Studies Regarding the Improvement Coagulation Process of Bega River Water Suspensions

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Paper objective was to search the effect of washing water of filters and sludge of settling tank recycling on coagulation process and on some water parameters after settling. The sludge of settling tank and washing water of filters recycling is useful in coagulation-settling process: it decreases coagulant dose with 40 % for settling tank sludge use and with 35 % for washing water of filters use, residual aluminium concentration decrease with the increasing of slugde dose addition and with washing water of filters percent. The more sludge dose and washing water of filters percentage is recycling, the higher efficiencies will be recorded.

Keywords: coagulation, sludge, washing water, turbidity, residual aluminium

Water of Bega river represents about 70 – 75 % of drinking water used by Timisoara town. After raw water treatment, driking water as basic product and washing water of filters and settling tank sludge as collaterals products are produced. On the other hand, after water treatment a few quality parameters are disturbed like residual aluminium, residual chlorine and desinfection by-products.

Water washing of filters and settling tank sludge represents a great pollution potential due to high content of suspensions, foam and free chlorine. In recent years, disposal of settling tanks sludge and water washing of filters is becoming more and more difficult because the most expedient method, direct discharge to surface waters, is forbidden by legislation.

Because of its pollution potential the ecosystems of Bega river are negatively influenced and floating foam on river is an undesirable aspect.

To eliminate these undesirables effects, it is necessary to clean this waters in order to remove the suspensions and rezidual chlorine. This operation imposed by legislation increases the drinking water costs. The decrease of drinking water price can be realised by volum reduction of these waters, problem resolved by partial or total recycling of washing water of filters and settling tank sludge.

On the other hand, the undesirable presence of residual aluminium and desinfection by-products on population health it is well known [1-3].

Their decrease at lower values involves an appropriate technology and also an adequate management of raw water treatment during entire potabilisation process (coagulation – sedimentation – filtration - chlorination) [4].

One of the most important steps in the process of raw water treatment is coagulation for the removal of suspensions, disinfection by-products precursors and residual aluminium in drinking water. There are some difficulties to realize optimum conditions for coagulation due to the variability of raw water quality, like temperature, turbidity and naturally organic matter content [5]. The flexibility and efficiency of this operation may be increased by washing water of filters and sludge of settling tank recycling in mixing step of coagulation process.

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Experimental part

Experiments regarding coagulation process were undertaken by use of Jar-test method [6], with a Phipps&Bird instrument. Operating conditions were as follows: rapid mixing for 60 s(140 rot/min), slow mixing for 20 min (40 rot/min) settling time 30 min. Turbidity and residual aluminum were analized by use of Hach 2100 turbidimeter and atomic absorbtion spectrophotometer SPECTRA AAS VARIAN with graphite furnance GTA 110.

In all experiments raw water from Bega river were used, with following parameters: turbidity T = 12.2 NTU, temperature t = 4 - 6° C where was used settling tank sludge and turbidity T = 7.0 NTU, temperature t = 11° C where was used washing water of filters. Aluminum sulphate was used as coagulant (AS), technical product, solution with concentration of 10 g/L. *p*H values of water samples treated with coagulant ranged between 7.4 – 7.6, due to different doses of AS. Experimental conditions were closed to those used for drinking water facilities.

The sludge was collected from settling tank evacuation and was characterized by dried substance concentration 13.87 g/L.

Washing water of filters (WWF) was collected from two filters. 10 L of water were collected in first six minutes of filters washing, under well mining, before use. Sludge was characterized by sediment volume after two hours settling in Immhoff vessels (100 mL) and supernatant turbidity. These parameters, determined for two parallel samples had the values: V = 25.5 mL/L and T = 6.75 NTU. The concentration of aluminium in WWF was 0.84 mg/L.

Results and discussions

Jar test method was applied to obtain necessary data for coagulation curve representation.

From coagulation curve representation were established some characteristic parameters: turbidity at zero dose (T_0), critical turbidity (T_C), critical dose (D_C) and limit turbidity (T_L).

