare names of their vendors and, also direct to ensure that these units have provided necessary pollution control systems and have valid consent from the Board.

Section Eight: Guidelines for Electroplating Sector

Plating involves different combinations of a wide variety of processes, and there are many opportunities to improve on traditional practices in the industry. The improvements listed below should be implemented where possible.

Process Changes

- Use trivalent chrome instead of hexavalent chrome. Trivalent based chrome passivation is proved technology and already being used.
- Use cyanide-free systems for zinc and copper plating
- Cadmium plating should be avoided. Where cadmium plating is necessary, use bright chloride, high-alkaline baths, or other alternatives. Where there are no feasible alternatives, a maximum cadmium load in the waste of 0.3 grams for every kilogram of cadmium processed is recommended.
- Give preference to water-based surface-cleaning agents, where feasible, instead of rganic cleaning agents, some of which are considered toxic.
- Ozone-depleting solvents such as chlorofluorocarbons and trichloroethane are not to be used in the process.

Bath Control

- **Optimized Bath Concentrations:** Run tests with successively lower bath concentrations to find the minimum level needed to achieve quality. This saves money by reducing overuse of chemicals and reduces contamination in wastewater. Remember that concentrations

recommended by vendors are usually higher than the minimum needed for quality.

- **High Process Bath Temperature:** Increased bath temperature will reduce the viscosity of the plating solution, enabling faster drainage from the workpiece and reducing the amount of solution that is dragged into subsequent baths. Install timer at all baths to control the dipping time.

- **Use of Wetting Agents:** The addition of a very small amount of surfactant or wetting agent can reduce drag-out by as much as 50%.

- **Chromium Plating:** To reduce emission from the chromium bath physical barriers as plastic balls should be used.

- Maintain the density, viscosity and temperature of the baths to minimize dragout.

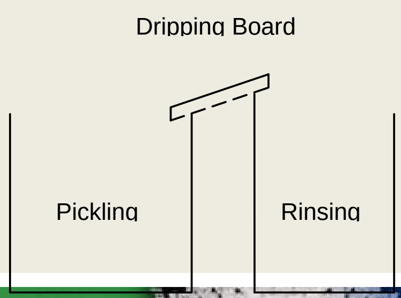
Reduction in Dragout and Wastage

- Use rectangular baths and arrange them close together to avoid spill on the ground and to reduce drag-out

- Plant Layout/ Tanks-inline: The scheme below shows an arrangement of baths to ensure an easy material flow and to reduce dripping. The close proximity of tanks reduce process time and spillage.

Degreasing	Rinsing	Pickling	Rinsing	Plating	Rinsing

- Install drain boards and drip guards between the baths to bring back valuable bath solutions. Boards and guards minimize spillage between tanks and are sloped away from rinse tanks so drag-out fluids drain back to the tanks.



- Install drip bars: Drip bars allow personnel to drain part hands free without waiting, so personnel will not use too short drag-out time.

- Minimize dragout through effective draining of bath solutions from the plated part, by, for example, making drain holes in bucket-type pieces, if necessary.

- Allow dripping time of at least 10 to 20 seconds before rinsing.

- Use fog spraying of parts while dripping.

- Maintain the density, viscosity, and temperature of the baths to minimize dragout.

- Place recovery tanks before the rinse tanks (also yielding makeup for the process tanks).

- The recovery tank provides for static rinsing with high dragout recovery.

Minimizing Water Consumption in Rinsing Systems

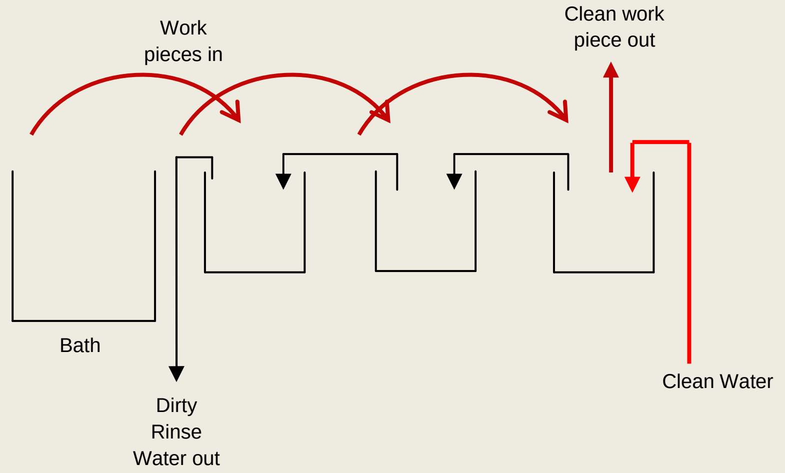
It is possible to design rinsing systems to achieve 50–99% reduction in traditional water usage. Testing is required to determine the optimum method for any specific process, but proven approaches include:

- Use demineralised water even for rinsing applications along with plating bath. The reduction of contaminants can reduce the frequency for process bath dumping. This also prevents the buildup of ions in rinse water allowing reuse of rinse water for more number of rinses and also improves the plating quality.

- Agitation of rinse water or work pieces to increase rinsing efficiency. Agitate water or parts manually or with mechanical means (stirring or air bubbling). By introducing air agitation for rinsing baths the rinsing process will be improved leading to product quality improvement and contamination reduction of following baths

- Multiple countercurrent rinses. Work pieces are moved through 3 stages where the water flows continuously against the work pieces flow. Work pieces are always rinsed at the last stage with the cleanest water. Counter current flow is the most effective way to rinse.

Counter Current Rinse System



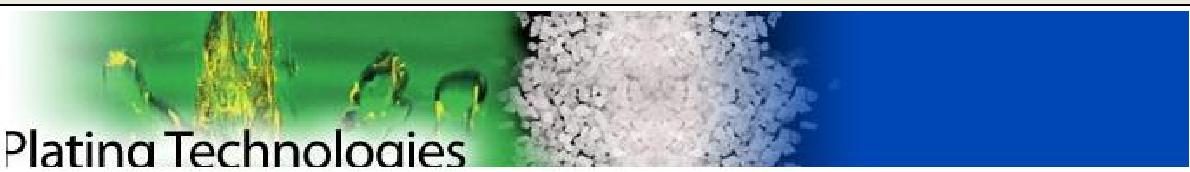
- Spray rinses (especially for barrel loads).

- Use spent rinsing water from pickling step as rinsing water in the degreasing step. This also neutralizes the rinsing water of the alkaline degreasing step.

