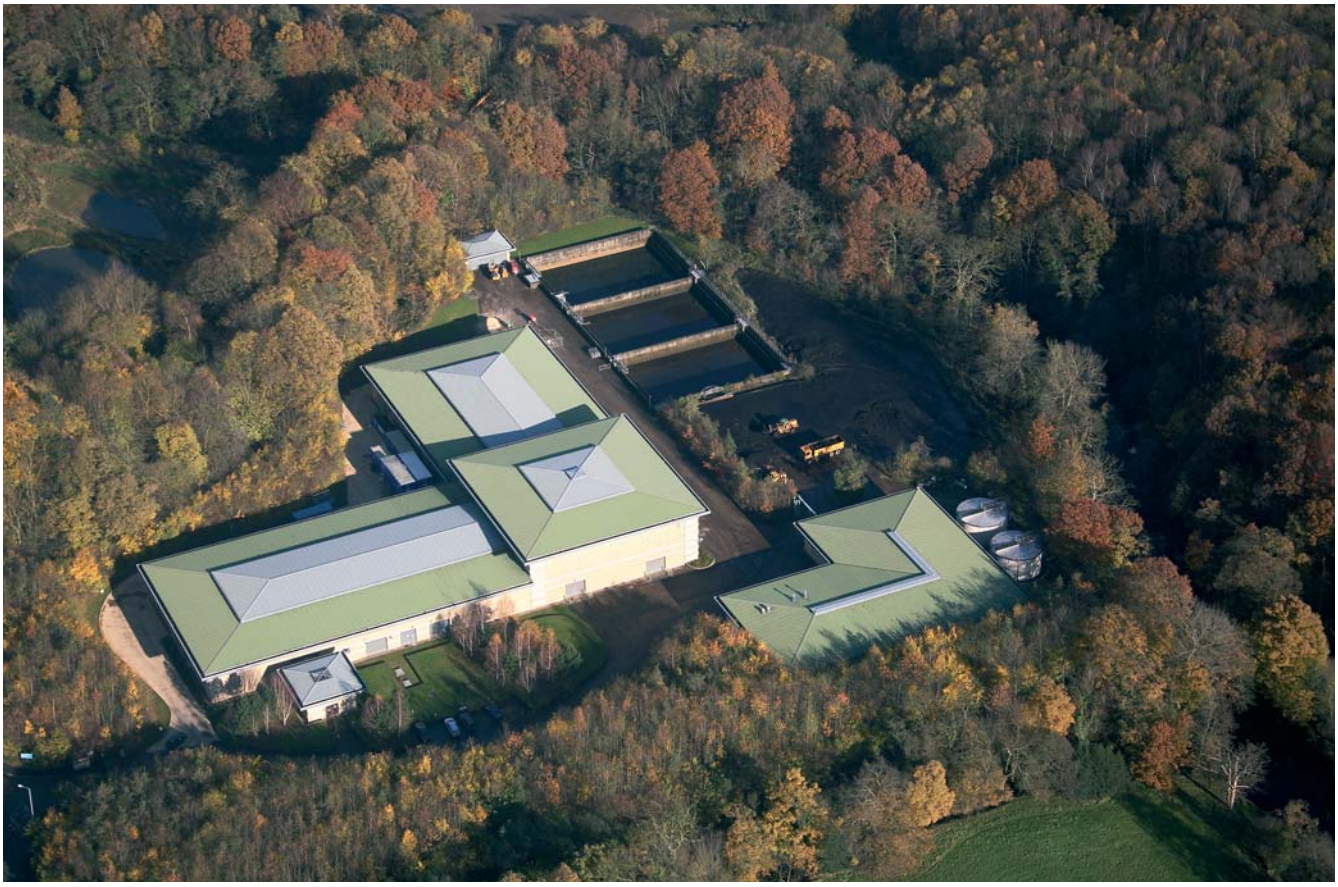
Ewden WTW & Graincliffe WTW

Raw Water Colour Reduction Schemes

by
Abi Morgan (BEng (Hons) MICE)
Simon Balding (BSc, MCIWEM)

Both Yorkshire Water's Ewden Water Treatment Works (WTW) and Graincliffe WTW employ a three stage treatment process comprising clarification by Dissolved Air Flotation (DAF) followed by Rapid Gravity Filtration (RGF) then pressurised secondary contact filters for manganese removal.



Ewden WTW *Photo courtesy of Peter Smith Photography*

Problem

Although Ewden WTW is located north of Sheffield whilst Graincliffe WTW is situated on the moors above Bradford, both treat raw water from upland sources and both have been suffering from increasing amounts of colour in the raw water. In order to supply water of an acceptable quality to the distribution network, it has been necessary to use increasing amounts of coagulants to aid the floatation and filtration of organic compounds. This practice results in a solids overloading of the DAF and RGF plant at the WTWs which in turn can affect the production capacity of the works.

Ewden WTW is designed to treat and supply 45Ml/d to Sheffield whilst Graincliffe supplies up to 60Ml/d to parts of the Bradford area. From current trends, it is thought likely that raw water quality (in terms of colour) will continue to deteriorate, further reducing the capacity of the works. In addition a further concern is the risk of formation of Tri-halomethanes (THM) arising from the chlorination of colour not removed by conventional treatment.

