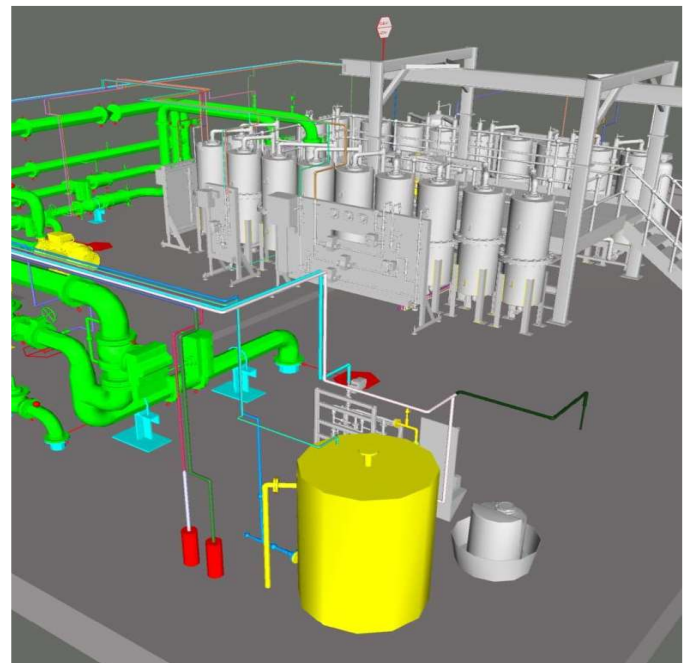




INNOVATION IN PROCESS

Nitreat®
Ion Exchange
Nitrate Removal



Nitrate Reduction

Why do we need Nitrate Reduction?

Nitrate and Nitrite (soluble forms of Nitrogen) are naturally present in the environment and are essential nutrients for plant cultivation.

With the continued population growth within the UK, farmers utilise artificial fertilisers, rich in Nitrate, to improve crop yields. Some of the Nitrate is leached by rainwater from the soil into the groundwater (local aquifers).

Elevated levels of Nitrogen within our watercourses encourage eutrophication (greater concentrations of algae and microscopic organisms – Algal Blooms), ultimately reducing oxygen levels within the

waterways, which reduces and harms plants, animals, and fish.

Nitrate levels in groundwater vary across the UK. It is recognised that these levels are on the rise, putting our sources of drinking water at risk without treatment.

As a result of the elevated Nitrate levels in our water supply, the Drinking Water Directive (DWD) has set the prescribed concentration at 50mg/L NO₃ within the UK to ensure our drinking water supply remains safe.

Nitrate Removal - Why choose Nitreat® over fixed media bed systems?

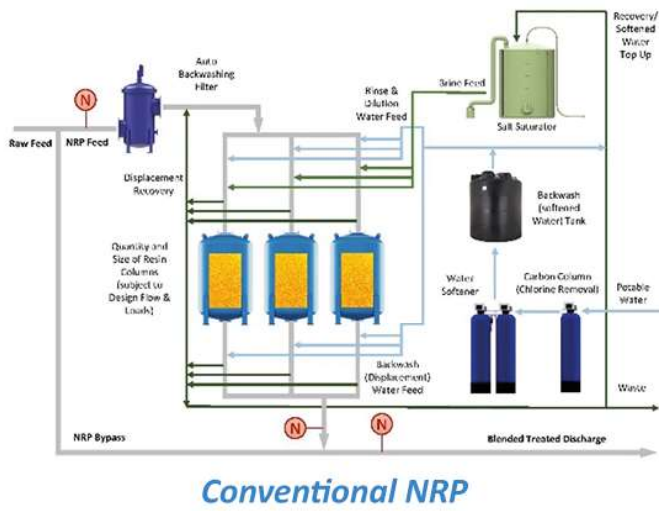
In the late '90s, ACWA introduced a Fixed Media Bed, Counter Current Ion Exchange technology (a batch process) to reduce nitrate levels in drinking water prior to chlorination and network feed.

ACWA observed that these plants required large volumes of flushing/displacement water during each vessel regeneration phase, resulting in large instantaneous flows (even after backwash, dilution, and rinse recovery) being discharged into the local sewer or to a large wastewater holding tank for off-site disposal via tanker, which significantly affects the OPEX over the plant's design life.

The large volumes of softened water required during the regeneration process (backwashing, dilution, and rinsing of the resin) further increased the demand pressure on the existing potable water network.

