

Industrial Pure Water for Teesside Site

high rejection RO system water delivered by 26km ring main

A high capacity water treatment system, which supplies industrial pure water has been provided for users within the Greatham and Seal Sands area of Teesside. The system comprises a fully automated and centralised high rejection (HR), reverse osmosis (RO) system, connected via a 12 kilometre ring main to supply Hartlepool Power Station and Huntsman site. RO permeate supplied to Huntsman's North Tees site is then demineralised in an additional water treatment facility using the latest mixed bed ion exchange technology. The system is linked with a nearby reverse osmosis system installed at Huntsman Tioxide plant.



ACWa Filters, Hartlepool Water Seal Sands, Teesside (photo GR Photographic, courtesy Technical Marketing Services)

The centralised design was specified by *Anglian Water Services* to provide the most economical solution for current requirements but allow additional customers to be connected to the high purity RO permeate ring-main supply in the future. The RO design for the new plant is based on the proven *ACWa* plant supplied in August 1999 and installed at Huntsman Tioxide. *ACWa* was selected by AWS to design, build, install, commission and maintain the new system because of its proven track record of high quality and responsive process contracting in the membrane systems field, with more than ten years experience in UK and overseas water sectors.

Our schematic of the plant shows the main components of the centralised facility, ring main distribution and mixed beds plant. The water source is a chlorinated mains supply from *Anglian Water's* Dalton Percy Water Treatment Works in Hartlepool. This supply is relatively high in hardness and alkalinity as shown in the attached table. The maximum required feed flow to the centralised facility is 410m³/h.

The RO system comprises four streams of identical equipment each rated to produce 82m³/h of pure water. The existing

Huntsman Tioxide site has three further identical 82m³/h streams providing a total potential output of 574m³/h.

Fail safe

Sodium bisulphite is dosed into the mains supply in order to neutralise residual free chlorine present. Dedicated dosing pumps are provided for each stream of RO in order to maintain the correct neutralisation dose of sodium bisulphite. The effectiveness of the chemical dosing is monitored by measuring the oxidation reduction potential (ORP) downstream of a static mixer. As the HR RO membranes installed are damaged by exposure to oxidative compounds such as chlorine, should the ORP increase over a fail safe level the control system will shut the plant down.

Water Quality Parameters

Feed Water	RO permeate maximum, levels	specification
Conductivity (µS/cm)	1,100	<25
Silica (mg/l)	10	<0.1
Sulphate (mg/l)	240	<4.0
Calcium (mg/l)	120	<1.0
Magnesium (mg/l)	60	<0.4
Alkalinity (mg/l)	400	<9.0
pH	6.9 – 7.9	5.0 – 7.0

Each RO stream is controlled by its own control panel, driven by an Allen-Bradley PLC with local operator interface. Data highway links connect the RO stream control panels to an overall 'Supervisory' PLC. This starts and stops the system whilst also providing monitoring data for analysis by AWS and ACWa's specialist engineers. Routine monitoring of the plant allows effective preventative maintenance to be planned and implemented by ACWa's service engineers. This ongoing after sales service minimises operating costs and maximises membrane life and plant reliability.



ACWa Filters, Hartlepool Water Seal Sands, Teesside
(photo GR Photographic, courtesy Technical Marketing Services)

Protection for RO plant

To minimise bacteriological growth and possible fouling of the HR RO membranes when the system is at rest, a non-oxidative biocide is dosed into the feed of each RO stream during each shutdown flush procedure. Additionally, to protect against the unlikely event of suspended solids reaching the RO plant, 5µm nominally rated cartridge 'policeman' filters are included. Downstream of these, an anti-scalant chemical is dosed to minimise scaling of salts and organic fouling within the RO membranes. This is necessary as the contaminants present in the feed water are concentrated into 20% of the feed flow. This 'reject' flow is formed as the feed is pumped into the membranes at high pressure to overcome the natural osmotic pressure of the feed water. At up to 24 bar, reverse osmosis occurs within the membranes and 80% of the feed supply permeates from the RO system as the treated 'permeate' with over 95% of the dissolved contaminants transferred into the reject flow and discharged to drain. The anti-scalant retains contaminants in solution throughout the RO plant and prevents rapid scaling and fouling that would otherwise occur.

