TECHNOLOGICAL PROCESS ASSESSMENT OF THE DRINKING WATER TREATMENT AT TARGU-MURES WATER TREATMENT PLANT

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ABSTRACT. – This paper intends to assess the technological process of obtaining drinking water at Targu-Mures water treatment plant. The assessment was performed before changing the technological process and four months were chosen to be analized during 2008: January, April, July and October for its efficiency analysis on treatment steps. Mures River is the water source for the water treatment plant, being characterized by unsteady flow and quality parameters with possible important variability in a very short period of time. The treatment technological process is the classic one, represented by coagulation, sedimentation, filtration and disinfection, but also prechlorination was constantly applied as additional treatment during 2008. Results showed that for the measured parameters, raw water at the water treatment plant fits into class A3 for surface waters, framing dictated by the bacterial load. The treatment processes efficiency is based on the performance calculation for sedimentation, filtration, global and for disinfection, a better conformation degree of technological steps standing out in January in comparison to the other three analyzed months. A variable non-compliance of turbidity and residual chlorine levels in the disinfected water was observed constantly. Previous treatment steps managed to maintain a low level of oxidisability, chlorine consumption and residual chlorine levels being also low. 12% samples were found inconsistent with the national legislation in terms of bacteriological quality. Measures for the water treatment plant retechnologization are taken primarily for hyperchlorination elimination, which currently constitutes a discomfort factor (taste, smell), and a generating factor of chlorination by-products.

Keywords: drinking water, water treatment plant, water source.

1.INTRODUCTION

The quantity and quality of water available for different uses represent the basis for the level of people's development and the subsequent quality of life improvement (Barba, 1997).

During the last three centuries the increasing demand of water for human use (from freshwater sources) was much more pronounced than the population growth. It is internationally accepted that identification of proper water sources,

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their severe protection and a complete and correct treatment can provide a water quality that does not represent a health hazard. The correct choice and water sources protection are of prime importance in ensuring safe drinking water supplies. It is always preferable to protect the water sources than to treat after contamination. Existing data in Romania highlight the sources quality degradation in time due to the anthropic impact (Gurzau, Bocos, 1995). A study showed a bacteriological contamination of surface waters that were the water sources for 7 water treatment plants in Transylvania, with a prevalence of 12% samples that did not frame in class A for surface waters.

Human impacts pose a threat to water quality maintenance due to contaminant introduction (Plummer, Long, 2007). It is often necessary to accept the current and historic pollution of the water source and to consider a water treatment in accordance with it. Population coverage with safe drinking water in sufficient quantity is the most relevant indicator for the population's state of health. The processes used to obtain water that is safe for drinking take their raw water from among a wide range of natural water sources, either from or below the surface of the earth (Sutherland, 2008). Raw water quality is recognized by the concentration of suspended matters (turbidity), color caused by dissolved matters, taste, smell, hardness and microbiological load. In order to obtain safe drinking water it is necessary to know the physico-chemical and microbiological characteristics of the raw water in order to determine in which class it frames and the best treatment method for it. Besides treatment, a monitoring plan is necessary that includes source water protection and maintenance of the distribution system integrity (Plummer, Long, 2007).

In Romania during 2000, from the total population of about 22 million inhabitants, 14.7 million persons (65%) benefited of drinking water from the public network, out of which 11.3 million in urban areas (92% of the total urban population), and 3.4 million in rural areas (33% of the total rural population). Drinking water quality in Romania is regulated by Law no.458/2002, which transposes Directive 98/83/CEE regarding drinking water. The water treatment plant in the city of Targu-Mures has Mures River as the raw water source, being characterized as any surface water by an unsteady flow and unsteady quality parameters with possible important variability in a very short period of time.

The objective of this paper is to assess the technological process of obtaining drinking water at the water treatment plant in the city of Targu-Mures.

2. MATERIAL AND METHODS

This paper used water quality parameters from Targu Mures water treatment plant for drinking purpose in 2008, while analysis of technological steps efficiency and their performance was based on current data available at the water treatment plant laboratory. This water treatment plant operates since 1907 with the technological line known as Plant I (old plant, shut-down in 2002). Plant II (new plant) consists of three complete and independent systems (modules) for water treatment, put into operation in 1974 (module I), 1982 (module II) and 1999 (module III). The water treatment plant is located in the north of the city on the right bank of Mures River and in the vicinity of AZOMURES plant – section for photosensitive materials – at north, Unirii district at south and east and agricultural lands planted with cereal products at west. The main source of pollution of Mures River upstream from Targu-Mures water treatment plant for drinking purpose is represented by the domestic faecaloid and industrial wastewaters from Reghin city, located 30 km upstream.

