Influence of the Coagulation to the Quality of Treated Water and to the Turbidity Parameter

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Abstract: The paper presents the study concerning the quality of raw water catched from the lake, the characteristics of this water in certain periods of the years took in study, and also the quality of drinking water obtained in the treated process using like coagulation agent the stas aluminium sulphate and for the pH correction the lime milk reagent. The turbidity parameter of the treated water is not in the frame of the law requirements in a few month of the year.

Keywords: coagulation, suspension elimination, turbidity, water quality

1. Introduction

The water is an indispensable factor for the human organism. In natural conditions, the water can not be found in pure state, it contains an amount of some chemical substances dissolved or in suspensions. The natural impurities from water that are under liquid, solid or gaseous form can be dispersed in this, from the point of view of the fineness degree, after three stages: suspensions, colloids and dissolved.

In the dissolved state these compounds that are in the natural waters there are in an high amount, but from the point of view of the quantity present interest the next one:
- dissolved gaseous: CO_2, O_2, N_2
- anions: HCO_3^-, CO_3^{2-}, SO_4^{2-}, Cl^-
- cations: Na^+, Ca^{2+}, Mg^{2+}

The pH value determine in a high way the chemical and biochemical process which take place in water, most of these taking place at 6.5 – 8.5 pH, over and under these values the biological process are slowing down.

The removal of suspensions is a concern of the treatment water plant which realizes a technological process by the use of treatment proceeds, what assure the quality of drinking water in the frame provided by the legislation.

The removal of suspensions by decantation is a separation process of the solid particles from suspension by the action of the gravitation forces, so that the mixture liquid – solid is separate in a clear liquid and in concentrate suspensions.

The removal of suspensions by filtration consists in the passing of water trough a sand bed with a certain granulometric composition and height where the remained fine particle in suspension after decantation are retain.

The removal of suspension by coagulation

The surface waters contain a high amount of colloidal substances with a specific weight closed of the water, which remain in suspension for a long time. This phenomena is due to their stabilisations in watery solution,

around these colloidal particles are formed pellicles with the same electric charge which cause the mutual repulse, causing in this way the impossibility of deposing of these, or they are deposing in a very long time.

In the treatment water are used some reagents which by their dissolution in water produce ions with contrary sign that those of the colloidal particles. The partial neutralizations of these charges lead to the colloids conglomerations in flakes (bigger and weightier aggregates).

The stable colloidal particles can not be removed by decantation and quick filtration, so it was introduce the coagulation process, which allowed the introduction of the quick filtration, with a very good result in the concerning of quality and productivity of water.

In the specific literature this procedure of the water treatment with chemical reagents is named coagulation – flocculation.

2. Experimental

The raw water collected from the Firiza lake represent the main source of alimentation with water of the Baia Mare municipal. The water quality is good with the exception of four month per year when the turbidity parameter of the treated water is not in the frame of the law 458/2002 requirements.

In Table 1 are presented some of the established parameters of the raw water.

TABLE 1

No	Parameter	value	
		Min	Max
1.	Turbidity,UNT	4	80
2.	pH	6.6	6.9
3.	Alkalinity, mval/l	0.45	0.6
4.	Hardness,G	1.68	2.7
5.	Aluminium, mg/l	0.001	0.010

The technological flux contain the next treatment procedures: the entry of the raw water, the mixing of water with aluminium sulphate and calcium hydroxide for the coagulation object, clarification, filtration and disinfection.