Management of Process Solutions

- Recycle process baths after concentration and filtration. Spent bath solutions should be sent for recovery and regeneration of plating chemicals, not discharged into wastewater treatment units.
- Recycle rinse waters (after filtration).
- Regularly analyze and regenerate process solutions to maximize useful life.
- Clean racks between baths to minimize contamination.
- Cover degreasing baths containing chlorinated solvents when not in operation to reduce losses. Spent solvents should be sent to solvent recyclers and the residue from solvent recovery properly managed (e.g., blended with fuel and burned in a combustion unit with proper controls for toxic metals).

Treatment Technologies



- Segregation of waste streams is essential because of the dangerous reactions that can occur. Strong acid and caustic reactions can generate boiling and splashing of corrosive liquids; acids can react with cyanides and generate lethal hydrogen cyanide gas. In addition, segregated streams that are concentrated are easier to treat.

- Exhaust hoods and good ventilation systems protect the working environment, but the exhaust streams should be treated to reduce VOCs and heavy metals to acceptable levels before venting to the atmosphere. Acid mists and vapors should be scrubbed with water before venting.

- The presence of significant levels of oil and grease may affect the effectiveness of the metal precipitation process; hence, the level of oil and grease affects the choice of treatment options and the treatment sequence. It is preferred that the degreasing baths be treated separately.

Key Points

The key production and control practices that will lead to compliance with emissions guidelines can be summarized as follows:

- Use cyanide-free systems.
- Avoid cadmium plating.
- Use trivalent chrome instead of hexavalent chrome.
- Prefer water-based surface cleaning agents where feasible, instead of organic cleaning agents, some of which are considered toxic.
- Minimize dragout.
- Use countercurrent rinsing systems; recycle rinse waters to the process after treatment.

- Regenerate and recycle process baths and rinse waters after treatment.
- Recycle solvent collected from air pollution control systems.
- Send spent solvents for recovery.
- Do not use ozone-depleting substances.
- Manage sludges as hazardous waste.

ANNEXURES

Annexure I

Office order for constitution of National Task

Electroplating – TF/PCI-SSI/2008 July 7, 2008

Sub: National Task Force for Pollution Control in Electroplating units

The competent authority of Central Pollution Control Board has constituted a Task Force for implementation of environment protection measures in electroplating industries in order to contain extensive pollution caused from this sector. The composition of the Task Force is as follows:

1. Composition of the Task Force:

1.	Prof. J.M. Dave	Chairman
2.	Dr. Shobha Jayakrishnan, Deputy Director, Central Electrochemical Research Institute	Member
3.	Representative of Metal Finishers Association of India	Member
4.	Representative of Madurai Electroplaters Association	Member
5.	Representative of National Productivity Council	Member
6.	Dr. (Mrs.) H.K. Parwana, Former Sr. Scientific Officer, Punjab SPCB	Member
7.	Shri. R. Kumar, Joint Chief Environment Engineer, Tamil Nadu SPCB	Member
8.	Member Secretary, Karnataka SPCB	Member
9.	Member Secretary, Andhra Pradesh SPCB	Member
10.	Member Secretary, Maharashtra SPCB	Member
11.	Member Secretary, Gujarat SPCB	Member
12.	Member Secretary, Haryana SPCB	Member
13.	Member Secretary, Punjab SPCB	Member
14.	I/C-PCI-SSI, CPCB, Delhi,	Member Convener

Invitees

1. Shri Asif Nurie, Atlanta Global Limited — Invitee
2. Shri B. Datta, ENC Consulting Engineers, Gurgaon, — Invitee

2. The terms of reference of the Task Force:

   The Task Force will provide guidance in the following matter related to electroplating sector

   i) Identifying specific problems/ issues of this sector and suitable approach in solving the problem.
   ii) Identification of cleaner technologies in electroplating sector.
   iii) Implementation of cleaner technologies/ waste minimization measures in electroplating industries.
   iv) Implementation of environmental discharge standards.
   v) To develop action plan for phase wise reduction of cyanide and chromium (VI) in electroplating.
   vi) Implementation of pollution control measures and compliance to environment standards in unorganized sector.

3. The Task Force may make field visit to electroplating units as and when required.

4. Tenure of the Task Force

   The tenure of the Task Force is up to two years from the date of issue of the order.

5. TA/ DA as per rule and Honorarium of Rs. 1000/- per day will be paid to non-official members/ invitees by the Central Board.

(B. Sengupta)

Member Secretary

Annexure II

Minutes of the First Meeting of the National Task Force for Pollution Control in Electroplating Units held on October 21, 2008 at Parivesh Bhawan, Delhi

The first meeting of the National Task Force for pollution control in electroplating units was held on October 21, 2008 at Parivesh Bhawan, CPCB, Delhi. The meeting was Chaired by Prof. J. M. Dave.

Sh. U. N. Singh Member Convener of the Task Force welcomed the participants and gave background of constitution of Task Force. He informed that Task Force was constituted with a view to address the issues/ problems in electroplating industry and to implement environmental norms, cleaner technologies, waste minimization and phasing out usage of cyanide in plating.

Prof. J. M. Dave said that constitution of National Task Force for highly polluting sector i.e., electroplating is important step taken by the Central Pollution Control Board in pollution control from this sector. Very high levels of chromium has been found in ground water near the clusters of electroplating industries and this is the time to eliminate pollution from electroplating industries. He further informed that earlier an Expert Committee was constituted by the Board with the objective to phase out the usage of cyanide in plating industry. This Task Force need to make a strategy and an action plan for pollution control from this sector.

Ms. Pavithra L.J. Assistant Environmental Engineer, CPCB made presentation on "Electroplating Industry – an Indian Scenario" explaining the pollution potential, tools for pollution control viz., cleaner technologies, waste minimization measures & End of Pipe treatment technologies, issues and challenges faced by the Regulatory Agency in pollution control from electroplating industry. She pointed out that, in spite of all the available technologies/ measures for pollution control, plating industry is causing extensive damage to the environment due to the discharge of hazardous waste.

Sh. Asif Nurie, Invitee Member, Atlanta Global Ltd., informed that alternatives to Cadmium and Chromium (VI) plating are available with the potential to replace these metals. He further stated that pollution prevention alone does not work, profitability in pollution prevention is very important. He insisted on nomination of the industry representative who is well aware of the plating operations, by the SPCBs as a Member for promotion of pollution control measures.

