Black Lane WTW, Blandford, Dorset
high recovery ion exchange process for nitrate removal

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Wessex Water operates three boreholes at its Black Lane Water Treatment Works in Blandford, Dorset with a daily licensed abstraction of 10.5 Ml/d The existing water treatment consists of granular activated carbon (GAC) filtration for pesticide removal and gas chlorination. In common with many chalk sources in the south of England, this site has suffered from rising nitrate levels which are predicted to reach 14.5 mg/l as N(64 mg/l as NO_3) in 2017, well above the maximum admissible concentration of 11.3 mg/l as N (50 mg/l as NO_3). Historical trending of the nitrate concentration water indicated that most high nitrate was seasonal and coincided with high groundwater levels prevalent during winter and spring.

Nitrate reduction plant at Black Lane *(courtesy Wessex Engineering Services).*

Initial investigations identified that no nearby alternative source of low nitrate water could be found to either substitute for or blend with this source. As a result, Wessex Water committed to install a nitrate reduction process during AMP3.

A review of most current available technologies for nitrate removal indicated that most of these would not be suitable for the Black Lane site because of waste streams that are either high volume or high salinity. Both of these wastewater scenarios could not be accommodated safely at the small local sewage treatment works. Therefore, only low waste discharge treatment options could be considered.

Most viable option

High recovery ion exchange was considered to be the most viable and sustainable option and Wessex Water already has operating experience of one such installation at its Langdon source in West Dorset. High recovery ion exchange processes are those that operate at recovery rates of 99% and above. By comparison. conventional ion exchange processes usually operate at recovery rates of approximately 93 to 97.5%. Other novel low waste processes such as in situ biodenitrification or a biological nitrate removal process were not considered suitable for this site.

Only two variants of high recovery ion exchange are currently available, with each system differing significantly in its configuration and mode of operation.

System adopted

The system adopted for Black Lane uses a rotating turntable and multiport valve arrangement which cycles 20 ion exchange beds through a continuous process of service, backwash, regeneration and rinse. At any one time 14 of these vessels are in service, one is being backwashed, three are being regenerated and two are being rinsed ready to return to service,

This system is able to obtain a high recovery rate through a highly efficient counter current regeneration process that recovers and re-uses the regenerant in three successive stages. Furthermore, rinse water is re-used in two successive co-current stages and is subsequently recovered for use in brine dilution.

The drawback of this system is that it is technically complex and can be prone to component failure or nuisance shut down when it is used in a stop-start fashion. However, when operated continuously, the reliability of the system is good and previous Wessex Water operating experience has indicated that product water recovery of up to 99.8% is possible. Salt use for regeneration is also optimised as much as possible.

A further additional benefit of this process is that there is very little risk of high chloride to bicarbonate ratio occurring in the treated water, as can happen with conventional ion exchange processes. This is because freshly regenerate beds entering service only contribute a relatively small proportion of the overall product water output. Water containing high chloride to bicarbonate ratio can selectively remove zinc from alloys into the water phase when brought into contact.

Contract

The project was implemented as part of Wessex Water AMP3 programme. In June 2002 a NEC Option C Contract was awarded to the water treatment alliance contractor, Earth Tech Engineering Limited, to design and build the project with a total project cost of £1,972, 000. In addition to the installation of the nitrate reduction process, the project also included a number of capital maintenance aspects including:

* modifications to the GAC pesticide removal plant;
* installation of variable speed borehole pumps;
* installation of variable speed re-lift pumps;
* modification to chlorine and sulphur dioxide dosing systems.

Integrated

Design of the nitrate reduction plant was integrated into the existing treatment on site. In view of the low levels of pesticide present in this source, a decision was taken to reduce the size of the existing pesticide removal plant to make room for the new nitrate reduction process. This enabled the new nitrate reduction plant to be installed into an existing treatment building together with a 30 tonne brine saturator and a brine waste balancing facility.

The treatment is designed to reduce the nitrate level in up to 10.5 Ml/d of groundwater from 14.5 mg/l to 9.0 mg/l as N, a total daily removal of some 58kg of nitrate (as N) per day from the ground water. Only a proportion of the flow will be treated by the nitrate removal process with the remainder of the flow bypassing the treatment for subsequent re-blending.

The proportion of flow entering the treatment is calculated and continuously monitored and adjusted by PLC control. The basis of this control is the continuous measurement of nitrate concentration in the raw water, the ion exchange treated water, and the final blended water. This measurement is carried out by three UV nitrate analysers. The total volume of nitrate selective ion exchange resin employed in the process is 5600 litres. The maximum production of saline waste from the process at this removal rate will be 26m^3 per day, this would be equivalent to a overall product water recovery of 99.75%.

Commissioning of this system took place early in 2003. ■

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