Process Buoy PBS1 (NH4) in a Sewage Treatment Works

The Isco/Stip Process Buoy PBS1 measures ammonium through direct immersion in aeration basins or final effluent. It's main advantage is that it can rapidly and easily be put into service and requires little in preparation like sample pumps transfer lines, shelters or sample pre-treatment.

Attached please find the success story of a sewage treatment works in the UK using the STIP – Isco process buoy for monitoring the ammonia concentration.

INTRODUCTION

Two separate inlet streams are received for treatment at this works, one being predominantly domestic in origin and the other being predominantly industrial, arising from a local dye works. Their treatment is kept completely separate with the municipal stream being subject to preliminary treatment, primary settlement, and secondary treatment in surface aerated activated sludge basins and final clarification.

The consent to discharge for this stream includes an ammonia level of 10 mg/l. It has been noted over an appreciable period that although this was complied with the majority of the time, nitrification would be lost during Holiday periods.

No satisfactory explanation has been found for these phenomena up to now and hence it was decided to study the effluent Ammonia concentration in greater detail over the Easter period of 2000.

To accomplish this it was necessary to install a continuous measurement Ammonia monitor on very short notice. For the majority of available Ammonia monitors this would not have been possible, requiring pumped delivery systems, weather proof housings and sample pre-treatment.

Envitech, one of the water companies suppliers, offered a system manufactured by Isco-Stip for a trial period over the Holiday period, which could be rapidly installed and deployed.

This gave the customer an opportunity to carry out both an instrument performance assessment and a process investigation at the same time.

Installation

The equipment comprises a wet end sensor, wall or hand rail mounted processor enclosure and an optional mobile phone data transfer system.

Due to the nature of the equipment it was possible to locate the monitor on the rotating bridge of the final clarifier, where a power source was readily available.

Fig.1 General Installation

Fig 1 shows the electronics housing fastened to the centre end of the rotating bridge handrails, with the wet end sensor suspended from the rails just outside the stilling box.

Fig 2 Wet End sensor detail

The unit was delivered to site on 13th April 2000, and installed on the rotating bridge within approximately 2 hours of delivery, including the remote communication facility.

An initial calibration sequence, which takes approximately 1 hr, was then initiated and the installation engineers left site to meet other commitments.

Operational sequences all performed satisfactorily, however on remote retrieval of data at Envitech head office, over the next few days, it was obvious that the calibrations were erroneous due to a sensor fault.

For simplicity and speed a complete replacement wet end (excluding support pole) was reinstalled on 19th April 2000. This unit then functioned perfectly.

Operational Principle

The Isco-Stip Ammonia process buoy uses a standard gas sensing electrode to measure the NH3-N in the aqueous phase, however it has been designed not to require any housings, pumps, pretreatments or large quantities of reagent.

The operating logic, data storage, communications facility and local display are all housed in the small weather proof enclosure, whilst the wet end sensor houses reagent and standard containers, liquor settlement chamber, sensor chamber, gas sensing NH3-N electrode, temperature sensor and pH sensor.

Liquid movement out of and into the sensing chamber is achieved by pressurising and venting the head space respectively, the air pressure being supplied by a small diaphragm pump housed in the weather proof enclosure.

The operational sequence is as follows:

1. Purge out old sample: A small solenoid valve actuates allowing air from the compressor to enter the measuring chamber. This forces the old sample out of this chamber and subsequently through and out of the settling chamber.

2. Admit new sample: The solenoid valves switch over allowing the hydrostatic head to force out the air in the settling chamber whilst allowing a new sample to enter. This continues up to a level-sensing electrode in the settlement chamber.

3. Sample settlement: The admitted sample is now kept in the settlement chamber for a pre programmed interval to allow solids particles (e.g. activated sludge) to settle. The duration of the settlement period is user programmable.

4. Sample entry to measurement chamber: The solenoid vent valve again actuates allowing the clarified supernate within the settlement vessel to enter the measuring chamber.

5. Sample conditioning: A low voltage mixer in the measuring chamber is switched on and the pH of the liquid is attenuated to pH11.5 by addition of an EDTA/NaOH mixture from the reagent vessel. This is achieved with minimum chemical usage by maintaining constant pressure in the reagent vessel and pulsing a solenoid valve leading to a machined orifice. Each pulse will deliver the same quantity of reagent and the resulting pH is monitored by the pH probe, further additions being controlled by a feed back control loop.

6. Ammonia measurement: When the correct pH is achieved such that all the Ammonia Nitrogen is in the NH_3 form the signal from the probe and head amp is then logged in the electronics platform.