With increasing pressure on UK water networks to maintain availability, ACWA developed a new approach to the Nitrate Removal Plant (NRP) utilising Continuous Counter Current, which optimised both the Nitrate Absorption Process and the usage of softened/flushing water. By having multiple vessels pass in series through the regeneration stages, the total wastewater produced was ultimately reduced to less than 0.5% of the total works flow, while also optimising salt consumption (Automated Cycle Adjustment).

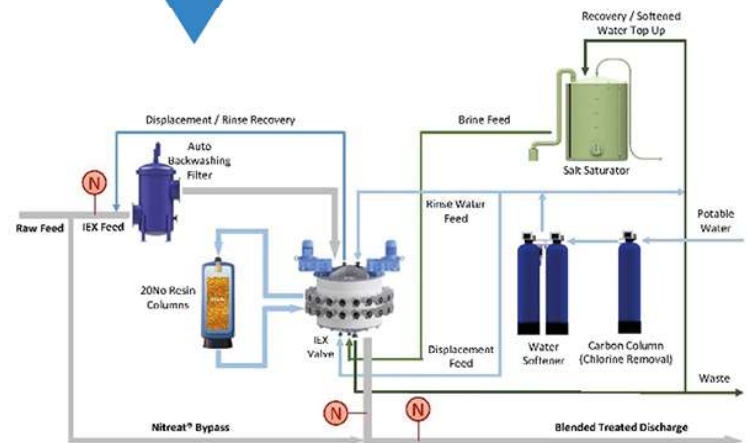
ACWA's first Nitreat® Plant went into service in 2005, and there are now over 38 Nitreat® Plants in operation throughout the UK, with capacities ranging from 3 MLD up to 92 MLD.



Evolved



Nitreat® Technology



AMP7 Installation



Features

The Nitreat solution has been developed to deliver the following benefits:

- Optimised Softened Water Production & Recovery
- Minimum Waste Production/Disposal Costs
- Automated Dynamic Inlet/ Bypass control
- Nitrate, Hardness & Conductivity Monitoring & Control
- Automated Softened Water & Brine Systems
- Automated Dynamic Blended Discharge Control
- Long Term Standby / Mothballing
- Design and Build (digital delivery and off-site manufacture)
- Commissioning
- Project Management
- No 'slug' waste discharges when discharging to sewer
- Operational Optimisation
- Servicing and Maintenance Contracts available

In finding the best solutions we look at innovative ideas and turn them into reality producing some of the most sustainable technological solutions on the market.



Nitreat® Vs ACWA Fixed Media Bed

Description	Units	ACWA Nitreat® NRP	ACWA Fixed Bed NRP
<i>Example Design Flow Scenarios</i>			
Scenario 1 - Total Works Flow	MLD	5.0	
Scenario 2 - Total Works Flow	MLD	50.0	
<i>Nitrate (NO₃) Removal</i>			
Design Basis - Resin (A520E - DWI Approved), Litres of Resin/KgNO ₃ Removed	g/l	15-30	
Total Resin Volume Required	litres	Absorption volume + Regen Volume + (N-1 if required)	
Nitrate Reduction Process Guarantee	-	Yes (Bespoke Design to Clients Requirements)	
<i>Resin Regeneration</i>			
Design Basis - Salt/Nitrate Removed - Process Guarantee Level	Kg/KgNO ₃	<8.5	
Calculated Salt Consumption Range/Nitrate Removed, Subject to Specific Site Variables	Kg/KgNO ₃	~6.0 - 7.5	~7.5 - 8.0
<i>Resin Regeneration Waste Production</i>			
Design Range Calculated (Including Waste Recovery) as % of Total Works Flow	%	0.2 - 0.5	0.4 - 0.95
Typical Waste % of Total Works Flow	%	0.23	0.45
Scenario 1 - Waste Volume	m ³ /d	11.5	22.5
Scenario 2 - Waste Volume	m ³ /d	115.0	225.0
<i>Waste Storage and Disposal Routes</i>			
Scenario 1 - 5 Days Waste Storage	m ³	57.5	112.5
Scenario 2 - 5 Days Waste Storage	m ³	575.0	1,125.0
Disposal Route A - Direct Discharge to Sewer Connection			
Continuous Discharge (24/7) Range	m ³ /h	0.48 - 4.8	Not available, Additional Flow Balancing Required
Resin Vessel regen - Cycles / Day	Vessels	Continuous	4 - 6
Waste Flow / 2 hour Cycle	m ³ /h	N/A	2.81 - 18.75
Risk of Instantaneous Volumes if High Salinity Levels into Sewer Discharge & Risk to Downstream Biological (WWTW) Systems	-	Low	High
Disposal Route B - Tankering vehicles per day (Based on 18m³ Capacity Tanker)			
Scenario 1 - Waste Volume	Vehicles	1	1
Scenario 2 - Waste Volume	Vehicles	4	8