Prof. J.M. Dave suggested that, the status of pollution control is well known to everyone and SPCBs need to specify the problems faced in implementation/ control of pollution.

SPCBs shared their experiences stating that these electroplating units are very tiny & small and are owned, operated & managed by a single man. The cost of ETP is much more than the plating equipment. Effective segregation of waste streams is prime factor for effective treatment which is not being followed. Small units do not have dedicated person for operation of ETP. The pre-treatment carried out by the individual units discharging their effluent to CETP is not satisfactory.

Sh. Asif Nurie, made a presentation on “Zero Discharge in Plating Industry”. He also explained the concept of air pollution control from the bath through membrane technology and recovery of chrome by Vacuum Evaporator.

The present scenario of electroplating units with respect to its pollution potential, legislation, status of pollution control and challenges in pollution control discussed during the meeting is summarized below.

Pollution Potential: Electroplating is one of the polluting industries which is identified under red category industry due to usage and discharge of hazardous chemicals. The process makes use of highly toxic or carcinogenic ingredients that are difficult to be destroyed or stabilized and disposed off in an environmentally sound manner. The major pollutants from this industry include, cyanides, acids & alkalies, chromate & chromic acid, metals (zinc, Nickel lead, copper).

Legislation: The electroplating unit is regulated under The Water (Prevention & Control of Pollution) Act, 1974, The Environment (Protection) Act, 1986 and The Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008. The standard for electroplating is notified under Schedule-1, Sr. no. 9 of Environment (Protection) Rules, 1986. The waste generated is identified as hazardous waste under schedule I of The Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008.

Also, due to potential hazard associated in the existing electroplating process, i.e. use of Cyanide based electrolyte solutions, the Central Pollution Control Board constituted an Expert Committee for phasing out usage of cyanide in electroplating under the Chairmanship of Prof. J. M. Dave. The Committee recommended to ban the usage of cyanide in zinc and copper plating within a timeframe of 3years. The recommendation has been forwarded to SPCBs to invite the views of Electroplaters Associations/ suppliers on the decision.

Pollution Control Tools: The Cleaner technologies with the potential to replace Cyanide, Cadmium and Chromium (VI) usage in plating are available and are being practiced in some of the units. Simple waste minimization measures have been identified specifically for the electroplating sector which requires little cost. End of pipe treatment technologies are well known.

Status: Although there are many available tools for pollution control viz., cleaner technologies, waste minimization measures and end of pipe treatment technologies, the pollution from plating operation had yet not been controlled satisfactorily. There are more than 30,000 electroplating units being carried out in different parts of the country in the organized sector. About 85-90% of these units are operated in tiny and small scale and 80% of these units either do not operate the ETP or have not installed ETP. The volume of wastewater, emissions or solid waste from these units may be small, but it aggravates the environmental problem because of large numbers. The pollutants discharged from this sector are highly hazardous. In addition, there are large numbers of units operating in non-confirming areas. **The major issues/ problems in small scale units are as below:**

- **No control of Bath**
- **No drip guards**
- **Very poor house keeping**
- **10-15% of chemical wastage as drag outs**
- **ETP installed but not operated**
- **No proper segregation of effluent**
- **No fume extraction**
- **No treatment in most of the tiny and small units**
- **Discharged into drains/ open land**

The units where effluent is treated partially, it is observed that,

- **Inadequate removal of metal including Cr(T) and cyanide**
- **Inadequate precipitation of metal sludge**
- **Unsatisfactory sludge handling and storage practices**

Challenges: In spite of many technologies available for pollution control, CPCB/ SPCBs, are facing problems in implementation. **Though the**

entrepreneurs are aware of technologies and waste minimization measures, but it is not being practiced.

The challenge before Regulatory Authority is ensuring the implementation of the following:

- Waste minimization at source
- Good house keeping
- Cleaner Technologies
- Effective segregation
- Effective Treatment
- Operation of ETP
- Proper disposal of hazardous sludge
- Compliance of environmental standards by electroplating units

Another biggest Challenge is the pollution control from unorganized sector.

After detailed deliberations, Chairman of the Task Force said that, **the status of the pollution control in electroplating is well understood. SPCBs should identify the problems/issues that need to be addressed for pollution control in electroplating units in the respective states, and also suggest a way or approach required for pollution control in electroplating units as response. These information from the SPCBs are required for taking the decision by the Task Force**

The meeting ended with vote of thanks to the Chair and Participants.

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List of Participants

1. Prof. J. M. Dave, Chairman of the Committee
2. Shri U. N. Singh, Sr. Env. Engineer CPCB, Delhi
3. Shri R. C. Saxena, Sr. Env. Engineer, CPCB, Delhi
4. Dr. Shobha Jayakrishnan, Deputy Director, CECRI, Tamil Nadu
5. Mrs H. K. Parwana, Former Sr. Scientific Officer, PPCB
6. Sh. Asif Nurie, Atlanta Global Ltd., New Delhi
7. J. H. Patil, RO, Maharashtra SPCB, Nasik.
8. Sh. S.P. Garg, EE, Punjab SPCB
9. Sh. Barham Prakash, AEE, Haryana SPCB
10. Sh. Nitin Mehta, AEE, Haryana, SPCB
11. Sh. Yunus A. Tai, EE, Gujarat SPCB
12. Sh. Ramesh Kumar, Sr. Env. Officer, Karnataka SPCB
13. Ms. Pavithra L. J. Asst. Env. Engineer, CPCB, Delhi
14. Mrs. Alka Srivastav, SRF, CPCB, Delhi

Annexure –III

Minutes of the Second Meeting of the National Task Force for Pollution Control in Electroplating Units held on June 17, 2009 at Regional Office, TNPCB, Madurai (Tamil Nadu)

The second meeting of the National Task Force for pollution control in electroplating units was held on June 17, 2009 at Regional Office, TNPCB, Madurai. The meeting was Chaired by Prof. J. M. Dave. The list of the Participants is appended in Annexure-I.

Sh. Mohan Naidu, Joint Chief Environment Engineer, TNPCB welcomed the participants.

Sh. U. N. Singh, Member Convener of the Task Force, while welcoming the participants, informed that Expert Committee of the CPCB has recommended to ban the usage of cyanide in zinc and copper plating within a timeframe of 3years. He further informed that the main purpose of the Task Force is to address the issues of electroplating units and implementing waste minimization and cleaner technologies in these units. As per the decisions taken in the first meeting of the Task force, the SPCBs were required to send the information related to problems/ issues to be addressed for pollution control in electroplating units. However except Maharashtra SPCB, the information could not be received from other Boards.