The efficiency of the treatment processes, namely the assessment of what was removed after applying a particular process, was calculated for each technological line of the investigated month and consisted in a performance assessment of sedimentation, filtration, global (comparison between the filtered water quality before disinfection and the raw water quality) and disinfection. For the efficiency analysis of the technological process on treatment steps, 4 months (January, April, July and October) were chosen according to seasonal oscillations of the raw water quality (temperature, oxidisability, turbidity, microbiological contamination - strictly dependent on rainfalls also).

3. RESULTS AND DISSCUSSION

Table 1 shows that the bacterial load expressed by total coliforms, faecal coliforms and faecal streptococci has significant values in almost all the 12 analyzed months. This shows a bacterial contamination of faecal origin that leads to framing in class A3 for surface waters treated for drinking purpose.

Table 1. ***Bacterial load of the raw water in-going the water treatment plant***

Year	**Total coliforms**	**Fecal coliforms**	**Fecal streptococci**
2008			
month	no./100cm^3	no./100cm^3	no./100cm^3
JANUARY	3068	1183	1644
FEBRUARY	429	392	1004
MARCH	1961	1692	4487
APRIL	10578	8472	4228
MAY	10525	8000	2413
JUNE	34506	8965	1834
JULY	18895	9158	3042
AUGUST	14419	6919	2313
SEPTEMBER	20833	7350	2156
OCTOBER	23944	11956	322
NOVEMBER	35188	20938	237
DECEMBER	21656	11563	5573
YEARLY AVREAGE	16333	8049	2438
	A3	**A3**	**A3**

Fig. 1 shows that between the turbidity evolution and coliform bacteria does not exist each time a positive correlation. In physico-chemical terms (pH, oxidisability, ammonium ion) the raw water in-going the water treatment plant is framing class A1 for surface waters treated for drinking purpose, and class A3 in terms of results obtained for iron and phenols (Table 2).

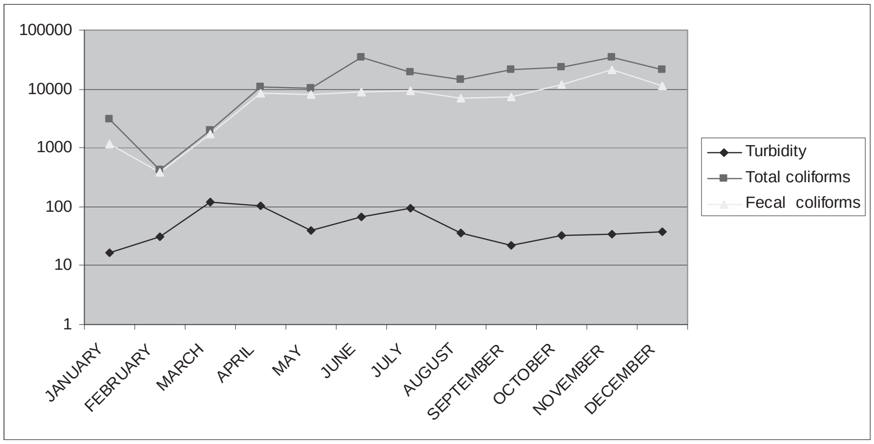

Fig. 1. ***Correlation between turbidity and coliforms (2008)***

Table 2. ***Physico-chemical parameters of the raw water in-going the water treatment plant***

YEAR 2008	**Turbidity**	**pH**	**Oxidisability**	**NH_4^+**	**Aluminium**	**Iron**	**Phenols**
month	FNU	unit pH	mg O2/dm^3	mg/dm^3	mg/dm^3	mg/l	mg/l
JANUARY	16.42	7.58	2.835	0.29	0,00	1161,20	
FEBRUARY	31.51	7.76	4.048	0.15	0,01	0,12	0,10
MARCH	118.05	7.73	8.510	0.18	0,02	0,15	0,44
APRIL	105.33	7.70	8.000	0.12	0,05	0,16	0,19
MAY	40.25	7.65	4.495	0.08	0,08	199,00	
JUNE	65.66	7.63	6.183	0.15	0,15	214,93	
JULY	93.44	7.76	8.020	0.10			
AUGUST	35.40	7.65	4.054	0.06	0,01	0,08	
SEPTEMBER	22.02	7.85	3.700	0.10	0,02	0,16	
OCTOBER	32.02	7.80	4.081	0.08	0,02	0,15	0,31
NOVEMBER	33.84	7.88	4.327	0.07		0,16	
DECEMBER	37.63	7.71	5.080	0.22		0,12	0,15
YEARLY AVREAGE	52.630	7.723	5.278	0.133	0,039	143,294	0,238
		A1	A1	A1		**A3**	**A3**

According to the measured parameters for framing the surface waters treated for drinking purpose, the raw water used in the water treatment plant that serves the city of Targu-Mures frames in class A3. This water class needs for the drinking purpose physical, advanced chemical treatment, perchlorination and disinfection - for example: intermediate chlorination, coagulation, flocculation, sedimentation, filtration by adsorption (on activated carbon), disinfection (ozonization, final chlorination).

