# REMOVAL OF TURBIDITY AND ORGANIC LOAD FROM SURFACE WATER BY COAGULATION-FLOTATION

**I. Pisoi*, D. Sonea**, F. Manea**, G. Burtica****

*SECOM Company, 53 Carol I Str., 220146, Drobeta-Turnu Severin, Romania.
** „Politehnica" University of Timisoara, P-ta Victoriei Nr.2, 300006, Timisoara, Romania
e-mail: pisoi.ilie@yahoo.com

## ABSTRACT
The aim of this study is to monitor comparatively and operationally two drinking water treatment flows, a new based on flotation unit using prehydrolyzed aluminium coagulation agent in comparison with settling based on the conventional technological flow using aluminium sulphate coagulation agent. The new proposed and introduced flow exhibited greater drinking water treatment performance under the conditions of raw surface water characterized by low and medium loading in terms of turbidity and organic load. The new proposed technological flow allowed that all studied parameters characteristics to the drinking water for treated water to meet the requirements imposed by the legislative norms.

*Keywords: dissolved air flotation, coagulation, prehydrolyzed aluminium, drinking water treatment*

## INTRODUCTION

Dissolved air flotation (DAF) is an increasingly applied technology for particle removal in water treatment. Prior to the DAF, the water must be chemically treated by coagulation-floculation, which can be regarded as the most important component of water treatment technology, because it is responsible by the performances of the filtration and disinfection stages [1]. DAF systems are designed to remove the solid particles formed by the coagulation and flocculation processes by using very small air bubbles that attach to the floc particles causing them to float to the surface for removal by skimming.

The performance of coagulation process depends on the diverse factors with respect to the efficiency of water purification, the coagulation agent playing the key role. In addition to the type of coagulant, these factors include the pH value, the coagulant dose, the temperature of water, the mixing operating conditions (fast and slow rate and time). The control parameter to determine the coagulation performance is residual turbidity. The most commonly used aluminium-based coagulant has been alum ($Al_2(SO_4)_3$). However, the main disadvantage of the use of alum is the high aluminium residuals in the treated water, especially under cold temperatures and at low pH conditions, which can cause possible health hazard or distribution system fouling [2, 3]. In recent years, prehydrolyzed aluminium coagulants by type of polyaluminium chloride (PAC), have been developed and researched [4].

The aim of this study is to assess comparatively a new proposed drinking water treatment technology based on flotation process using polyaluminium chloride in comparison with conventional technology consisted of settling stage after coagulation process that use aluminum sulphate coagulation agent, for the treatment of a surface water characterized by low turbidity loading.

## MATERIALS and METHODS

The performances of two drinking water treatment flows, the conventional based on alum using and coagulation-settling and the new proposed based on the prehydrolyzed aluminium and coagulation-flotation were assessed in relation with water quality parameters. The turbidity, organic load expressed as chemical oxygen demand (COD) and total organic carbon (TOC) parameters, and residual dissolved alumium were monitorized in accordance with the standardized methods. The schemes for the both water treatment flows are presented in Fig. 1. The source for the raw surface water is Danube river, Drobeta Turnu-Severin, Romania.