The ACWa RO design works with the control system maintaining a fixed feed flow from the high pressure pump via a variable frequency drive and mag-flow meter. A second control loop maintains a fixed reject flow using a modulating valve and mag flow meter. As the osmotic pressure of the feed supply changes due to natural variations in temperature and concentration, and as the HR RO membranes gradually foul and scale, the flows are maintained – the feed pressure being automatically adjusted to ensure a constant high quality permeate supply. The gradual fouling and scaling of the RO system results in the need to clean in place (CIP) the membranes. ACWa service engineers will supervise the CIP procedure approximately once per quarter per RO stream. A fully integrated and installed CIP system utilises specialist acid and alkali based chemicals, diluted with permeate and heated to 40°C, as part of the semi-automated CIP sequence.

Ring main

Carbon dioxide naturally present in the feed water is removed from the permeate by four duty degassing towers. Air is blown up through the tower media to scour carbon dioxide from the permeate which is then pumped on to a balance tank. Product water from the centralised facility is pumped via a ring main system to provide a constant high purity water supply to Huntsman North Tees and Hartlepool Power Station, with capacity for additional future users. The ring main can be fed in either direction and a 'spill back' facility is incorporated to maintain pressure at all times. In addition, a separate system allows the transfer of permeate either

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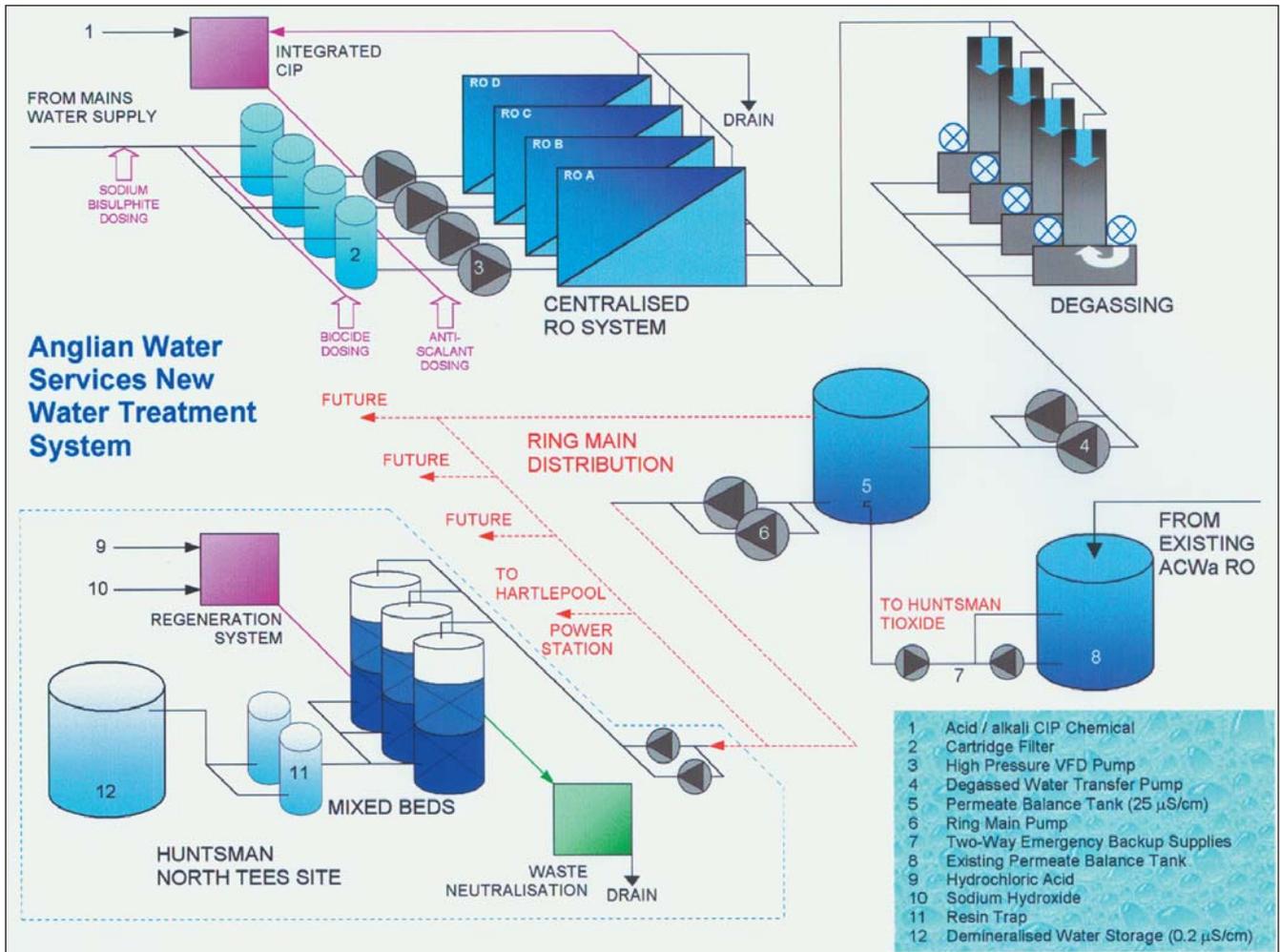
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Anglian Water Services Water Treatment System (courtesy ACWa)

