Study of Toxicity of Heavy Metals Pollutants in Waste Water Effluent Samples

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Abstract - The objective of the present study is to determine the toxicity in untreated waste water effluent of industries (Beverage). The samples have been collected from discharged sampling points of industries, contributing to the heavy metal pollutants in the surrounding aquatic environment. The toxic heavy metals (e.g chromium (Cr), cadmium (Cd), zinc (Zn), copper (Cu), lead (Pb), when released in aquatic environment will enter the food chain through biological / food cycle, causing various health problems in humans beings . The results of analysis indicate that there is need to strong initiative for improvement of effluent treatment system to discharge the treated and safe water in the environment, which will finally help to prevent the entry of metallic contaminants in the Food Cycle Chain.

Keywords: Toxicity, Effluent, Pollutants, Food Cycle, Aquatic system.

I. INTRODUCTION

In last few decades there is shortfall in rain throughout the year. As a result Industries (Beverage) has started in deduction in the usage of water, which has disturbed the water usage ratio, and its validation system, whereas the production of industries increasing in multiple folds. The industries have registered a quantum jump, which is contributing to high economic growth. But it has also given rise to severe environmental pollution. Consequently, the water quality (effluent discharged) has been affected seriously in comparison to the international standards. Waste water from manufacturing industries (Beverage)contributes to water pollution. Industrial waste water usually contains specific and readily identifiable chemical compounds. It is found that one-third of the total water pollution comes in the form of effluent discharge, solid wastes and other hazardous wastes. Out of this a large portion can be traced to the processing of industrial chemicals and to the food products industry. The surface water is the main source of industries for waste disposal. Untreated treated effluents have increase the level of surface water pollution approx. 20 times the safe level in 22 critically polluted areas of the country.

Different norms and guidelines are given for all the industries depending upon their pollution potentials. Most major industries have treatment facilities for industrial effluents. But this is not the case with small scale industries, which cannot afford enormous investments in pollution control equipment as their profit margin stands lower side. In India there are sufficient evidences available related with the mismanagement of industrial wastes? There are several industries other than Beverage industries these are petrochemical industries, sugar mills, distilleries, leather processing industries, paper mill, agrochemicals and pesticides manufacturing industries and pharmaceutical industries. The increasing trend in concentration of heavy metals in the environment has attracted considerable attention amongst environmentalist globally during the last decades and has also begun to cause concern in most of the major metropolitan cities.

Untreated and Economically motivated industrial untreated effluents and sewage water contains variable amounts of heavy metals such as arsenic, lead, nickel, cadmium, copper, mercury, zinc and chromium which have the potential to contaminate crops growing under such irrigation.

These heavy metals have a marked effect on the aquatic flora and fauna which through bio-magnification enter the food chain and ultimately affect the human beings as well. Heavy metal pollution is an ever increasing problem of our oceans, lakes and rivers. Incidence of heavy metal accumulation in fish, oysters, sediments and other components of aquatic ecosystems have been reported globally. These toxic heavy metals entering in aquatic environment are adsorbed onto particulate matter, although they can form free metal ions and soluble complexes that are available for uptake by biological organisms. The key impacts on Aquatic ecosystems are as:

I. The deposition of organic matter gets break down in the aquatic system and reduces DO(i.e. dissolved oxygen) in water body , as the decomposition of process avail available dissolved oxygen and finally leads adverse impact on aquatic animals.

II. The accumulation of untreated effluent waste water increase bioavailability of nutrients, which may enhance the plankton and increase the chance of algal bloom (ref. Munwar et al 1993)

II. METHODS

2.1 Area of study: The study is conducted in for beverage industries in NCR (National Capital region) which is one of the most rapidly developing industrial belt. The main water source for the industrial consumption is underground water /water supplied by municipal corporation.. This has created health hazards not only for local population but also resulted in disturbances of aquatic life flowing near the industrial areas.

2.2 Requirements

The glassware's, pipettes were first cleaned with tape water thoroughly and finally with de-ionized distilled water, followed by heating for 02 hrs at 60 deg.cel. to ensure proper drying of glassware's. The equipment used for analysis and determination of contaminants were calibrated as per approved procedure. The analytical grade reagent are used for effluent sample analysis. The results are calculated in the laboratory (NABL accredited and MOEF approved) using approved and validated\ methodology.

2.3 Sampling of Waste Water Effluent

The samples under study are taken form established sampling protocol. The waste water effluent samples were collected randomly at different times i.e. morning, afternoon and evening session. The sampling also covered:

I. As per operational shift schedule
II. During low production season.
III. During maintenance

The samples were collected in Polythene bottles of 5.0 Ltr .The 24 samples were studied in 2012-2015.