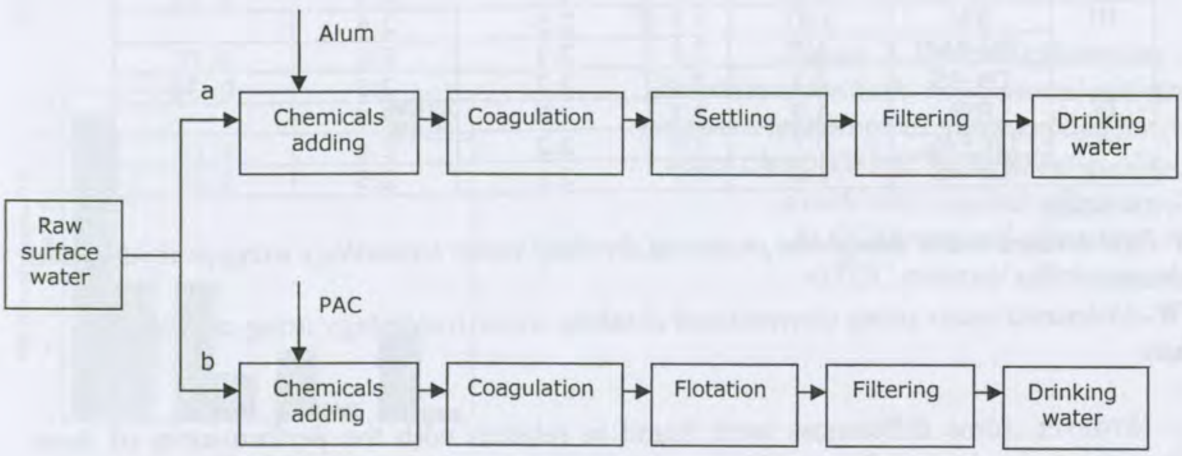



*Figure 1. Drinking water treatment technological flow: a–conventional; b–proposed*

The optimum doses of the coagulation agents were previously established at the laboratory-scale by Jar-Test method [4] correlated with the turbidity of the raw water, and the optimum dose of Alum used on the conventional flow is 5 mg Al*$L^{-1}$ and the optimum dose of PAC is 0.5 mgAl*$L^{-1}$.

Aluminium sulphate (alum) and SACTHOKLAR polyaluminium chloride (PAC) with basicity of 45% were used as the coagulation agents. pH was adjusted using 30 % $H_2SO_4$ solution.

Turbidity was measured on a Hach Ratio/XR model 43900 turbidity meter, pH was determined using a Radiometer PHM 95 pH/ion meter TOC was measured using TOC\TN analyzer multi N\C 3100, Analytik Jena AG, and COD was determined in accordance with Romanian standardized method. The dissolved aluminium concentration was determined using ZENIT 700 AAS spectrophotometer, Analytik Jena AG.

## RESULTS

In Table 1 are presented the results of the comparative monitoring of the both drinking water treatment technological flows for the turbidity, COD, TOC and residual aluminium in the comparison with the raw water characteristics. Under these raw water resource characteristics corresponding to a low loading surface water in relation with the turbidity and organic load, no overtaking the maximum allowance concentrations for these parameters were noticed for both conventional and new proposed drinking water treatment technological flows.

***Table 1.** Comparative monitoring of the both drinking water treatment technological flows. Optimum dose of Alum = 5 mg Al*L^-1 and the optimum dose of PAC = 0.5 mg Al*L^-1*

| Serie | Sample | Turbidity [NTU] | pH | COD [$mgO_2*L^{-1}$] | TOC [$mg*L^{-1}$] | Residual aluminum [$mg*L^{-1}$] |
|---|---|---|---|---|---|---|
| I | RW* | 4.6 | 7.6 | 2.5 | 2.6 | - |
| | TW-PAC** | 0.7 | 7.6 | 1.4 | 2.1 | 0.14 |
| | TW-AS*** | 2.0 | 7.6 | 1.9 | 2.4 | 0.26 |
| II | RW | 6.2 | 7.6 | 2.4 | 2.6 | - |
| | TW-PAC | 1.1 | 7.5 | 1.9 | 2.4 | 0. 15 |
| | TW-AS | 2.6 | 7.5 | 2.2 | 2.5 | 0. 31 |
| III | RW | 3.97 | 7.7 | 2.5 | 2.6 | - |
| | TW-PAC | 1.1 | 7.7 | 2.1 | 2.6 | 0.17 |
| | TW-AS | 2.2 | 7.7 | 2.2 | 2.5 | 0. 30 |
| IV | RW | 4.0 | 7.7 | 2.7 | 2.6 | - |
| | TW-PAC | 0.7 | 7.7 | 2.2 | 2.4 | 0.12 |
| | TW-AS | 1.6 | 7.7 | 2.1 | 2.5 | 0.28 |

