

Determination of Physico-Chemical Properties and Heavy Metals in The Effluents of Match Industries of Hayat Abad Industrial Estate, N.W.F.P

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Summary: Effluent samples were collected at different intervals from match industries located at Hayat Abad Industrial Estate. These samples were analyzed for their physico-chemical properties and selected toxic metals suspected to be released by match industries. The effluents of all match industries contained high concentration than the permissible level of chromium (VI), iron and manganese ranging from 11.00 ± 0.01 - 38.91 ± 0.05 ppm, 11.76 ± 0.10 - 21.70 ± 0.08 and 0.06 ± 0.01 - 2.28 ± 0.09 respectively. Other heavy metals like copper, lead, zinc and nickel were found to be below detection limit.

Introduction

Industrial discharge is one of the major sources of water pollution. Water pollutants can enter the food chain through crop irrigation and the contamination of aquatic life. Industrial water pollutants such as organic and inorganic compounds, metals and dissolved solids can have serious impacts on environmental quality, depending upon their characteristics and concentration [1-3].

The discharge of the effluents of various Industries in the Industrial Estate are of major concern from environmental point of view. As the pollution load and type vary from industry to industry. Among these pollutants heavy metals and organics are of special concern because of their bio-accumulation.

The untreated effluents of the industries located in the Hayat Abad Industrial Estate find their way into various water bodies and have seriously degraded their quality [4].

A variety of methods and instruments are available for the determination of trace heavy metals in effluent samples [5-8]. Among the instruments atomic absorption is the instrument of the choice and has been used in the present work for heavy metal determination in the effluent samples.

Results and Discussion

There are a number of match industries operating in Hayat Abad Industrial Estate Peshawar. The ignition mixture that is coated at the tip of the match stick and the abrasive sides of the match box

is prepared using a number of chemicals, which are explosive in nature and include potassium chlorate, sulfur, glass powder, china clay, potassium dichromate, iron oxide, zinc oxide, manganese oxide and Keiselgur.

The effluents of match industries were investigated for their physico-chemical properties like temperature, pH, TSS, TDS, BOD, COD and color.

The effluents of match industries were highly turbid and colored due to the presence of pigments used to impart the desired color to the ignition mixture at the tip of the match sticks. Malachite blue and red are mainly used in this regard which increase the turbidity of the wastewater. The NEQ standards allow pH in the range of 6-10. The measured level of pH 6.6-7.0 in the effluent streams is therefore within the permissible limits. The concentration of TSS and TDS in the effluents are in the range of 2170.0-3220.0 mg/l and 3800.0-5800.0 mg/l and are higher than the NEQS limits of 150.0mg/l and 3500.0 mg/l respectively. The BOD and COD concentrations in the effluents are 392-433 mg/l and 2870-3820 mg/l respectively, which are also higher than the limits of NEQS for BOD and COD levels of 80 mg/l and 150 mg/l respectively. All the values of TSS, TDS, BOD, COD and pH are also above the USPAH standards.

The effluents of these industries were analyzed for selected heavy metals like chromium, copper, lead, iron, manganese, zinc and nickel

Table 1: Investigation of the Physico-Chemical Properties of the Effluents of Match Industries.

Name of Industry	TSS mg/l	TDS mg/l	BOD-5 mg/l	COD mg/l	pH	Temp. C°	Color
Match Industry-1	3220.0	5800.0	433.0	3820.0	7.0	29	Blue
Match Industry-2	2750.0	4715.0	411.0	2911.0	6.9	32	Red
Match Industry-3	2170.0	3800.0	392.0	2870.0	6.8	26	Blue
Match Industry-4	3120.0	4112.0	511.0	3600.0	6.6	28	Red
NEQS Discharge	150.0	3500.0	80.0	150.0	6.0-10.0	40	Colorless
USA Standard	5.0	500.0	4.0-6.0	4.0	6.0		Colorless

Table 2: Determination of heavy metals in the Effluents of Match Industries(mg/L).

