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Pollution threat to surface and ground water quality due to electroplating units

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Abstract-- In Delhi, a significant part of the pollution load to the river Yamuna is contributed by small scale electroplating units. These types of industries are inadequately equipped to deal with the environmental problems in a professional way. The study reflected the most of the elements in the effluent discharged by electroplating units are crossing the limits prescribed by state pollution control board. The heavy load of trace elements in effluents tends to get absorbed easily on surface like soil or sediments of conveyer system which will contaminate the surrounding environment. Three different pockets of industrial area in Delhi were selected for the study. The concentration of Iron, Total chromium, Hexavalent chromium, Nickel and Copper are exceeding the prescribed limits in all three pockets, whereas concentration of Zinc is crossing the limits in two pockets. The concentration of Cyanide is below the prescribed limit in all three pockets. The cost effective treatment technology and metal recovery techniques should be introduced amongst the small scale entrepreneurs.

Keywords-- Electroplating industries, Heavy metals, River Yamuna, Treatment Process, Water pollution.

INTRODUCTION

Electroplating industries has a long history in India. Like many industrial activities it gained momentum after the independence. Modern day electroplating started in early sixties in Mumbai with "Dull Nickel [1]. With the increase demand of non-corrosive artistic looking consumer items, there has been a remarkable growth in electroplating units. The growths of these units are mainly urban oriented owing to the inherent advantages associated with it [2]. In Delhi alone there are more than 3000 electroplating units both authorized and unauthorized units operating in different industrial pockets. A significant pollution load to the river Yamuna is contributed by these units including the local environmental problems.

Electroplating is the application of a metal coating to a metallic or other conducting surface by an electrochemical process. The article to be plated is made the cathode of an electrolysis cell through which a direct electric current is passed. The anode is usually a bar of the metal being plated. The electroplating units are spread across the entire Delhi with momentous concentration in several industrial pockets. The electroplating unit is considered as a major pollution unit due to presence of heavy metals in the effluent discharge into the recipient environment. In the plating process, the items to be plated are placed as the cathode in an electrolytic bath containing metal salts. At low voltage Direct Current is passed through the electrolyte, wherein metal ions are plated onto the cathode. After plating, the plated items are washed with water. After rinsing the items are dried either normal air drying or hot air drying or in an oven. A variety of chemicals and substances are used, depending upon the surface properties of the objects to be electroplated. There are numerous, acid, alkalis, inorganic and organic chemicals are used in various electroplating operations. Some of these chemicals are unknown for both users and traders, as they are marketed as proprietary items manufactured by chemical companies. The main source of wastes from electroplating units are identified as, drag out losses, concentrated liquid wastes, spent acid bath, spent alkali baths, spent passivation dip and rinse water.

The most adverse effect is the health effects on workers, who are exposed routinely and persistently. Over a period of time such exposures, even at a low level, have been known to cause diseases and various infirmities. Moreover, the pollutants can enter the environment through air, water and soil.

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The toxicity of these metals has also been documented throughout history: Greek and Roman physicians diagnosed symptoms of acute lead poisoning long before toxicology became a science. Today, much more is known about the health effects of heavy metals. Exposure to heavy metals has been linked with developmental retardation, various cancers, kidney damage, and even death in some instances of exposure to very high concentrations [3].

WASTE TREATMENT

Electroplating wastewater is typically from washing, rinsing and batch dumps and is at a low pH of ~3-5 and contains soluble forms of the various metals. In order to remove soluble metals from the wastewater it must first be made insoluble. The insoluble metal is then coagulated, flocculated and clarified by sedimentation [4]. In this process different streams of liquid waste generated, which require different treatment techniques. Such separate treatment will minimize the possibility of mixing incompatible wastes, which makes treatment difficult, expensive and less reliable. Incompatible mixing can be a hazard to personnel e.g. mixing of Nickel plating wastewater with Cyanide bearing wastewater leading to formation of Nickel Cyanide, which is very difficult to be treated. Therefore, segregation of wastewater streams is of great importance. During the study, it has been noted that in majority of small-scale and tiny units, this is just not done, indicating an urgent need to introduce this basic requirement.