Efficiency of each treatment method in relation to the previous method must be: coagulation/sedimentation: 90% on the basis of turbidity; rapid filtration: >80% on the basis of turbidity and colimetry; final disinfection: >99% on the basis of colimetry and free residual chlorine. For the overall efficiency to be 100%, values of the following indicators before disinfection should be: turbidity: <5 turbidity units; total coliforms: <50/100ml; faecal coliforms: <5/100 ml.

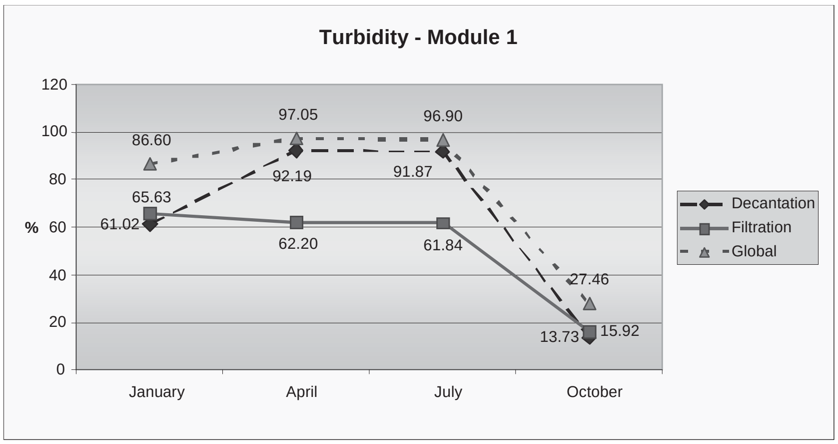

Fig. 2. ***Efficiency of treatment steps for turbidity at module 1 (2008)***

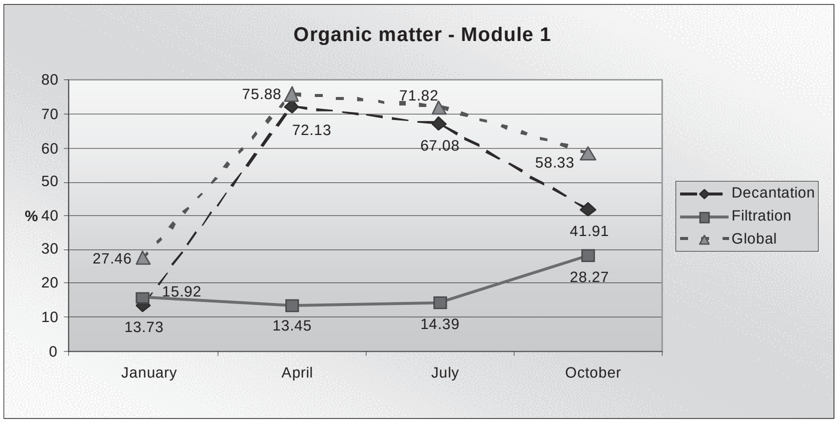

Fig. 3. ***Efficiency of treatment steps for organic matter at module 1 (2008)***

Efficiency of each module of the water treatment plant depends mainly on the raw water quality. During the first analyzed month, January, the raw water quality was influenced by the seasonal oscillations, in exchange during the following three analyzed months, April, July and October, a better quality of the raw water was recorded. Figure 2 shows that the decantation efficiency, except for January, calculated on the basis of turbidity was 86%, in exchange filtration efficiency was reduced. During the following three analyzed months efficiency increased over 90% for turbidity and over 70% for organic matters present in water. In terms of low overall efficiency, it showed that there were many water turbidity values before disinfection exceeding the maximum admitted value – 5 FNU. In module 1 turbidity and organic matter act in parallel in sedimentation, filtration or globally. In terms of organic matter, filtration is poor for module 1 during January (Fig. 3).

Module 2 of the water treatment plant has functioned sporadically during 2008, so that its efficiency was not calculated.

