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Spectroscopic Estimation of Iron in Drinking Water by 1,10 Phenanthroline Complex formation method in Moradabad

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ABSTRACT

Moradabad is situated in western Uttar Pradesh on the Bank of Ram Ganga River and popularly known as PEETAL NAGRI. This city has attained its popularity in the World for exporting valuable gift items, decoration pieces, made up of Iron, copper, silver & gold plated, and mostly of Brass. A survey has been conducted for the quality of drinking water to ensure the contamination of Iron in drinking water sources. Most of the people in Moradabad complain about yellow color in drinking water. This shows poor quality and contamination of water and presence of Iron. 20 water samples have been collected from different locations. 10 water samples have been collected from City (L1 to L10) , 2 samples from Sambhal Road (L11 to L12) , 2 samples from Amroha Road (L13 to L14) , 2 samples from Kanth Road (L15 to L16) and 4 samples from nearby villages on the Kashipur Road (L17 to L20). The concentration level of Iron has been found very high than the maximum permissible limit of 0.3 parts per million (ppm) while other metallic concentration like, Arsenic, Copper, Lead and chromium have been found within permissible limit. In these studies surface water and underground water has been chosen to conduct these studies. In some water samples (L1 to L10) the high concentration of Iron (29.79ppm to 48.14 ppm) and L11 to L20 8.87pm to 30.09ppm have been found under these studies . The excess of Iron is posing severe health hazards such as liver cancer, diabetes, cirrhosis of liver, and diseases related to heart and nervous system and infertility. It also causes adverse effect on color, odor taste, yellow spots on clothes during washing and accumulation of Iron in pipe lines. This work has been done as a challenge for the welfare of the people of Moradabad. Alternative suggestions have been conveyed to the people of Moradabad to attain healthy life style.

Keywords: Iron contamination, poor quality, Yellow color, surface and underground water, parts per million (ppm).

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1. INTRODUCTION

Moradabad city is known for brass handicrafts, Iron molding and is thickly populated due to manufacturing and export business around the world. Most of the people in the city and nearby surrounding use ground water for their daily need and drinking. The industrial waste water, industrial effluents and waste water directly

meet the river and The River water is directly used for irrigation. Recycling of waste metals is also done in the city near the Ram Ganga River and causes severe environmental pollution [1]. The polluted water is a very serious loss to the public health and environmental conditions [2]. Although Iron is essential component for good health but it excess causes severe health hazards [3]. The higher concentration causes bad odor, stains on the clothes, and severe liver and heart problems [4]. Iron occurs in the form of minerals and automatically leaches to water bodies. US EPA (United state Environmental Protection Agency) and BIS (Bureau of Indian Standards) have approved 0.3 parts per million (ppm) Iron contents for drinking water. In these studies focus has been given to the high level of Iron in the drinking water and raw water used for washing and cooking. 20 samples have been collected from the Moradabad city and surrounding of Moradabad for knowing the higher concentration of Iron in the water system [5].

2. MATERIALS & METHODOLOGY

Following chemicals and their solutions are required for systematic analysis of Iron in drinking water at Moradabad:

- 1,10 Phenanthroline ($C_{12}H_8N_2$): 25% solution of the monohydrate in water
- Hydroxylamine hydrochloride ($CH_2NOH.HCl$): 10 % aqueous solution
- Iron (II) standard solution [$FeSO_4.(NH_4)_2SO_4.6H_2O$]
- Ammonium acetate (CH_3COONH_4) buffer solution: 1% solution in an acetic acid buffer of pH (mix 65ml of 0.1M acetic acid and 35 ml of 0.1 M ammonium acetate solution).

Theory/ Principles: 1,10 phenanthroline reacts Iron (II) metal ion to develop orange-red complex {Ferrous ortho–Phenanthroline [(C12H8N2)3 Fe}$^{+2}$ which impart orange –red color complex. This complex show maximum absorbance at wave length 510nm. The intensity is independent of the acidity in the pH range 2—9, and is stable for long time. All Fe^{+3} contents may be reduced with hydroxylamine solution to Fe^{+2}.

