**Background:**

Electroplating is one of the varieties of several techniques of metal finishing. It is a technique of deposition of a fine layer of one metal on another through electrolytic process to impart various properties and attributes, such as corrosion protection, enhanced surface hardness, lustre, color, aesthetics, value addition etc.

Electroplating industry in India is spread throughout the country. They are mainly in small scale sectors with over 3,00,000 small scale units.

On one hand, the process has number of applications but, simultaneously it has been included among 17 major polluting industries in India by Central Pollution and Control Board, government of India. Electroplating is considered a major polluting industry because it discharges toxic materials and heavy metals through wastewater (effluents), air emissions and solid wastes in environment. It was found that a large amount of metals and chemicals is disposed into main stream without treatment as they have no effective measures for treatment or recovery of metals in unorganized sectors.

At the same time it is to be kept in mind that majority of units are in tiny and small scale, which are not able to upgrade the technology immediately to achieve cleaner production.

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**Issue, CP Options and Benefits:**
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<th>Issues/Challenges</th>
<th>CP Options</th>
<th>Benefit</th>
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| Pre-cleaning of small size Work pieces                | Use a centrifuge to remove all dirt prior to degreasing or to impose cleanliness requirement onto the client (medium tech) | - Reduce length pretreatment  
- Reduce electricity consumption in surface preparation |
| Removal of accumulated oil and grease                 | Use centrifuge (medium tech)                         | - Reduce infiltration of impurities oil and grease (undesirable salts and organics including oil and grease) in degreaser tank  
- Prolong life span of degreaser bath |
| Ultra-filtration of alkaline Degreaser bath for inlet water | Self-explanatory (high tech)                         | As above                                                                |
| Ultrasonic degreasing                                 | Self-explanatory (high tech)                         | As above                                                                |
| Alkaline cyanide bath consistent deposit of metals high current densities, affects the cost | platers should use the alkaline cyanide bath for flash deposits of metal (thin layer). | Reduce cost                                                             |
| Cyanide has been hazardous to the health of humans and thus, has serious environmental concerns (air, water and soil) | cyanide-zinc solution can be replaced with a non-chelated alkaline zinc solution (Meltzer et al., 1990). Non-cyanide cadmium baths are now available to replace a cyanide cadmium bath |
The gold colored brass often use as a decorative has the problem of tarnishing (dull brightness) after plating. The conventional solution to this problem is application of a protective layer of clear transparent powder coat or lacquer. To give brighter look.

Non-cyanide solutions used in electroplating have insufficient colour in the deposits and thus insufficient color. additive Histidine is added to Brass pyrophosphate solution. maintaining the conventional quality of brass plating

Flouborate bath solutions have fluoride ions which are chemically active and attacks the portion of object which is not to be plated. In order to prevent areas from unwanted plating from fluoride, they should be masked. consistently plated

Higher contents of trivalent chromium (more than 2%) may cause:
- Reduction in Throwing power which causes reduction in plating rate
- Treeing of the deposit.

If the trivalent chromium is too high, re-oxidation operation should be carried out at high anode area/cathode area ratio at specific current density. 

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<th>Application in Plating</th>
<th>CP Options</th>
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<td>Water flow meter and</td>
<td>- Introduce on-line flow meter</td>
<td>Water savings from correct</td>
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| Conductivity meter | in water intake pipe  
- Introduce on-line conductivity meter in process tank | adjustment of:  
- water flow into last rinse tank  
- plating chemical replenishment |
|-------------------|-------------------------------------------------|------------------------------------------------|
| Reverse osmosis (RO) on last Rinse water for inlet water | RO is not recommended for use in systems where:  
- pH is 12-14 or pH is 0-2  
- organics in influent water > 5 g/l | Reduce infiltration of impurities (undesirable salts and organics) into rinsing tanks |
| Zinc plating | Place evaporator next to the plating bath. The inlet pipe and back-filling pipe is installed in the process tank | Reduce consumption of zinc |
| Nickel, chrome, copper and tin plating | Recover heavy metals from used rinsing water for reuse in plating baths by means of electrolysis cell or ion exchanger (and evaporation unit, if required) | - Saving of raw materials  
- Reduce amount of sludge  
- Reduce concentrations of heavy metals in wastewater  
- Recover heavy metals for re-use or secondary raw materials to be sold off |

**CASE STUDY:** SHARDDHA ELECTROPLATERS, (Modified Rinsing techniques)
The demonstration unit, Shraddha Electroplaters is located at k-1, 243/5, Road, behind Melt Tech Foundry Opp. Turbo Bearing, Aji G.I.D.C., Rajkot established in 1993.

The Industry is job platters involved mainly in the electroplating of material like automobile parts, fasteners, agricultural parts, some domestic furniture parts etc.

Employ strength of the unit is 18 persons.

The major plant utility consumption is freshwater, DM water and electricity. The source of water is from GIDC water supply. Units also gets job orders from out side the country and hence they have to be quality conscious.