2.4 Sample Preparation:

The samples were prepared using laboratory grade calibrated glassware's and analytical grade chemicals and followed by filtration of samples using Whatman No. 41 (0.45 µm pore size). The Filtrate of (500 ml) was preserved with nitric acid to prevent the precipitation of metals. The samples were concentrated to tenfold on a water bath and subjected to nitric acid digestion using the microwave digestion microwave-assisted technique.

2.5 Analysis of samples using AAS (Atomic absorption) Spectrophotometer.

The analysis of samples were conducted for the metallic contaminants i.e. chromium (Cr), cadmium (Cd), zinc (Zn), copper (Cu), lead (Pb) was done by AA-7000, Shimadzu .The SPC (Statistical Process Control) tools were used for the result interpretation. One blank sample was analyzed parallel to the samples to get the clarity about the result. One reagent blank sample was analyzed and subtracted from the samples to correct for reagent impurities and other sources of errors from the environment. Average values of three replicates were taken for each determination.

Effluent Pollutants	Heavy Metals (mg/l)	Year-2012							Year-2013						
		Jan	Feb	March	April	May	June	Average	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Metallic Contaminants	Cr	24.9	29.6	24.2	22.9	29.5	40.7	28.63	31.9	32.6	39.2	28.5	21.7	29.5	30.57
	Cd	20.9	30.3	23.5	18.4	17.8	22.2	22.18	23.7	29.4	33.9	23.5	18.6	20.1	24.87

	Zn	15.1	19.6	17.1	18.2	24.3	29.4	20.62	26.9	29.5	32.1	25.2	20	26.2	26.65
	Cu	21.6	26.3	26.2	12.9	15.2	23.2	20.90	19.1	23.3	30.4	25.1	24.8	26.5	24.87
	Pb	21.6	22.8	19.9	19.4	20.4	27.8	21.98	19.9	23.8	27.4	20.4	17.1	20.4	21.50
Average Mix Contaminants Conc.		20.82	25.72	22.18	18.36	21.44	28.66	22.86	24.3	27.72	32.6	24.54	20.44	24.54	25.69
Effluent Pollutants	Heavy Metals (mg/l)	Year-2014							Year-2015						
		Jan	Feb	March	April	May	June	Average	July	August	Sept.	Oct.	Nov.	Dec.	Average
Metallic Contaminants	Cr	23.9	31.6	25.2	32.9	30.5	39.7	30.63	31.0	31.6	40.4	26.5	31.7	30.5	31.95
	Cd	22.9	31.8	21.5	22.4	26.8	24.2	24.93	23.4	27.4	31.9	20.5	19.6	22.0	24.13
	Zn	19.1	19.6	18.6	18.2	25.6	29.4	21.75	24.9	31.4	33.7	28.4	22.5	28.3	28.20
	Cu	22.6	26.3	25.8	16.9	18.2	24.2	22.33	20.5	24.6	30.5	25.1	26.8	28.4	25.98
	Pb	21.6	22.8	20.9	18.4	20.2	26.8	21.78	18.6	20.9	22.6	23.7	22.8	27.4	22.67
Average Contaminants Concentration		22.02	26.42	22.40	21.76	24.26	28.86	24.29	23.68	27.18	31.82	24.84	24.68	27.32	26.59

Table-1: Concentration level of Metallic Contaminants

Effluent Pollutants	Heavy Metals (mg/l)	2012 Average	2013 Average	2014 Average	2015 Average
Metallic Contaminants	Cr	28.63	30.57	30.63	31.95
	Cd	22.18	24.87	24.93	24.13
	Zn	20.62	26.65	21.75	28.2
	Cu	20.9	24.87	22.33	25.98
	Pb	21.98	21.5	21.78	22.67

Table-2: Average of metallic Contaminants.