It was studied the turbidity parameter of the raw and treated water during of two years, 2003 – 2004 from which we represented graphic the turbidity variation function of the days from the month with the highest values for the mentioned parameter.
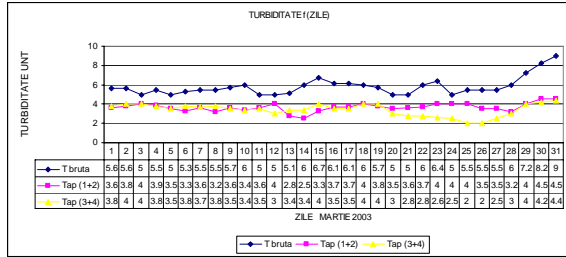
Figure 1. The turbidity variation functions by the days in the March month, in 2003 – characterized by a good quality of the raw water.
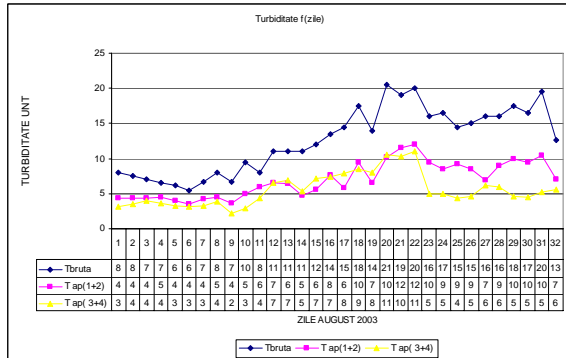
Figure 2. The turbidity variation in August 2003-caracterized by drought a law volume of water in the lake.
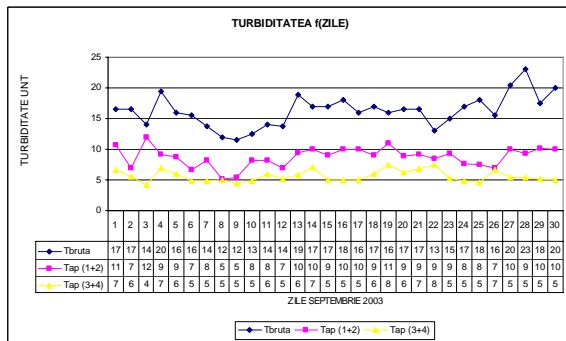
Figure 3. The turbidity variation in September 2003-caracterized by law volume of water in the lake and rains.
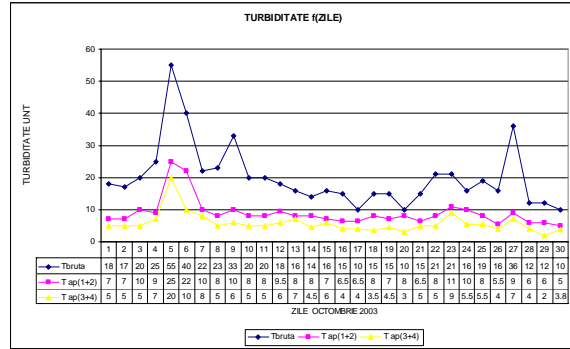
Figure 4. The turbidity variation in October 2003-caracterized by law volume of water in the lake and rains.
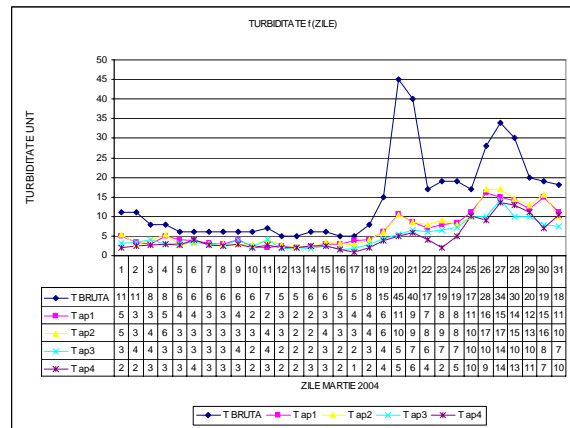
Figure 5. The turbidity variation in March 2004-caracterized by snow melt and rains
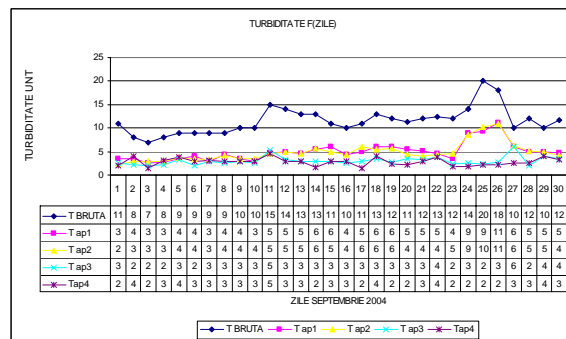
Figure 6. The turbidity variation in September 2004-caracterized by law volume of water in the lake and rains
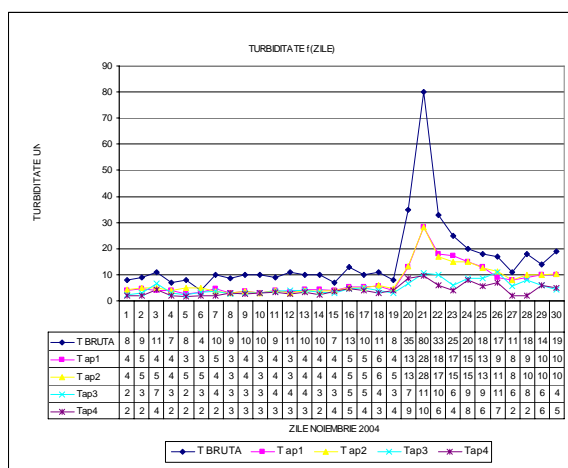
Figure 7. The turbidity variation in October 2003-caracterized by law volume of water in the lake and overflows rains

*ap(1+2)-drinking water reservoir 1+rezervoir 2 –stage I,II
*ap(3+4)- drinking water reservoir 3+rezervoir 4 -stage III
*ap1- drinking water reservoir 1stage I,II
* ap2- drinking water reservoir 2 stage I,II
*ap3- drinking water reservoir 1stage III
*ap4- drinking water reservoir 2 stage III

In accordance with the graphical representations we can see that the water turbidity in the periods of spring – autumn increase for the raw water from 5 to 80 UNT and for the treated water from 3 to 30 UNT. The turbidity value of the treated water it's due to the deficit conditions of the existent technological flux.

The water quality corresponds regarding the turbidity parameter eight months per year.

The high values of turbidity it's due to the fact that the function of natural clarification of the lake was extenuated in time.