**RW-raw water*

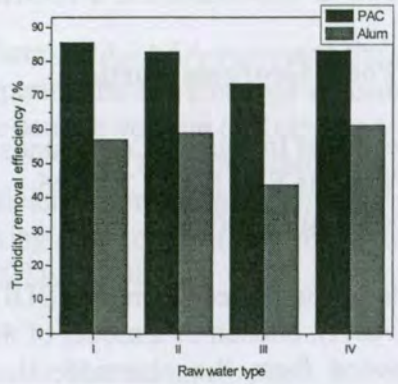
***TW-PAC-treated water using new proposed drinking water technology using prehydrolyzed aluminum*

****TW-AS-treated water using conventional drinking water technology using aluminum sulphate*

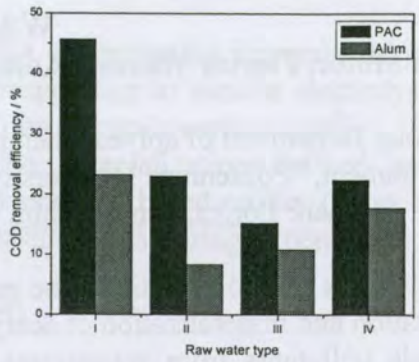
However, some differences were found in relation with the performances of these drinkin water technological flows, which were assessed based on the process efficiencies for the removal of turbidity and organic load. Figure 2 a-c show comparatively the process efficiencies for both water treatment technological flows regarding the removal of the turbidity, chemical oxygen demand and total organic carbon. From Fig. 2 correlated with the results of Table 1 in relation with the residual dissolved aluminum concentration in treated water, it can be underlined the superiority of the new proposed technological flow due to the two main reasons.

One of the reason is the use of the prehydrolyzed aluminum as coagulation agent, which led to very good process efficiency at lower optimum dose in comparison with the use of aluminum sulphate coagulation agent, allowing the presence of the residual dissolved alumium above maximum allowance concentrations imposed by Romanian Drinking Water Law, avoiding the potential to cause possible health hazard by Alzheimer's disease or distribution system fouling.

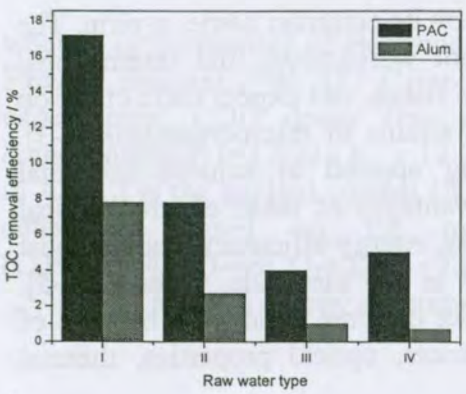
The other reason is linked to the replacement settling unit process with dissolved air flotation, which is most suitable for raw surface water characterized by low turbidity loading.




a)




b)




c)

*Figure 2. Process efficiencies determined for both conventional and new peoposed tehnological flows applied for raw water characetrized by different quality ; a)turbidity removal efficiency; b) COD removal efficiency; c)TOC removal efficiency*

## CONCLUSIONS

The new proposed and introduced flow exhibited better drinking water treatment performance in comparison with the conventional one under the conditions of raw surface water characterized by low loading in terms of turbidity and organic matter, and it allowed that all studied parameters characteristics to the drinking water for treated water to meet the requirements imposed by the legislative norms, especial the residual dissolved aluminum concentration.

## ACKNOLEDGEMENTS

This study was supported by PNII – STEDIWAT, no. 32-125 / 2008

## LIST OF REFERENCES

[1] Matilainen A., Vepsäläinen M. and Sillanpää M. (2010). Natural organic matter removal by coagulation during drinking water treatment: A review, *Advanced in Colloid and Interface Science*, 159, p. 189-197.

[2]Chow C.W.K., van Leeuwen J.A., Fabris R. and Drikas M. (2009). Optimised Coagulation Using Aluminium Sulfate for the Removal of Dissolved Organic Carbon, *Desalination*, 245, p. 120-134.

[3] Berube D. and Dorea C.C. (2008). Optimizing alum coagulation for turbidity, organics and residual A1 reductions. *Water, Science and Technology*, 8 (5), p. 505-511.

[3] Pisoi I., (2011). Coagulation of surface water using simple and prehydrolyzed aluminum salts, *Revista de Chimie*, 62(5), p. 575-578.