IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 8 Issue 11, November 2021
ISSN (Online) 2348 – 7968 | Impact Factor (2020) – 6.72
www.ijiset.com

Physico-Chemical Characterisation of Electroplating Industrial Effluent

Megha Thakur[1], Rupinder Sharma[1], Sudha Rani[1] and Rajeev Sharma[2*]

1. Department of Applied Sciences, Desh Bhagat University, Mandi Gobindgarh, Punjab

2* P.G. Department of Chemistry, Multani Mal Modi College, Patiala

Abstract

Electroplating industry in India are largely in small scale sectors and are spread throughout the country. Nickel electroplating is one of the oldest coating and plating processes known and offers several benefits to a broad variety of industries. It is quiet popular as it is a low cost process and has many benefits particularly in aviation to telecommunication. The effluent from Nickel plating industry is quiet harmful to the environment and health of living organisms as it contains high concentration of Nickel ions in addition to other chemicals. In the present paper an attempt has been made to characterise the effluent of electroplating industry situated in Sangrur District of Punjab and to correlate the physical and chemical parameters of the effluent released with its toxic effects.

Introduction

Nickel and compounds belong to classic noxious agents encountered in industry but also known to affect non-occupationally exposed individuals. Nickel electroplating is a process of applying a Nickel coating on to a metal surface by means of electrolytic deposition. The effluent from Nickel electroplating industrials unit pertain Nickel beyond the permissible limits and also contain other chemicals which are harmful to health of environment and living organisms.

Experimental Section

The effluent collected from any outlet of electroplating industry were collected and 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 ion (Ni^{2+}) concentration by standard methods (APHA, 1989).

Results and Discussion:

The effluent samples from an outlet of electroplating industry (small scale) were collected and stored at 4°C in laboratory. 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 sample 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). The results been summarised in Table 1.

Table 1

Physico-Chemical Characterisation of Nickel ions in electroplating Industrial Effluents

Parameter	Result	Standard
pH	3.8	6.5-8.5
Temperature	22	<40
Electrical Conductivity	1028mS/cm	250
TSS	970	2-0
TDS	340	500
COD	470	250
BOD	73	30
Oil and Grease	19.5	10
Alkalinity	24	20
Phosphate	1.5	5
Sulphate	340	500
Nitrate nitrogen	14.0	5
Chloride	178	100
Ni^{2+}	274	2

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

The *pH* of nickel electroplating industrial effluent is 3.2, which indicates acidic condition of waste water. *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 (Henland and Boffretta 2000; EPA, 2012).

The cause of acidic *pH* in the nickel electroplating industrial wastewater 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 discharge of electroplating industrial effluent is in range of 7-10 but the *pH* of the waste water sample collected has been found to be 3.8 which is acidic in nature. The high acidic condition increases the tendency to leach the heavy metals, which are toxic to living organisms and contaminate the groundwater and soil.

The temperature of the waste water 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).

Generally, the amount of dissolved solids in water determines the electrical conductivity. Electrical Conductivity (EC) 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 waste water effluent.

TSS and TDS found in the industrial effluent sample has been found to be 970 and 1340 mg/L while permissible limits are 600 and 1000mg/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). In addition TSS can also cause the death of fish because of clogging of gills (Billota and Brazier, 2008).

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

The permissible limits of TSS are 25mg/L as per the Indian standards. The higher amount of suspended solids as found in 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). TSS when exceed the permissible limits are aesthetically unsatisfactory and may cause distress among human beings and livestock (Shrivastava and Thakur, 2003).

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 470 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).

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 19.5mg/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 1.5 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 274 ppm while on permissible limit is 2 ppm, thus it can be quiet toxic.

Thus electroplating industry effluents are very much toxic for our environment and the health of living organisms and thus require proper treatment before disposal into the environment.

References:

APHA (1989), Standard methods for the examination of water and waste water (17th Edn) Washington DC.

Butler, Barbara A and Robert G Ford (2019). Mine Water Environ. 37 (1): 18-30.

Billota GS and Brazier RE (2008). Water Res., 41: 2849-61.

EPA (2012, March), Channel Processes Bedload Transport in Water: Science Technology Retrieved from http://water-epa.gov/scitech/datait/ tools/waress/ bedlead.cfm.

Kumar, Ameet, Balouch, Amana, Pathan, Ashfaque Ahmad, Jagirani, Muhammed Sadaf, Mahar Al Muhammad, Zubair Muneeba and Lagheri, Benazir (2019) Acta Chemical Malaysia, 3 (1) 1-15.

Poonkothai M and Vijayavathi BS (2015). Physico-chemical characterisation of nickel electroplating effluent before and after treatment with dead *Aspergilus*Niger. Int. REs. J. Pharma Biosci. 2: 1-13.

Shrivastava S and Thakur I S (2003). Biosorption potential of Acinetobacter sp. Strain IST 103 of bacterial consortium for removal of chromium from tannery effluent J. scientific and industrial Res. 62: 616-22.

Singh V., Ram C and Kumar A. (2016). J. Civil and Environ Engg. 6 (4) DOI: 10.4172/2165-784X.1000237

SECTAC, Society of Environmental Toxicology and Chemistry (2008) Technical issue paper: Whole effluent toxicity testing ion imbalance. SETAC, Penabcola.

Weber-Scannell PK and Duffy LK (2007). AM J. Environ. Sci. (3): 1-6.

World Health Organization(2003). The World Report Shaping the Future, Geneva.