

Cationic polymers in water treatment

Part 1: Treatability of water with cationic polymers

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Abstract

This paper investigates the best attainable treatability to which a water polluted with a technologically significant concentration of organic matter is treatable by different cation-active polyelectrolytes and their blends with mineral coagulants in comparison to that attainable by traditional hydrolysing coagulants. The negative influence of these reagents used as primary coagulants on the treated water quality is demonstrated in the case of Saulspoort Waterworks.

Introduction

One of the prime objectives of water treatment is the removal of colloidal impurities of which organic matter is the most important. It should be emphasised that impurities of an organic nature are far more objectionable from a hygienic point of view than impurities of a mineral nature. Since organic matter can be precursors of organohalogens (carcinogens)(Hocman, 1986), water treatment technology design should always be aimed at achieving the maximum possible removal of organic matter (Polasek and Mangeot, 1988).

The substitution of traditional hydrolysing reagents by cationic polymers (CPE) is becoming increasingly popular in South Africa, although no comprehensive investigation into the suitability of CPE as primary coagulants and their possible side-effects has been carried out. The decision to substitute hydrolysing reagent with CPE is usually based on a simple comparison of reagent dosage costs. Another reason used is that CPE are more user-friendly, i.e. do not change water pH and are easier to handle.

There is relatively little information available in literature on the use of CPE as the primary coagulant and their effect of the final quality of treated water. Some information on this topic can be found in foreign articles (Narkis and Rebhun, 1977; Glazer and Edzwald, 1979; Amy and Chadik, 1983; Carns and Parker, 1985; Tanaka and Pirbazari, 1986; Aizawa et al., 1990; Gregory and Lee, 1990;) and only limited information is available in local articles (Healey et al., 1987; Nozaick et al., 2000a and Nozaick et al., 2000b; Pryor and Freese, 1999; Polasek and Mutl, 2000).

The authors have tested different CPE over many years at different localities in South Africa and verified the suitability of their application on some of the localities where CPE are in use (Polasek and Mutl, 1995b; Mutl and Polasek, 1996; Polasek and Mutl, 1997; Polasek and Mutl, 1999). A comprehensive investigation into the treatability of water attainable with different CPE was carried out at Saulspoort Waterworks during 1993. The objective of this study was to establish the feasibility of using CPE for the treatment of water with a technologically significant organic content. The results obtained are presented in this paper. Part 1 of this article

investigates the influence of CPE on the attainable treatability of water. Part 2 of the article investigates the influence of CPE-formed suspension on the performance of filters.

Significance of organic pollution

The most important organic pollution is produced by humic matter. Humic matter is the most significant precursor of organohalogens and other chlorine-derivates. Therefore, their presence in drinking water is undesirable. In natural waters humic matter occurs, depending on pH value, as negatively-charged macromolecules. The negative charge is caused by the presence of carboxyl and phenolic groups (-COOH and -OH). Both groups dissociate in an alkaline pH range in which humic acids dissolve readily. In an acidic pH range, humic acids do not dissociate and are poorly soluble. Therefore, they can only have a negative charge, the value of which decreases with a decreasing pH value. In surface waters, mixtures of different molecular and micellar colloids exist. Therefore, a compromise operational reaction pH, at which the highest removal of organic impurities is achieved, together with operational dosage of primary coagulants are investigated by jar tests. Most organic impurities contained in water have an acidic character. Therefore, as a rule, the surface waters should be treated in an acidic pH range (Tucek et al., 1977).

The humic matter occurring in low molecular form cannot be removed from water by current chemical treatment (Pitter, 1981). Their removal necessitates the use of advanced treatment processes such as ozonation and activated carbon adsorption.

Testing site

The Saulspoort Waterworks belongs to the Municipality of Bethlehem. The source of raw water is the Saulspoort Dam fed by the Axel River and the Liebenberg Vlei, and is one of the most polluted waters in South Africa. Its turbidity fluctuates considerably throughout the year while organic pollution, characterised by a COD_{Mn} value, is relatively high but fairly steady, varying between $COD_{Mn} = 5$ to $7 \text{ mgO}_2 \cdot \text{L}^{-1}$. For raw water data see Table 1.

The design capacity of the Saulspoort Waterworks is 40 Ml/d . The treatment process is based on a two-stage separation of the formed suspension. The flocculent suspension is formed under conditions of the Inline High Density Suspension (IHDS) process

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