Contribution to the Knowledge of Iron Contains in Water from West Zone of Romania

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Abstract: Iron ions belong to the undesirable substances presents in drinking water. Their presence in water can produce organoleptic modification and make water not suitable for drinking. The aim of this study was to analyze the iron ions in ground water resources in the west part of Romania, in the period of years 2001-2005. Water samples from 846 wells and drillings were drawn, in 100 localities. The iron ions were analyzed with a spectrophotometer, with 1,10-phenanthroline chloride monohidrate. In more than half (64,85 %) of the drilling the obtained iron ions values were over the sanitary limit, the highest concentrations of iron were recorded in the drillings of 150-200 m deep.

Keywords: drinking water, iron ions

1. Introduction

Drinking water is an essential element for public health assurance the and for the quality of life. In present the drinking water sources – rivers, lakes and deep waters, are threaten by different types of contaminants [1].

In the underground water and sometimes in the surface water, one can find dissolved ferrum compounds. In most of the cases, ferrum could be found together with manganese. It is considered ferruginous water, the water that contains more ferrum than the limit admitted by the Law No.458/2002 [2], Law No.311/2004 [3] and STAS 1342/1991 [4].

In the underground water, the ferrum concentration level is high, but it is lower in the surface water (to 0.2-0.3 mg/L). This is happens because the ferrum is found especially under the form of carbonate acid, which, coming in the contact with the oxygen, suffers a hydrolysis and oxidation reaction:

$$4Fe(HCO_3)_2 + O_2 + 2H_2O = 4Fe(OH)_3 + 8CO_2 \quad (1)$$

This type of water is clear at the beginning, but then it becomes muddy because of the ferrum hydroxide. This phenomenon already appears at the level of concentration of about 0.3 mg/L. If there are humic acids present, these act like protection colloids and, because of that, the ferrum hydroxide is found in the solution in a colloidal status.

The drinking water with ferrum does not harm the human organism, but, because of some inconvenient that could appear, the ferruginous water should be treated. The ferruginous water has a metal taste and the color is opalescent yellow. This water stains the laundry and the bathroom objects, and because of the ferrum hydroxide and the accumulation of bacteria and fungus (Leptothrix, Crenothrix, Gallinonella, etc) the pipes could even become clogged. The industrial water with ferrum has some disadvantages for the manufacturing of the paper, cellulose, bier, for the laundries and chemical dye works, etc.

The maximum allowed content of ferrum from the water is regulated by the Law No.458/2002 at 200 mg/L, and sometimes, under special circumstances, at 300mg/L (Fe + Mn) according the STAS "Drinking Water" 1342/1991.

The ferrum from the deep underground water could come from mineral or organically sources. The ferrum compounds (carbonates or bicarbonates) appear because water with a high aggressive carbonate dioxide concentrate dissolves the ferrum from rocks and minerals. The ferrum compounds (silicates or oxides) are not soluble into the water and come from ferrum compounds oxidation. The proportion Fe^{+2}/Fe^{+3} are linked with the carbonate dioxide and oxygen level from the water.

Sometimes, the ferrum is found into the water as sulphides, and, in this particular case the water contains sulphurate hydrogen; the ferrum sulphate could be found only into the acid water. The ferrum could be also found into the water as organically compounds (humic compounds), that originate from the dead plants and animals decomposition, under the anaerobic conditions that exist on the bottom of the ponds.

Sometimes, the water does not contain ferrum from the source but it appears as ferrum hydroxide in the pipe system because of the corrosion of the metallic pipes. Also, the aggressive waters alter the pipes and tanks, and, if these are made from materials that contain iron, the ferrum can appear into the water as soluble salts. Some microorganisms (Polyspora, Cladotrix, Dichotoma, Tusca) divide into the ferruginous water with pH=6-10 and temperatures of 17–74º Celsius. These bacteria accumulate ferrum oxides on their gluey body. From the practice of removing ferrum from the water resulted that the ferrum could be removed easier than the manganese and it is easier to remove ferrum from the water with a high level of ferrum than from the water with a low level of ferrum that is close to the admitted level according to the law.

The ferrum and the manganese that appear as bivalent soluble salts could be tolerated in the water. Through oxidation with the oxygen from the water, the ferrum and manganese soluble salts precipitate and these precipitates are the start for the problems mentioned before [5].

$$4Fe(HCO_3)_2 + O_2 + 2H_2O = 4Fe(OH)_3 + 8\ CO_2 \quad (2)$$

$$4Fe(SO_4)_2 + O_2 + 10H_2O = 4Fe(OH)_3 + 8\ H_2SO_4 \quad (3)$$

Sources of Iron in Drinking Water

Iron is common metallic element found in the earth's crust. Water percolating through soil and rock can dissolve minerals containing iron and manganese and hold them in solution. Occasionally, iron pipes also may be a source of iron in water.

Potential Health Effects

Iron and manganese in drinking water are not considered health hazards. In addition, iron and manganese bacteria are not known to present a health risk.