$3(C_{12}H_8N_2) + Fe^{+2} \rightarrow [(C_{12}H_8N_2)_3]Fe$

1,10 Phenanthroline + Ferous ions→Ferrous Ortho –Phenanthroline complex (Orange –Red)

Procedure: -

1. Now standard stock solution of ferrous ammonium sulfate is transferred into 100ml volumetric flasks to prepare 10, 20, 30, 40, and 50 ppm solutions. Each flask is half filled with distilled water/ de ionized water.
2. Added 2 ml of conc. hydrochloric acid solution and 1 ml of hydroxylamine solution to each flask, then heated up to boiling to convert all Fe^{+3} into Fe^{+2} ions and cooled it.
3. Added 3ml of the ammonium acetate buffer solution to each flask and mixed properly.
4. Finally, added 4.0ml of the 1, 10 phenanthroline solution to each flask. Filled each flask up to mark with distilled water.
5. Mixed thoroughly and waited for completion of reaction for color development.
6. Similarly blank is prepared by taking 10 ml of buffer + 2 ml of hydroxylamine hydrochloride solution + 4ml of 1, 10 Phenanthroline solutions in a 100 ml volumetric flask and making 100ml up to mark with distilled water.
7. Now the absorbance of five standards and blank samples is recorded by UV-Vis spectrophotometer at 510nm.
8. Calibration curve has been plotted between iron concentration Vs absorbance. By using this plot and linear line equation (y=mx+c) conversion factor to convert absorbance to concentration has been obtained.
9. All the collected samples (L1 to L20) have been prepared in 100ml volumetric flasks.

The volumetric flasks were marked from L1 to L20. Each volumetric flask was poured 10 ml buffer + 2ml hydroxylamine hydrochloride solution + 4ml of 1, 10 phenanthroline solution to each L1 to L20 + the volumetric flasks were filled up to mark with the water samples (L1 to L20) in the sequence. Each volumetric flask was shaken for homogeneous mixing and color development. After 15 minutes the absorbance of all volumetric flasks from L1 to L20 were recorded and concentration of Iron was calculated as per calibration graph and conversion factor.

3. RESULT & DISCUSSION

All the water samples prepared for Iron (II) determination were tested on UV-Vis spectrophotometer at 510nm. The samples (L1 to L10) collected from the Moradabad city showed high concentration of Iron (II). The minimum 29.79ppm and maximum 48.14 ppm [6]. These water samples were yellowish in color and this is a clear indication that water is not fit for drinking as permissible limit is 0.3 ppm [7]. High concentration of Iron is very dangerous for lung diseases, cancer and stomach malfunctioning [7].

Table 1: Showing standard concentration & absorbance

Concentration	Absorbance	Conc. (X)=Absorbance/slope
0.00 pm	0.00	0.00
10ppm	0.66	9.93
20ppm	1.33	20.01
30ppm	1.99	29.94
40ppm	2.66	40.02
50ppm	3.32	49.95

Table 2: Showing unknown (L1 to L20) water samples of drinking water

Water samples	Absorbance	Fe(II) in ppm
L1	2.89	43.48
L2	3.00	45.13
L3	2.70	40.63
L4	2.65	39.87
L5	2.76	41.52
L6	1.98	29.79
L7	2.56	38.51
L8	2.99	44.98
L9	3.20	48.14
L10	2.50	37.61
L1 to L10 samples collected from Moradabad City		
L11	1.96	29.49
L12	2.00	30.09
L13	1.78	26.78
L14	1.80	27.08
L15	1.45	21.81
L16	1.55	23.32
L17	1.98	29.79
L18	1.66	24.97
L19	0.99	14.89
L20	0.59	8.87

L11 to L12 samples from Sambhal Road, Moradabad
L13 to L14 samples from Amroha road, Moradabad
L115 to L16 samples from Kanth road, Moradabad
L16 to L20 samples from Kashipur road, Moradabad

L11 & L12 showed high concentration of Iron (II) while L19 & L20 showed lowest concentration of Iron (II) in comparison to other locations L13 to L18 [8]. These abnormal values of iron (II)in various location proof that in Moradabad city the underground water is badly affected due to more iron metal work which after rusting and reduction change to Iron (II) and goes to underground water [9]. This is an alarming condition for the health

issues of the people of Moradabad. The Figure 1- shows calibration of standard Iron (II) solution and absorbance obtained in UV-vis spectrophotometer. The collected samples L11 to L20 have also been tested and absorbances obtained have been shown in Table- 2.