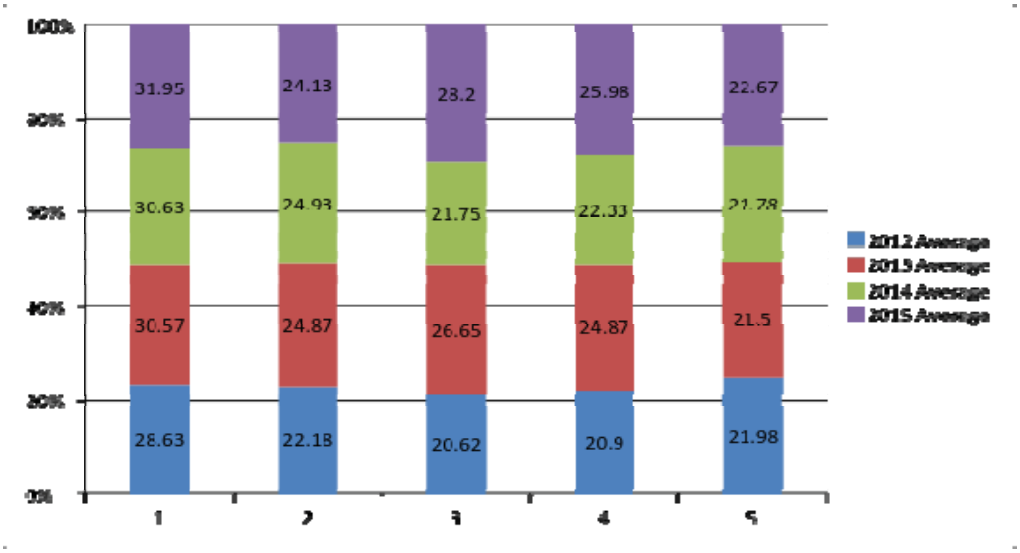

Figure 1: Graphic representation of the above results.

III. DISCUSSION AND CONCLUSIONS

The experimental data on heavy metal content in waste water effluent samples collected from different industries years 2012 and 2015 is presented in Tables I and table II respectively. The experimental details have been presented graphically also, along with summary details

A number of elements are present in mg/l concentrations. Heavy metals are a special group of trace elements which have serious adverse impact to human health and causing hazards. The hazard is chemical in nature, which comes in touch of human beings through food chain system i.e. called as "Farm to Fork". The experiment include the group of , Cr, Cd, Zn, Cu, and Pb . These are called heavy metals because in their metallic form, their densities are greater than 4 g/cc.

Chromium (Cr) :

The experimental result varies from 28.63 mg/l to 31.95 mg/l ,(Permissible limit WHO[28]: 0.05 mg/l) in the effluent samples collected . The experimental data indicates that there is presence of chromium in the discharged effluent , which goes to the aquatic system. The chromium shows its toxic impact on invertebrates present in the aquatic system as well as on plants . The plants present around the water shows different characteristics in comparison to the plants presents normal water .

Cadmium (Cd)

Cadmium is contributed through glass enamel and deterioration of galvanized pipes used in the industry .As per study details of experimental data it the concentration varies from 22.18 mg/l to 24.93 mg/l, (Permissible Limit WHO [32], 0.01mg/l) The discharged effluent goes to the aquatic system and consumed by Fishes . The fishes gets contaminated and enter in the food cycle and consumed by human beings , which causes serious health hazards.

Zinc (Zn):

The contribution of Zinc in effluent as pollutant varies from 20.62 mg/l to 28.2mg/l,(USPH Standard [5.5 mg/l] the collected sample was found contained with paint like odour. The toxicity of Zinc gets in the aquatic system, through which it moves in the cultivated land and enter in the food cycle system . During study it was reported that area having high concentration of Zinc leads the high possibilities of Necrosis , chlorosis and inhibition of growth of plants .

Copper (Cu):

The concentration of copper was also reported during study, its concentration in discharged effluent 20.9mg/l to 25.98mg/l,(WHO and USPH established limit [1.0mg/l]) Copper is highly toxic for most of the fishes and

invertebrates , as it getin the system it make imbalance the ecosystem of ponds . Through ponds system it movement in the cultivating land leads adverse impact in plants and animals. The high concentration of Copper may damage to roots, by rupturing the cell membrane and destroying the normal membrane structure. It enters in food cycle system through the food grains and cause adverse impact on reproductive system in animals.

Lead (Pb):

During study the presence of lead was also reported, its concentration varies from 21.98mg/l to 22.67mg/l(permissible USPH drinking water Std[<0.05mg/l]) in discharged effluent samples. The discharged effluent through surface water moves in the aquatic system and its presence lead contamination and increase the toxicity .The presence of high concentration of lead impact the photosynthesis and create morphological abnormalities .

The study details of experimental data shows that uncontrolled discharged effluents are appearing as key factor for collapsing of ecosystem and finally contaminants are entering in the food cycle system. As a result creating significant impact on plants as well as human beings .There is need to have more strict monitoring and controlling system on discharge pattern of effluent system of industries.

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