Drift WTW

the application of UV/peroxide advanced oxidation in combination with granular activated carbon at Drift WTW, West Cornwall

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Drift Water Treatment Works is the most westerly water treatment works in mainland England, situated just outside Penzance, within the historic World Heritage mining region of Cornwall. The works supplies the town of Penzance and the area's rural communities, which has a total residential population of approximately 50,000. The raw water source has a history of low level pesticide detections. To protect against the risk of these compounds reaching the final water, a scheme to provide a more robust treatment barrier at the site was promoted as part of South West Water's quality improvement programme. By the innovative application of advanced oxidation in combination with granular activated carbon the company has achieved these goals and expects a range of other water quality and acceptability benefits.

GAC pipe gallery and UV unit - Courtesy of Interserve Construction Ltd

Scheme drivers

In recent years within the UK and Europe, the main water quality treatment targets have shifted from the historical focus on microbiological contaminants to include organic micro-pollutants that may be present today or in the future.

South West Water was looking to efficiently address the current pesticide and future risks it saw in this area by applying a technology that was effective against the widest possible range of organic micropollutants.

Drift Water Treatment Works

Drift WTW was built in the 1960s and takes its raw water from an impounding reservoir with a net capacity of 1,200ML. The WTW supplies 12.7ML/day to 50,000 people in Penzance and the surrounding area.

Due to the horticultural nature of the catchment, the site has a history of low level raw water pesticide detections. In addition, the reservoir experiences over wintering populations of algae resulting in geosmin and 2-menthyl-isoborneol (MIB) present for extended periods from early summer to late autumn. In order to improve the treatment of these pollutants, an advanced oxidation process using low pressure UV light in combination with hydrogen peroxide (AOP) followed by granular activated carbon (GAC) was selected as the preferred method.

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UV unit - Courtesy of Interserve Construction Ltd


UV unit - Courtesy of South West Water

The proposed AOP solution involved a £3.5m capital project to provide and install a new GAC plant, hydrogen peroxide storage and dosing facility, UV unit and new 2.7ML final water tanks (to replace a circa 50-year-old circular tank).

Innovation and collaboration

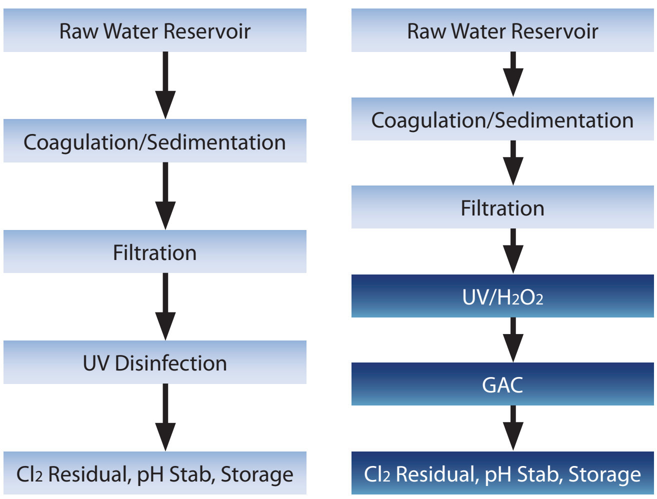
The application of AOP in this way is unique within the UK. In order to fully understand the implications of pioneering this process in the UK, a collaborative approach has been adopted between the company, its long-standing engineering partners and a number of specialists in the field. These include PWN (Water Supply North Holland; Andijk, The Netherlands) who pioneered the process for surface water treatment globally, and Trojan Technologies.

Prior to the implementation of the main capital scheme, a detailed pilot study was undertaken at the WTW in 2010. The pilot plant consisted of a Trojan UV unit and 5 columns of GAC which varied in carbon type, surface loading rate and empty bed contact time. The results of the trial concluded that AOP utilising low pressure UV, hydrogen peroxide and GAC, provides a robust and effective barrier against a range of organic micro-pollutants. A separate paper, *'Advance Oxidation for Surface Water Treatment in Cornwall - A New Lighthouse Project in Europe',* has been written on the specifics of the pilot plant study and subsequent results.

Design

For the purposes of the design the throughput of the works was agreed at 12.13ML/d (140l/s), the existing works maximum output was 11.2ML/d (130l/s). The works required to upgrade the treatment included the following:

- Installation of a Trojan UV unit.
- Construction of 4 (No.) GAC contactors (each approximately 3m x 7m x 5m high).
- A $150m^3$ clean water backwash tank including duty/standby variable speed pumps.
- A pumping station downstream of the GAC, duty/standby variable speed drive providing 50-145l/s to supply the new chlorine contact tank (CCT).
- A two-compartment final water tank providing 2.7ML of treated water storage.
- Air blowers.
- Interconnection pipework and valves (including eccentric plug) between the above units.
- New motor control centre, data acquisition, integration and appropriate quality analysers.
- Steel frame, aluminium profile cladding building to house GAC and UV.



The existing (left) and upgraded (right) processes at Drift WTW

The GAC design parameters opted for at Drift were an empty bed contact time of 20 minutes, surface loading rate of 8m/hr, with typical backwash rate of 20m/hr, and air scour of 41m/hr, although the backwash rate is varied according to water temperature.

The WTW site has been developed over the years and available space for the project was limited. The site sits in a valley, with steep rock sides to the west, the existing filter and clarifier buildings to the north, lagoons to the east and works boundary to the south and west. The water supply main to Penzance also crosses the southern part of the site. Provision also had to be made to accommodate any future requirements at the site, such as replacement filters.