Prof. Dr. J. M. Dave, said that, the one of the objectives of the Task Force is to develop a programme to eliminate cyanide. The recommendation of the Committee is only a policy guideline to regulators. The Task Force should develop an action program to implement Committee recommendations on banning cyanide usage, based on the priorities and limitations of the State Boards. He further informed that Cr(III) has been accepted in Europe in place of Cr(VI) for electroplating.

It was observed that, Members from Punjab, Haryana, Karnataka and Andhra Pradesh SPCBs were not present in the meeting. With the introduction by the Members, the meeting proceeded with the Agenda.

The Members of the State Boards made presentation on status of electroplating units in respective states.

Tamil Nadu (Presented by Sh. Mohan Naidu)

Status: There are 400 registered electroplating units in the state located in Thiruvallur, Kancheepuram, Krishnagiri, Madurai and Coimbatore, mainly operating in small scale and 90% of them are practicing zinc, nickel and chromium plating. The issues concerning to these units are, unskilled and untrained labour, space constraints, inadequate operational facility, improper storage and handling of toxic chemical, lack of awareness on handling toxic chemicals. Large scale units outsource the plating work, to reduce pollution output. The existing units are operating in residential area since long time with inadequate space for pollution control measures.

Board Initiatives: Based on the recommendations of Expert Committee (CPCB), TNPCB is not giving Consent to cyanide based plating except to Cadmium and gold plating. For medium and large scale plating units, implementation of effluent recycling system is insisted.

Suggestions: To make it mandatory for large scale units to implement metal recovery/ zero discharge and also to encourage development of industrial estates for small scale units with combined treatment system & zero discharge concept.

Madurai, Tamil Nadu (Presented by Sh. Krishna Ram, Regional Officer, Madurai)

Status: There are 80 electroplating units located in mixed residential area in Madurai. Presently 58 units are under operation. These units are tiny and small in nature with inadequate space to provide ETP. The untreated wastewater is discharged to public sewer. Mostly Zinc, Chromium and Nickel plating is practiced and cyanide plating is not in use.

Eco Electroplaters Park: The Electroplaters have planned to develop Eco-Electroplaters Park. Total 27 acres of land has been acquired for development of Park at D. Karaisalkulam with CETP. MoEF has given EIA clearance in August 2005, subsequently TNPCB has given consent to establish in November 2005 valid upto March 2009.

Board Initiatives: The TNPCB issued closure directions to 58 electroplating units in November 2008, since there was no progress in development of Eco Electroplaters Park and existing electroplating units are operating without consent of the Board & without providing ETP. These units approached the High Court for further extension of time for shifting to Park. The Court issued further extension of time upto May 2009.

Madurai Electroplaters Association (Presented by CECRI- consultant)

Due to lack of space and infrastructure for expansion at present location and pressure of Regulatory Authorities to implement pollution control measures, the Association has planned to develop Eco-electroplaters Park. The park is planned for relocation of 80 electroplating units, with CETP for waste water treatment including effluent recycling system. A Special Purpose Vehicle (SPV) has been formed for development of Park. Total 27 acres of land has been acquired for development of Park. Due to non-availability of funds, the shed and CETP construction work has been delayed.

GTZ organized two brainstorming sessions and three workshops in local language to create awareness among the members. Dr. Edzard Ruhe, German Technocrat, conducted workshop (translated in local language) on HRD, plating plant set up, energy and environment. Based on the present status of operation, technical recommendations regarding plating quality, bath control, chemical savings, water savings etc, were made by GTZ Consultants and were presented during the workshop.

During the meeting, the Association mentioned the time frame upto December 2010 for shifting electroplating units to Electroplaters Park.

Maharashtra (Presented by Sh. Ajay Deshpande, RO-PCI-II, Mumbai)

Status: Major auto manufacturers and engineering units are located in Pune, Nasik and Aurangabad. The Electroplating activity is generally outsourced resulting in unplanned growth of these units. Total there are about 167 registered plating units in these 3 regions. More than 500 units are not registered and are operating in illegal areas. The pollution control from these units is a major challenge. 90% of these units are operating in small scale. A separate division “Clean Technology division” in MPCB is working on implementation of waste minimization activities in plating units.

Board Initiatives: The following directions was issued by the Board to the electroplating units for compliance

- Existing electroplating units in non-CETP areas to implement segregation of metal bearing effluent for treatment and recovery within 6 months with the suitable Bank Guarantee.
- Large units to implement metal recovery, with possible recycle of effluent.
- Existing electroplating units connected to CETP, treated effluent should meet CETP inlet standards. If the CETP is not functioning properly then the electroplating units in that area shall also comply non-CETP area norms for individual electroplating units.
- New electroplating units are allowed only with metal waste recovery and recycle of the effluent.

Directions issued to large automobile industries to declare names of their vendors providing electroplated parts and, also were directed to ensure that these units have provided necessary pollution control systems and have valid consent from the Board.

Gujarat (Presented by Sh. Yunus Tai, EE)

Status: There are 400 plating units covered under Consent mechanism. Small units operates in about 10-25 m^2 area. The Production capacity varies from 10-200 M^2 of plated surface area per day. Most of the units are operating in residential area with poor industrial infrastructure facilities. The CETPs catering to electroplating units are inadequate. In Jamnagar most of the cyanide based zinc plating units have shifted to acidic zinc plating

Board Initiatives: GPCB has successfully assisted in commissioning of CETPs at Rajkot and at Jamnagar. It is under implementation, but due to lack of funds and subsidy available to promoters the ventures are being delayed. Waste Minimization Programme was launched in Jamnagar under Forest & Environment Department (GoG), which was assisted by GPCB. As a result of this Programme, the total acidic effluents from the units got reduced from 500-1000 lit/day to 100-200 lit/day depending on the size of the units

Suggestions: The following suggestions were made

- Carrying out inventorization of electroplating units.
- Making available the success story/ information on alternative technology/ ecofriendly chemicals through documentation.
- Encouraging common facilities for effluent treatment and metal recovery.
- Capacity building for both SPCBs & Industry, and, sharing of information between SPCBs.
- Interaction between suppliers of clean technology/ ecofriendly chemicals and users is most important.

