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Research Article

DETERMINATION OF IRON CONTENTS IN WELL-DRILL WATER USING UV-VIS MEASUREMENT DEVICE

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ABSTRACT

Well-drill water is used as domestic water in many households in Tich Luong ward, Thai Nguyen city. In well-drill water often contaminates with heavy metals, especially iron (Fe), making the water cloudy and fishy yellow. If the iron content exceeds limitation, it will pollutes the water source and causes diseases as heart, joints, liver cancer, ... greatly affect to human health. Therefore, the article proposes a way to determine iron content in well water by UV-VIS measuring device, essentially using photometry method, and comparing with the permissible limit according to Vietnamese standards, to ensure the quality of clean, safe water for people to use.

Keywords: *Fe, heavy metals, well-drill water, UV-VIS measurement, photometry method, Thai Nguyen*

INTRODUCTION

In well-drill water, iron often exist in below form Fe (II) solubility of the salt sulfate, bicarbonate, chloride, … When exposed to oxygen or oxidizing agents, oxidized iron (II) precipitates as a reddish-brown floc. When using iron-contaminated water, it will have a fishy, unpleasant smell, make clothes yellow when washing, stainless steel pipes are rusty [1]. Using iron-contaminated water in daily life is very unhealthy. According to research by the Health sector, most of the causes of cancer are due to pollution problems, in which the use of iron-contaminated water is also one of the main causes. In Vietnam every year thousands of people die, with about 200,000 people suffering from cancer caused by iron-contaminated water [9]. Therefore, there is a need for a specific study to determine iron content in well water by advanced scientific methods.

In Vietnam, there have been a few studies on the determination of heavy metal content in well-drill water like "Simultaneous determination of As (III), As (V), Monomethynarsonic (MMA) and Dimethynarsonic (DMA) in well-drill water by HPLC-IPC-MS in Chuyen Ngoai and Chau Giang communes, Duy Tien district , Ha Nam province" of Pham Hai Long, Tran Van Cuong (2015) [4]; "Research on Fe and Mn treatment in well-drill water by filter tank combined with growing ferns" of Nguyen Market Hang Nga (2013) [6]; "Determination and assessment of iron content in domestic wastewater in some households in Phuc Trach commune - Bo Trach - Quang Binh " by Nguyen Mau Thanh (2017) [8]; etc.

The above studies have used many different methods to evaluate, analyze and determine the content of heavy metals such as iron, zinc, manganese, arsenic, ... well- drill water according to each specific case study at the research sites. locality of Vietnam [10]. The results of these studies have scientific value and practical significance in domestic water treatment for people. However, in the methods of determining heavy metal content in water, there are very few works using photometric methods (using UV-VIS measuring equipment) [3]. The use of different methods, at different times, in different locations, will produce different research results.

Thai Nguyen is a province with many mineral and precious metal mines. The mining and metallurgical industries flourished. Tich Luong ward of Thai Nguyen city is geographically located near the non-ferrous metallurgy plant and Thai Nguyen iron and steel factory. Moreover, most of the untreated waste is discharged directly into the environment, leading to the level of environmental pollution that makes the impact of heavy metals in the well-drill water in Tich Luong ward is higher than in other regions. However, the analysis and research to determine the iron metal content here is still small.

With all the above reasons, the author selected the research on "Determination of iron content in some well-drill water samples in Tich Luong Ward, Thai Nguyen by UV-VIS measuring device (by photometric method)" as necessary, ensuring the topicality of the research problem, contributing to solving the real problem of using well-drill water as domestic water here.

MATERIALS AND METHODS

According to TCVN 5002:2003 there are many methods to determine the content of heavy metals in general and ferrous metals in particular, such as: Atomic absorption spectroscopy (AAS), polar spectroscopy, photometric methods. One of the methods that the article uses in the research process is the photometric method. This method gives high sensitivity and accuracy, allows analysis of a large number of samples with only one standard curve, the solution to be analyzed is applicable to very small concentrations and eliminates the influence of the background sample when taken. analysis.

Chemicals:

All reagent chemicals used must be of pure grade. Concentrated acid H_2SO_4 (ρ = 1.84 g/ml); concentrated acid HCl (ρ = 1.12 g/ml); solution H_2SO_4 4.5M; buffer solution CH_3COONH_4; hydroxylamine $NH_2OH.HCl$ 10%; bato-phenantroline solution 1%; standard iron (II) solution 100mg/l; standard iron (II) solution 5 mg/l. Distilled water 2 times; sulfochromic washing solution (mixture of concentrated H_2SO_4 and $K_2Cr_2O_7$).