OPEX Savings

In addition to the OPEX savings in tanker costs for offsite disposal of wastewaters produced through the regeneration phase, other potential savings would be:

- **Softened Water Production:** This is a continuous direct feed to the Nitreat® Skids, eliminating the need for bulk backwash storage and transfer pumps required in the conventional system.
- **Greater Volumes of Softened Water:** Conventional columns that require more softened water for regeneration will also need more brine for softener regeneration, ultimately increasing salt consumption for the conventional process.
- **Waste Removal by Tanker:** Reduced waste production from Nitreat® decreases the number of tanker movements to the site each day.
- **Discharging Directly to Sewer:** The Nitreat® waste flow does not require buffering prior to discharge, as the flow and load are continuous. In contrast, the conventional system (4-6 regeneration cycles/day) requires waste buffering prior to discharge to prevent instantaneous 'slug' discharges of brine waste, which could impact local treatment facilities if not sufficiently diluted.

Material Selection

The use of suitable construction materials for product (potable water) applications has always been critical to ensure product quality. ACWA's Nitreat® technology complies with DWI Reg 31. Where specific products (with DWI Approval) are not available, ACWA has utilised WRAS approved materials instead.

DWI Reg 31 and Material Selection

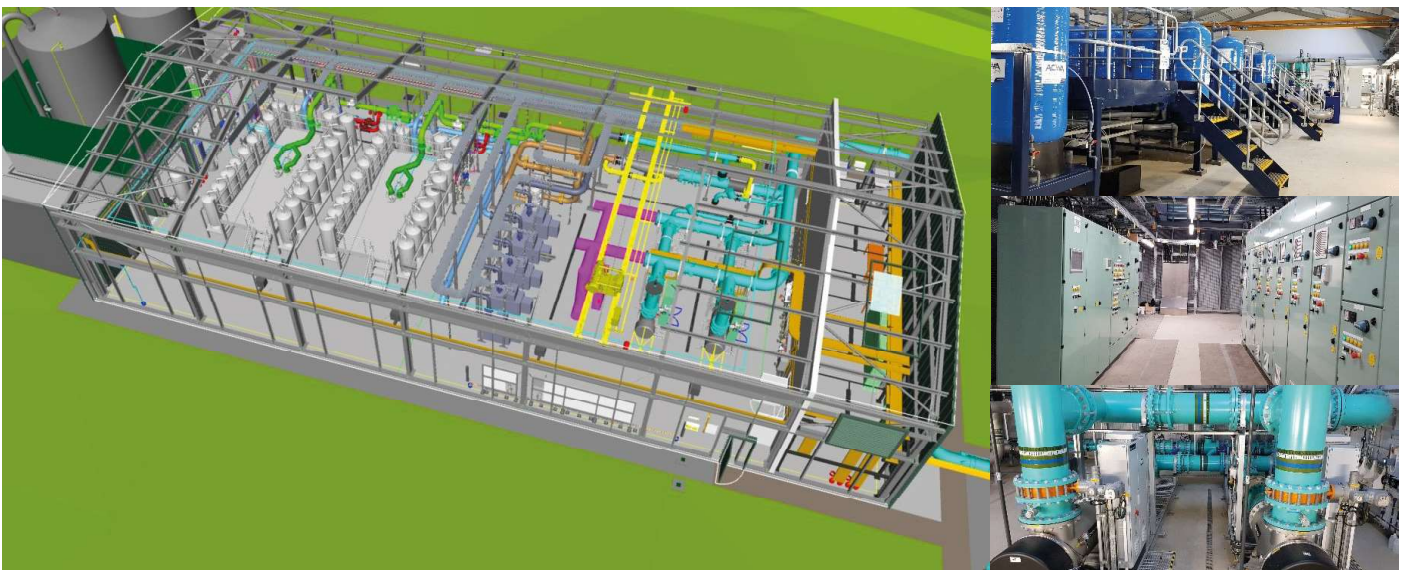


Nitreat® References

Since 2005, ACWA's Nitreat® Technology has been adopted by most Water Companies providing network resilience with the potential to process up to **228MLD Raw Feed Water** removing up to **13,818kg/NO₃ (Nitrate) every day**.

- Affinity Water
- Anglian Water
- Cambridge Water
- Southern Water
- SouthEast Water
- South Staffordshire Water
- Severn Trent Water
- Thames Water
- Yorkshire Water

ACWA's reliable bespoke Nitreat® Design can be configured to meet any/all of your network requirements utilising ACWA's Standard Skid Arrangement and Instrument Board Monitoring which are assembled in our workshop utilising DfMA techniques.





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