Sh. Asif Nurie, presented zero effluent scheme for electroplating industry using distilled/ de-mineralised water with evaporative (vacuum) chemical recovery as new approach for industry,

Discussions

- Dr. J. M. Dave, said that electroplating units in Madurai are operating since 20 years without any pollution control measures. He pointed out that the technical recommendations of GTZ during workshop to Madurai platers are viable, which do not require much investment and also has economic benefits. In spite of conducting workshops in local language to make platers understand the benefits of quality control and waste minimization, the recommendations have not been implemented.

- He informed that use of de-mineralized water for plating prevents build up of ions and improves the quality of plating and also the wastewater generated can be recycled. He suggested that centralized De-mineralized plant may be set up in Electroplaters Park at Madurai.

- Ms. Pavithra L.J., AEE, CPCB, pointed out that, aeration is one of the treatment units planned for CETP in the Eelctroplaters Park at Madurai, which is mainly required for treating organic wastewater. Whereas electroplating wastewater is mainly characterized by metals, cyanide, acids and alkalies where there is no organic pollutant. It was replied by the representative of Enviro Care (CETP Consultant to

Madurai Electroplaters Association) that keeping in consideration the future use of organic chemicals if any, a provision of aeration unit is made, which was not agreed by the Task Force.

- Sh. Ajay Deshpande, MPCB suggested that large scale industries may be directed to declare the names of their vendors and to ensure effective pollution control measures in those vendor units before outsourcing the work. However the Task Force felt that most of the tiny and small scale units do not have established customers. Sh. Asif Nurie, Global India Ltd., informed that the platers in Ludhiana have established customers, this approach may be followed in Ludhiana.

- Sh. Asif Nurie, informed that non-cyanide gold plating is in use in Machalipatnam and Rajkot. The cadmium is replaced by Zn-Ni plating and acid bath is also available in place of cadmium, which is viable. Cadmium has been almost replaced in automobile industry, however, it is being used for aircraft and defense purpose.

- Dr. J. M. Dave, suggested that pre-fabricated plating units for tiny and small scale industries, with plating bath and rinsing tank equipped with waste minimization measures like counter current rinsing, drip boards, density meters for bath control and also with fume extraction system, would help in reducing the pollution from small and tiny units which do not have established system of plating. The suggestion was accepted by the members of the Task Force and was decided to demonstrate in any one cluster. Sh. Ajay Deshpande, MPCB said that such type of mechanism can be started from Maharashtra.

Success Stories of SPCBs in control of pollution from electroplating units:

- **Maharashtra SPCB:** Directions issued to small scale and large scale units regarding implementing metal & water recovery and declaration of plating vendors by large scale units

- **Tamil Nadu SPCB:** Discouraging use of cyanide and insisting large & medium scale units for effluent recycling.

- **Gujarat SPCB:** Implementation of Waste Minimization.

Observations on Planned Eco Electroplaters Park at Madurai

Prof. Dr. J. M. Dave, Sh. U. N. Singh and Ms. Pavithra L. J. visited the Electroplaters Park site and some of the existing plating units.

Observations:

- A collection tank in CETP site and 3-4 sheds were partly constructed. During visit, work was not in progress.
- The planned sequence of treatment in CETP is as below:
- collection tank, neutralization, primary clarifier aeration tank, secondary clarifier, sand filter, carbon filter, dual media filter, carbon filter, ultra filtration, bag filter, catridge filter, RO –I, cartridge filter, RO-II, multiple effect evaporator –MEE (reject)
- The treatment sequence appears to complex with increased number of unnecessary treatment units viz., aeration tank, secondary clarifier, filters.
- The RO reject will be evaporated in MEE and salt will be disposed in Hazardous waste disposal facility at Chennai
- In spite of spending crore on RO and multiple effect evaporator, the salt recovered from MEE is to be disposed in landfill.
- A separate sewage treatment is also planned with the treatment units;
- Screens, anaerobic digester, aeration tank, settling tank, sand filter, carbon filter, sludge digester and forced solar evaporation pan.
- As informed, the total cost of the project is Rs. 30 crore, out of which CETP construction cost is Rs. 8 crore. Due to non- availability of funds, there is no progress of work since November 2008 either in shed construction or CETP construction.

Decisions

After detailed deliberations, the following decisions were taken by the Task Force

- Until commissioning of Eco-electroplaters Park, the existing plating units at Madurai should treat their waste before discharging to drain.
- The existing units are located within a radius of 3-4 km. Mobile treatment units should be set up for batch treatment of wastewater from each existing plating units. The individual units should have

collection cum storage tank for collecting the wastewater generated from process.

- An interim facility for storage of hazardous sludge generated from mobile treatment unit should be developed until TSDF for disposal is made available.
- TNPCB should take time bound (not exceeding 3 months) Action Plan from the platers for setting up mobile treatment unit and interim storage facility.
- The progress of work in Eco-Electroplaters Park should speed up and Association should submit time bound Action Plan for shifting to Park.
- Draft Guidelines for Eco Electroplaters Park which is planned to come up in Madurai is enclosed in Annexure -II

The Task Force felt that the large and medium scale units are resourceful to implement zero discharge by recovering water and metal along with de-mineralized plant. The State Boards may insist such units for implementing recovery system. Pollution control from tiny/ small scale units and unorganized/ illegal plating units is a greater challenge. Development of Industrial Estate/ Eco-Park specifically for small and tiny electroplating units needs to be promoted. The State Boards may play a facilitator role in the development of such Estates/ Park.

For isolated small scale units prefabricated plating units with waste minimization system for small scale tiny units should be developed by SPCBs in co-operation with local plating Associations to reduce volume as done at Jamnagar in Gujarat.

It was proposed to hold next meeting in Maharashtra (Pune)

The Meeting concluded with Vote of Thanks.