7. New sample: the cycle normally returns to step 1, except when a calibration is called for.

8. Calibration: Probe calibration is done at selectable intervals. When a calibration is due the above measuring procedure is performed, at the end of which the sample is NOT purged out but kept within the measuring chamber such that a standard addition procedure may be performed. This is achieved in a similar manner to that of adding reagent, i.e. by pulsing a solenoid valve. One pulse is admitted to the chamber and a measurement made. A further eight pulses are then added and another measurement made, thus allowing the slope of response and actual values to be calculated. Once calibration is complete the measuring and settlement chambers are purged in the normal manner and the measuring sequences recommenced.

Results

Example graphs of Ammonia – N as recorded by the Isco-Stip process buoy are given in appendix 1, fig 3 – 6

In addition daily spot samples of final effluent were taken by the works operatives at approximately 8 to 9 am. These samples were analysed using a colorimetric portable kit.
Exact comparison between these results and the on line results is not possible due to (a) the differing sample point locations and (b) the imprecise time log for the spot samples.

However an attempt to allow for the time of flight between sample points has been made and approximate comparisons given in table 1.

Discussion

The initial process objective of this study was to investigate the Ammonia concentration patterns achieved over the Bank Holiday period of Friday 21/4/00 to Monday 24/6/00.

Fig 3 is typical of data obtained over the Bank holiday, no significant elevation of Ammonia occurring, except for a slight diurnal variation peaking around 1 am.

However, later traces e.g. fig6, show significant elevation during night-time. It should be noted that the manual samples did not reflect this, see table 1.

On two occasions, figs 4 & 5, major excursions in the Ammonia concentration occurred, which on investigation were found to be due to power failure and the failure of the aerator auto restart mechanism.

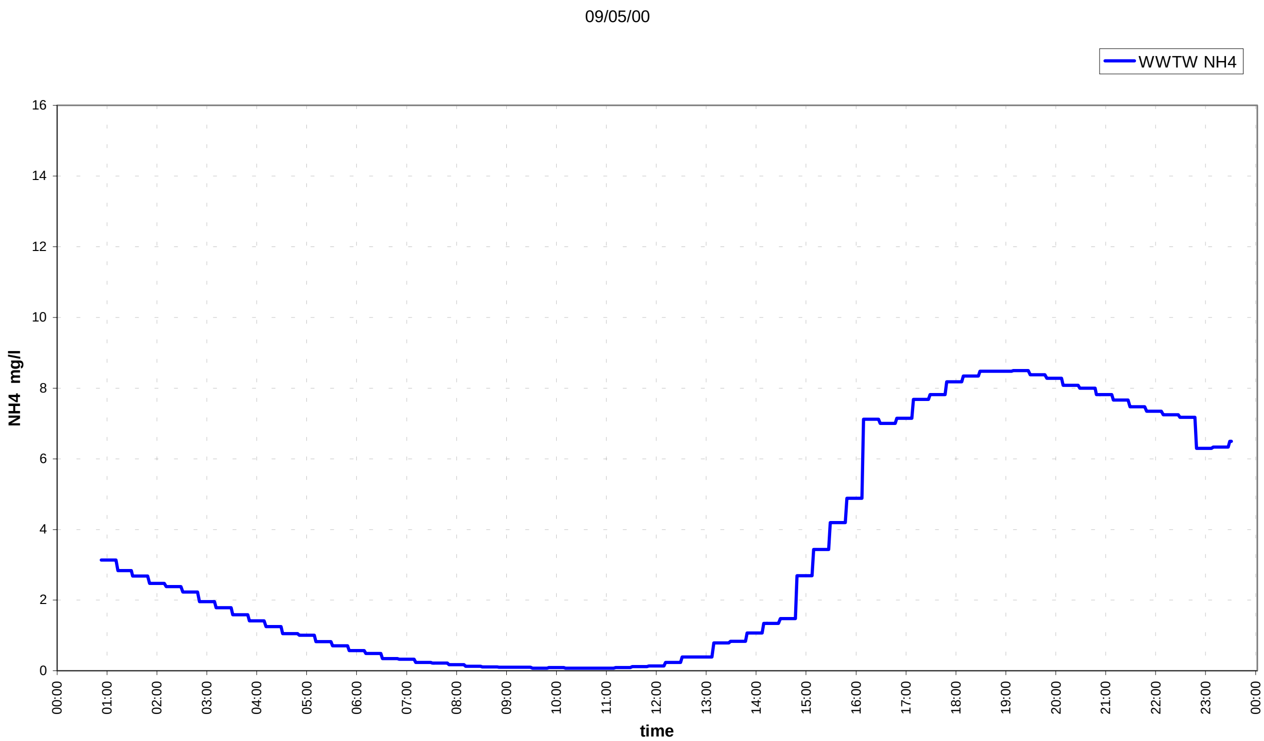
Comparison of the manual samples with concentrations indicated by the Isco – Stip process buoy were good, as can be seen from table 1.

