Albert Water Treatment Works

raw water colour reduction

by
Alan Bennett

Albert Water Treatment Works is a three stage 60 MLD works situated on a compact site to the west of Halifax, West Yorkshire serving a population of 155,000. Raw water is sourced from upland Pennine catchments. The existing treatment process was commissioned in 1988 and comprises of clarification by Dissolved Air Flotation (DAF) followed by Rapid Gravity Filtration (RGF) and pressurised secondary contact filters for Manganese removal.

Albert WTW: Ongoing construction of the contactor and resin separation tanks *courtesy Yorkshire Water*

Problem

Over recent years there has been an increase in the levels of Dissolved Organic Carbon (DOC), in the raw water resulting in peaks in colour rising from around 100 Hazen to 160 Hazen. This high colour level has resulted in the need for increased coagulant doses which, in turn, has led to overloading of the DAFs and the formation of weak residual small flocs that easily break through the RGFs.

Additionally, in late summer, colour peaks and high raw water temperatures can lead to Trihalomethane (THM) formation. THMs form when residual organic matter not removed by the existing treatment process is chlorinated. This organic matter can be dissolved or particulate.

Trends show that there is a significant risk of future THM failures if the decline in raw water quality were to continue.

In winter, the filtration problems are exacerbated by cold temperatures. Particles held within the filters are subject to greater shear forces, hence filter capacity is reduced and filter breakthrough occurs sooner.

High raw water colour also necessitates higher Ferric coagulant doses which increases the total solids load through the plant; this increased solids load and filter breakthrough mean that at times of peak raw water colour, the plant throughput can be limited to 40MLD.

Regulatory Undertaking

The regulator-approved clean water capital programme for AMP4 includes an undertaking for Albert WTW. The undertaking cites an increase in colour in raw and treated waters, and a proposal to install a Magnetic Ion Exchange (MIEX®) process to reduce colour levels at the works inlet to 60% of current values.

MIEX® is an innovative process technology developed by *Orica Watercare* in conjunction with two leading research organisations: CSIRO Division of Molecular Science and South Australia Water Corporation. The process is a pre-treatment incorporating MIEX® DOC resin for the removal of DOC. The MIEX´® DOC resin is a patented high capacity ion exchange resin that includes a magnetised component that attracts the negatively charged DOC compounds that can cause colouration in untreated water. The resin is continually regenerated in brine, by exchanging charged DOC with chloride ion thus giving a unique, continuous ion exchange process providing a cost effective and environmentally friendly DOC removal solution.

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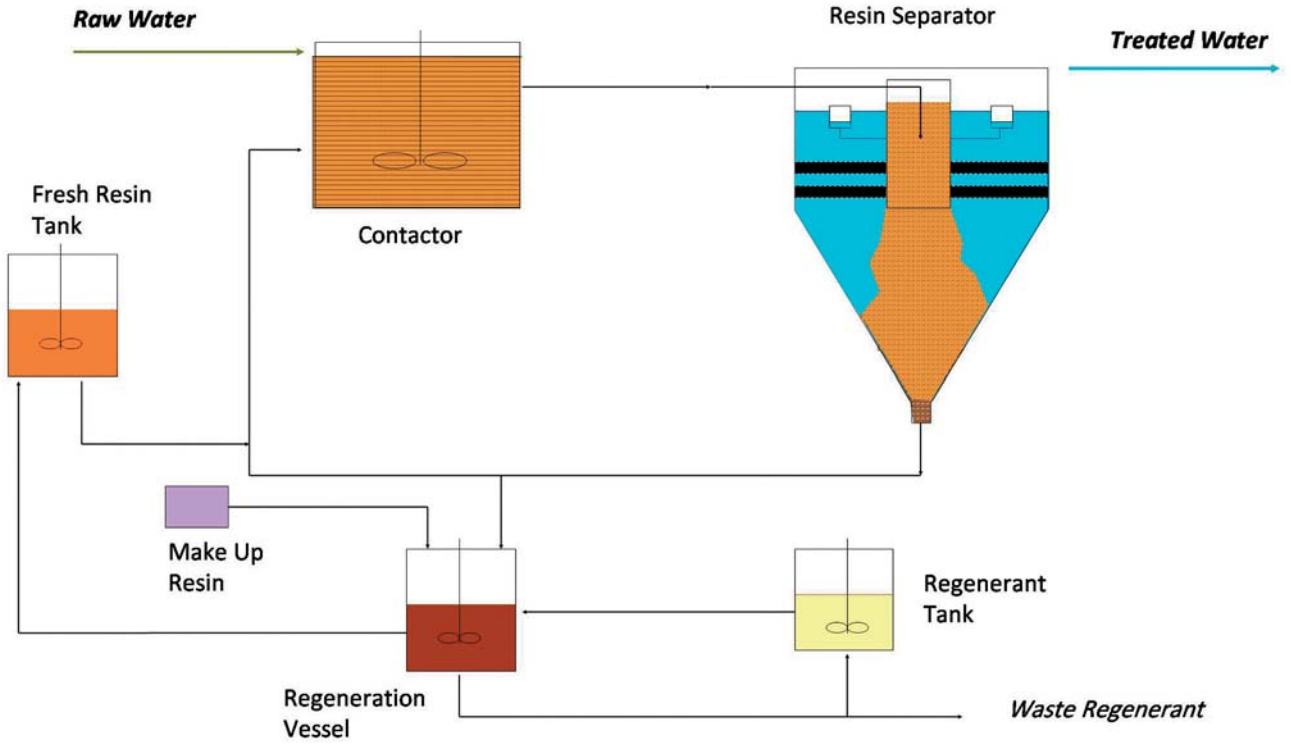

