Buletinul Ştiinţific al Universităţii "Politehnica" din Timisoara, ROMÂNIA
Seria CHIMIE ŞI INGINERIA MEDIULUI
Chem. Bull. "POLITEHNICA" Univ. (Timişoara) *Volume 53(67), 1-2, 2008*

Studies Regarding the Drinking Water Quality Using Aluminium Sulphate Comparative with Aluminium Base Poly

C. Mihali[*], E. Cical[**], G. Oprea[*], G. Vâtcă[*], G. Burtică[***], L. Lupa[***]

[*] North University from Baia Mare, Science Faculty, Department of Chemistry – Biology, no. 77, Romania, E-mail: cmihali@yahoo.com

[**] S.C. Vital S.A., Baia Mare, Gh.Şincai street nr.19-21,Romania,E-mail: elenacical@yahoo.com

[***] University "Politehnica " from Timişoara, Faculty of Industrial Chemistry and Environmental Engineering Timişoara, Victoria Square, no.2,Romania

Abstract: The paper present a study regarding the water treatment from the accumulation lake Strimtori – Firiza with aluminium sulphate and calcium hydroxide, comparative with aluminium base poly chlorine and calcium hydroxide. Aluminium base poly chlorine is a new coagulation reagent, which was studied for the first time on this source. Was followed the efficiency of these chemical reagents in the treatment process, because the raw water used in this study is characterised by variable turbidity, low alkalinity and temperature. The main purpose of the experimental studies is the obtaining of the drinkable water quality in accordance with the legislation.

Keywords: water treatment, drinking water quality, aluminium base poly chlorine, aluminium sulphate

1. Introduction

In natural conditions the water is never find in pure state, in this is always find a quantity of chemical substances under dissolved form or in suspension. The removal obligation belongs to the water treatment stations which trough the approach treatment procedures realise a technological flux which assure the drinking water quality in the limits provided by the legislation. The stable colloidal particles from water can not be removed by decantation and fast filtration, so was introduced the coagulation process which allowed the introduction of the fast filtration, with best results from the point of view of the water quality and productivity [1, 2].

In the water treatment, the coagulation process is used to improve the aggregation, to transform a stable suspension in one unstable. The stability of the colloidal particles from water is given by the fact that in a aqueous solution, around these is formed films with electrical charge of the same mark, which make both reject. Trough coagulation the particles which stayed in lake months or years can be aggregated in a hour or less. The coagulation process must be lead so that it may be changed and control the aggregation degree of the particles [3].

The aluminium sulphate with the chemical formula $Al_2(SO_4)_3*18H_2O$ and a 8.1% Al content, is an incontestable efficient coagulant, in the most of the cases, his results are mediocre in the case of the waters wit low temperatures, higher turbidity and low alkalinities. The hydrolyse velocity is low, the aluminium sulphate quantity dosed and the residual aluminium concentration is higher so the coagulation process efficiency is decreased [4, 5].

Aluminium base poly chlorine with the chemical formula $Al_n(OH)_m(Cl)_{3n-m}$ is a coagulation reagent partial hydrolysed, based on aluminium chlorine. Is an acid product under liquid form (density = 1.27 kg/dm^3 and with 10% Al content) can be dosed in installation in diluted solution [6].

The accumulation lake Strimtori – Firiza, component part from the hydro technique system Runcu Firiza, in the present represent the main source of alimentation with water of the Baia Mare municipal.

In general the water quality is good with the exception of 4 – 5 months per year when is registrated higher turbidity caused by the snow melt, abundant rains and alluviums from the versants [7].

2. Experimental part

In the frame of the made paper is present a study regarding the water treatment with aluminium sulphate and calcium hydroxide, comparative with aluminium base poly chlorine and calcium hydroxide. For the establishment of the efficiency of those two treatment techniques was made experimental studies in the laboratory and practice studies on a treatment station.

