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Physico-chemical investigations of nickel electroplating industrial effluents situated in Sangrur district of Punjab

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Abstract
Small scale nickel electroplating industries are widely spread throughout India. Nickel electroplating is one of the oldest coating and plating process widely used in out the world and quiet popular particularly in aviation to telecommunication industries. This process being a low cost process is highly preffered for coating purposes. The effluents from small scale nickel electroplating industry is quiet harmful to the health of living organisms; plants, animals and human beings and the environment as it contains high concentrations of nickel i.e. beyond the permissible limits set by WHO and EPA. In the present paper an attempt has been made to investigate the effluents physico-chemically from small scale nickel electroplating industries situated in Sangrur district of Punjab. The results thus obtained have also been correlated with the toxic effects of the constituents of the industrial effluents on the plants, animal, human beings and environment.

Keywords: Nickel electroplating, organisms, plants, animals, human beings, WHO, EPA

Introduction
Nickel and its compounds belong to a class of noxious agents, encounterd commonly in industrial environment and are also known to affect the non-occupationally exposed individuals, living organisms and environment. Nickel is also known to be carcinogenic in nature. The effluent from small scale nickel electroplating industries is found to contain nickel and other harmful constituents beyond the permissible limits. The nickel can be removed from waste water by using low cost adsorbents (Jyoti Shah, 2016) [5]

Experimental Section
The effluent was collected from the point of disposal of the identified nickel electroplating industry in cleaned and sterlised glass containers and kept in dark at 4°C in laboratory for further investigations.
The collected and stored effluent sample was analysed for various parameters like pH, temperature, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), chemical oxygen demand (COD), biological oxygen demand (BOD), alkalinity, phosphate, sulphate, nitrate nitrogen and nickel ions (Ni^{2+}) by standard methods as reported (APHA, 1990) [13].

Results and Discussion
The sample collected was small enough in volume to be conveniently transported to a non-reactive bottles for the physico-chemical investigation. This implies, firstly the relative portions of the concentrations of all pertinent components must be same in the sample as in the material being used and secondly, that the sample must be handled in such a way that no significant changes in the composition occurs, before the tests are performed. The various effluent parameters such as temperature (at the time of discharge), pH, electrical conductivity total suspended solids (TSS), total dissolved solids (TDS), chemical oxygen demand (COD), biological oxygen demand (BOD), alkalinity, phosphate, sulphate, nitrate nitrogen and nickel ion (Ni^{2+}) concentration were determined as per standard method (APHA, 1989) [1]. The results been summarised in Table 1.

Table 1: Physico-chemical Characterisation of Nickel ions in electroplating Industrial Effluents

Parameter	Result	Standard
pH	3.7	6.5-8.5
Temperature	21	<40
Electrical Conductivity	1027mS/cm	250
TSS	968	2-0
TDS	342	500
COD	470	250
BOD	75	30
Oil and Grease	19.8	10
Alkalinity	25	20
phosphate	1.6	5
Sulphate	340	500
Nitrate nitrogen	14.0	5
Chloride	176	100
Ni^{2+}	276	2

All values are in ppm except pH range, temperature (1°C) electrical conductivity (mS/m)

The pH of nickel electroplating industrial effluent is 3.7, which indicates acidic condition of waste water discharged from the nickel electroplating industry. pH is a simple parameter, but it is extremely important as most chemical reactions in aquatic environment are controlled by any change in its pH value. If the pH of water is too high or too low, the aquatic organisms living within it will die, because aquatic organisms are sensitive towards pH changes. Aquatic organisms like fish are also sensitive towards pH changes. The eggs of the most of the fish species are unable to hatch into offsprings in the acidic waters. pH can also affect the solubility and toxicity of chemicals and heavy metals in water (EPA, 2012) [2].

The cause of acidic pH in the nickel electroplating industrial waste water is the use of high concentration acid in the process of cleaning and draining out of residual water without any treatment. The permissible limit of pH of the industrial effluent in the range of 7-10 but the pH of the industrial effluent of nickel electroplating industry collected and analysed has been found to be 3.7 which is acidic in nature. The high acidic condition due to lower pH value 3.7 increases the leaching tendency of metals into waste water and the resulting wastewater become more toxic to living organisms and contaminate the groundwater and soil.

