DEVELOPMENTS IN THE CONTROL AND DESIGN OF 'NITREAT®' NITRATE REMOVAL PLANTS DURING AMP4 AND AMP5 AT ANGLIAN WATER

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1. BACKGROUND / INTRODUCTION

In 2004 ACWA introduced the 'NITREAT®' process into the UK. 'NITREAT®' is a continuous Ion Exchange process for Nitrate removal incorporating a patented multiport distribution valve.

Rather than a traditional 'batch' treatment utilising 'Duty' and 'Standby' streams, 'NITREAT®' incorporates all aspects of the process (adsorption / displacement / brine regeneration / regeneration rinse) into a single stream where all are operating continuously and simultaneously within the single process stream.

This is achieved via a patented multiport valve directing process flows to 20 resin vessels of which at any time 14 are in the adsorption phase at varying degrees of exhaustion, 1 in displacement, 3 in regeneration and 2 in regeneration rinse.

Robert Ingham presented a paper at IEx 2008 detailing the 'NITREAT®' process (a short resume is given in the full paper) which has since gained almost universal acceptance in the UK Water industry as a highly reliable and competitive technology for the removal of Nitrate from drinking water in terms of both capital cost (CAPEX) and operating cost (OPEX).

Capital investment in the UK Water Industry is organised into a series of 5-year Asset Management Periods (AMP). The first of these (AMP1) ran from 1990-1995, the 2nd (AMP2) from 1996-2000 etc. During AMP4 (2005-2010) approximately 50% of all new builds (of Nitrate removal plant) in the UK water industry utilized the 'NITREAT®' process and so far in AMP5 (2011-15) a 90% success rate has been achieved.

All AWS AMP4 plants were built to cater for a worst case 2025 design horizon with a 5:1 turn down (I.E. – the minimum flow to the plant was fixed at 20% of the design (maximum) flow). The design also used a conservative 180g/l salt usage. These factors combined meant that at 'present day' nitrate levels the plants were sometimes operating inefficiently on a day to day basis when actual works flows and loads were very low.

2. SUBSEQUENT DEVELOPMENTS

The earliest AWS plants were installed in 2005 and reliability has been established across a range of plant sizes. However an opportunity was seen during 2009 to improve the efficiency of day to day operation of the AWS plants. AWS set up an 'Optimisation Team' consisting of a multidisciplined group of its operations and scientific staff along with input from ACWA.

The aim was to increase the efficiency of operation of the ten (now 15) sites in operation and further develop the skills and capability of AWS Technicians and Scientific personnel in this area so as to enable on-going optimisation.

One site in particular was chosen for the initial research. Simply reducing the salt usage to 160g/l would be ineffective as the resultant (PLC) calculations of the plant control system would result in calculated brine and other flows being less than the 5:1 turn-down limit.

It was necessary therefore to simultaneously modify the maximum and/or minimum ranges for a range of operational parameters – effectively allowing up to a 10:1 turndown (subject to the development of control issues – e.g. the limiting effect of minimum pump speeds) in order to have the reduced salt usage take effect at the low end of the operating range.

3. RESULTS OBTAINED

3.1 Savings in CAPEX

Eleven of the first twelve AWS AMP4 plants were designed as 2 x 100% duty streams (one as a single 100% stream). Operating experience has demonstrated remarkable reliability leading to a decision to opt for full redundancy on only the most critical of site in AMP5. The three AWS AMP5 sites there are a variety of configurations and these coupled with other design changes (which will be detailed in the full paper) resulted in an overall footprint saving of 22% and subsequent savings in CAPEX.

3.2 Savings in OPEX

Significant savings were achieved in terms of salt consumption (with subsequent savings in waste production) and, during 2010/11 the necessary operational modifications and revised software has been rolled out to the other operational sites. The savings achieved and lessons learned will be dealt with in the full paper.

These design and philosophy changes were adopted prior to commissioning on the few remaining AMP4 schemes and have been rolled on into AMP5 which have been designed with all the necessary process modifications for more efficient operation.

During the rolling out of the required software changes additional ‘Advanced Operator Training’ has been provided and a range of Key Performance Indicators (KPI’s) set to help operating staff monitor and manage the day to day efficiency of plant operation.

Going forward the plant settings will be reviewed yearly by ACWA after provision of up-to-date operating analyses provided by AWS.

4. CONCLUSIONS

The ongoing optimisation of design ‘NITREAT®’ and control during the last 3 years has fostered a greater depth of understanding of the ‘NITREAT®’ process within the AWS operations, scientific and management teams. The setting of KPI’s for plant performance, coupled with advanced training for selected staff will ensure routine re-optimisation going forward as operating conditions and priorities change year by year.