The experimental studies made in laboratory were lead during a period of 6 months and have like main objective the determination of doses and coagulation optimal conditions for aluminium sulphate and aluminium base poly chlorine, using raw water with turbidity between at 10 – 100 UNT. The calcium hydroxide is an alkalinise reagent which was used for the realising of the coagulation optimal pH.

For the establishment of the coagulation optimal conditions were used Jar – test method. The coagulation doses for aluminium sulphate and aluminium base poly chlorine were added corresponding in the samples of 1 litre of raw water, after which were quickly stirred (140 rot/min) for 2 minutes, respective slowly stirred (40 rot/min) for 15 minutes and 30 minutes of settling. From supernatant was sampled treated water and was determining the next parameters: turbidity, COD, alkalinity, pH and residual aluminium. Function of the admitted values by the legislation of the mentioned parameters was established the optimum doses of coagulation for aluminium sulphate and aluminium base poly chlorine. The practical studies were made at the "Micro plant" in the period of technological test. The coagulation optimal doses obtained in the laboratory for the aluminium sulphate and aluminium base poly chlorine were applied in the technological flux, function of the corresponding turbidity in the raw water from the period of the practical studies. It was studied a month the water treatment technique using aluminium sulphate and calcium hydroxide and a month of water treatment technique using aluminium base poly chlorine and calcium hydroxide.

The water turbidity was determined using a turbid meter WTW 350 IR. The determination of the raw water pH, conductivity and temperature were made with corresponding apparatus HANNA. The water COD, alkalinity, hardness, CBO_5, were made using volumetric chemical methods. The residual aluminium, nitrates, nitrites, iron, manganese was determined using a molecular absorption spectrophotometer Hach DR 2000. The metal ions: copper, zinc, nickel, was determined using an atomic absorption spectrophotometer NovAA 400.

3. Results and discussion

The technological flux from the "Micro plant" contain the next steps: catching of the raw water, shaking room of the water with chemical reagents, reaction room combined with lamellar settle, water filtration trough under pressure filters, water disinfection with sodium hypochlorite and drinkable water storage. Practical trough the studied technological flux is wanted the obtaining of the drinking water quality in accordance with the legislation requirements [8].

The raw water composition in the period in which were made the practical studies was determined in accordance with standard methods; the obtained results are present in table 1 comparative with the recommended values by the legislation [9 – 10]

TABLE 1. Raw water composition

No.	Determined parameters	M.U.	Determined values		NTPA-0.13/2002
			Min	Max	
1.	Turbidity	NTU	4	16	-
2.	pH	pH units	6.7	6.8	5.5-6
3.	Alkalinity	mval/L	0.5	0.5	
4.	COD	mg/L O2	1.97	2.76	20
5.	Hardness	d G	1.68	1.79	-
6.	Aluminium	mg/L	0.008	0.028	-
7.	Nitrites	mg/L	0.003	0.009	-
8.	Nitrates	mg/L	0.325	0.450	50
9.	Temperature	^{0}C	6	9	22
10.	Conductivity	µS/cm	57	120	1000
11.	CBO_5	mg/L	1.5	2	<5
12.	Iron	mg/L	0.074	0.136	1
13.	Manganese	mg/L	0.019	0.047	0.1
14.	Copper	µg/L	<10	13	50
15.	Zinc	µg/L	25	68	1000
16.	Nickel	µg/L	<20		50

From the presented data in table 1 can be observed that the raw water correspond with the quality norms which must lead the surface waters used for the drinkable, in conclusion can represent a source of water alimentation.

3.1. The coagulation process efficiency using aluminium sulphate and calcium hydroxide

In the frame of the made studies was followed the coagulation process efficiency using aluminium sulphate and calcium hydroxide. From the experimental studies made in laboratory results that in the case of this water treatment techniques is obtained optimal results of pH with 7 and alkalinity of 0.5 mval/L to the treated water. This pH is obtained by added of hydroxide [11].