Consideration about the chemical process

The destabilization of the colloidal systems using chemical reagents has place by a complex mechanism, which has lead to elaboration of more theories that are based on **physical forces, adsorption forces or chemical forces.**

The theory of destabilization by physical forces

Between two particles charged electrical, which are going one to another, action repulse forces and Van der Waals attraction forces. For the attraction forces to be significance, the particle must close enough one on each other, these is realised by Brownian moving, so they have kinetic energy. If the energy is higher enough, the particles become closer until them crossing their sphere of versus ions charges.

So a colloidal particle is situated in two force field, each field being characterizes between a certain potential energy.

A particle entering in the attraction field of another particle has a potential energy conferred by the presence of those two fields. The resulted potential energy is the sum of the corresponding potential energy of those two fields.

If **ΔE_p<0**, the particles are attractable, the zeta potential (PZ) decrease by the compressing of the   diffuse thickness.

If **ΔE_p>0**, the particle are repulsive.

In the crossing zone of the electrical thickness of those two colloidal particles the ions concentrations is higher, same is the ions straight which determine the compressing of the diffuse thickness and the degreasing of the zeta potential.

The most used salts as coagulation reagents are the aluminium salts.

At acid pH in a watery solution, the cations of these salts are found under hydrolyzed form $[Al(H_2O)_6]^{3+}$.

With the increase of the pH take place the hydrolyzing of these ions.

The general equation of hydrolyzing is:

$$xMe^{3+} + yH_2O \leftrightarrow [Me_x(OH)_y]^{3x-y} + yH^+ \quad (1)$$
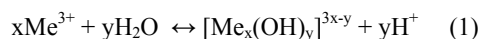
The hydrolyze products are formed in a big amount or small amount depending on the pH value. The increase of the pH value lead to the increasing of the numbers OH^- groups.

The species with positive charge are formed only at law values of the pH. [12]

After hydrolyze result protons which react with the bicarbonates from water and lead to the decay of these, wading the degreasing of the pH

$$HCO_3^- + H^+ \leftrightarrow CO_2 + H_2O$$
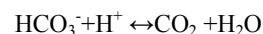
3. Conclusions

The water quality is not corresponding regarding the turbidity parameter, resulting higher values over 5 UNT (1 UNT in accordance of Law 458/2002).

We can observe the inefficiency of the coagulation process in the mentioned periods, also characterized by the low temperature of the raw water.

The perikinetic and ortokinetic coagulation is realised in the blended room and on the way from the tower to the clarifying tanks. The distance between the blended tower and the clarifying tanks is covered in   5 – 7 minutes, insufficient to realise the optimal conditions of coagulation.

The colloidal systems are not total destabilized, what made impossible the formation of big and stabile kinetic flakes, which than to be depose in clarifying tanks.

Small flakes are formed which can not be depose in the clarifying tanks, they passed in the filtrate thickness making difficult the wash operation.

The depose with suspensions make difficult the washing of these because the treated and the wash water pass trough the clarifying tanks in the ascending way.

The concentration of the residual aluminium is higher.

The higher values of the turbidity indicate a higher consumption of chlorine for assuring the disinfection,

which involve the higher costs in ratio with the obtained quality.

The absence of the settling stage overloads the contact clarifying tanks, retaining almost 40 % from suspensions and causing a small efficiency of filtration.

The quality of clarificated and filtrated water is influenced by the absence of the determination systems of the loss of charges on the filter and clarifying tanks which made that the washing to be effectuated arbitrary leading to higher consumptions of washing water and electrical energy.

For the improving of the quality of the drinking water obtained in treatment station we recommended:

- the testing of new coagulation reagent: prehydrolyzed aluminium sulphate, aluminium bases polichlorures, alsal;
- the testing of new alkalinized reagents: sodium carbonate, alsal, sodium hydroxide;
- the testing of different combination of the presented reagents;
- the introduction of a settling stage in the technological process and the elimination from function of the clarifying tanks;
- modern filters with higher efficiency and lower consumptions of washing waters;
- the improving of the laboratory apparatus regarding the determination of a higher numbers of parameters;
- the automation of the technological process.

Regarding the lower amounts of suspensions, the lower temperatures of the raw water would be efficient a suspensional drought, the retaining of suspension in the sludge thickness can be realised by an adsorption mechanism.

For assuring the quality of drinking water, the lower temperature of the raw water involves the leading of the technological process at the higher pH than 7, degreasing so the aggressive character of the water which have negative consequence in the distribution plant.

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14. *** NTPA-013 Normele de calitate pe care trebuie să le îndeplinească apele de suprafaţă utilizate pentru potabilizare-prevăzute în anexa nr.1

15. *** NTPA-014 Normativul privind metodele de măsurare şi frecvenţa de prelevare si analiză a probelor din apele de suprafaţă destinate producerii de apă potabilă prevăzute în anexa nr.2

16. *** Legea 458/2002 privid calitatea apei potabile

17. *** Directiva 98/83/EC

18. *** Regulamentul cadru de exploatare si intretinere a Statiei de tratare