**Issue:**

Once the plating operation is over, the plated object is put in a Drag out tank. Drag out tank is a rinse tank that is filled with pure water for rinsing the plated object. Usually, more than one tank is available for rinsing. 90% of the water used in electroplating industry is consumed in rinsing. We can minimize water use by providing different rinsing techniques.

**Implementation:**

**Counter current rinsing:** Countercurrent rinsing consists of serious of rinse tanks arranged in which the water flows in the opposite direction of the work flow (dirtiest to cleanest). In order to minimize the use of water required for rinsing, the water of the farthest tank (having least concentration) is transferred to the preceding tank (having higher concentration in comparison to succeeding tank). The transfer can be done by mechanical valves, pumps or manually. This technique is termed counter flow (or countercurrent) rinsing because the plated piece and the rinse water move in opposite directions. The efficiency of counter current rinsing technique increases with the number of counter flow rinse tanks (three-stage, four-stage, etc.) and lower the rinse rate needed for adequate removal of the process solution from object.
The cost of a new two stage counter-current rinse system is about Rs 25,000 (approximately). In addition to this aerator, Poly vinyl chloride (PVC) pipe and connectors and mechanical flow control valves are also required.

**Benefits:**

On comparison, it was found that counter current system not only reduces the consumption of water more effectively than spray rinsing but, also operating and maintenance cost is cheaper than spray rinsing in given case study. Thus, counter current technique should be used instead of spray rinsing for the above mentioned electroplating unit.

By using 2 stage counter-current rinsing it was found that the consumption of rinse water reduced from 2250 l/day to 160 l/day, which is almost 93% reduction in the consumption of rinse water. The spray rinsing technique reduces the water consumption from 2250 l/day to 282 l/day. This is a remarkable achievement both in terms of environmental and economic point of view.

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Issues/ Challenges:

1. Buffing - Powder formed from buffing. If not controlled the dust may enter the respiratory tract and cause breathing problems.
2. Acid activation - Uncontrolled vapour, gases emitted by acids can cause damage to the eyes, nose, throat and lungs.
3. Cleaning of surface of object - Inhalation of tetra-chloro-ethylene may affect different organs of human like Liver, kidney etc. Long-term inhalation exposure cause reproductive problems, such as spontaneous abortions
4. Electrocleaning (Anodic electro cleaning (reverse electro cleaning) Cathodic electro cleaning (direct electro cleaning)) - It causes irritation on skin. Overdose can cause damage to the exposed part. It can also alter the salinity of soil
5. Rinsing - Water which contains the residual of chemicals in process of washing is equally harmful as chemicals. This wastewater should be treated before disposal.

Type of Plating and their Environmental Concerns:

1. Brass - Cyanide being highly poisonous may affect the biota. Also, cyanide vapours emitted may causes headache, nausea, dizziness and difficulty in breathing
2. Bronze - High concentrations may cause unconsciousness, abnormal heart rhythm, coma and even may lead to death , No detrimental effect on health.
3. Cadmium - Irritation of respiratory system, sore and dry throat, chest pain and breathing problems. A long term exposure effect includes kidney damage and is a suspected carcinogen, Long term exposure to low levels of cyanide may affect the nervous system
   These can cause damage cornea of the eye and can affect nose and throat, with frequent nosebleeds.
   After many years of exposure, burns in the nostrils are especially slow to heal and may develop into open, oozing sores (ulcers)
5. Copper - Cyanide vapours emitted may causes headache, nausea, dizziness and difficulty in breathing, Chronic exposure of HF can discolour, damage tooth enamel
6. Gold - Highly toxic in nature and can prove to be life threatening
7. Nickel - Nickel compounds can cause skin allergy and cause a chronic skin condition called "nickel itch"
   Nickel fumes have been proven to cause nasal and sinus cancers.
   Hydrogen chloride vapours can discolor the teeth, and both sulfuric and hydrochloric vapours can also cause erosion of the enamel in exposed teeth
   Hydrogen fluoride vapours cause digestive disorders, including nausea, vomiting, abdominal cramps and diarrhea
8. Palladium: Vapours and mists released by acid baths can dissolve in the moist tissue of the eyes, nose, throat and lungs, and cause irritation and burns of the tissues.

9. Platinum - It causes respiratory allergies. Diseases such as conjunctivitis, dermatitis, asthma, urticaria etc.
   Ammonia gas emits vapors that are suffocating and can lead to serious health problems, even death.

10. Silver - Potassium cyanide vapours can cause death.

11. Tin - Lower levels of alkali mist can cause dermatitis. Very high vapour exposures can cause pulmonary edema.
   At relatively low vapour levels, the vapours dissolve before they get deep into the lungs, and the irritation is felt in the upper respiratory system.
   Hydrofluoric acid in contact with skin destroys tissue. In case, vapours penetrate deep, it can destroy soft tissues and bone, and cause electrolyte imbalance (particularly with calcium).

12. Zinc - Unpleasant ammonia odour. Persistent vapour exposure can damage the nostrils of the nose.