In figure 1 are present the optimal doses of aluminium and hydroxide doses obtained experimental in laboratory on raw water with turbidity between 10 – 100 UNT.

From the presented data can be observed that the aluminium and hydroxide dose increase linear with the increasing of the raw water turbidity. For a turbidity of the raw water of 10 UNT the coagulation optimum dosed are: 1.1 mg/L Al and 2.31 mg/L OH^-, and for a turbidity of 100 UNT the optimum dose of coagulation are: 6.7 mg/L Al and 14.21 mg/L OH^-. Can be observed that the ratio between aluminium dose: hydroxide dose is 1: 2.1.

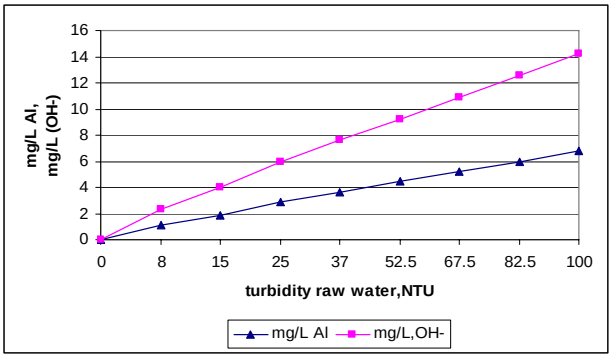

Figure 1. The variation of the optimum doses of aluminium and hydroxide versus of raw water turbidity

With the help of the experimental results obtained in the laboratory for the mentioned treatment technique were made practical studies on the technological flux. The main studied parameter during a month was the turbidity of the raw water. The turbidity of the raw and drinking water obtained during the study are presented in figure 2.

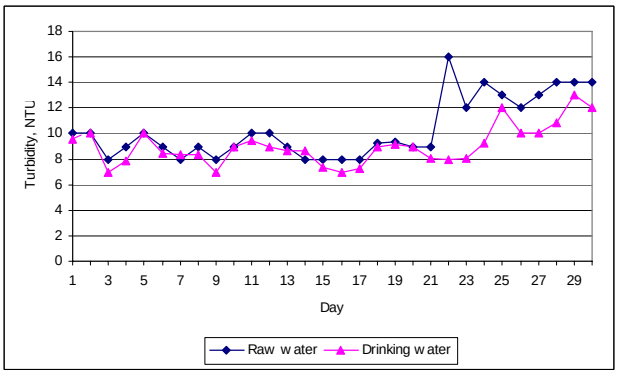

Figure 2. The turbidity variation of raw water and drinking water in the studied month

From the experimental data can be observed that the raw water turbidity in the studied month is between 7 and 16 UNT. The obtained turbidity of the drinking water is between 7 and 13 UNT, the values being over the maximum concentration admitted by legislation (turbidity MCA <5) [8]. Because of the fact that the alkalinity of the raw water is very law, the temperature of the raw water is under 10ºC, the hydrolyse velocity of the aluminium sulphate is very slowly, the aluminium doses added in the treatment process are higher, in conclusion the coagulation process efficiency is slowly [4, 5]. Besides this the technical conditions of the installation doesn't assure an intimate contact of the water with the reagents, the quickly stirring is less than 2 minutes, inefficient for the realising of the perikinetic coagulation. In conclusion this treatment technique presents a law efficiency on the coagulation process for the studied technological flux.

3.2. The coagulation process efficiency using aluminium base poly chlorine and calcium hydroxide

In the frame of the made studies was followed the efficiency of the coagulation process using aluminium base poly chlorine and calcium hydroxide. In figure 3 are presented the optimum optimal doses of aluminium and doses of hydroxide obtained experimental in laboratory on raw water wit turbidity between 10 – 100 UNT.