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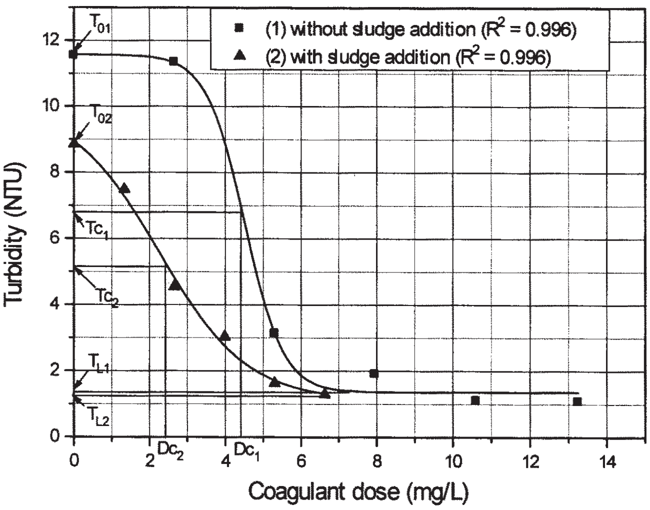

Fig. 1. Coagulation curves with and without slugde addition

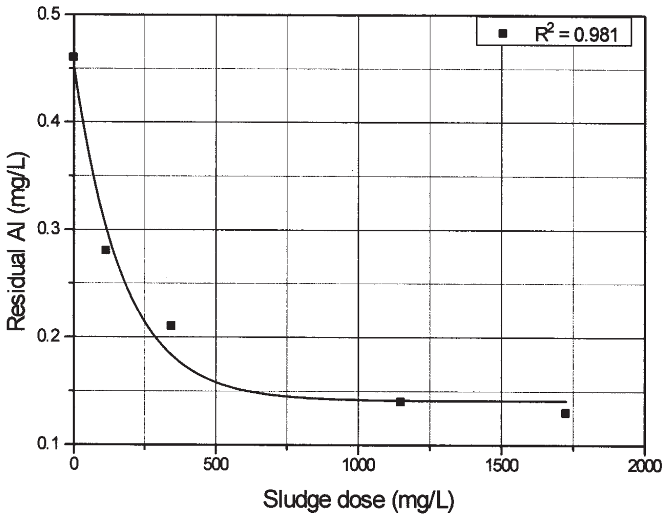

Fig. 3. Aluminium residual dependence against sludge dose (mg/L) introduced

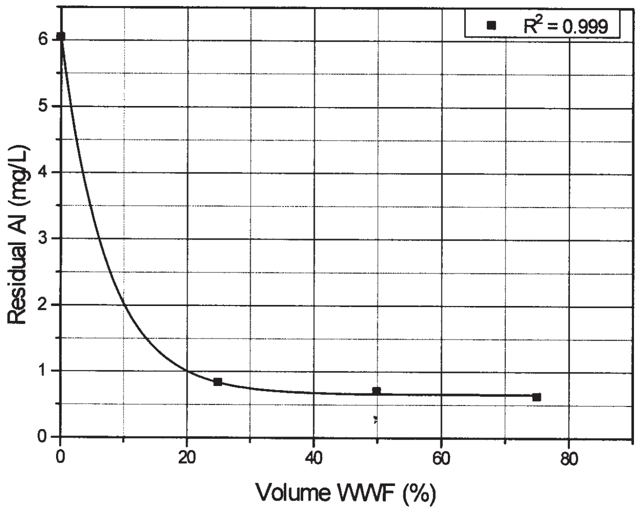

Fig. 4. Aluminium residual dependence against volume (% from total water volume) of WWF introduced

Coagulant critical dose was established using first derivate (critical dose correspond with the point where first derivate has a minimum).

Figure 1 presents coagulation curves with and without sludge addition, sludge dose value 172.5 mg/L. The results from figure 1 show that sludge addition decreases T_0, D_C, T_C and in a low measure T_L. Critical dose D_C decrease with 40 % which indicates the same decrease of the necessary coagulant dose.

T_C decrease approximately with the same percent as T_0. Limit turbidity T_L has a low value even at coagulant dose much smaller than water without sludge suitable dose.

Figure 2 presents coagulation curves with and without WWF addition, WWF percent of 12.5 % from total water volume. The results from figure 2 show that WWF addition decreases T_0, D_C, T_C and in a low measure T_L. Critical dose D_C decrease with 35 % which indicates the same decrease of necessary coagulant dose, in conditions of easier settling and bigger flocs.