Conclusions

1. No significant event was observed over the Easter Bank Holiday period 2000.
2. Significant elevation of Ammonia concentration sometimes occurs in the final effluent during the night-time hours.
3. The process buoy detected Major Ammonia excursions, caused by power failure.
4. The picture obtained by taking spot samples during the normal working day did not reflect the true quality of discharge, the situation being significantly worse.
5. The Isco-Stip process buoy proved easy and quick to install, gave reliable unattended operation for approximately 5 weeks and enabled useful data to be accessed remotely via a cell phone.
6. The process buoy presents the opportunity to monitor Ammonia in difficult locations e.g. rotating bridges, and without pumping or pre-treatment systems.
7. The process buoy is capable of use within aeration tanks thus enabling in process studies.
8. Due to the nature of the process buoy it may be implemented easily as a transportable piece of equipment, subject to the availability of power.

APPENDIX 1

a. Daily Graphs	figs 3 – 6
b. Approximate comparative results	Table 1



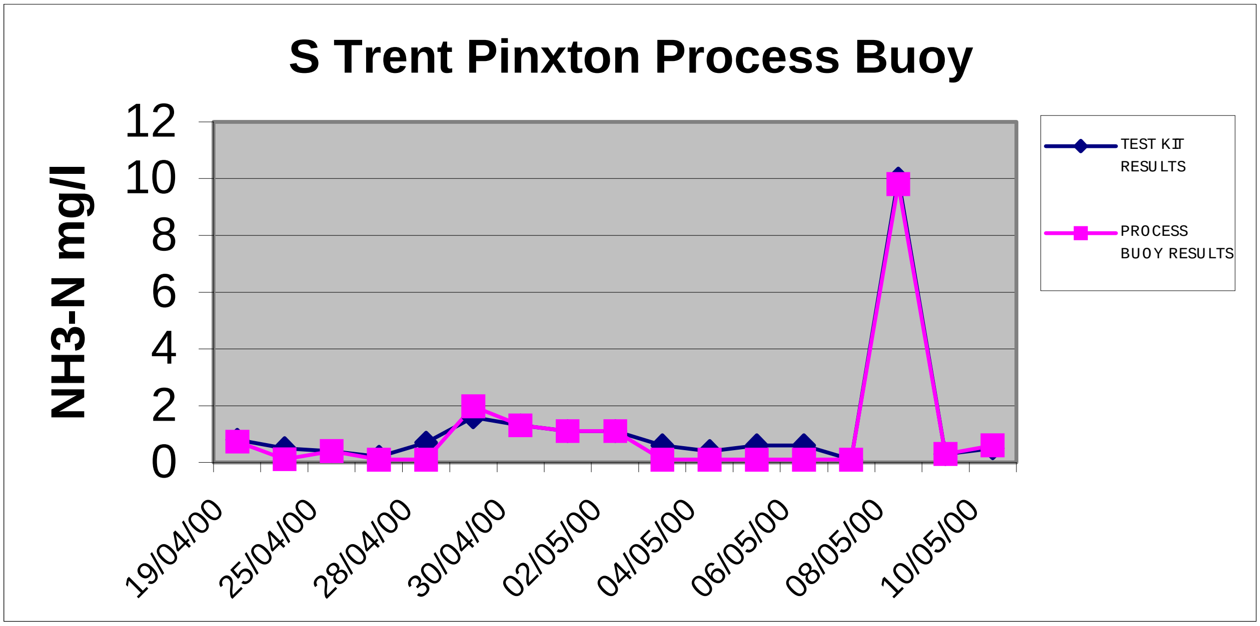


Table 1

date	Test kit	buoy
19/04/00	0.8	0.73
20/04/00	0.5	0.12
25/04/00	0.4	0.4
27/04/00	0.2	0.1
28/04/00	0.7	0.1
29/04/00	1.6	1.98
30/04/00	1.3	1.3
01/05/00	1.1	1.1
02/05/00	1.1	1.1
03/05/00	0.6	0.1
04/05/00	0.4	0.1
05/05/00	0.6	0.1
06/05/00	0.6	0.1
07/05/00	0.1	0.1
08/05/00	10	9.8
09/05/00	0.3	0.3
10/05/00	0.5	0.6