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WATER DEFERRIZATION METHODS

Vlad-Cristian TUDOR

Scientific coordinator: Paulina IANCU

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67, email: yovlad_88@yahoo.com

Corresponding author email: yovlad_88@yahoo.com

Abstract

The depth aquifer has an important role for ensuring water treatment . In many of these cases abstracted water is loaded with iron compounds , and needing special processes for the treatment. This paper presents the results of water treament from depth drill, loaded with iron compounds using coagulation-flocculation reagents.

Key words: *water treament, deferrization, precipitation.*

INTRODUCTION

We all depend on water for our survival, and we all have to take global responsibility for it (Kemira Kemwater. 2003).
During the industrial revolution insufficient water treatment led to waterborne diseases. Even the existence of entire communities could be threatened. This development was simply not sustainable and water management became a prioritized area. Today, the processes and technologies to deliver acceptable drinking water quality are quite similar all around the globe. However, the conditions and requirements can differ between regions. Searching for tomorrow's technology and fine-tuning processes remain important issues.

MATERIALS AND METHODS

This project aims to demonstrate evolution of water treatment technologies. Sample refers to the system implemented at a drinking water treatment plants, raw water coming from deep wells (35-40 m). Water is loaded with iron, with an average concentration around 2 mg / l. The deferrization process involves several steps, including the chemical that is used for iron removal, iron-based coagulant (ferric chloride) (Iancu Paulina. 2005).
This water plant model is being implemented in Romania.

RESULTS AND DISCUSSIONS

Water treatment plant presentation:
Station is performed in order to treat an average flow of drinking water up to 460 mc / h extracted from 27 wells with depths between 30-45 m.Water caracteristics and specification (Table 1).

Table 1. Water caracteristics and specification

	Raw water	MAC*	Apa tratata
pH	7.4	6.5-9.5	6.5-8
Turbidity (NTU)	2.75	≤5	< 1
Conductivity (μS/cm)	1474	2500	<2500
Total hardness (° d)	18.48	> 5	> 5
Ammonia (mg/l)	0.41	0.5	< 0.3
Iron (mg/l)	1.5-2.3	0.20	< 0.1
Color (units of Pt/co)	10	< 25	< 25

* Maximum admissible concentration - law 458/2002

Water extracted from the wells is pumped through intermediate pumping stations to a common collecting pipe where is injected chlorine for pre-chlorination and soda (NaOH) to increase the pH for deferrization support (Figure.1). The deferrization proces begins in aeration tank were the dissolved iron from raw water will by oxidise in the presence of oxygen and form ferric hydroxide. The amount of air required for iron oxidation and precipitation is maintained in the aeration tank of oxygen to a value of about 5 mg / l. Water pH is a critical parameter for the oxidation and precipitation of iron. For oxidation pH should be at least 7.2 and ideally should have a value between 7.5 and 8.0. With NaOH injected before aeration tank pH will be maintained around the values of 8.

Theoretical is necessar 0.1432 mg / l of oxygen per 1 mg iron / L.

Maintaining a proper amounts of oxygen is necessary for various reasons:

- provide a "buffer" of oxygen to react to sudden increases iron;
- the resulting water tastes better;
- air needed to maintain oxygen tank mixing facilitates iron to react quickly and efficiently with oxygen.

Value of 5 mg / l residual oxygen is generally accepted. Oxidation tank is fitted with diffusers that uniformly distributes air from two blowers that provide an average flow of 71.45 m3 air / h.

Iron oxidation is not instantaneous. For this reason the station have specific reaction times follow to such a process. Sizing of reaction tanks is optimal, aeration tank with a retention volume of 125 m^3, guarantees a reaction time of 17 minutes at maximum output. Mixing tanks are sized to a total volume of 14 m^3, which guarantees a minimum of 2 minutes rapid reaction. Flocculation tanks are sized to a volume of 50 m^3, guaranteeing the slow reaction time of 8 minutes.

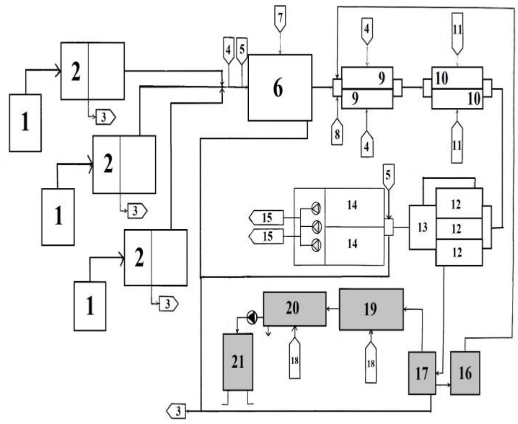
Once oxidized, iron from the aeration chamber it should be removed from the water. Processes that continue deferrization are coagulation and flocculation. Coagulation occurs in mixing tanks where $FeCl_3$ (ferric chloride) is introduced to produce the phenomenon of coagulation and NaOH (soda) for pH correction.

The next stage is represented by flocculation tanks, where an anionic polyelectrolyte prepared at a concentration of 0.1% is dosed to performed in slow mixing flocculation of particles produced in previous processes.

The last step of this process is the water treatment filtration. This is done in three sand filters, which provide water to the finish like removing agglomerates formed in the chemical step.

Filtered water is collected in deposits where final disinfection with chlorine occurs.

The station is provided also with a line for sludge resulting from the treatment process. Loaded sludge is thickened and dehydrated in special installations where cationic polyelectrolyte is dosed.