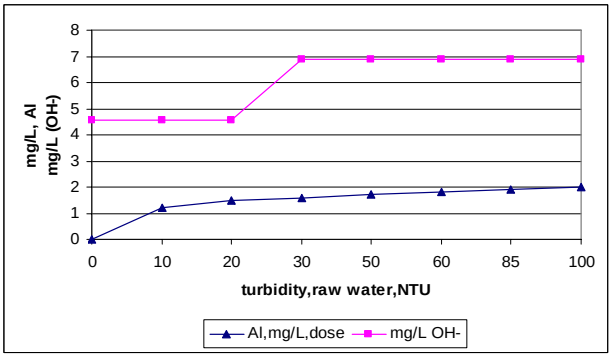

Figure 3. The variation of the aluminium and hydroxide doses versus of the raw water turbidity

From the experimental data made in laboratory result that in the case of waters with turbidity under 20 UNT the treatment process is efficient if is realised an increasing of the raw water alkalinity with calcium hydroxide from an alkalinity of 0.5 mval/L and pH = 6.8 to an alkalinity of 0.6 mval/L and pH = 7.2. In this case the added hydroxide dose is 4.57 mg/L OH^-. At turbidity of the raw waters over 20 UNT is needed the water alkalinise with calcium hydroxide from the alkalinity of 0.5 mval/L and pH = 6.8 to an alkalinity of 0.7 mval/L and pH =7.4. In this case the hydroxide doses added is of 6.89 mg/L OH^- [11].

From the experimental data presented in figure 3 can be observed that at the turbidity under 20 UNT the aluminium doses are between 1.1 – 1.5 mval/L Al being smaller than the Al doses obtained experimental in the case of use of aluminium sulphate. At turbidity higher than 20 UNT can be observed that the aluminium doses present a slowly increasing, the values being between 1.5 - 2.0 mg/L Al, being by 2-3 times lower than the experimental Al doses obtained in the case of aluminium sulphate.

With the help of the experimental results obtained in the laboratory for this treatment technique was made practice studies on the technological flux. The main parameter studied for a month was the turbidity of the obtained drinking water. The turbidity of the raw and drinking water during the study are presented in figure 4.

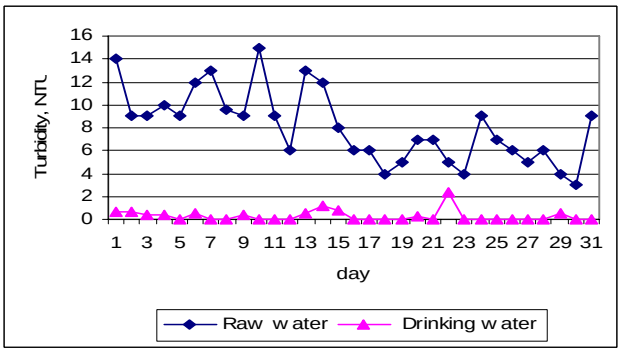

Figure 4. The variation of the raw water and drinking water turbidity obtained in the studied period

From the presented data can be observed that the raw water turbidity is between 3.5 and 15 UNT, and the turbidity of the drinking water is between 0,001 and 2.1 UNT. Because of the fact that the aluminium base poly chlorine is a coagulation reagent partial hydrolysed can be observed that is obtained conform turbidity of the treated water even in conditions in which the turbidity of raw water is under 20 UNT, the lower alkalinity and temperature under 10ºC [7]. This treatment technique presents higher efficiency on the coagulation process for the studied technological flux. In the view of assurance of the drinking water quality were analysed the main parameters during the studied period: residual aluminium, COD, nitrates, nitrites.

The use of the coagulation reagents based on aluminium leads, in most of the cases, to the higher concentration of aluminium in the treated water than in the raw water, practical is wanted a decreasing of the aluminium content in the treated water. In figure 5 is presented the variation of residual aluminium concentration from the treated water during the studied period (a month).