Residual aluminum concentration against sludge dose addition is presented in figure 3.

In accordance with figure 3 residual aluminum concentration decreases with the increasing of slugde dose addition from 0.46 mg/L when sludge was not used to 0.13 mg/L, when sample contained a sludge dose equal to 172.5 mg/L .

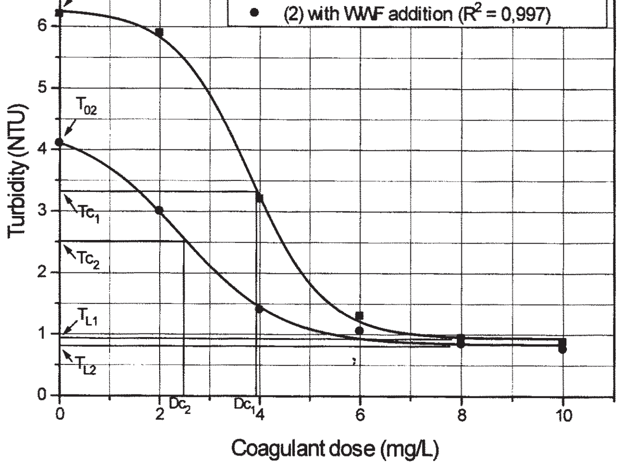

Fig. 2. Coagulation curves with and without washing water of filters addition

Residual aluminum concentration against WWF introduced is presented in figure 4.

The results presented in figure 4 show that the increasing of WWF percent from 0 to 75 % produced an important decrease of residual aluminum concentration from 0.69 mg/L when WWF was not used to 0.1 mg/L, when sample contained 75 % WWF.

The results show the efficiency of sludge of settling tank and WWF recycling on improvements of coagulation-settling process. Earlier, it was established that these improvements are due either to decrease of slow mixing time or turbidity decrease at zero dose [7-8].

Influence of slow mixing time on coagulation effiency and residual aluminium concentration from treated water was determined.

The obtained results are presented in figure 5 and 6.

Figures show that T_0 and T_L decrease with the increase of sludge dose addition and WWF percent introduced, at the same coagulant dose, regardless of slow mixing time.

After platted data, critical time which corresponds to maximium rate of turbidity evolution is practically constant. This shows that sludge and WWF addition and its percent does not change slow mixing time; as is the case of prehydrolysed coagulants [9].

The effect of washing water of filters and sludge of settling tank recycling is favourable for coagulant dose reducing especially at low temperature.

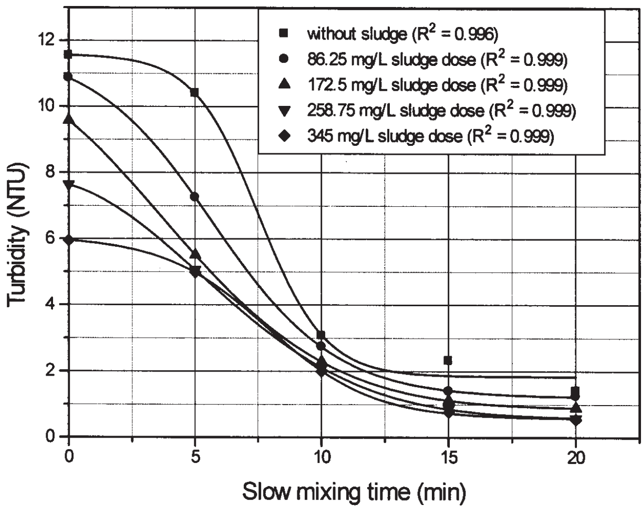

Fig. 5. Water turbidity dependence against slow mixing time for different sludge dose (mg/L) addition