TREATMENT TECHNOLOGY

pH of effluent is raised from ~3 to 8.5 with the pH controller using caustic while adding a coagulant such as ferric chloride. Testing of the wastewater may confirm that a coagulant is not needed. A "pin floc" is developed indicating the metal is insoluble [4]. Some applications have plating enhancing chemicals present, emulsifiers and such that may require more sophisticated high performance coagulants to break the bonds and allow the metal to precipitate. In the case of Hexavalent Chromium, it is necessary to first reduce the metal to trivalent state and then form insoluble precipitates. Some hazardous heavy metals like Cadmium, require separate treatment system, where the wastewater contains cyanides, removal of cyanides is achieved by oxidation to harmless residues, followed by a precipitation step to remove accompanying soluble metal ions. Due to inadequate drainage system and lack of proper disposal facilities and environmental awareness, industries and local bodies use large areas of land as mode of disposal of wastewater. Small-scale industries located in unauthorized zone, not having proper disposal facilities are causing ground water pollution due to discharge of industrial effluent on land. Heavy metals and other toxic compounds present in the effluent may pose considerable health risks amongst the population using such contaminated water. It is estimated that 75 to 80% of water pollution by volume is caused by domestic sewage [2]. The remaining is industrial wastewater, which could be more toxic. Certain diseases have been encountered amongst the affected persons coming in contact with toxic effluent discharged in the water bodies by highly polluting industries.

MATERIALS AND METHODS

Three pockets of Industrial belt in Delhi were chosen for the study. These pockets are pocket-1, pocket-2 and pocket-3. All these pockets have common effluent treatment plant (CETP). The industries doing activity in these areas are required to discharge their effluent in the conveyer system after proper treatment with the prescribed norms by state pollution control board. The most common electroplating operation in these areas is Nickel-Chrome, Hard Chrome, Zinc and Copper plating. Four samples from the drainage system of these areas were collected for the study. These areas are located in the midst of thickly populated residential area. The sampling was done as per the standard protocol. A polyethylene bottle of 1000ml capacity was taken and it was rinsed three times with the representative sample before it was filled. Samples were then acidified to pH below 2 with concentrated nitric acid. After preservation, the samples were placed in an insulated ice box for transportation to laboratory for the analysis of respective parameters as per APHA protocol [5].

RESULTS AND DISCUSSIONS

The collected samples were analyzed for fifteen parameters, including pH, Total suspended solids, Oil & Grease, Nickel, Total Chromium, Hexavalent Chromium, Copper, Zinc, Ammonical Nitrogen, Cyanide, Total Residual Chlorine, Lead, Cadmium and Total Metal. Figure-1 represents the concentration of these elements in pocket-1 at different sampling sites of the Delhi industrial area

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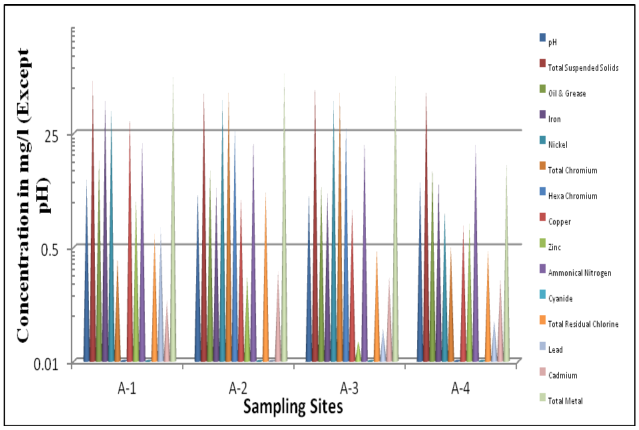

Figure-1: Concentration of different elements at different sampling sites in pocket-1.