The slope was obtained through the graph (Fig-1) and concentrations of all samples were calculated by dividing the absorbance by slope 0.06646 as shown in the graph. Table- 1 shows verification of standard Iron (II) solution by dividing the absorbance by the slope. The values obtained are very much close to the standard concentrations. The present studies have been done to create awareness among the people of Moradabad. The high concentration of Iron in water than the permissible limit, 0.3 ppm is causing damage and causing health issues among the children, youngsters and old people. It is acting like slow poison for damaging the vital parts of the human physiology [10].

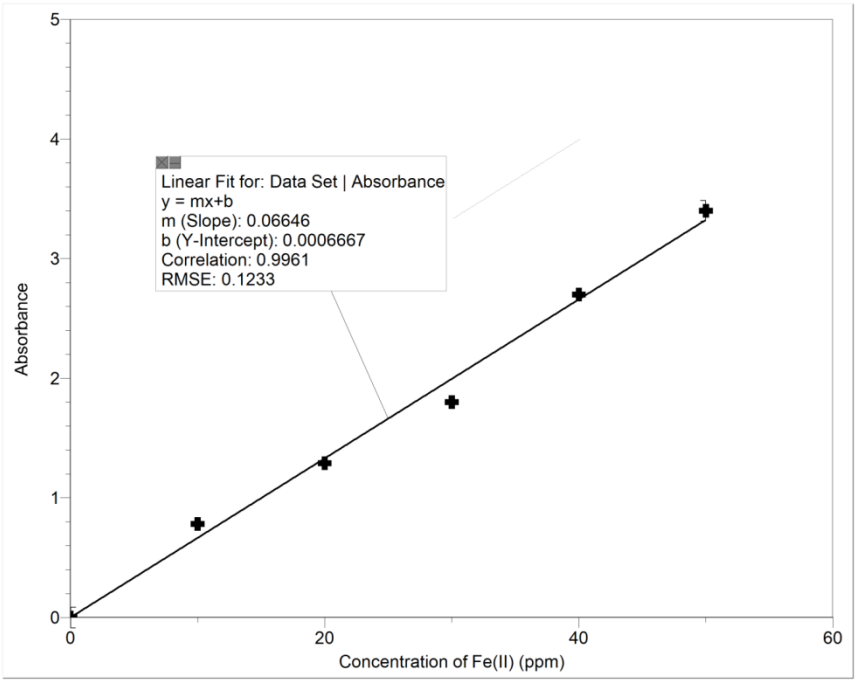

Figure 1: Relationship between Absorbance and Concentration

Remedial suggestion for the people of Moradabad:-

Keeping in view the abnormal hazardous water pollution and due to excess of Iron (II) can be treated through Ion Exchange process. This is recommended that drinking water should not be used directly obtained from the source. It should be treated through cationic ion exchanger and through anionic ion exchanger. The Excess of Iron will be absorbed by the cationic ion exchanger. Finally this water can be treated with anionic exchanger to remove excess of anions. The required nutrients may be added for healthy drinking water, free from Iron (II) contamination.

4. CONCLUSION

This is very much obvious that Moradabad is an industrial city popular for Iron work, brass, silver plating, gold plating, chrome plating, nickel plating, and other metallic work. The metallic contamination is very high in underground water. There should be regular monitoring about contamination of Iron (II) and other metals to bring in the notice of the people. Always treated water should be used for drinking and precautionary testing should be carried out time to time for better health issues.

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