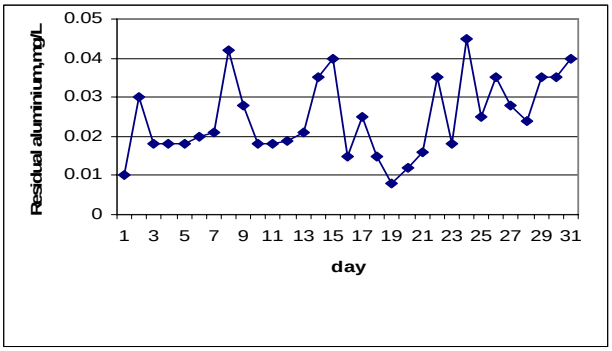

Figure 5. The variation of the residual aluminium in the studied period

From the experimental data presented in figure 5 can be observed that the aluminium concentration from the drinking water are between 0,009 – 0,047 mg/L Al being under the limit of the maximum admitted concentration by the legislation (aluminium MAC <0,2 mg/L) [8] The organic materials from water influence the chose of the coagulant dose the same like the inorganic particles. In figure 6 is presented the variation of the COD during the studied period (a month).

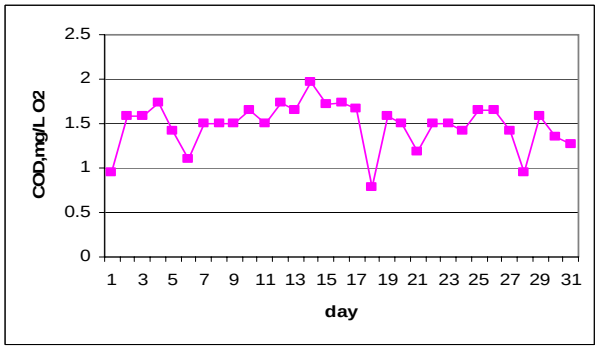

Figure 6. The variation of the COD in the studied period

From the experimental data presented in figure 6 can be observed a significant reduction of the COD trough coagulation, the obtained values are between 0.7 – 2.0 mg/L O_2, being under the maximum concentration admitted by the legislation (COD MAC < 5 mg/L O_2) [8].

The nitrates presence in drinkable water over the limit, determine negative effects on the human health. Noxious are in fact the nitrites which results from nitrates in some conditions, in organism but also abiotic zincates vessels and pipe where the nitrates are reduced generating a secondary toxicity of the nitrates. In figures 7 and 8 are presented the variations of the nitrates and nitrites concentrations during the studied period (a month).

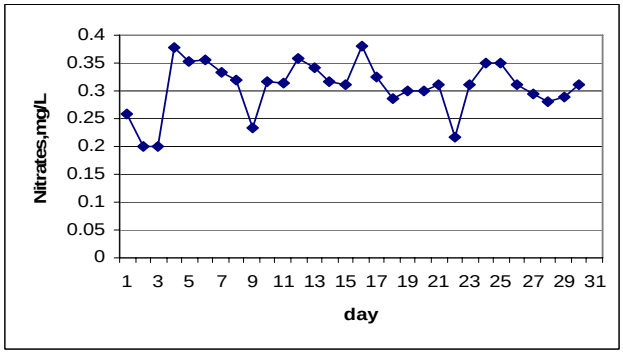

Figure 7. The nitrates variation in the studied period

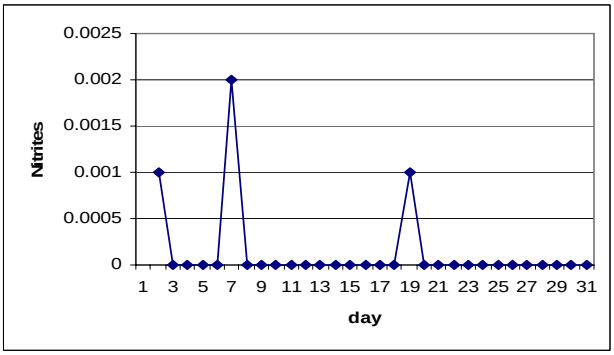

Figure 8. The nitrites variation in the studied period

From the presented data can be observed that the obtained concentrations values of nitrates and nitrites are under limit of the maximum concentration admitted by legislation of water quality (nitrates MAC < 50 mg/L, nitrites MAC < 0.5 mg/L).[8]

