ABSTRACT

The submitted doctoral thesis deals with the optimisation of chemical treatment process of water with the high concentration of aluminium and natural organic matter (NOM). Natural organic matter in connection with the higher concentration of natural aluminium is the common components of some surface water in the Czech Republic. The high aluminium in water reservoirs can lead to the higher concentration of residual aluminium in drinking water and then it can cause some health problems. Both of these components can be removed from drinking water by chemical treatment process based on the destabilisation and the aggregation. Chemical treatment aims at the formation of aggregates that are separable by filtration through a layer of granular media.

The efficiency of the NOM and Al removal is influenced by many chemical and physical factors (the reaction conditions under which the aggregation takes place, the type and dosage of destabilisation reagent, the reaction pH value, the mean velocity gradient, and the period of its duration). For this reason it is very important to optimise the condition of water treatment. The main problem is inadvisable type and dose of the reagent and unsuitable intensity and duration of mixing. Common water treatment technologies are based only on the reagent doses optimisation. Properties of formed aggregates (namely their size, shape, and density) and their separation capabilities are also influenced by the magnitude of the velocity gradient and the period of its application. The agitation conditions have to be optimised with respect to the raw water quality and the separation method applied. A uniform distribution of a velocity field in the agitation volume belongs among other important physical and chemical aspects of water treatment. Unfortunately, in many cases it is unconsidered.

The thesis evaluates the influence of types and doses of destabilisation and alkalisation reagents as well as the conditions of agitation (mean velocity gradient and time of its application) on destabilisation and subsequent aggregation of impurities contained in water (NOM and Al). Optimisation with aluminium sulphate (alum), ferric sulphate, polyaluminiumchlorid, and polyaluminiumsulphate was made with raw water from two drinking water reservoirs Pilská and Lázská in Czech Republic. Tests of treatability were conducted by virtue of jar tests using the laboratory mixing unit. Jar tests were used to determine the optimal conditions of coagulation and to compare the effects of chosen destabilisation reagents. The jar tests were also used for an evaluation of the influence of velocity gradient and time of its duration on the aggregation

efficiency. The coagulation conditions were optimised for the best NOM and aluminium removal. The operational measurements on the water treatment plant Kozicin were made by the reason of comparison with laboratory tests. The full size plant testing aimed at the evaluation of the efficiency of the perforated baffle type flocculation chamber on the aggregation. The perforated baffles are installed at the waterworks as the agitation element. The quality of water (especially residual NOM and aluminium concentration) and the speciation of aluminium were monitored through the treatment at the water treatment plant and during the jar tests as well. Fractionation was applied to improve the characterisation of Al in the treated water. This fractionation could help understanding which of the Al fractions are hardly removed during the water treatment. The efficiency of aggregation during laboratory tests as well as during operational monitoring was evaluated with the help of the degree and test of aggregation.

The results of the thesis show that the concentration of aluminium and representation of aluminium fractions in raw water has been significantly changed during year. The highest concentration of aluminium and NOM were detected in the spring months and the dissolved inorganic Al represents the dominant fraction in raw water in this period. The results of the laboratory testing proved the fundamental significance of optimisation both reagents dosing and agitation conditions (particularly its intensity and duration) at water treatment of water with high content of NOM and Al. In general, it was proved that the type of destabilisation reagent have the slightly influence on the concentration of residual aluminium and NOM in comparison with the dose of the destabilisation reagent. It was also showed that for this type treated water the optimum treatability was demonstrated by application velocity gradients $< 100\ s^{-1}$ with the time of its application at least 10 minutes. The highest removing effectivity of aluminium and natural organic matter with the use of different destabilisation reagents were attained in pH range between 5.5 to 6.2. The results indicate that the concentration of organic matter and all aluminium fractions decreased significantly after laboratory jar tests in comparison with operational treatment. The obtained results of the thesis show that conditions of water treatment are slightly improved by the addition of filtration aid Magnafloc LT 20, and the application of this reagent is not necessary if the optimal conditions of treatment are secured in the laboratory and operational testing, as well.