Legend:

1 Wells drilled;	12 Filters
2 Pumping station	13 Filtered water storage
3 Overflow	14 Treated water storage
4 NaOH dosage	15 Treated water output
5 Chlorine dosage	16 Float recovery storage
6 Aeration tank	17 Wash water recovery storage
7 Air dosage	18 Cationic polymer dosage
8 $FeCl_3$ dosage	19 Sludge thickener
9 Mixing tank	20 Sludge dewatering
10 Flocculation tank	21 Dried sludge storage
11 Anionic polymer dosage	

Figure 1. Treatment plant scheme

In the first step deferrization occurs by oxidation. The phenomenon takes place in the aeration tank where water is brought by soda at pH 8.

The following reaction describes the oxidation of iron in the presence of oxygen: $4\ Fe(HCO_3)_2 + O_2 + 2H_2O \rightarrow 4\ Fe(OH)_3 + 8CO_2$

At the end of the oxidation processes of iron water is loaded with iron hydroxide particles, colloids and other substances and suspensions. Removing water loading is performed in coagulation and flocculation step.

Coagulation is a very important step in the process of drinking water treatment, by chemical reaction of destabilization, colloids and matter in suspension suspended solids in water, forming settleable flakes or microflakes easily removed by filtration.

To achieve a maximum efficiency of this chemical process advance documentation is needed and laboratory tests to determine the optimal dose of coagulant.

At this moment in our country are used for coagulation aluminum and iron salts.

Aluminum salts are:

- Aluminum sulfate, is a solid product with a concentration of the active ingredient - 15-17% aluminum, which is used at different concentrations dissolved in water.
- Polihidroxide aluminum chloride is a liquid, with different active ingredient concentrations 4-9% aluminum, is proposed to replace aluminum sulphate, showing advantages in terms of dosing and improved reaction on water.

Iron salts:

- Ferric chloride, is a liquid, reddish brown, very corrosive, concentration used at 40% ferric chloride, the substance is more used for wastewater treatment plants.
- Ferric sulfate is a liquid, dark brown, less corrosive than ferric chloride, used in concentrations of 40-43% ferric sulphate, applied over wastewater treatment plants.

The choice to treat water loaded with iron with an iron salt highlight more the phenomenon of chemical coagulation.

To establish the optimal dosage we have to take into consideration pH and the water loading. Before chemical coagulation step the water has a pH of 8 and a load of iron hydroxide, suspension matter and colloids.

Laboratory tests are performed, demonstrating practical and spreadsheet coagulation process, finding the optimal dosage of coagulant (Table 2).

Also at laboratory level is established the flocculant dose required to speed up process of removing colloids and the suspensions from water.

Laboratory tests were made jar-test type, in 1 liter glasses, simulating the processes of the plant, respecting the response time of each stage. (quick mixing 2 minutes, slow mixing 8 minutes and decanting 12 minutes).(Figure 2).

Raw water characteristics:

pH – 8
Turbidity – 2.75
Fe – 2 mg/l
Color – 10 units Pt/Co

Table 2. Laboratory Jar-test results

Probe nr.	MU	1	2	3	4	5
$FeCl_3$ dosage	µl/l	2	4	6	8	10
Polymer dosage	ml/l	0.7	0.7	0.7	0.7	0.7
NaOH dosage	µl/l	1	1.5	2	2.5	3
pH		7.21	7.18	7.15	7.13	7.09
Turbidity	NTU	1.2	0.9	0.7	0.82	0.95
Fe	mg/l	0.26	0.15	0.08	0.06	0.05
Color	units Pt/Co	11	14	18	24	27

Considering the data obtained in the laboratory, it was determined an optimal dose of coagulant FeCl3 at 6 ml / l, an anionic flocculant dose (conc. 0.1%) at 0.7 ml / l and the pH correction with soda at a dose of 2 ml / l.

Using these doses all parameters were rated according to the law 458/2002 on drinking water quality.

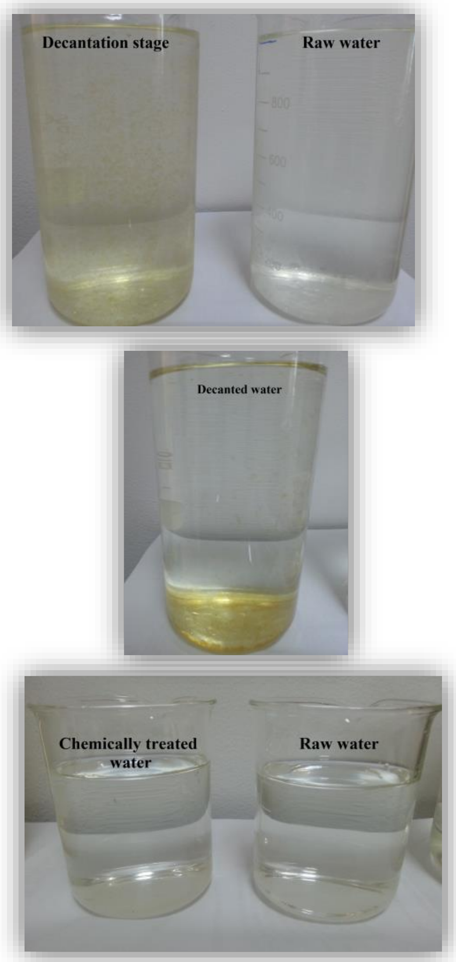


Figure 2. Photos from laboratory – optimal doses results

CONCLUSIONS

Treatment processes for drinking water are continuously developing. Rehabilitation and upgrading their flow changes require new technology and new solutions applied to increase the quality and the economic efficiency of treatment plants.

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