Iron can affect the flavor and color of food and water. They may react with tannins in coffee, tea and some alcoholic beverages to produce a black sludge, which affects both taste and appearance [6].

2. Material and methods

In this study iron ions concentrations were analyzed in water from different sources, from vary depths, in urban and rural medium

For this purpose 208 samples from urban localities and 635 samples from rural localities in Timis County have been analyzed, in the period of years 2001-2005.

For iron qualitative determination and in order to establish the concentration domain it was used the reaction with aromatic compounds which contain the α,α'-diamine group –N=C-C=N-, include the well-known colour reaction of iron(II) with 2,2'-bipyridine (carmine red complex λ_{max} = 522 nm)

For iron quantitative determination in water it was used the reaction with 1, 10-phenanthroline chloride monohydrate. The principle: iron is pass in solution and decrease in ferrous iron stage by boiling with chlorhidric acids and hydroxylammoniumchlorid. Ferrous iron, in medium week acid, reacts with 1, 10-phenanthroline chloride monohydrate and can make one complex red – orange. This compound we measured with the spectrophotometer UV-Vis Varian Carry 50 at the wavelength 510 nm [7-9].

3. Results and discussion

First we wanted to assess the depth of the drilling and the correspondence with the iron ions concentration. We tried to establish the interval of concentration for each locality study. Results are show in table 1.

TABLE 1. Distribution of ionic concentration of iron in water samples (mg Fe/L) distribute on the deep of drillings, in South Vest Area of Romania

No.	Locality name	Sample no.	H(m)	Value interval µg Fe/L	% of drillings over MAC
1	Albina	5	10-18	295-510	100
2	Alioş	22	7-80	132-1234	95,5
3	Apateu	1	30	120	0
4	Arad	5	20-75	0-520	20
5	Bîrsău	1	3	30	0
6	Beregsăul Mare	2	7-8	18-114	0
7	Beregsăul Mic	2	7-50	51-54	0
8	Biled	1	50	246	100
9	Birda	1	14	0	0
10	Bocşa	1	12	162	0
11	Bogda	1	7	359	100
12	Bucovăţ	2	6-8	0-170	0
13	Buziaş	1	84	4715	100
14	Calacea	1	25	30	0
15	Caransebeş	3	5-100	14-174	0
16	Cărpiniş	1	40	152	0
17	Cenei	4	40-50	156-795	75
18	Chevereşul Mare	1	120	206	100
19	Chişinău Criş	1	30	40	0
20	Chizătău	3	200-250	27-132	0
21	Ciacova	30	60-169	241-4031	100
22	Ciarda Roşie	20	5-104	134-1280	95
23	Cintei	1	15	85	0
24	Covăsânţ	31	4-20	110-872	90,3
25	Crai Nou	3	6-40	145-1776	67
26	Cruceni	3	80-120	228-1307	100
27	Curtici	1	15	150	0
28	Denta	2	40	214-656	100
29	Diniaş	2	80-240	978-3492	100
30	Dobra	2	30	10-30	0
31	Dorobanţi	1	12	54	0
32	Dracşina	2	10	6-12	0
33	Dumbravita	26	75-160	0-1027	33
34	Fibiş	12	12-80	33-573	75
35	Fiscuţ	1	10	62	0
36	Folorât	1	10	15	0
37	Gătaia	4	170-200	251-521	100
38	Geoagiu	4	25-60	30-133	0
39	Ghiorog	7	10-40	124-1284	85,7
40	Giarmata Vii	39	6-99	0-632	92,3