Process Flow diagram of the MIEX® Process

photo courtesy of Orica Water Care & Yorkshire Water

Yorkshire Water has worked very closely with *Orica* and Cranford University in recent years to:

i) determine the treatability of a high DOC, low alkalinity moorland water using MIEX®;
ii) provide a pilot-scale comparison between treating water with conventional coagulation and using MIEX® pre-treated water with reduced coagulant doses;
iii) use floc diagnostic tools to investigate the properties of the flocs formed with and without MIEX® pre-treatment and link them to the observations seen during pilot scale treatment.

The major findings of this work were that MIEX® can provide:

* Cost effective removal of DOC.
* Significant reduction in disinfection by product formation.
* Raw water colour reduction;.
* A flexible process that can adjust to wide variations in raw water quality.
* Reduction in chemical sludge volumes:
* Reduction in chlorine demand for disinfection;
* Removal of other anions eg, sulphate, sulphide & nitrates.

The MIEX® system to be installed at Albert is the *Orica* Dual Stage Configuration system where the resin is utilised in a continuous ion exchange process, designed for the removal of DOC from the raw water supply. The resin has been developed to enable removal of DOC to occur in a stirred contactor much like a flash mixer in a conventional water treatment plant. The resin beads are much smaller than conventional resin beads at around 180µm (80 mesh) to allow rapid DOC exchange in the contactor vessel. Only very low resin concentrations are therefore required to achieve DOC removal because of efficient mass transfer in the uniformly mixed contactor.

The resin suspension then passes to a separating stage where the resin is recovered and recycled. A magnetic component is dispersed within the resin bead structure so that when passed to a settler the fine resin beads rapidly agglomerate into larger, fast settling particles. The settled resin is recovered from the separator and recycled back to the contactor while a small side stream is regenerated. The resin is regenerated in a brine solution where attached organics are substituted for chloride ions producing a concentrated stream of natural organics.

This regenerated resin is returned to the contactor to maintain the ion exchange capacity of the process. Treated water overflows the resin separator to downstream treatment. Virgin resin is periodically added to the process to make up the minimal quantities of resin that may be carried downstream.

This continuous process differs significantly from conventional ion exchange processes. In conventional ion exchange columns, as the ion exchange capacity is progressively exhausted, the water produced deteriorates in quality. The leakage of undesired ions eventually reaches the point where product water is not of an acceptable quality. At that point the column has to be taken off line and the resin regenerated. In contrast the MIEX® DOC resin is used in a process where the overall ion exchange capacity is continually maintained. As a consequence the product water is of a consistent quality with DOC controlled at a predetermined level.

Unlike conventional ion exchange processes this continuous process does not require pre-treatment for solids removal and can therefore be used to treat raw water at the start of the treatment chain. Pre-treatment with MIEX® DOC resin can reduce the coagulant demand by 60%.

As a result of the findings of the pilot plant studies with Orica and Cranfield University a design and build contract to install MIEX ® at Albert WTW was awarded to Earth Tech Morrison in September 2007. Construction work is now well advanced on site in order to meet the DWI regulatory date of 31 March 2009. The current forecast outturn cost of the project is £6.5m

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