Name of Industry	Cr	Fe	Mn	Cu	Zn	Ni	Pb
Match Industry-1	25.97	21.71	2.28	BDL	BDL	BDL	BDL
Match Industry-2	19.05	17.16	0.23	BDL	BDL	BDL	BDL
Match-Industry-3	11.00	11.76	0.06	BDL	BDL	BDL	BDL
Match-Industry-4	38.91	19.57	0.21	BDL	BDL	BDL	BDL
NEQS Discharge	1.0	2.0	1.5	1.0	5.0	1.0	0.5
Limit							

concentration. The concentration of copper, lead, zinc, and nickel was found below detection limit in all the effluents investigated. Manganese and Iron were present in the range of 0.06 ± 0.01 - 2.28 ± 0.09 ppm and 11.76 ± 0.10 - 21.71 ± 0.08 ppm respectively. The concentration of chromium was found to be in the range of 11.00 ± 0.01 ppm to 38.91 ± 0.05 ppm. Match industry-4 effluents were found to have highest chromium concentration of 38.91 ppm while match industry-3 effluents were found to have the lower chromium concentration of 11.00 ppm. For assessing the toxicity, speciation studies were carried out to find out Cr(VI) by diphenyl carbazide method. It was found that all chromium was present in the form of chromium (VI). Thus the effluents of all the match industries have concentration higher than the NEQS of 1.0 ppm and WHO and USA standard of 0.05 ppm. The higher concentration of chromium and iron found in the effluent of match industries is due to the use of potassium dichromate as oxidizing agent, iron (Fe_2O_3) as a filler and manganese (MnO_2) as a catalyst in the raw material. Further the defective handling leads to higher concentration of these pollutants in the effluents. Chromium(VI) is present in the effluents which is toxic than chromium(III). Thus the match industry effluents cause water pollution in the stream.

Experimental

Instrument

Atomic absorption spectrophotometer model AA-660X VI42 was used for determination of metals during this investigation.

Chemicals and Reagents

All chemicals used were of analytical reagent grade purity and were used without further purification.

Collection of Samples

The effluent samples were collected from the selected industries of Hayatabad Industrial Estate, at the end of the pipe, in clean and dry polyethylene bottles. The bottles were first rinsed with sample water at the sampling spot and then filled in such a way that no air bubble was left behind in the bottles. The samples were brought to the laboratory for conducting physico-chemical and chemical analysis.

Procedure

Total dissolved solids, total suspended solids, BOD and COD were determined by standard methods (6). Total dissolved solids and suspended solids were determined gravimetrically while COD was determined by open reflux oxidation followed by volumetric measurement of unreacted oxidizing agent. For determination of BOD, first DO was determined by Winkler method then the sample was incubated for 5-days with suitable microorganism. After 5-days incubation, dissolved oxygen was again determined by Winkler method in samples.

$$\text{BOD, mg/L} = \frac{D_1 - D_2}{P}$$

D_1 = DO in samples before incubation

D_2 = DO in samples after incubation

P = Decimal fraction of sample used

For determination of metal, 100 ml of the unfiltered well mixed effluent sample was taken in a beaker and evaporated to 50 ml then added 10 ml of concentrated nitric acid- hydrochloric acid mixture (1:3). This mixture was evaporated again to oxidize the organic content of the sample. After cooling the volume was made up to 100 ml with distilled water in 100 ml volumetric flask. The solutions were then aspirated into the flame atomic absorption spectrometer AA-660X VI42 for determination of metals like Cr, Cu, Pb, Fe, Zn and Ni under the following operating parameters.

Metals	Wavelength (nm)	Lamp Current (m-Amperes)	Band Pass (nm)
Cr	357.9	10	0.5
Zn	213.9	8	0.5
Ni	232.0	15	0.2
Fe	248.3	15	0.5
Mn	279.5	12	0.2
Cu	324.8	5	0.5
Pb	217.0	10	0.5

The flame used was air acetylene flame

Conclusion

The effluents of all match industries were found to contain higher concentration of TSS, TDS, BOD, and COD. The higher level of BOD and COD indicate the release of organic pollutants apart from the inorganic one by these industries. Higher concentration of Cr(VI) were found in the effluents of all the match industries. Here it may be pointed out that based on oxidation state of the chromium, match industries effluents poses higher health risk than the tanning industries, which releases relatively less toxic chromium(III).

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