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List of Participants

CPCB

Prof. Dr. J. M. Dave,	Chairman of the Committee
Shri U. N. Singh, SEE, CPCB, Delhi	Member Convener
Ms. Pavithra L. J. AEE, CPCB, Delhi	

SPCB

Sh. R. Mohan Naidu, JCE, TNPCB, Chennai
Sh. Krishna Ram, RO, TNPCB, Madurai
Sh. R. Vijayabhaskaran, EE, TNPCB, Madurai
Mrs. M. Vijayalakshmi AEE, TNPCB, Madurai
Sh. S. Pandia Rajan, AE, TNPCB, Madurai
Sh. Ajay Deshpande, RO, Maharashtra SPCB, Nasik.
Sh. Yunus A. Tai, EE, Gujarat SPCB

Expert Member

Dr. Shobha Jayakrishnan, Deputy Director, CECRI, Tamil Nadu
Sh. Asif Nurie, Atlanta Global Ltd., New Delhi

Association

Sh. T. Pasupan, EPMFAT, Madurai
Sh. S. Raja, EPMFAT, Madurai
Sh. P. Manimaran, EPMFAT, Madurai
Sh. R. Vasantha Kumar, EPMFAT, Madurai
Sh. C. Alaugaswamy, EPMFAT, Madurai
Sh. Veeramani, CECRI, Karaikudi, Tamil Nadu
Sh. M. Manikant, Enviro Care, Madurai

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Annexure –IV

Minutes of the Meeting held with Electroplaters Association, Pune on October 8, 2009

A team of National Task Force for pollution control in electroplating units comprising Prof. Dr. J. M. Dave, Chairman of Task Force, Sh. U. N. Singh, SEE cpcb and Ms. Pavithra L.J., AEE, CPCB, visited Pune and held meeting with the electroplaters of Pune region on October 8, 2009. Subsequently, team visited electroplating units in the region in association with Maharashtra SPCB.

Meeting was held in Mahratta Chambers of Commerce, Industries and Agriculture. About 50-60 electroplaters of the Pune region participated in the meeting. Individual electroplaters shared their views/ experiences/ initiatives taken for pollution control.

Meeting proceeded with welcome address by Association.

Presentation by Maharashtra SPCB

- Pune has organized electroplating cluster of total 65 electroplating units with total effluent discharge of 700 m3/ day.

- Plating is mainly done for automobile parts and defense applications.

- All the plating units have individual effluent treatment plant and discharge treated effluent on land (gardening).

- Hazardous waste is sent to Ranjangaon MIDC TSD Facility.

- Common effluent treatment plant (CETP) is being planned in order to collect and treat effluent from individual plating units to proposed CETP. Maharashtra Industrial Development Corporation (MIDC) has allotted land for CETP at Pimpri Chinchwad MIDC.

- Automobile sector is not covered in Environment Clearance (EC), but electroplating process requires separate EC, therefore, the plating is outsourced by the Automobile Corporate sector.

- It was suggested by the Maharashtra Pollution Control Board that, Corporate should have check on vendors and sub-vendors and take the responsibility in the matter of type of plating and pollution control practices.

Experiences/ views shared by the Electroplaters

- In early 90s, cyanide was partly replaced with chloride zinc plating by the Pune platers. However now, it is being replaced with Alkaline zinc plating, as it gives good resistance, consistency & appearance. In Pune about 60% of the units have shifted to non-cyanide based plating.

- International norms do not allow usage of Chromium (VI), hence platers exporting to western countries have shifted to Cr(VI) alternatives. Chromium (VI) alternatives are available and is being used by the platers. It can be banned with immediate effect.

- European Union has banned usage of Cr(VI) in electroplating for automobile parts.

- Cr (III) passivation is in demand for vehicles which are exported. No standards have been fixed for Indian vehicles for electroplating. The representatives suggested to enforce cyanide and Cr(VI) free products for Corporate sectors like automobile & defense, which are outsourcing plating process.

- Olive green has been found suitable alternative for Cr(VI) even for defense applications.

- The cost difference between Cyanide and Chromium (VI) electroplating and their alternatives is meager if cost is considered in terms of total cost of the product (Vehicle, etc). Even this cost difference in recent days is further decreasing gradually.

- Recycling of rinse water can be done once or twice. The buildup of impurities affects the plating quality.

- Most of the electroplating units in Pune are of small and medium scale. Pune region does not have common effluent treatment facility presently. This facility will help in recovering and recycling of effluent (water) collectively.

Suggestions

- Prof. J. M. Dave suggested to use demineralised water even for rinsing applications along with plating bath. This prevents the buildup of ions allowing reuse of rinse water for more number of rinses and also improves the plating quality.

- Sh. Deshpande, MPPCB, made a submission to the Task Force to recommend cyanide and Cr(VI) free electroplated products to automobile and defense sectors as alternatives are available for these processes and they are the major plating customers in Pune, Nashik and Aurangabad region.

- Industry representative expressed their views to make Pune, Cyanide and Chromium (VI) free by a year. They unanimously consented to phase out cyanide.

- The representatives suggested to organize Interaction-Meet for electroplaters inviting technology providers platers, chemical suppliers and manufacturers at Pune.

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Annexure -V

Minutes of the Meeting held with Electroplaters Association, Rajkot, on February 4, 2010

A team of National Task Force for pollution control in electroplating units comprising Prof. Dr. J. M. Dave, Chairman of Task Force, Sh. U. N. Singh, SEE, & Member Convener, CPCB and Ms. Pavithra L.J., AEE, CPCB, visited Rajkot. The team along with officials of SPCB visited (A) Electroplating units, (B) CETP in the region in association with Gujarat SPCB and subsequently, (C) held meeting with the electroplaters of Rajkot and Jamnagar region on February 4, 2010.

(A) Visit to Electroplating Units

The team with SPCB Officials visited the following electroplating units

M/s Ashok Iron & Steel Works

The unit is manufacturing kerosene stoves and plating with Nickel and Chrome. They have installed hot water generator for supply of hot water for plating baths resulting in 60 % cost saving in electricity. The energy consumption has reduced from 72 KVA to 28 KVA.

Mahavir Electroplaters

It is a tiny scale unit carrying out Cyanide free Alkaline Zinc Plating on pump parts. The owner of the units informed that Cyanide free Alkaline Zinc Plating is economical than Cyanide Zinc Plating. Cyanide zinc bath chemical costs Rs. 150-160/kg, whereas Alkaline zinc bath chemical costs 25-30 /kg

VEKO Electroplaters

The unit carry out Hard Chrome Plating on diesel engines.

ECHJAY Pvt. Industries Ltd.

The unit mainly manufactures cast iron components for heavy industries and automobiles. The main activity is steel making (induction furnaces). Plating is only a part of the several activities, and, carryout Cyanide free Alkaline Zinc Plating for components as required. Demineralised water is being used for both plating bath and rinsing which enable reuse of rinse water for more number of rinses. Also, the unit is carrying out trivalent chromium based passivation on the components in place of hexavalant chrome based passivation which is hazardous.

(B)Visit to Common Effluent Treatment Plant

A common effluent treatment plant (CETP) catering to electroplating units was also visited. The effluent is supplied to CETP by tankering system .The design capacity of the CETP is 25000 lts/ day operating at 22000 lts/day. It consists of following treatment units
(i) Neutralization tank (ii) Settling tanks (iii) Aeration tank (iv) settling tank (v) sand filter (vi) Carbon filter. The treated effluent is reused for horticulture.

