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Determination of Heavy Metals in Sugar Industry Effluent

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ABSTRACT: *Heavy metals such as Zinc, Nickel, copper, Manganese, cadmium, chromium Iron and lead, are major (heavy metal) pollutants in the environment, particularly in areas with anthropogenic activities and industrial activities. Heavy metal accumulation in soils is of great concern in agricultural production due to the adverse effects on food safety and crop growth. The amount of consumption of fresh water is equal to the amount of discharge of wastewater as effluent. In this aspect the present study pointed out the pollutants concentration in the sugar industry effluent maximum concentration of pollutants in the wastewater. As per the CPCB direction every industry should adopt the Zero Liquid Discharge (ZLD) in their industry premises to avoid discharge of effluent without treatment. In the present study the influent was analyzed of a sugar industry and revealed that the pollutant concentration was comparatively high. And it has been observed that high amounts of heavy metals such as Zn, Cu, and Pb whereas low levels of Ni, Mn, Cd, Cr and Fe according to the Indian Standards. Effluent contains nutrients as well as toxic components depending upon the source of production.*
Keywords: *Accumulation, Analysis, Effluent, Heavy metals, Industry*

I. Introduction

The Environmental contamination by trace and heavy metals through industrial wastes is one of the main health problems in industrial countries. Metal contaminants can easily enter to food chain if contaminated water, soils and/ or plants are used for food production. The industrial effluents generally consist of organic compounds, inorganic complexes and other non-biodegradable substances (Huguet *et al*., 2009). The term ‘‘heavy metals’’ refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (Lenntech Water Treatment and Air Purification, 2004).

Heavy metals include lead (Pb), cadmium (Cd), nickel (Ni), iron (Fe), zinc (Zn), chromium (Cr), and copper (Cu) group elements. There are different sources of heavy metals in the environment such as: natural, agricultural, industrial, domestic effluent, atmospheric sources and other sources. Activities such as mining and smelting operations and agriculture have contaminated extensive areas of world such as Japan, Indonesia and China mostly by heavy metals such as Cd, Cu and Zn (Herawati *et al*., 2000).

As in most developing countries, including India, the accelerated developments in industry and agriculture in the last few decades have made environmental pollution more noticeable. India is the largest producer of sugar in the world. The sugar industry plays an important role in the economic development of India, but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystems. Among the effluent discharging industries, sugar mills plays a major role in polluting the water bodies. The effluents also alter the physico-chemical characteristics, and flora and fauna of receiving aquatic bodies. In addition, sugar factory effluent discharged in the environment poses a serious health hazard to the rural and semi-urban populations that use stream and river water for agriculture and domestic purposes. Sugar factory effluent that has not been treated properly has an unpleasant odor when released into the environment. (Usha Damodhar and M. Vikram Reddy, 2012).

The most widespread visual evidence of heavy metal toxicity is a reduction in plant growth (Sharma and Dubey, 2007, (Akhionbare *et al*., 2010).), On the other hand, wastewater is also a resource that can be applied for productive uses, since wastewater contains nutrients that can be used for the cultivation of agricultural crops (Hati *et al*., 2007; Chandra *et al*., 2009; Rath *et al*., 2011)

II. Materials And Methods

2.1 Study area

The sugar industry is situated at Nelavoy, Chittoor District, Andhra Pradesh at a distance of, 33 Kms from Chittoor, A.P, India. The climate is subtropical which seasonal rainfall during June to October. About the site of sugar industry, at Nelavoy, the latitude 13° 19′ 36.48″ N, and longitude 79° 15′ 48.24″E, annual average temperature is minimum 12^{o} C to 14^{o} C and maximum 36^{o} C and annual rainfall 935 m.

Collection of effluent

The effluent samples were collected in a pre-cleaned, plastic container from the point of disposal from Sugar industry located at Nelavoy, Chittoor District, A.P, India. For the determination of Heavy metals, the effluent was brought into the laboratory. The collected effluent was stored at 5°C to maintain its original characteristics (APHA 2002).

2.2 Sample preparation and method

Filter the effluent sample through a 0.45 µ Millipore filter and acidify with Hcl to a 10 ml pH of 4-5 Place a 750-ml aliquot of the filtered, acidified effluent into a 1-liter polypropylene flask. Add 35 ml of MIBK followed by 7 ml of 1 % ADPC solution. Equilibrate for 30 min on a mechanical shaker. (Brooks *et al*., 1967).Separate the organic layers in a separator funnel and store in polypropylene bottle. The extracts should be analyzed within 3 hrs. Save the aqueous layer for the preparation of standard solutions. The water sample solution was analyzed for determination of Zn, Ni, Cu, Mn, Cd, Cr, Fe and Pb by AAS (Perkin-Elmer, 2380).

III. Results And Discussions

The heavy metals Zn, Ni, Cu, Mn, Cd, Cr, Fe and Pb concentrations of sugar industry effluent were shown in Table 1. The mean Zn concentration in sugar industry effluent is 7.2 mg/L. compare with the standard level that showed in table-1 beyond the Permissible limit (IS 1992) (Usha Damodhar and M.Vikram Reddy., 2012). It is an essential micronutrient that affects several metabolic processes of plants (Rout and Dass, 2003) and has a long biological half-life. The phytotoxicity of Zn decrease in growth and development, metabolism and an induction of oxidative damage in various plant species like Tobacco (Tkalec *et al.*, 2014).