The results show that the average concentrations of most of the elements are above the prescribed limit by Delhi Pollution Control Committee. Out of fifteen parameters only the average concentration of Oil & Grease, Zinc, Cyanide, Lead, Cadmium, Total Residual Chlorine and Ammonical Nitrogen is well within the prescribed limits.

Figure-2 represents the concentration of these elements in pocket-2 at different sampling sites of the Delhi industrial area.

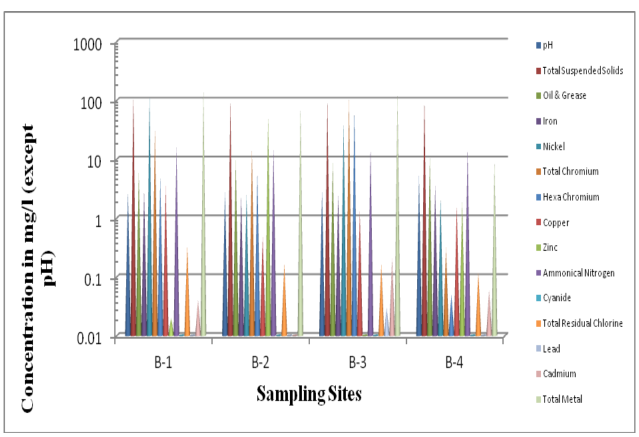

Figure-2: Concentration of different elements at different sampling sites in pocket-2.

The results obtained from the pocket-2 shows that the average concentrations of pH, Total suspended solids, Iron, Total chromium, Hexavalent chromium, Copper, Nickel, Zinc, Total Residual Chlorine and Total metal are crossing the limits prescribed by Delhi Pollution Control Committee. Only the average concentration of Oil & Grease, Cyanide, Lead, Cadmium and Ammonical Nitrogen is well within the prescribed limits.

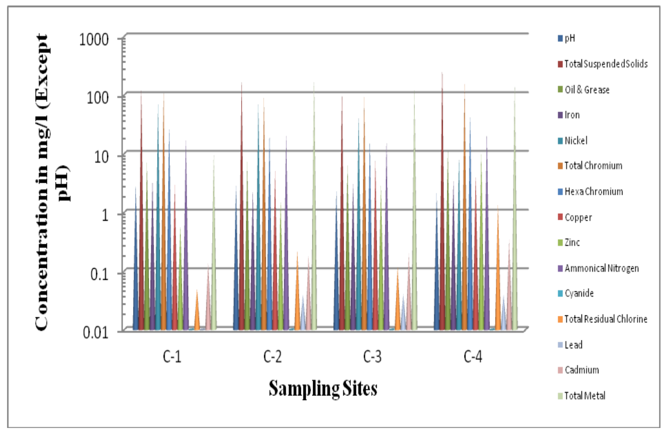

Figure-3: Concentration of different elements at different sampling sites in pocket-3.

Figure-3 represents the concentration of these elements in pocket-3 at different sampling sites of the Delhi industrial area. The results obtained from this pocket shows that the average concentrations of all the elements except Oil & Grease, Cyanide, Lead, Cadmium and Ammonical Nitrogen are crossing the limits prescribed by Delhi Pollution Control Committee.

CONCLUSIONS

Discharge of significant amount of untreated or inadequately treated industrial effluent in the river, results in degradation of water quality of river Yamuna. Most of units in these pockets are releasing their effluent either without treatment of without proper treatment. The effluent discharged contains high concentration of heavy metals like Iron, Chromium, Copper and Nickel. The pH values of the effluent are acidic in nature,

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which will degrade the water quality of river Yamuna. The degradation in water quality results in the disturbance in eco system and aqua life. The employees in these units are mostly untrained and ignorant of health impacts arising out due to untreated effluent discharge. The small scale entrepreneurs have a fear that the effluent treatment would be a financial burden to them. The government, academia or consultant in this field should suggest or introduce the cost effective technology for metal recovery and recycling of waste stream, which will certainly encourage them to minimize the pollution load in the discharge stream.