way between the existing RO facility at Huntsman Tioxide and the new centralised RO system, providing an emergency link between the two sites.

Water for Huntsman North Tees is further treated by mixed bed demineralisation ion-exchange technology using a new system installed at their site by ACWa and fed directly from the ring main. The plant comprises three 50% streams of ion exchange followed by two 50% streams of cartridge filtration acting as a resin trap in the unlikely event of a resin leakage.

The mixed bed vessels contain a combination of cation exchanging and anion exchanging resin. The cation resin has H^+ ions attached that are readily exchanged for cations such as calcium and magnesium in the RO permeate fed to the plant from the centralised facility. The anion resin has OH^- ions attached, to be exchanged for anions such as sulphate and chloride. The resulting H^+ and OH^- ions released from the resin combine to form water. The treated water produced is extremely pure with a conductivity of less than $0.2\mu S/cm$.

As the H^+ and OH^- ions are removed the performance deteriorates and the resin becomes exhausted. The plant is normally regenerated on volume throughput with the backup of on-line conductivity monitoring and 'time elapsed' adding to operator

flexibility in optimising the system. As with the RO plant, all operating data is available for review by AWS and ACWa engineers.

Regeneration

The regeneration is undertaken automatically one stream at a time on one of the three vessels utilising hydrochloric acid, caustic soda, treated water and air. Bulk storage facilities for the regeneration chemicals are provided with measure tanks installed local to the vessels. Backwashing with treated water fluidises the resin and separates the heavier cation resin from the lighter anion resin. Diluted hydrochloric acid (HCl) is then passed upwards through the cation resin and diluted sodium hydroxide (NaOH) is passed downwards through the anion resin. The combined flow exits at the cation-anion resin interface via a common collection system and is transferred to the waste neutralisation system. The HCl regenerates the cation resin with H^+ ions whilst the NaOH regenerates the anion resin with OH^- ions. Displaced cations and anions are released into the waste stream. The resins are then re-mixed using low pressure air. Following rinsing the vessel is put back on line and the regeneration is complete. Demineralised water is transferred to Huntsman North Tees' storage facility. ■

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