Badentinan WTW

improved water treatment in the Elgin and east coastal area

by
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The existing water treatment works at Badentinan (approximately 9km south of Elgin) is one of the sources that supplies Elgin, Rothes, Baxters and the Coastal Trunk Main network. It has an output capacity of 27 Ml/d and has been providing flows to supply since 1992. As part of Scottish Water's Q&S III Capital Investment Programme Scottish Water Solutions determined that the required quality driver for turbidity could be met by a new ultra-filtration membrane plant.

Membrane treatment plant - module assembly view *Courtesy of Enpure Ltd*

The raw water supplying the site is abstracted from the Dipple North and South well fields (approximately 6km from the works south of Mosstodloch). There are 36 wells in total in river gravels adjacent to the banks of the River Spey. Raw water is pumped via two 450mm diameter ductile iron mains to the existing treatment works. Existing treatment comprised a raw water tank, lime dosing to raise pH, chloramination disinfection and chlorine contact. Additionally there are two clear water tanks, one 45 Ml and the other 9Ml, each providing supply into the distribution network.

The £4.26 million improvement scheme awarded by Scottish Water Solutions has been undertaken by the Morrison Enpure Joint Venture to provide the ultra-filtration membrane plant and all associated works. As part of the overall scheme an upgrade of the existing works telemetry and SCADA systems has also been undertaken to provide for the integration of the new treatment stage.

Membrane Treatment

The new treatment stage is located between the existing raw water tank and the existing works such that flows exiting the membrane plant pass forward to the existing dosing stages prior to flow into the contact tank. The control of flows to the membrane plant is by means of variable speed feed pumps which respond to changing level in the inlet feed tank as determined by the flows received from the well field borehole pumps. Ultimate control of throughput is matched to the required works output.

The membrane plant has been supplied and installed by Siemens Memcor and is based on their hollow fibre membrane technology. The plant consists of five separate CP96 units each of which contain 96 of their L20V membrane modules with membranes manufactured from PVDF (polyvinylidene). Each module contains a sub module of membrane fibres that run vertically in the module assembly, each

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Water Technologies

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fibre has a pore size of 0.1 micron. Each of the membrane sub modules is housed within an outer "shell" which is fitted with "headpieces" at either end to form the "Module". These modules are formed into an "Array" by being connected together at the top and bottom headpieces effectively connecting the 96 off L20V membrane modules in a parallel formation.

Raw water is pumped via the array of inlet headers to the outer membrane tube and then passage though the fibres under pressure for collection in the respective outlet headers, and then discharge via a common piped outlet manifold. The plant is designed to achieve a turbidity of less than 0.1NTU and a minimum 4 log reduction in cryptosporidium removal.

Membrane Cleaning Process

During the filtration process, the feed side of the membranes collects the particulates that cannot pass through the membrane pores. This build up of particulate matter reduces the rate at which the feed can pass through the membrane (permeate) and thus reduces the filtrate flow The resulting rise in differential pressure (TMP) initiates an automatic backwash. During backwash, material that has accumulated on the surface of the membrane is dislodged by introducing low pressure air to the bottom of each module. This air flows around the outside of the membrane fibres scours the surface contaminants from the fibre. Filtrate can then be passed from the inside of the hollow fibres through the membrane wall which in turn aids removal of any deposited solids on the membrane outer surface. Backwash waste is then discharged using a low pressure air assisted drain down to the local burn via the existing works drainage pipeline.

Periodically chemical cleaning of the membrane using the Clean In Place (CIP) sequence is used to remove any organic and inorganic foulants from the membranes that may not removed by backwashing. The plant control system will determine when a CIP is required via the CIP Map, typically initiated on a unit every 28 days. The CIP is normally carried out using pre heated water which is recirculated and dosed with sodium hypochlorite and sulphuric acid. There is also the provision for the use of citric acid when fouling is particularly severe and possibly the need for removing metals from the membranes. After the soak period the unit is rinsed to the CIP Waste Holding Tank in a number of steps designed to remove all traces of cleaning chemicals from the unit. During the final rinse steps the quality of the filtrate is checked by the CIP System pH transmitter and if the pH is with +/- 0.5pH of the filtrate pH the CIP is complete and the unit performs a backwash before returning to standby to await a return to service. The spent chemical solutions are neutralised before discharge as per the backwash waste.

Plant Control

The membrane plant has its own dedicated control system (Siemens PLC) which monitors plant performance and initiates the controlled sequencing of backwash and CIP on both a time and pressure basis. Access to the plant control for configuration and diagnostics is done via a Siemens HMI within the ICA section of the motor control centre and communications between the existing and new plant is done via Ethernet link. Telemetry connections for hardwired and derived analogue and digital signals is provided by means of an outstation installed within the MCC which communicates with the membrane plant master PLC.

Changes have been made to the existing works PLC and Telemetry system in order to provide and receive key signals from the new plant. In addition a significant upgrade of the existing works SCADA system has been undertaken to provide a fully integrated single point monitoring system.

Civil Works

The new treatment plant including inlet feed tank, feed pumps, strainers, membrane modules and cleaning systems are housed in a new building adjacent to the existing works. The new building is of an RC base slab construction with structural steel portal frame superstructure, and with external brick and cladding to match the existing buildings as required by Planning. Integral with the RC construction is the inlet feed water tank which supplies the membrane plant. Below ground works include all necessary pipework connections to and from the existing works and the building is self contained in respect of all building services. To accommodate the new plant an electrical service diversion has been carried out by the power supply utility provider.

Progress

Project Completion and performance testing have been achieved on programme (March 2009) and output water quality is meeting all scheme requirements.

This fully automated, robust and compact plant fulfils the existing works pre-treatment needs without significantly impacting the current operational burden, a credit to all involved.

Note: ***The Editor & Publishers thank Trevor Farrow, Project Manager with Enpure Ltd for the above article.***■

Membrane treatment plant - control panel view ***Courtesy of Enpure Ltd***