The cause of acidic pH in the nickel electroplating ind The temperature of the small scale nickel electroplating industrial effluent of the sample collected was 22 and is not very harmful as according to permissible limits the temperature should not exceed 40 °C in any sector of stream within 15 meter down streams.

Thus, pH affects the quality of waste water and any value lower or higher than 5.4-8.5 limit could be harmful to the environment as per World Health Organization (WHO, 2003) [12].

Generally, the amount of dissolved solids in water determines the electrical conductivity(EC). Electrical Conductivity actually measures the ionic process of a solution that enables it to transmit current. According to WHO standards, EC value in drinking water should not exceed 400 /µS/cm. But the electrical conductivity of the collected sample has been found to be 1028mS/cm indicating the high concentration of dissolved ionic solids in nickel electroplating industrial waste water effluent.

TSS and TDS found in the industrial effluent sample has been found to be 968 and 345 mg/L while permissible limits are 600 and 500mg/L in industrial effluents.

Most of the aquatic organisms are acclimated to some levels of TSS and TDS concentrations but increase in loads can degrade aquatic ecosystems through several mechanisms. TSS can increase the turbidity of a water body which decreases light penetration, which in turn impairs photosynthetic activities of aquatic plants potentially leading to oxygen depletion (Billota and Brazier, 2008) [3]. In addition TSS can also cause the death of fish because of clogging of gills and the other aquatic organisms (Billota and Brazier, 2008) [3].

The specific ions and their concentrations contributing to TDS may cause ecotoxicological effects (SETAC, 2018) [10]. TDS can also contaminate groundwater via recharge to the aquifer and exceed drinking water standards (Webber and Duffy, 2007; Butler and Ford, 2019) [6, 14].

The permissible limits of TSS are 25mg/L as per the Indian standards. The higher amount of suspended solids as found 968 in nickel electroplating industrial effluent, may elevate the density and turbidity of water which may in turn affect the osmoregulation and also interfere with the photosynthesis (Poonkothai and Vijayavathi, 2015) [7]. TSS when exceed the permissible limits are aesthetically unsatisfactory and may cause distress among human beings and livestock (Shrivastava and Thakur, 2003) [8].

Biochemical Oxygen Demand (BOD) is the most widely used parameter to determine the extent of organic pollution applied to both waste water and surface water. BOD is a 5 day bottle test and its determination involves the measurement of amount of dissolved oxygen used by microorganisms in biochemical oxidation of organic matter for 5 day. The most widely recommended limits of BOD are 30 ppm. The BOD value determined for the collected sample is 75 ppm. This higher BOD value indicates more oxygen is required, which is less for oxygen demanding species to feed on and signifies lower water quality (Singh *et al*., 2016) [9].

Chemical Oxygen Demand (COD) is a quick, inexpensive means to determine the amount of oxygen required by organisms in water. When the COD level are higher, there is a greater demand for oxygen. This means that there is likely more oxidizable organic material in water with high COD levels. This also means treat there are reduced dissolves oxygen (DO) concentrations in waste water with high COD levels. The recommended COD levels are 75-100mg/L. But the COD level found in the industrial effluent sample in 470, which is much higher and toxic thus the effluent must be treated before discharge to minimise pollution potential.

The oil and grease concentration observed in sample is 19.6mg/L while the acceptable limits of oil and grease are 10 mg/L. The acceptable limits of phosphate are 5 mg/L and the phosphate found in sample collected has been found to be 1.6 mg/L. The acceptable limit of sulphate is 500 mg/L and the sulphate found in samples is 340 mg/L.

The concentration of nickel has been found to be 276 ppm while on permissible limit is 2 ppm, thus it can be quiet toxic.

Thus small scale nickel electroplating industry effluents situated in the Sangrur district of Punjab are very much toxic for our environment and the health of living organisms and thus require proper treatment before disposal into the environment.

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