Regulatory Undertaking

For both sites Yorkshire Water Services has agreed Undertakings with the Drinking Water Inspectorate with associated compliance dates to address the raw water colour problems. Yorkshire Water's solution to the problem is the installation of Magnetic ion exchange plants (MIEX®) upstream of the existing WTW processes. MIEX® is an innovative process technology that has been developed by, and supplied through, Orica Watercare Ltd. Ewden and Graincliffe will be only the second and third MIEX® plants to be constructed in the UK, the first being at Yorkshire Water's Albert WTW in Halifax.

MIEX® uses magnetised ionic resin particles to attract the negatively charged dissolved organic carbon (DOC) compounds that can cause colouration in untreated water. The raw water enters a contactor where it is mixed with MIEX® resin and the ion exchange process takes place as DOC is attracted to the MIEX® resin. Flow then enters settlers where the MIEX® treated raw water is separated from the resin, the magnetic resin beads forming large agglomerates that settle to the base of the separator. Resin is recycled to the contactor with a small proportion being sent to the regeneration plant for regeneration, a process which involves exchanging charged DOC with chloride ions obtained from brine. The MIEX® process results in a small waste stream and requires some replacement of minimal quantities of resin that can get lost from the process.

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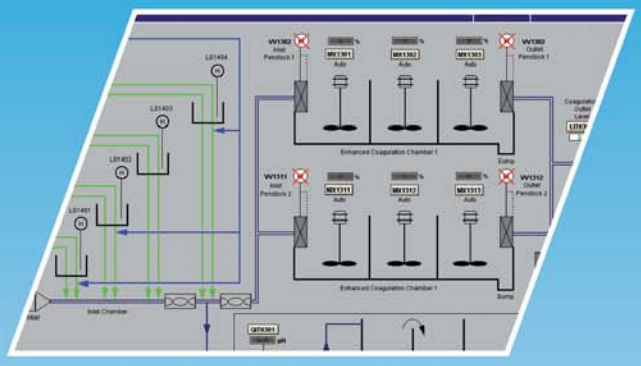

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Graincliffe WTW *Photo courtesy of Peter Smith Photography*

Graincliffe contactors under construction *Photo courtesy of Arup*

Both schemes are being procured under Yorkshire Water's AMP4 Framework for Large Schemes as one contract and have similar programmes which is expected to result in a degree of efficiency in design and construction. Yorkshire Water's Framework technical consultant, Arup undertook feasibility and tender preparation work for both schemes with input from commercial consultant Turner and Townsend.

A key constraint at Ewden was the lack of an existing sewer on site for which several potential solutions were evaluated, these included nanofiltration, chemical coagulation and filtration, tankering to nearby wastewater treatment works and a new sewer pipeline. The solution that offered best value and least risk to Yorkshire Water was the procurement of a new 4km long sewer to be laid along the main road into Sheffield. This road had already suffered from a year long road closure due to previous flood damage and the decision was made by Yorkshire Water to bring the procurement of the sewer construction forward to ensure that it could be laid before the road was to be re-opened in order to eliminate further public disruption. This part of the works was successfully completed by Yorkshire Water's Framework contractor MMB in December 2008.

The existing Ewden WTW has a hydro-generator on the inlet which is used to generate some of the energy used on the WTW site. It was therefore important that the design sought to minimise the headlosses through the new MIEX® process, to minimise the change in power generation capacity of the hydro-generator.

Environmental constraints at Ewden WTW included undertaking bat surveys to ensure the small number of trees that required removal for the scheme did not affect ecological habitats and also ensuring designs took account of the likely flood risk from the adjacent River Don.

A key constraint at Graincliffe WTW was the limited amount of space close to the existing inlet works to locate the new MIEX® plant. This is further constrained by the need to maintain chemical and other deliveries to the existing WTW. The MIEX® plant layout has been optimised to provide the best value solution in the available space.

A further challenge at Graincliffe was the definition of a raw water envelope for the design of the MIEX® plant. Unlike Ewden WTW which is supplied by one reservoir, the existing WTW is supplied by a large network of upland sources and as the blend of these sources received by the WTW can vary significantly, work was required to ascertain likely future blends in order to determine in particular, the DOC limits of the raw water to be treated.

Following a successful tendering process the NEC Option C contract for the construction of the new MIEX® plants were let to Black and Veatch in September 2008. Orica Watercare is a key subcontractor appointed by Black and Veatch to provide process design of the MIEX® plants and procurement of the regeneration plants. NEC Project Management and Supervision is provided by Arup. Each scheme value is in the region of £7.5M.

Key to the success of the Ewden and Graincliffe MIEX® schemes is application of learning from the installation of the first UK's MIEX® plant recently been completed at Albert WTW, common personnel are employed on the three schemes where appropriate to facilitate sharing of lessons learnt between all the parties involved in the schemes.

The majority of design works are now complete and Black and Veatch started construction on the two sites in November 2008. Diversion of services is complete and construction of the reinforced concrete contactors and settlers is progressing well with planned completion of the scheme by March 2010 to meet the DWI compliance date.

The key project participants on the project were Yorkshire Water Services (the client), Black and Veatch (principle contractor/designers), Arup (technical consultant) and Turner & Townsend (commercial consultant).

Note: ***The editor & Publishers thank Abi Morgan, NEC Project Manager with Arup and Simon Balding, Solution Manager with Yorkshire Water Services Ltd for providing the above article.***■