Biddulph WwTW

conversion of existing COUF Filters to Nitrifying Sand Filters to meet a stringent Ammonia Consent

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United Utilities' Biddulph Wastewater Treatment Works a medium sized treatment works located in the town of Biddulph, Staffordshire. The works is currently designed to treat mainly domestic crude sewage from a population equivalent of approximately 17,000, and its consented Flow to Full Treatment is 13,400 m³/day. The works discharges treated final effluent into the Biddulph Brook. The works was up rated in AMP3 Capital Programme (2003) to meet the current final effluent consent of 15mg/l BOD, 25mg/l SS, 5mg/l Ammonia (NH3) (95%ile spot sample basis) and principally contains screening, grit removal, primary settlement (PST's), biological secondary treatment by an Activated Sludge Plant (ASP) with anoxic selector tank and Tertiary Filtration via Continuously Operated Upward Flow Filters (COUF's).

Lifting a new NSF unit into place on the far side of the existing 10 COUF units (left) and offloading 2 new NSF units adjacent to existing 10 COUF units (right)

Courtesy of United Utilities Integrated Alliance

Project Need

The works will receive a more stringent final effluent ammonia consent under the AMP4 Freshwater Fish Directive for a 15mg/l BOD, 25mg/l SS, 1mg/l NH_3 (95%ile). The regulatory project in use date is 15th January 2010.

The project team commenced investigation of options to meet the new consent in October 2006. They recognised that the conventional solution to achieve a 1mg/l ammonia standard, which is to provide a tertiary biological process incorporating solids removal such as a Biological Aerated Floating Filter (BAFF), would make the existing COUF's, (which were installed in 2004) redundant and incur a significant write-off cost (estimated to be up to £1,5M). Furthermore initial cost estimates for the BAFF solution indicated that costs would significantly exceed the OFWAT financial determination of circa £7.2M for the scheme.

A more cost effective solution was required. The project team instigated a program of ammonia concentration sampling within the crude and final effluent (upstream of the existing COUF's). The data gathered indicated that whilst the existing process achieves sustained periods of ammonia concentrations below 1 mg/l, the incoming ammonia load is seen to periodically spike, which results in peaks of up to 5 mg/l (for periods of 6-12 hours) in the final effluent that would exceed the new consent of 1mg/l ammonia.

Conversion of Existing COUF's to NSF's

The team identified that the existing COUF's had the potential to be converted to Nitrifying Sand Filters, (NSF's) which would optimise existing assets, eliminate write off costs associated with abandoning the COUF's and offer an attractive low whole life cost solution.

NSF's are a low footprint solution that are a similar construction to

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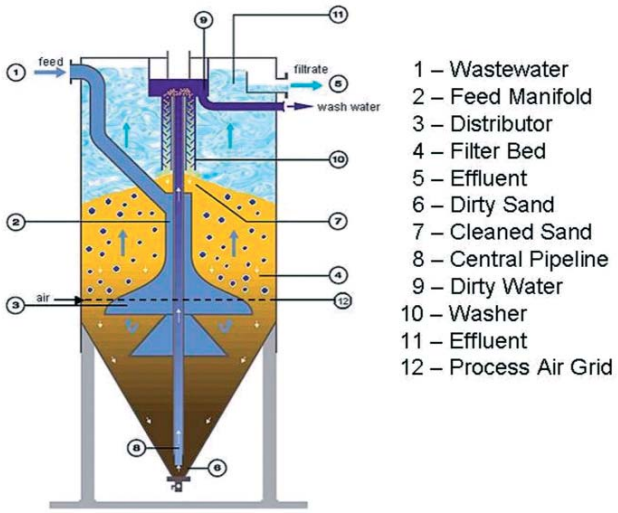
COUF filter units but have an aeration grid installed within the sand filter bed to provide the oxygen necessary for ammonia oxidation.