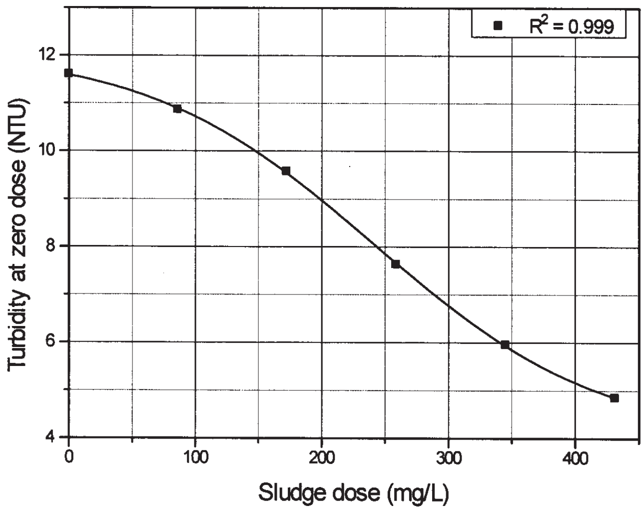

Fig. 7. Dependence of turbidity at zero dose against sludge dose (mg/L) addition

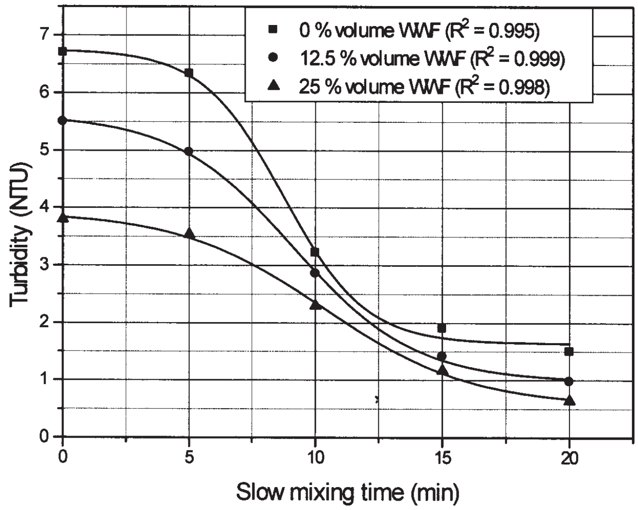

Fig. 6. Water turbidity dependence against slow mixing time for different volume (%) of WWF introduced

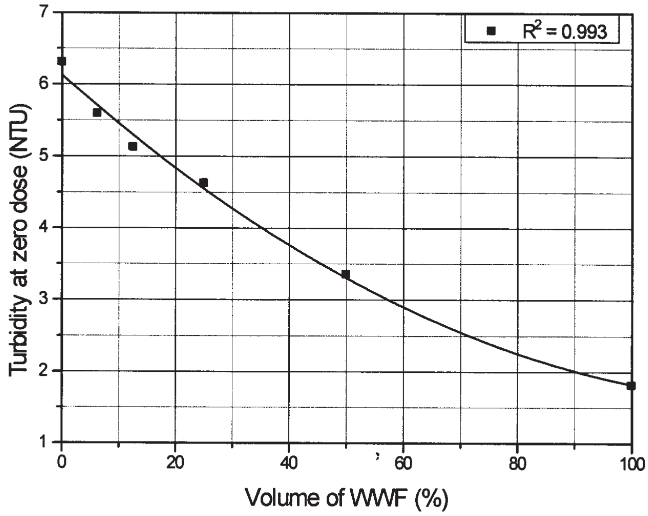

Fig. 8. Dependence of turbidity at zero dose against volume (% from total water volume) of WWF introduced

Also, the influence of sludge from settling tank and WWF recycling percent on turbidity at zero dose was studied , figure 7 and 8.

The results presented in figure 7 and figure 8 show that T_0 decreases with increasing of sludge settling tank dose and with increasing of volume percent of WWF addition.

This is the main reason for decreasing of both coagulant dose and residual aluminum.

Conclusions

The sludge of settling tank and WWF recycling is useful in coagulation-settling process: it decreases coagulant dose with 40 % for settling tank sludge use and with 35 % for 12.5 % WWF use, residual aluminum concentration decrease with the increasing of slugde dose addition and with WWF percentage. The more sludge dose and washing water of filters percentage is recycling, the higher efficiencies will be recorded.

Recycling of settling tank sludge and WWF does not decrease slow mixing time, defined by critical time for slow mixing. But recycling decreases turbidity at zero dose, which is proportional with sludge dose and WWF percentage. This decreasing explains the efficiencies due to sludge and WWF recycling.

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Manuscript received: 22.01.2009