Solutions:

- Acetate buffer: Dissolve 250 g of CH_3COONH_4 in 150 ml of water. Add 700 ml of glacial acetic acid.
- Phenantroline bato solution 1%: Dissolve 1g $C_{24}H_{16}N_2$ in 100 ml containing 2 drops of concentrated HCl.
- Iron (II) standard solution 100 mg/l: Dissolve 0.3511 g of pure Morh salt $(NH_4)_2SO_4.FeSO_4.6H_2O$ in 25 ml of distilled water, place in a 500 ml volumetric flask containing 5 ml of concentrated H2SO4. Make up to the mark with distilled water.
- Iron (II) standard solution 5 mg/l: Draw 5 ml of the 100 mg/l iron solution into a 100 ml volumetric flask and make up to the mark.

Lab equipments:

All glassware should be rinsed with sulfochromic washing solution, and rinsed with double distilled water. Plastic sample container 500 ml; volumetric flasks 25 ml; 50 ml; 100 ml; 500 ml; pipette 1 ml; 2 ml; 5 ml; 10 ml; glass chopstick; glass cup; chemical scoop; filter paper; electronic scales; Hach Dr/2400 Spectrophotometer.

RESULTS AND DISCUSSION

Investigate the effect of CH_3COONH_4 buffer solution:

Take into a 25 ml volumetric flask: 2 ml of iron (II) standard solution 5 mg/l; 0.5 ml of phenantroline bato solution 1%; 0.5 ml of 10% hydroxylamine and change the volume of acetate buffer from 0 to 10 ml. Make up to the mark with distilled water, and mix the solution. Measure the optical density of the complexes at 510 nm. The results are shown in Table 1 and Figure 1.

Numbers of flasks	Volume of buffer solution	A
1	1,0	0,147
2	2,0	0,154
3	3,0	0,152
4	4,0	0,153
5	5,0	0,154
6	6,0	0,156
7	7,0	0,154
8	8,0	0,153
9	9,0	0,153
10	10,0	0,152

Table 1: The dependence of the buffer volume into optical density

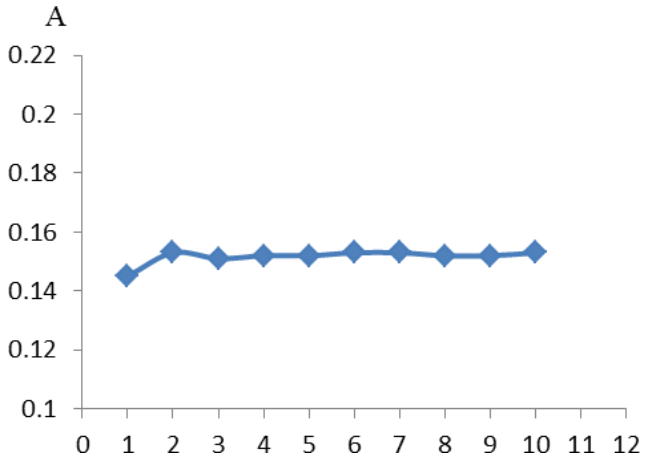

Figure 1: The dependence of the buffer volume into optical density

The optimal volume of acetate buffer was selected to be 3 ml corresponding to a 25 ml volumetric flask.

Investigate the effect of optimal reagent volume for complexation:

Take into a 25 ml volumetric flask: 2 ml of iron (II) standard solution 5 mg/l; 0.5 ml hydroxylamine 10%; 3 ml ammonium acetate buffer, change the volume of 0.5% bato-phenantroline solution from 0.5 to 5 ml. Make up to the mark with distilled water, and mix the solution. Measure the optical density of the complexes at 510 nm. The measurement results are shown in Table 2 and Figure 2.

Numbers of flasks	Volume of bato-phenantroline solution 1% (ml)	A
1	0,5	0,136
2	1,0	0,140
3	1,5	0,150
4	2,0	0,152
5	2,5	0,152
6	3,0	0,153
7	3,5	0,154
8	4,0	0,153
9	4,5	0,154
10	5,0	0,154

Table 2: The dependence of the reagent volume on the optical density A

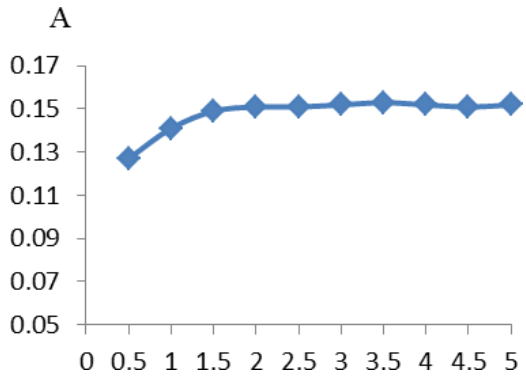

Figure 2: The dependence of the reagent volume on the optical density A

From the results of Table 2 and the graph Figure 2, select the optimal volume of bato-phenantroline reagent of 2 ml corresponding to a 25 ml volumetric flask. At this volume, the optical density does not change.