This space restriction was resolved though a compact design and layout, with the main GAC building located and orientated so that it could be readily extended to accommodate future plant/processes. The hydrogen peroxide storage and dosing system was designed, constructed and commissioned by Tecker using an innovative skid mounted approach which allowed a smaller footprint and reduced cost.

Due to the compact nature of the GAC building itself, the pipe gallery was complex. In order to position and visualise the layout and location of pipework, valves, sampling equipment, platforms, walkways and other equipment a virtual 3D model was used. This could be rotated, viewed from any angle and items removed from the screen to allow internal pipework to be seen.

This proved to be most effective for operational staff, to allow them to *'walk through'* the plant and make comments on the layout and location of equipment prior to final design. The designer, pipework fabricators and sub-contractor installing the pipework were able to work in conjunction to discuss and agree how the pipework could be broken up into fabricated sections for ease of fabrication, transport, installation and to reduce construction time on site. Each section of pipework was individually labelled within the 3D model to assist construction on site.

In order to get best value from the design, items such as the blowers and clean backwash tank were designed with sufficient capacity to accommodate requirements for the replacement of the rapid gravity filters in the future.

Chemical storage

As the AOP process requires the use of hydrogen peroxide, the safe storage of the chemical was a key requirement of the process. In its normal form the chemical is stable, but any form of contamination will lead to decomposition and subsequent vapour release with the risk of a pressure burst.

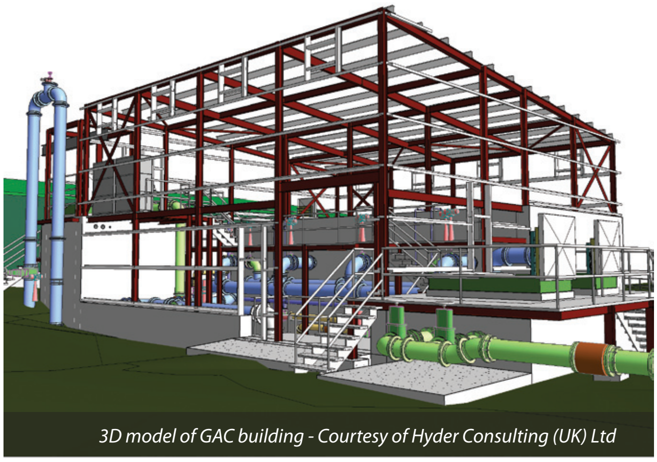
The storage area has been located away from other structures, chemical storage/deliveries and trees, thus minimising contamination risks. This location allows tanker deliveries to be made safely without the need to access any other parts of the site. The storage facilities are designed in line with the European Chemical Industry Council (CEFIC) Bulk Storage of Hydrogen Peroxide Guidelines 2005.

Planning and construction

The main GAC building required a full planning application, which was submitted and successfully approved with no conditions in line with the programme. Construction of the scheme commenced in June 2010 and was commissioned in phases from January 2011. It is now fully operational.

The WTW is, like much of Cornwall, in a location of significant historical mining activity. The site is crossed by many lodes and shafts, which posed a significant construction risk. Historical maps were consulted and boreholes were undertaken to establish ground conditions for the new treated water tank (TWT) and GAC

Drift Reservoir Dam - Courtesy of South West Water



3D model of GAC building - Courtesy of Hyder Consulting (UK) Ltd

GAC building - Courtesy of Interserve Construction Ltd

GAC viewing gallery - Courtesy of Interserve Construction Ltd structures. No mine workings were encountered; however, during piling works for the TWT, an unknown lode was encountered and piling had to be extended down to 12m (rock was typically at 4m depth).

It was a requirement that the works remained fully operational during construction. To meet this challenge the working area was segregated from the main works as far as practical, but chemical deliveries had to be carefully planned as access was required through the construction area. Sequencing of the construction works was key due to the limited working space.

Commissioning

Commissioning of the works was phased to allow each process to be brought on line with minimal risk. Existing pipework, which would ultimately become redundant and be removed, has been utilised to help facilitate the commissioning.

The sequence has been:

- Commission the new TWT.
- Demolish the existing TWT.
- Commission the CCT.
- Relocation of dosing facilities.
- Commission GAC and AOP.

Implications for the industry in UK and future development

The project proves that AOP provides an efficient and effective barrier against a wide range of organic micro-pollutants in this situation. Following the success of the Drift project, AOP is now being considered for implementation by South West Water at other water treatment works. The key factors that drive the efficiency of the AOP process are UV Transmittance (UVT) and hydroxyl radical scavenging effects of the water being treated.

The piloting work has indicated that a reduced GAC empty-bed contact time (EBCT) is effective in this situation when combined with AOP, as are extended GAC regeneration intervals.

Significant improvements in acceptability (taste and odour), a reduced reliance on chlorine and disinfection for 'free' have also been provided by the implementation of AOP.

Conclusion

South West Water operates 30 (No.) WTWs, supplying 358ML of drinking water per day to 1.6 million customers throughout Cornwall, Devon and small areas of Dorset and Somerset. In addition to the main customer base, SWW supplies up to 8 million tourists during the summer months.

The Drift WTW scheme has been delivered by H_5O, the alliance set up by South West Water to undertake all capital work for the AMP5 regulatory period. The alliance consists of five partners; South West Water, two consultants and two contactors. Hyder Consulting and Interserve Construction Ltd were the respective partners for the Drift scheme. H_5O uses the New Engineering Contact (NEC), Option C, with a gainshare/painshare mechanism to provide an incentive for innovation and added value throughout the life of the project.

The use of AOP, pioneered in the UK by South West Water, has significant benefits to the water industry. South West Water is committed to providing good, safe drinking water that has the trust of its customers and will continue to exploit innovation across the region for the benefit of its customers and visitors alike.

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