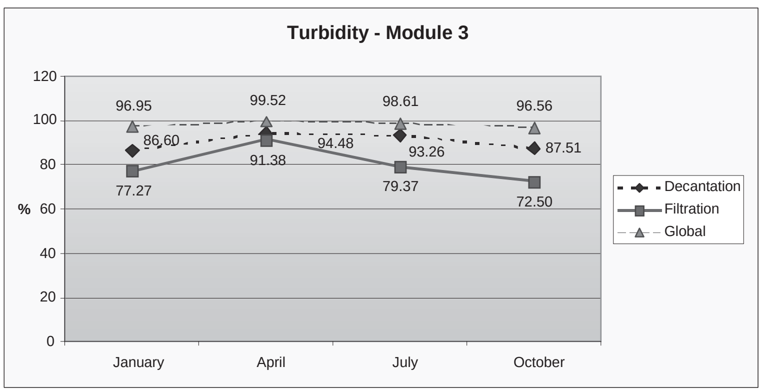

Fig. 4. ***Efficiency of treatment steps for turbidity at module 3 (2008)***

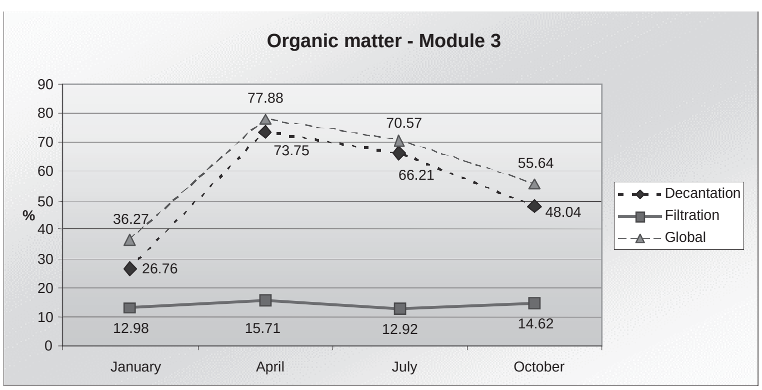

Fig. 5. ***Efficiency of treatment steps for organic matter at module 3 (2008)***

Module 3 of the water treatment plant for drinking purpose shows a higher efficiency in terms of removal turbidity and organic matters present in the water previously decanted and filtered in the other two modules. Overall efficiency in all four analyzed months was over 95% for turbidity (Fig. 4). In the case of organic matters in water during January and October when the raw water quality was degraded by the quantity of rainfall, the overall efficiency was 36% and 55% respectively, while in May or July efficiency increased to over 70% (Fig. 5).

After the decantation process, turbidity values are lower than the maximum admitted value – 5 FNU, except for January when a parallel reduction of organic matter and turbidity was observed at decantation. Low efficiency recorded in January was due to the raw water quality for both module 1 and module 3. A constant variable non-compliance of turbidity and residual chlorine levels in the disinfected water was observed. At the water tretament plant output the water quality raises the quality issue related to residual chlorine levels (Table 3).

Table 3. ***Residual chlorine levels in water and their ratio at the water treatment plant output - average values***

YEAR 2008	FREE RESIDUAL CHLORINE	TOTAL RESIDUAL CHLORINE	RECOMM. VAL. FREE RES. CHLORINE	RECOMM. VAL. TOTAL RES. CHLORINE	PERCENTAGE FREE/TOTAL
JAN	0.862	1.058	0.5	0.625	**81.408**
FEB	0.996	1.193	0.5	0.625	**83.444**
MAR	1.006	1.202	0.5	0.625	**83.713**
APR	0.998	1.198	0.5	0.625	**83.306**
MAY	0.900	1.100	0.5	0.625	**81.818**
JUNE	0.885	1.085	0.5	0.625	**81.561**
JULY	0.919	1.116	0.5	0.625	**82.394**
AUG	0.925	1.132	0.5	0.625	**81.704**
SEPT	0.971	1.162	0.5	0.625	**83.558**
OCT	1.050	1.249	0.5	0.625	**84.065**
NOV	0.987	1.181	0.5	0.625	**83.601**
DEC	0.983	1.179	0.5	0.625	**83.370**

Actual technological process provides that complete treated water on each module must be mixed and then distributed. Until it reaches the consumer, water is no longer rechlorinated, as there are no rechlorination points in the tanks.

In terms of bacteriological quality, 12% samples were found inconsistent with the national legislation. The most likely explanation is the lack of a sufficient contact time between water and chlorine at the point where sampling was performed. On the other hand, this contamination cannot be neglected because the group of coliforms and faecal streptococci are indicator bacteria, their presence can be accompanied by the presence of other pathogenic bacteria, viruses or parasites that can cause endemic or waterborne epidemic epidemiological phenomena.

4. CONCLUSIONS

Targu-Mures water treatment plant processes water from the river Mures, characterized by a generally important bacteriological contamination (class A3). It can be concluded that the treatment process is imposed by the poor microbiological quality of the raw water due to upstream discharges of untreated or insufficiently treated wastewaters. The treatment efficiency interpretation should consider the raw water quality parameters taken into account (turbidity). Microbiological contamination of water is another indicator that should necessarily be taken into account. The main problem of the water quality at the water treatment plant output is the high levels of free residual chlorine since the current water treatment and distribution system in Targu-Mures requires hyperchlorination.

Measures for retechnologization of the water treatment plant and rehabilitation of the distribution network will contribute substantially to the improvement of the drinking water quality, and will lead to hyperchlorination elimination which is currently a discomfort factor (taste, smell).

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