Investigate the linear interval according to Bouger - Lamber – Beer's law:

Put into 10 volumetric flasks 25 ml, respectively: Vml of iron (II) standard solution 5mg/l from 0.15 to 3 ml; 3 ml ammonium acetate buffer solution; 0.5 ml hydroxylamine 10%; 2 ml of 1% bato-phenantroline solution. Make up to the mark with distilled water, and mix the solution. Measure the optical density of iron at 510 nm, and select a linear concentration range of iron concentrations from 0.1 to 0.4 mg/l. Measurement results are shown in Table 3 and Figure 3 .

Numbers of flasks	Volume of iron (II) standard solution 5mg/l	Concentration C (mg/l)	A
1	0,15	0,03	,022
2	0,3	0,06	,040
3	0,5	0,1	,062
4	0,7	0,14	,097
5	0,9	0,18	,134
6	1,0	0,2	.151
7	1,5	0,3	,243
8	2,0	0,4	,333
9	2,5	0,5	,459
10	3,0	0,6	,511

Table 3: The results of the investigation of the linear range of iron

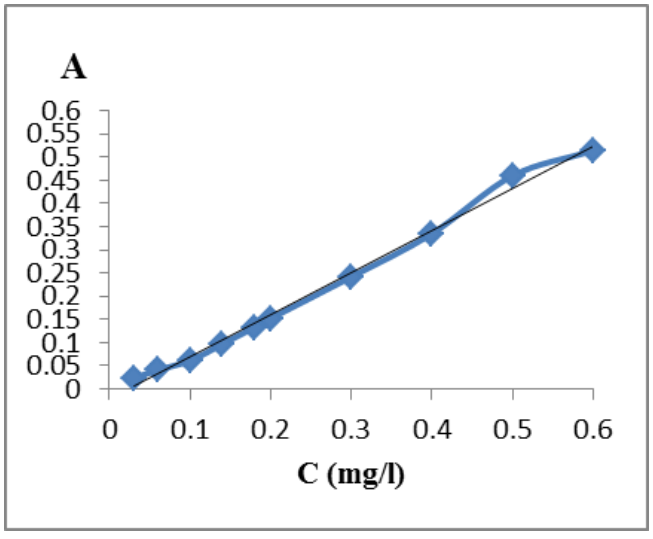

Figure 3: The results of the investigation of the linear range of iron

Build road standard:

Based on the linear range obeying Bouger - Lamber – Beer's law, construct a standard curve showing the dependence of absorbance on the concentration of iron solution from 0.1 to 0.4 mg/l in the 25 ml volumetric flask.

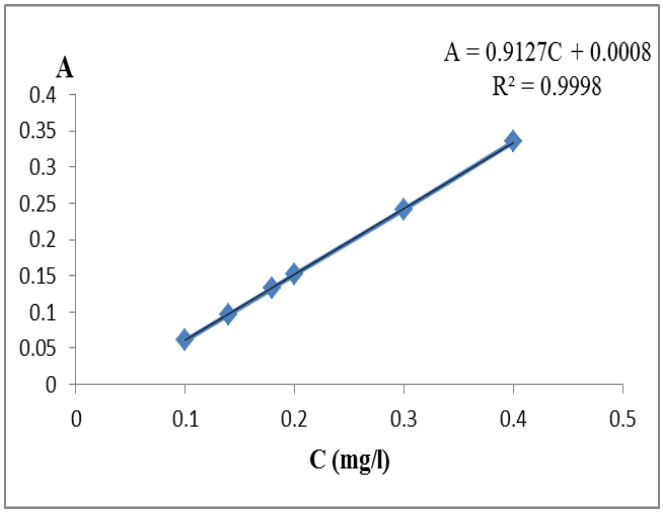

Figure 4: Iron solution photometric standard curve

Determination of iron content in some well-drill water samples in Tich Luong ward, Thai Nguyen.