At Biddulph NSF's offer the major advantage over a BAFF process for the treatment of prolonged low level NH_3 loads interspersed with intermittent short period peaks. The nitrifiers, which exist throughout the entire sand bed depth, are continually recirculated by the air lift process which maximises contact between the nitrifying population and the NH_3, ensuring a high base population level. This minimises the time required for the nitrifier population to react to the increased NH_3 concentrations during the peaks and minimises the risk of NH_3 passing through the NSF's untreated and into Final Effluent.

NSF operation

Wastewater enters via feed pipe (1), manifold (2), and distributor (3) and continues in an upward direction through the sand bed (4) in a cylindrical vessel. The effluent is discharged in the upper part of the filter (5). The filter bed is continuously moving downward and the dirty sand (6) at the bottom is abstracted from the sand bed, washed, and released back on the top of the sand bed (7). At the top of the pipeline the air is released and the dirty water is discharged (9). Air is fed into the filter as small air bubbles and provides the oxygen used by the bacteria to convert the ammonia into nitrates.



Design Development

NSF technology has not been previously tried and proved within United Utilities. However, there are a number of working plants within the industry which achieve nitrification down to less than 1 mg/l ammonia on a consistent basis.

The IA project team approached the market place to seek expressions of interest from suppliers for the conversion of the existing COUF's to Nitrifying Sand Filters. Dutch process supplier PAQUES undertook a thorough assessment and inspection of the existing COUF installation and concluded that the existing units would be well suited for conversion to NSF's.

PAQUES have previously undertaken successful conversion of existing COUF units to NSF's and were able to demonstrate experience with NSF's installations where the plants adapt rapidly to 'shock loading' similar to that which will would be experienced at Biddulph.

Through the use of the ongoing site sampling the team were able to develop the design with PAQUES to obtain an offer of a process guarantee for the conversion of the COUF's to NSF's.

The final project solution comprises converting the existing 10 COUF's to NSFs and installing 3 additional new NSF units. It incorporates a number of key measures designed to safeguard the performance of the new NSF installation and ensure risks to process performance are reduced.

- Installation of mixers in the anoxic selector tank to provide adequate agitation and fine tuning of the dissolved oxygen distribution within the activated sludge plant.
- Replacement of the existing PST de-sludging system to ensure efficient, automated sludge removal and mitigate the potential that the present inefficient arrangement to exacerbate the ammonia peaks.

Lessons learnt from existing COUF's installations were incorporated into the design of the NSF plant to ensure a robust solution.

- Biddulph is bounded by many mature trees and blinding of the existing feed pumping station static basket strainers with leaf litter was a recognised problem. Provision of powered fine band screen on the FST effluent will be provided to safeguard the filters.
- A recirculation pipeline will ensure a minimum recirculation rate through the NSF units to ensure the media is adequately wetted under low flow conditions to maintain the bacteria population and prevent coalescence of the sand particles which may block the air lift pumps.
- A sand trap will be retrofitted to the existing filter dirty backwash returns pipeline to ensure that any sand loss from the filters can be captured and returned to the filters.

The development of these features and the use of detailed supplier involvement during the design phase allowed the IA team to gain approval from United Utilities internal asset standards review group to adopt NSF's as the solution for Biddulph. The project gained approval in May 2007 with a projected £2million (approx) savings against the OFWAT financial determination.

Construction

Construction works commenced on site in April 2008. The site team have worked closely with the United Utilities operation staff, to plan and manage the installation and commissioning of the works. So far in excess of 25,000 hours have been worked without a lost time accident.

Through the development of a close working relationship with PAQUES, who have provided a dedicated supervisor on site to manage the installation, conversion and commissioning of NSF's, the project has been able to move ahead of schedule. Performance and reliability trials on the NSF installation have commenced and the project is presently targeting an early project in use date.

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CFA Piling for new NSF foundations (existing 10 COUF units, two banks of 5 in picture) *Courtesy of United Utilities Integrated Alliance*