4. Conclusions

In the frame of this paper is presented a study regarding the water treatment with aluminium sulphate and calcium hydroxide, comparative with aluminium base poly chlorine and calcium hydroxide. Calcium hydroxide is an alkalinise reagent which was used for the realising of the optimal coagulation pH. For the establishment of the efficiency of those two techniques was made experimental studies of laboratory and practical studies. The laboratory experimental studies consisted in the determination of the

aluminium optimal dose using aluminium sulphate, comparative with aluminium optimal doses using aluminium base poly chlorine on raw water with turbidity contented between 10 and 100 UNT. For the determination of the coagulation optimal conditions were used "Jar – test" methods. From the made experimental data can be observed that the optimum dose of aluminium for the aluminium sulphate are between 1.1 – 6.7 mg/L Al and higher comparative with the aluminium doses, for the aluminium base poly chlorine which are between 1.1 – 2.1 mg/L Al.

The practical studies was made at a "Micro plant" and has like objective the applying in practice the mentioned treatment techniques having like scientific support the laboratory experimental studies. The water content of the raw water in the studied period was analysed in parallel with the composition of the drinkable water. Each treatment technique was studied for a month. The water treatment technique using aluminium sulphate and calcium hydroxide presents a slowly efficiency for the studied technological flux. The turbidity of the drinking water is over the limit of the maximum concentration admitted by legislation [8]. The water treatment technique using aluminium base poly chlorine and calcium hydroxide is optimal and present higher efficiency for the studied technological flux. All the analysed parameters have values under the limit of the maximum concentration admitted by the legislation [8].

The use of aluminium base poly chlorine in the process of water treatment present the advantage that react very quickly with the water, assure a good elimination of the organic materials from water only trough coagulation, determine small values of the residual aluminium from treated water and correspond to the European requirements.

The made studies present an original contribution, having like finalisation the applying in practice of the optimal technique studied. In present at the "Micro plant" administrated by SC VITAL SA Baia Mare is used in the water treatment process aluminium base poly chlorine and calcium hydroxide. The obtained drinkable water is distributed to the inhabitant from the Ferneziu district of the Baia Mare municipal.

REFERENCES

1. Faust, S.D., Aly, O.M., Chemistry of water treatment, 2nd Edition, Stonenham, MA:Butterworth Publishers,**1998**.
2. Jiang, J.Q., Graham, N.J.D.,Chem Ind., **1997**, 10, pp. 389.
3. Jarvis, P., Jeferson, B., Simion, A., **2006**, 40, pp. 2727.
4. Tardat-Henry, M., *Sciences et tehnique de l'eau*, **1989**, 22, No. 4.
4. Schintu, M., Meloni, P., Contu, A., *Ecotoxicology and Environmental Safety*, 46, **2000**, pp. 29.
5. Gerardin, I., Taulelle, F., *J Chim Phys*, **1995**, 92, pp. 1877.
6. Cordos, E., Roman, C., Ponta, M., Frentiu, T., Rautiu, R., *Rev. Chim.*, **2007**, 58.
7. ***Legislation 458/**2002** regarding the quality of the drinkable water
8. ***NTPA-013 The qualities norms which must fulfil the surface waters used for the drink ability
9. ***NTPA-014 The normative regarding the measures methods of sampling frequency and analyse of the sample from surface waters addressed to the drinkable waters production
10. Cical, E., Burtică, G., Gasparik, G., Proceeding of The International Symposium on Trace Elements in the Food Chain, Budapest, May 25-27, **2006**, pp.107.