Warkworth WTW

granular activated carbon adsorbers - pesticide removal scheme

by Ian Surley & Paul Williams

Warkworth WTW is situated in the heart of the picturesque Northumberland countryside, approximately 35 miles north of Newcastle Upon Tyne. With a normal maximum output of 45 Ml/d, the works supplies 92,000 customers in the Northumberland and North Tyneside distribution zones. The WTW was originally built in the early 1960s by the then Coquet Water Board, as a part of the River Coquet Abstraction Scheme. The treatment works has been subject to elevated concentrations of commercial pesticides in the catchment area of the River Coquet since the turn of the century.

GAC Plant roofline showing actuated penstocks, access covers and instrumentation *courtesy MWH*

The treatment process prior to upgrade comprised:

* Raw water abstraction from the River Coquet.
* Inlet flash mixing and chemical dosing.
* Powdered activated carbon dosing for pesticide removal.
* Clarification via 4 No. sludge blanket clarifiers (with the aid of polyelectrolyte).
* 8 No. rapid gravity filters (RGFs) containing1200mm of 16/30 sand suspended on a plenum floor. Polarite (10% by volume) added to media to aid manganese precipitation.
* Disinfection of filtered water with chlorine gas, orthophosphoric acid dosing for plumbosolvency control and lime dosing for final pH trim.
* Storage in a 23Ml Treated Water Reservoir.

Pesticide Problem

Warkworth WTW is supplied exclusively from the River Coquet in Northumberland. The catchment area is bordered by agricultural land with cereal crops being the main activity. Since the turn of the century, the WTW has seen increasing levels of commercial pesticides in the raw water. Principal contaminants were identified as agricultural and amenity herbicides such as Isoproturon (IPU) and Propyzamide, occurring at levels above the Environmental Quality Standards (EQS) of 0.1µgl.

A catchment survey carried out by ADAS confirmed the extent of use of such herbicides. Users in the catchment were identified as agricultural, rail authorities, councils and amenity users. IPU was identified as being the main tool for autumn weed control used by farms. Summer applied herbicides such as Mecocrop and MCPA were also identified.

Techniques for reducing pesticide contamination at source such as interception of watercourses and changes in farmyard practice were considered at this stage. A risk workshop concluded that NWL would have to invest in a treatment process to give the robust level of protection required to meet its future obligations under the Water Quality Regulations.

The primary treatment for pesticide removal was powdered activated carbon (PAC), dosed into the sludge blanket clarifiers. The efficacy of such a system was dependent upon dose and contact time in the clarifier sludge blanket, but was also influenced by the competition-effect of organics present in the raw water. The maximum dose of PAC used was typically 15mg/l.

The system was found to be reactive to pesticide contamination events in the raw water. The time needed to build up sufficient PAC

in the clarifier sludge blanket meant that pesticide spikes in the raw water were already present in the treatment process. NWL installed an advanced monitoring system on the raw water feed to the treatment works in order to provide an early warning of pollution events but recognised a need for a more proactive approach to pesticide treatment.

The upgrade of treatment works was undertaken by Black & Veatch and designers MWH on behalf of Northumbrian Water.

Scope of Work
The principal works provided under the project were:

* 6 GAC adsorbers;
* Pre-interstage pumping station;
* Clean backwash facility;
* Chemical dosing chamber;
* MCC room;
* Dual feed transformers.
* Major process connections (including dirty washwater and GAC inlet/outlet)
* Two new 700m^3 dirty washwater tanks;
* SCADA interface/new telemetry;
* Installation of pH correction prior to RGFs for improved manganese removal;
* Installation of caustic soda plant for final pH correction.

GAC Process Outline
The newly installed GAC adsorbers are designed to provide a minimum empty bed contact time (EBCT) of 10 minutes at maximum works flow. The design takes into account redundancy due to backwashing and maintenance requirements. The maximum nominal filtration velocity is 13.1m/h. During normal operation (all units in service), the nominal velocity will be 8.7m/h with 15 minutes EBCT.

Filtered water discharges into the interstage pumping station prior to transfer to the GAC adsorber inlet channel. Pesticide and organic contaminants are adsorbed onto the GAC media. Treated water is collected in the underdrain system and gravitates into the outlet channel. GAC treated water gravitates into the existing 800mm diameter reservoir inlet main where it is dosed with chlorine, orthophosphoric acid and caustic soda.

Media backwash can be triggered by turbidity or headloss, but is usually pre-determined by time. The dedicated GAC clean backwash tank holds 4 bed volumes, which is equivalent to 315m^3. Each wash involves passing 2 bed volumes through the media at a wash rate of 30m/h. The backwash pumps are controlled by variable speed drives and automatic temperature compensation to achieve 20% expansion of the media bed. Dirty washwater is discharged to two new washwater tanks prior to recycling to the head of the works.

The media consists of 2.2m of Chemviron F400 N carbon supported by a proprietary multi-block underdrain system. Extensive trials during the feasibility stage of the project estimated a regeneration frequency for the media of 18 months to 2 years. Process monitoring is provided by turbidity and UV_{254} instruments.

Construction
Completion of the GAC adsorbers was linked to a DWI Authorised Departure. This resulted in a tight construction programme with little float, requiring a high level of control if the end date was to be met.

Backwash and eductor pipework in GAC Plant Gallery courtesy MWH

Effective communication and co-ordination between competing projects on site was essential to minimise disruption to the construction process, the works is strategically important for the water supply to a large area of Northumberland. Works outages were a major constraint to construction activities and were carefully co-ordinated with other NWL commitments to minimise the risk to the distribution network. Teamwork and early involvement of stakeholders contributed to the success of this aspect of the project.

An advance earthworks contract to progress bulk excavation activities was let during the tender negotiation phase to reduce pressure on the main construction programme. The construction activities of civil, mechanical, electrical, ICA and process engineering progressed as expected. Notable events were the discovery of sand lenses at formation level which were not detected by the site investigation and the cutting of the 800mm diameter filter outlet pipe to insert a valve, tee and mixer assembly in a four hour works shut down.

Conclusion
The main contract commenced in January 2006. The GAC adsorbers were commissioned into service in July 2007 before the expiry date of the DWI Authorised Departure. The remaining process work was completed shortly after, compliant with NWL standards.

NWL's total investment was in the order of £13m. The project was delivered within the authorised budget.

The plant has been in service for approximately one year and has provided a reliable treatment process to protect the public water supply against pesticide contamination.

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