(C) Meeting with Electroplaters Association

Members of Rajkot Electroplaters and Metal Finishers Association (REMA), Jamnagar Electroplaters Association (JEA) and Officials of SPCBs participated in the meeting.

Secretary, REMA, Welcomed the participants.

Sh. S. M. Jha, RO, GPCB, informed that There are 3000 registered industrial units in Rajkot out of which 200 are electroplating units. These are tiny and small scale units. They are the service industry doing plating on automotive parts. There are two CETPs catering effluent only to Electroplating units. The effluent is sent to CETP through tankers. Sludge from CETP is sent to TSDF at Naroda.

Sh. U.N Singh, SEE, CPCB, said main purpose of the Task Force is to address the issues of electroplating units and implementing waste minimization and cleaner technologies in these units.

Regional Officer, Jamnagar, informed that there are about 150-170 electroplating units in Jamnagar and carrying out mainly Zinc, Nickel and Chrome Plating. They are very tiny units having no space for treating effluent. The Jamnagar Electroplaters Association is planning for construction of CETP.

President, Rakjot Electroplaters Association stated that cyanide free electroplating adapted by Rajkot plating units is good development and see no objection in prohibiting it. However for Chromium (VI), prohibition to be made on corporate sectors who demand for Chromium (VI) based plating.

(D) Clean Technology Measures Observed

Following Clean Technology measures were observed in Rajkot

- Supply of hot water for plating baths through hot water boiler which reduces 60% electricity consumption
- Use of Cyanide free Alkaline Zinc plating
- Use of trivalent chrome based passivation in place of Heaxavalant chrome.
- Use of demineralised water for both plating and rinsing

(E) Suggestions

- Prof. J. M. Dave suggested to use of demineralised water in rinsing prevents build up of ions and helps in reuse of rinse water for more number of rinses and also improves the plating quality.

- Prof. J. M. Dave informed that precise bath control will help in successful use of cyanide free plating technology.

- The Associations requested for conducting Interaction workshop for electroplaters and chemical suppliers.

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Annexure VI

Minutes of the Meeting held on May 13, 2010, with Electroplaters in Ludhiana

A team of National Task Force for pollution control in electroplating units comprising Prof. Dr. J. M. Dave, Chairman of Task Force, Mrs. H. K. Parwana, Member of the Task Force and Ms. Pavithra L.J., EE, CPCB, visited Ludhiana. The team along with officials of SPCB visited (A) Electroplating units, (B) CETP catering to electroplating units, and (C) held meeting with the electroplaters of Ludhiana on May 13, 2010.

A) Industry visit

National Electroplaters

The unit carries out nickel, chrome and zinc plating on automobile parts. The plating capacity of the unit is about 1.5 lakh Sq. ft., chrome and nickel are being recovered through Ion Exchange process. The unit is practising recovery since 15 year. Cyanide free Alkaline Zinc process is being used. The effluent generated from degreasing and membrane regeneration is treated in settling and subsequently passed through RO. The RO permeate is reused in the process.

S. K. Electroplaters

The unit is tiny scale carrying out Zinc and Chrome plating on cycle parts. Cyanide Free Alkaline Zinc Plating is being used by the unit. House keeping is very poor. The layout of cleaning, plating and rinsing is very poor with spillages of dragout throughout the process area. One time rinsing is in practise leading to enormous wastage of water. The effluent generated is sent to CETP through tankers.

Sarpal Electroplaters

It is primary user unit manufacturing cycle parts. Nickel & Chrome Plating is being carried out on cycle parts. Plating is one of the many activities. The production capacity is about 7000-8000 handles per day. The unit does assembling cycles also. The effluent generated is sent to CETP through tankers.

Vijay Nickel Works

It is small scale unit engaged in manufacturing chairs and carrying out Nickel and Chrome plating on chair parts. Very poor house-keeping with spillage of dragouts throught the process area was observed. DG set is placed on top of the roof in open space without acoustic enclosure.

(B) Common Effluent Treatment Plant

The design capacity of the CETP is 200 m^3/day operating at a capcity of about 150 m^3/day. 582 electroplating units are members of the CETP. The treatment units comprises (i) storage tank (ii) Equalization tank (iii) tube settler (iv) Bio Reactor (v) Clarifier (vi) Reverse Osmosis (viii) Multiple effect Evaporator. The CETP is equipped with a water recovery system through RO. The part of the permeate from RO is reused by dyeing units located nearby to CETP and the rest used in CETP boiler. The reject is evaporated in Multipe Effect Evaporator and salt generated is stored in interim sludge storage facility within the CETP premises along with sludge from chemical treatment. The sludge finally is disposed off in TSDF at Nimbua. CETP management charges 60 paisa per litre of wastewater from member units.

(C) Meeting with Electroplaters

Sh. S. P. Garg, RO, PPCB, made Welcome Address and informed that CPCB has National Task Force with one of objectives of replacing Cr (VI) by other less toxic alternatives in electroplating industry. He also informed that Cyanide is not being used for zinc plating in Ludhiana.

Prof. Dr. J. M. Dave, Chairman of the Task Force, informed that the Expert Committee of the Central Pollution Control Board under his Chairmanship has recommended to phase out cyanide in copper and zinc plating. The electroplaters should also look into Cr (VI) alternatives which is already available and is already being used in some parts of the Country.

He further said that European Commission under Restriction on Hazardous Substance (ROHS) directive has restricted usage of Cr(VI) in plating.

Mrs. H.K. Parwana, Member of Task Force said that Cr (VI) alternatives have already been used by platers in Pune and other parts of Maharashtra. We should work together to replace Cr(VI) in plating industries in Ludhiana within a time frame and also minimize the waste by better house keeping as this would result in savings for the industry and help conserve resources – a win–win-situation.

Ms. Pavithra L.J., EE, CPCB, informed that the along with implementation of clean technologies like cyanide and Cr(VI) free technologies, one of the objectives of the Task Force is also to address the issues / problems faced by the electroplaters in pollution control. She requested entrepreneurs to make collective efforts in solving the problems faced by them in pollution control.

She also said that, platers should also give consideration to waste minimization which yields in profitability by saving the cost on water consumption, process chemicals and effluent treatment.

