Wanneroo Groundwater Treatment Plant

world's first large scale MIEX® water treatment plant

by

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Intermittent outbreaks of DMTS (Dimethyl Trisulphide) in the clear water distribution system of Perth have been an issue for the Water Corporation of Western Australia. Known as "swampy" odour, the presence of DMTS is in tap water is suspected to be the product of biological action in the distribution system. DOC (Dissolved Organic Carbon) in the treated water promotes biofilm growth in the distribution system, and this coupled with NSRS (non sulphide-reduced-sulphur) in the water leads to DMTS formation. In order to tackle this problem The Water Corporation has been investigating means of reducing DOC levels in the water it supplies into distribution.

Aerial photo of Wanneroo June 2002 *(courtesy Black & Veatch and Water Corporation of Western Australia)*

The Wanneroo (GWTP) is a conventional water treatment plant, using aeration, coagulation, clarification and filtration steps. It is capable of a maximum flow of 225 MLD and draws water from a borefield consisting of both shallow and deep artesian bores. The raw water quality can vary greatly, depending on the number and type of bores feeding the plant at any particular time. During periods of high flow, the raw water contains high levels of naturally occurring DOC of up to 18mg/l. Not all the DOC is removed in the conventional treatment process, with the clear water for distribution still containing up to 5 mg/l of DOC.

For the Wanneroo GWTP, a number of technologies aimed at reducing the level of DOC further were investigated. The MIEX® Process was identified as the most practical and lowest cost treatment option.

The MIEX® process uses ion exchange resin to remove DOC from water. Whilst the basic chemistry is that of conventional ion exchange technology the way that it is applied is very different. Resin is contacted with the water in stirred contactors before gravity separation and return of the resin to the contactor vessels. High resin separation efficiency of 99.9% is possible due to the unique magnetic properties of the resin. Once mixing energy is removed, the resin beads attract to one another to form large agglomerates with a high settling velocity (25 m/hr). This affords the use of settling tanks with up flow rates of 10 to 15 m/hr. A proportion of the resin in the system is constantly extracted to a side stream regeneration system where it is regenerated with brine (sodium chloride solution). This removes the DOC from the resin and makes it ready for reuse.

Wanneroo under construction *(courtesy Black & Veatch and Water Corporation of Western Australia)*

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A 1MLD pilot plant was operated at Wanneroo over a period of two years. Based on the pilot plant performance, the MIEX® process was chosen as a new treatment step for the Wanneroo GWTP. The Water Corporation selected *Black & Veatch Australia* as Main Contractor for the engineering, procurement and construction (EPC). Design commenced in May 2000, the plant commenced operation late 2001 and passed performance tests early in 2002.

Plant process

The Wanneroo MIEX® plant is designed to treat up to 112 MLD with the potential to be expanded to 225 MLD. Located at the head of the works after the aerator, the plant treats the raw water prior to alum coagulation, clarification and filtration in the existing plant.

At the heart of the process are two 400m³ concrete Contactors, in which the MIEX® resin and raw water are intimately mixed. The resin concentration in the Contactors may be varied to suit raw water quality and plant flow at any time.

The resin/raw water mix flows from the Contactors to six concrete hopper-bottomed Settlers. The Fitch-type feedwells inside the Settlers encourage inter-particle contact, while dissipating the velocity of the inlet stream. The gentle flow conditions inside the feedwells allow the magnetic forces of attraction between the resin particles to take effect resulting in larger agglomerates of resin to form and settle out into the hopper bottoms of the Settlers. The Settler overflow of MIEX® treated water then rejoins the existing conventional process stream upstream of the Clarifiers. The resin slurry is collected at the base of the Settlers and is pumped back to the head of the process to either return to the first Contactor or be taken off for regeneration.

A percentage (5% to 10% of the resin slurry is removed from the recycle stream and diverted to the regeneration facility. Resin regeneration is accomplished using a 12% brine solution (the regenerant). Although the regenerant increases in DOC and sulphate concentration with each regeneration step, the regenerant can be used for multiple regenerations. Operating experience shows that regenerant reuse over six cycles or more significantly reduces chemical consumption and waste production without an adverse affect on product water quality. Each reuse cycle requires an adjustment of the regenerant, returning the chloride concentration to the original starting point prior to the next regeneration cycle.

Once regenerated, the resin is dumped from the Regeneration Vessel into the Fresh Resin Tank, from where it rejoins the MIEX® Process in the first Contactor.

MIEX® process performance

Pilot trials, laboratory work and the performance of the plant to date have provided conclusive results indicating that the MIEX® process, and alum coagulation complement each other. For the raw water at Wanneroo GWTP, it was found that the MIEX® process favoured the lower molecular weight fraction of DOC, while alum coagulation removes the larger molecular weight DOC components. This results in impressive reduction of DOC through the plant. A final DOC of less than 2mg/l is achieved through the combination of MIEX® treatment and coagulation.

Test results show that 75% and 90% reductions in DOC and NSRS respectively could be achieved through MIEX® and coagulation treatment. An 85% reduction in THMFP also resulted from jar tests.

Removing the smaller DOC fractions prior to coagulation enables more efficient use of the coagulant. Jar tests have shown that MIEX® treated water, with a coagulant dose of 1/3 the conventional dose, can produce a higher water quality, in terms of DOC, than conventionally treated water. The lower coagulant dose also creates less of a pH depression, placing less demand on pH correction after coagulation. The treatment process downstream of MIEX® treatment therefore operates using reduced chemical dose rates and. therefore. produces less sludge.

Conclusions

When coupled with an existing conventional treatment plant, MIEX^R water treatment can result in substantial DOC reduction, while using a lower coagulant dose. A more stable water, in terms of chlorine demand, is produced, reducing operating costs by using a lower overall chlorine dose. The capacity of the water to form disinfection by-products (THMs) is also reduced.

Completion of the Wanneroo MIEX^R plant on budget and within an aggressive programme has demonstrated that successful collaboration of contractor and end user can effectively deliver innovative technology solutions to improve treated water quality. ■

Acknowledgements

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Note: *John Tattersall & Raymond Lange are with Black & Veatch; Chris Botica and Paul Smith are with the Water Corporation of Western Australia.*