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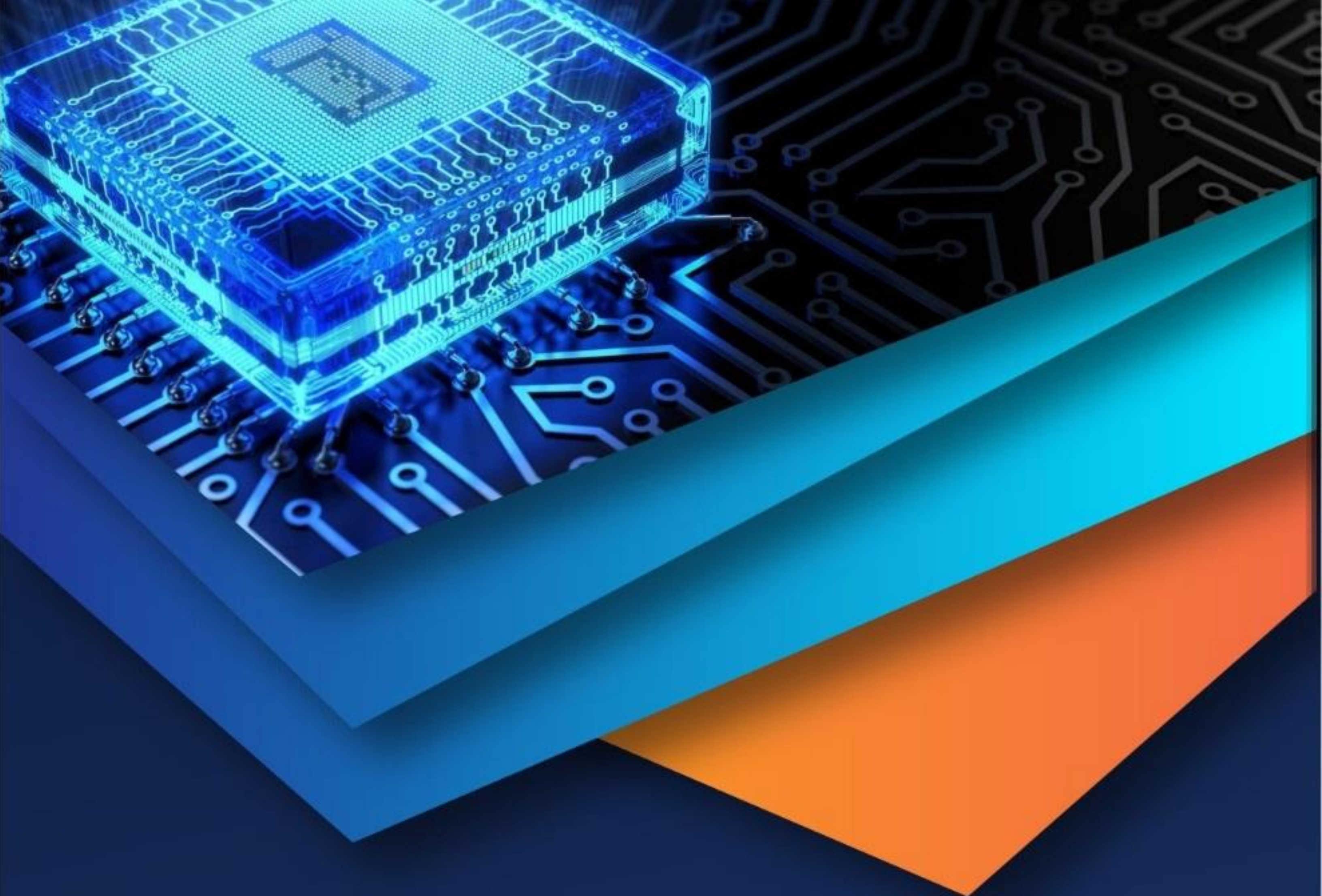

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