President, Ludhiana Electroplaters Association, said that there are about 1000 electroplating units in Ludhiana out of which about 200 small scale units are located in residential areas. Association have made submission to State Government for land allocation for relocating the units operating in residential areas. He also said that land nearby CETP is available with PSIEC. Association has been pursuing with Punjab Small Industries and Export Corporation (PSIEC) for land allocation for relocation of small units.

President Association made submission to the Task Force for assisting in acquiring land for relocation.

Prof. J. M. Dave, suggested Association to explore possibilities of acquiring land from farmers/ private entrepreneurs for relocation of small units operating in residential areas.

Prof J. M. Dave, insisted the platers to specify time frame for switch over to Cr(VI) free process.

All the Electroplating Entrepreneurs assured to discuss the issue of Cr (VI) among all the stakeholders and will write to the Task Force about their views on shifting over to Cr(VI) alternatives.

(D) Clean Technology Measures Observed

Following Clean Technology measures were observed in Ludhiana

- Recovery of Chromium and Nickel from rinse water through Ion Exchange and recovery of water from wastewater (degreasing) through Reverse Osmosis process.
- Use of Cyanide free Alkaline Zinc plating.

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Annexure VII

Minutes of the Third Meeting of the National Task Force for Pollution Control in Electroplating Units held on June 15, 2010 at Parivesh Bhawan, Delhi

After detailed deliberations the final recommendations were made which have been given in Section Four - Recommendations of the National Task Force for Pollution Control in Electroplating Sector.

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MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 30th March, 2012

G.S.R. 266(E).—In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:-

1. (1) These rules may be called the Environment (Protection) (Second Amendment) Rules, 2012.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule I, for serial number 9 relating to "Electroplating Industry" and entries relating thereto, the following serial number and entries shall be substituted, namely:-

S. No.	Industry	Parameter	Standard
(1)	(2)	(3)	(4)
"9.	Electroplating, Anodizing Industry	**A.- Effluent Standards**	
			Limiting concentration in mg/l, except for pH and Temperature
		(i) Compulsory Parameters	
		pH	6.0 to 9.0
		Temperature	shall not exceed 5°C above the ambient temperature of the receiving body
		Oil & Grease	10
		Suspended Solids	100
		Total Metal*	10
		Trichloroethane	0.1
		Trichloroethylene	0.1
		(ii) Specific Parameter as per process	
		a. Nickel and Chrome plating	
		Ammonical Nitrogen, as N	50
		Nickel, as Ni	3
		Hexavalent Chromium, as Cr	0.1
		Total Chromium, as Cr	2
		Sulphides, as S	2
		Sulphates, as SO_4^{2-}	400
		Phosphates, as P	5
		Copper as Cu	3
		b. Zinc plating	

(1)	(2)	(3)	(4)
		Cyanides, (as CN^-)	0.2
		Ammonical Nitrogen, as N	50
		Total Residual Chlorine, as Cl	1
		Hexavalent Chromium, as Cr	0.1
		Total Chromium, as Cr	2
		Zinc, as Zn	5
		Lead, as Pb	0.1
		Iron, as Fe	3
		c. Cadmium plating	
		Cyanides, (as CN^-)	0.2
		Ammonical Nitrogen, as N	50
		Total Residual Chlorine, as Cl	1
		Hexavalent Chromium, as Cr	0.1
		Total Chromium, as Cr	2
		Cadmium, as Cd	2
		d. Anodizing	
		Ammonical Nitrogen, as N	50
		Total Residual Chlorine, as Cl	1
		Aluminium	5
		Flourides, as F	15
		Sulphates, as SO_4^{2-}	400
		Phosphates, as P	5
		e. Copper, Tin plating	
		Cyanides, (as CN^-)	0.2
		Copper, as Cu	3
		Tin	2
		f. Precious Metal plating	
		Cyanides, (as CN^-)	0.2
		Total Residual Chlorine, as Cl	1
		B.- Emission Standards+	
			Limiting concentration in mg/m^3, unless stated
		(i) Compulsory parameters	
		Acid mist (HCl & H_2SO_4)**	50
		(ii) Specific parameters as per process	
		a. Nickel & Chromium plating	
		Nickel**	5
		Hexavalent Chromium**	0.5
		b. Zinc, Copper or Cadmium plating	
		Lead**	10
		Cyanides, (Total)**	5
		* 'Total Metal' shall account for combined concentration of Zn+Cu+Ni+Al+Fe+Cr+Cd+Pb+Sn+Ag in the effluent. + Emission standards shall be applicable to electroplating units having water consumption atleast 5 m^3/day. These units shall	

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(1)	(2)	(3)	(4)
		channelize their emission through a stack or chimney having height at least 10 metres above ground level or 3 metres above top of shed or building of the unit, whichever is more. ** The existing units shall comply with the norms of asterisked pollutants by 1st January 2013. However, new units shall comply with the norms with effect from commissioning of plant.	
		C. Stormwater	
		Note: (i) Stormwater for a unit (having plot size atleast 200 square metres) shall not be allowed to mix with scrubber water, effluent and/or floor washings. (ii) Stormwater within the battery limits of a unit shall be channelized through separate drain/pipe passing through a High Density Polyethylene (HDPE) lined pit having holding capacity of ten minutes (hourly average) of rainfall.".	

[F. No. Q-15017/44/2009-CPW]
RAJNEESH DUBE, Jt. Secy.

Note :- The principal rules were published in the Gazette of India vide number S.O. 844 (E), 19th November, 1986; subsequently amended vide S.O. 433 (E), dated 18th April 1987; G.S.R. 512 (E), dated the 9th July, 2009;G.S.R. 543 (E), dated the 22nd July, 2009; G.S.R. 595 (E), dated the 21st August, 2009; G.S.R. 794 (E), dated the 4th November, 2009; G.S.R. 826 (E), dated the 16th November, 2009; G.S.R. 01 (E), dated the 1st January, 2010; G.S.R, 61 (E), dated 5th February, 2010; G.S.R. 485 (E), dated 9th June, 2010; G.S.R. 608 (E) ,dated 21st July, 2010 ; G.S.R. 739 (E), dated the 9th September, 2010 ; and G.S.R. 809(E), dated, 4th October, 2010, G.S.R. 215 (E), dated, the 15th March, 2011; G.S.R. 221(E), dated, the 18th March, 2011; G.S.R. 354 (E), dated, the 2nd May , 2011; G.S.R. 424 (E), dated, the 1st June, 2011; G.S.R. 446 (E),13th June, 2011; and GSR 152 (E),dated the 16 th March, 2012.

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