Sample Handling and Preservation:

All samplers were washed and rinsed several times with double distilled water. Water samples were collected in plastic bottles with a capacity of 05 liters, before taking samples, they had to rinse the bottles several times with the same water samples, and label the samples to avoid confusion. The samples taken should not contain many air bubbles. Samples after taking are pre-treated by immediately filtering through filter paper, the water after filtration is acidified to pH = 1 (about 3ml of 4.5M H_2SO_4 solution for 100ml of sample) to protect the sample.

Process of processing well-drill water samples:

Use an electric stove to concentrate 100ml of the acidified water sample to 50ml of the sample. Then transfer 20 ml of sample to a 50 ml volumetric flask and add 3 ml of acetate buffer; 0.5ml 10% amine hydroxyl solution; 2 ml of 0.5% bato-phenantroline solution. Make up to the mark with distilled water, and mix the solution. Measure the optical density of iron at 510 nm and obtain the results.

Analytical results of iron content by photometric method:

Aspirate 15 ml of acidified well-drill water sample solution into a 25 ml volumetric flask, add 0.5 ml of 10% hydroxylamine solution, 3 ml of acetate buffer, 2 ml of 1% bato-phenantroline solution, and to the mark of a 25 ml volumetric flask. Measure the optical density of the solution at 510 nm by two methods: standard curve method and standard addition method with standard iron solution ($A_{0.2mg/l}$); and samples with added standard ($A_{x+0.2mg/l}$). Based on the standard curve to determine the dissolved iron content in the

analyzed sample. The results are shown in Table 4.

The formula for calculating the concentration of C_x of the research solution according to $V_{\text{defined level}}$

$C_x = C_{0.2mg/l} . (A_{(x+0.2)mg/l} - A_{0.2mg/l}) / A_{0.2mg/l}$

Dissolved iron content = $C_x . V_{dm} / V_{xd}$

No.	Sampling location	Date of sampling	Standard curve method			Standard addition method		
			A	C_x	Fe (mg/l)	A	C_x	Fe (mg/l)
1	Mr Nguyen Tuan Anh'house Sn25D, group 3, Tich Luong ward	09/03/2023	0,114	0,155 ± 0,018	0,252	0,128	0,172 ± 0,023	0,280
		21/03/2023	0,137	0,187 ± 0,017	0,297	0,182	0,231 ± 0,020	0,378
2	Mrs Nguyen Thi Chung'house Sn86, group 3, Tich Luong ward	09/03/2023	0,102	0,142 ± 0,019	0,240	0,116	0,160 ± 0,025	0,268
		21/03/2023	0,125	0,175 ± 0,015	0,293	0,170	0,220 ± 0,021	0,366
3	M r Nguyen Van Hanh'house , group 5, Tich Luong ward	09/03/2023	0,103	0,145 ± 0,018	0,242	0,118	0,162 ± 0,023	0,270
		21/03/2023	0,124	0,175 ± 0,017	0,292	0,171	0,222 ± 0,020	0,370
4	Mr Tong Viet Cuong'house, group 4, Tich Luong ward	09/03/2023	0,104	0,145 ± 0,018	0,241	0,118	0,161 ± 0,022	0,272
		21/03/2023	0,127	0,177 ± 0,017	0,295	0,172	0,221 ± 0,020	0,368
5	Mrs Nguyen Thi Ngoc'house Group 6, Tich Luong ward	09/03/2023	0,106	0,147 ± 0,020	0,245	0,121	0,165 ± 0,024	0,275
		21/03/2023	0,129	0,179 ± 0,017	0,298	0,175	0,223 ± 0,021	0,369

Table 4: *Results of determination of iron content in well water in some households in Tich Luong ward, Thai Nguyen city*

From the results of determining iron content in well-drill water in Table 4, it shows that optical density A, temperature C_x of the studied solution and iron content in two standard and additional methods are not significantly different. According to both methods, iron content in households with well-drill water in Tich Luong Ward, Thai Nguyen Province is less than the allowable limit of 0.5 mg/l compared with Vietnamese standards (TCVN 5502:2003). That proves the quality of drilling water in this area is perfect.

CONCLUSIONS

Applying photometric method by UV-VIS measuring device at 500nm wavelength, iron content was determined in some well drill water samples in some households in Tich Luong ward, Thai Nguyen city. Table 4 shows that the obtained iron content is less than the allowable limit of 0.5 mg/l compared with Vietnamese standards (TCVN 5502:2003) [7]. From the above results, it has been confirmed that the safety and quality of the well water in this area does not affect the daily life of the people. The photometric method is one of the useful methods for the analysis and assessment of the accuracy of the content of heavy metals in water.

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