No.	Locality name	Sample no.	H(m)	Value interval µg Fe/L	% of drillings over MAC
41	Giulvăz	3	120-170	235-1002	100
42	Grăniceri	2	8-12	41-72	0
43	Gura Honţ	1	12	280	100
44	Haţeg	1	19	12	0
45	Hitiaş	1	8	960	100
46	Hodoni	1	200	0	0
47	Hunedoara	1	200	24	0
48	Ilia	2	50	5	0
49	Ineu	2	5-7	23-214	50
50	Ionel	28	65-200	6-1247	67,8
51	Ivanda	8	14-130	60-2364	50
52	Izvin	1	80	226	100
53	Jimbolia	1	24	415	100
54	Lăţunaş	13	6-15	10-92	0
55	Lipova	1	20	3400	100
56	Lugoj	5	10-80	66-425	17
57	Maşloc	35	7-150	100-698	91,4
58	Mintia	6	10-31	153-612	83,3
59	Mişca	1	10	75	0
60	Moşniţa Nouă	31	6-90	100-918	80,6
61	Moşniţa Veche	20	5-24	100-742	75
62	Orţişoara	4	6-21	125-3490	50
63	Otelec	24	50-100	6-1297	75
64	Pâncota	2	12-15	0-81	0
65	Pădureni	1	18	150	0
66	Păltiniş	1	8	6	0
67	Pecica	1	8	0	0
68	Peciu Nou	3	7-102	3-271	33
69	Pilu	2	6-8	43-61	0
70	Poiana Mărului	2	8-10	12-131	0
71	Pojejena	1	7	177	0
72	Pustiniş	19	10-210	28-2374	52,6
73	Răuţi	2	50-80	479-1656	100
74	Recaş	3	10-18	90-460	33
75	Remetea Mica	1	10	476	100
76	Reşiţa	3	15-35	184-246	67
77	Roviniţa Mare	3	18-35	18-70	0
78	Sânicolau Mare	3	7-23	124-246	67
79	Sânmartinu Maghiar	2	90	569-858	100
80	Sânmartinu Sârbesc	2	96-98	569-858	100
81	Sânmihaiu German	29	5-87	100-777	69
82	Sânmihaiu Român	63	5-85	79-742	74,6
83	Sântana	1	7	72	0
84	Satu Nou	1	10	44	0
85	Sepreuş	1	12	71	0
86	Socodor	1	6	4	0
87	Şandra	1	45	146	0
88	Şiclău	1	10	20	0
89	Teregova	1	20	421	100
90	Timişoara	135	21-122	2-3994	44,4
91	Topolovăţu Mare	2	7-25	341-421	100
92	Ţipari	1	7	48	0
93	Uivar	8	69-120	20-1067	62,5
94	Urseni	41	5-14	100-700	73,2
95	Utvin	58	5-90	100-770	79,3
96	Vânători	1	10	91	0
97	Vârşand	1	8	153	0
98	Zărand	1	11	552	100
99	Zerind	1	12	46	0
100	Zerveşti	3	7-8	175-514	67

We can observ that the wells and drillings contaminated were in a lot of localities, but the higest procent are in: Albina, Biled, Bogda, Buziaş, Cenei, Chevereşul Mare, Ciacova, Ciarda Roşie, Covăşânţ, Cruceni, Denta, Diniaş, Gătaia, Ghioroc, Giarmata Vii, Giulvăz, Gura Honţ, Hitiaş, Izvin, Jimbolia, Lipova, Maşloc, Mintia, Moşniţa Nouă, Răuţi, Remetea Mică, Sânmartinu Maghiar, Sânmartinu Sârbesc, Teregova, Topolovăţul Mare and Zărand.

From experimental data it can be calculated the number of drillings which have iron ions quantity over the maxim acceptable concentration (MAC) established by the laws, which is 200 µg Fe/L. This value is presented in table 2.

TABLE 2. Variation of number of drillings in correlation with iron concentration in the water

	Concentration of Fe below MAC	Concentration of Fe over MAC
% drilling in urban medium	49,5 %	50,5 %
% drilling in rural medium	30,1 %	69,9 %

From data shown we can say that the number of drillings with iron ions quantity over the maximum admissible concentration is over fifteen, in all sources, rural and urban.

We have calculated how many drilling correlate with depth and the value interval of iron on every established interval. These data are shown in table 3.

TABLE 3. Variation of percent of drillings with iron ions concentration over MAC with depth

No.	H(m)	Samples no.	Value interval mg Fe/dm^3	% drilling with concentration of Fe over MAC
1	0-50	489	0-7270	68,9
2	51-100	188	0-4715	67,0
3	101-150	144	0-3167	48,6
4	151-200	19	0-1423	73,7
5	201-250	5	27-978	60

Figure 1 shows the correlation between depth and percents of drillings with iron ions concentration over MAC.

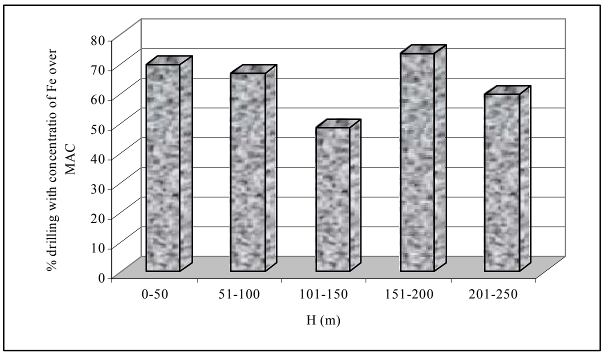

Figure 1. Variation of percent of drillings with iron ions concentration over MAC with depth

As you can see, the most contaminated water was from the first category of drillings: 151-200 m (more than 70 %).

4. Conclusions

The study shows that water from wells and drillings with iron ions concentrations over MAC is used as drinking water, in urban and rural medium.

The number of 548 water sources show iron ions concentration of over the MAC in drinking water.

These most contaminated wells and drillings were wth depth of 0-50 m, 5 - 100 m and 151-200 m.

This fact is important for to people to pay attention deferrization or other proceedings in order to decrease the iron quantity in drinking water.

It is necessary to find some protection measurements for coat water pipes used for drinking water, in order to prevent their degradation and to study the possibility to remove this iron ions form water.

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