The mean concentration of Ni in sugar industry effluent is 0.032 mg/L. It is in permissible limit, Nickel is nutritionally essential trace metal for least several animal species, micro-organisms and plants. Therefore either deficiency or toxicity symptoms can occur when too little or too much Ni is taken up. Similar findings were reported in earlier research (P.G.Rohokale., 2015.)

The high concentration of Cu in sugar industry effluent is 0.10 mg/L. It exceeded the maximum tolerance level of Indian standards. This could be attributed to the reason of anthropogenic activities, agriculture and industrial waste dumped into the surrounding agricultural lands. Occurrence of higher concentration of Cu in the water can also be attributed to the resulting of natural weathering of soil and discharges from industries. Similar findings were reported by Romo-Kroger *et al*., 1994; Wu *et al*., 2001.

The Mn in sugar industry effluent is 0.06 mg/L. (Table 1), the concentration of Cd in the sugar industry effluent was within the permissible limit of Indian standards (fig 1). However, it is also toxic when too high concentration of Mn is consumed by living beings. (Thamizhiniyan *et al*., 2009 and Borale and Patil .,2004).

The Cd and Cr concentration in effluent is 0.004 mg/L. and 0.021 mg/L these are the most dangerous pollutants due to its high-potential toxic effects, and is extremely toxic, and the primary use of water high and cause adverse health effect to consumers such as renal disease and cancer (Fatoki *et al*. 2002). The concentration of Cd and Cr were within the permissible limit of Indian standards for effluents discharge. (Table 1 & Fig 1),(Usha Damodhar and M. Vikram Reddy., 2012).

The Fe is in sugar effluent recorded as 0.12mg/L. (fig 1) and within the permissible limit when compare with the Indian standards denoted in Table-1. Similar findings were observed by Ezhil and Ramakrishnan.2010).

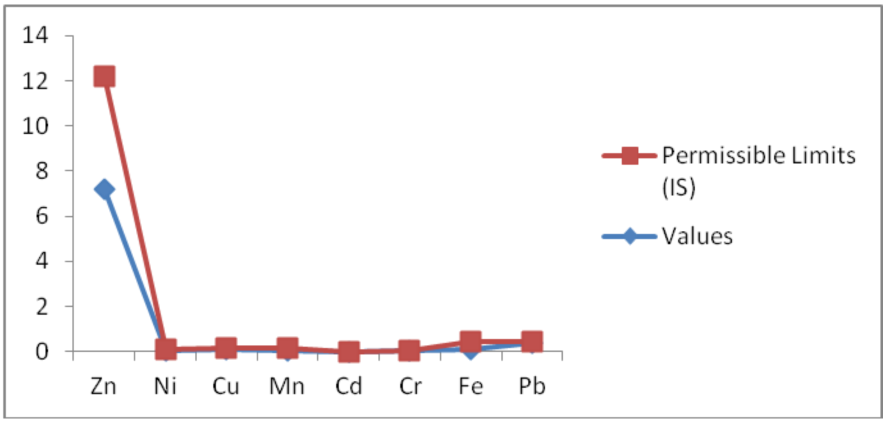
In effluent analysis the Pb concentration is 0.37 mg/L. It was exceed the Standard level (IS 1992) indicted in Table 1. Despite of natural occurrence of Pb in the environment, anthropogenic sources such as discharge of various industrial effluents and discharge of public sewage also plays a major role in the higher Pb concentration at the sugar industrial surrounding areas. Similar findings were reported by Venugopal *et al.*, 2009, High Pb concentration also induces oxidative stress by increasing the production in plants (Reddy *et al*., 2005).

IV. Figures And Tables

Table- 1: Heavy metal concentrations in sugar industry effluent

S.NO	Parameter	Unit	Values	Permissible Limits (IS)
1	Zn	mg/L	7.2	5
2	Ni	mg/L	0.032	0.05
3	Cu	mg/L	0.1	0.05
4	Mn	mg/L	0.06	0.1
5	Cd	mg/L	0.004	0.01
6	Cr	mg/L	0.021	0.05
7	Fe	mg/L	0.12	0.3
8	Pb	mg/L	0.37	0.1

Fig-1: Heavy metal concentrations in sugar industry effluent



V. Conclusion

The long-term use of Sugar industrial effluents for irrigation may increase the concentrations of the Heavy metals Zn, Ni, Cu, Mn, Cd, Cr, Fe and Pb in surface soil. In the above discussion the results have been observed that high amounts of heavy metals such as Zn, Cu, and Pb whereas low levels of Ni, Mn, Cd, Cr and Fe according to the Indian Standards (IS: 10500, 1992). Effluent contains nutrients as well as toxic components depending upon the source of production. Thus, it is clear that the sugar mill waste water contains minerals and can be used for agricultural irrigation after giving suitable treatment and proper dilution. Water treatment plants should be installed nearby sugar industries and the people living near to the factory should be supplied ground water for drinking necessarily after proper treatment. Time to time assessment of the ground water near to a sugar factory for its quality should be done and waste water management is a big challenge in today's world.

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