

Installation and a year's operational experience of an on-line BOD monitor supplied and installed by Envitech Ltd. monitoring surface water run-off at Gatwick Airport

Introduction

Consultants acting on behalf of Gatwick Airport contacted Envitech Ltd in September 1995 for information concerning the STIP On-Line BOD-M3 analyser. Discussions and a visit to see two units operating on a final & process effluent at a paper factory led to the decision to install a trial unit, version BIOX-1000, at the proposed airport from November 1995 to March 1996. Due to the success of this trial a new BIOX-1010 BOD monitor was installed in April 1996 and has been in continuous operation since - automatic control has been transferred from the TOC units to the BIOX at the beginning of January 1997.

BOD-M3 on-line BOD method

The continuous short-time BOD-M3 measurement technique incorporates a procedure where micro-organisms control the computer of the monitor. The effluent sample is continuously pumped to the instrument where it is coarsely filtered and then diluted by an automatic feedback control system so that the internal immobilised biomass is fed with a constant level of waste sample. The required dilution ratio of waste to dilution water is then used to calculate the BOD. Waste sample concentration within the bioreactor is kept constant and at a low level to achieve a constant 3mg/litre oxygen consumption by the microbes. Thousands of small plastic rings within the bioreactor provide a growth surface for the biomass which is in constant contact with the waste sample and so is adapted to variations in the waste sample in the same manner as a biological waste treatment system. Toxic shocks are rarely a problem due to the feedback dilution control system.

Reliable sample preparation

A key factor of the success of the BIOX BOD analyser is the large flows and large diameter pipes for analysis. Typically a BIOX will be analysing 1000 times the volume measured by a standard TOC monitor. This helps greatly to reduce any problems with blockages and ensures a true representative sample is measured. In addition a simple sample preparation technique i.e. coarse filtration with a 0.5mm mesh size with built-in autoflushing enables the BIOX-1010 to operate almost without the need of maintenance.

Site specific factors

The BIOX requires a continuous source of organic material and nutrient in order for the maintenance of the growth of the biomass. Typically this is supplied from the analysed sample and hence there are no reagent requirements for the BIOX analyser. However in the case of an airport application it was considered possible that at periods during the summer very low levels of BOD/nutrients could be encountered. Hence tests were done to operate the BIOX sampling using simply tap water and with a dosing system to provide sufficient BOD and nutrients to maintain growth. This was tested at Envitech's site with excellent results obtained with the BIOX itself controlling the BOD at 1-5 - see enclosed chart.

However, once on site it was found that during the summer of 96 the BOD/nutrient levels were always sufficient to maintain the biomass and so such a control dosing system was not required. At other sites this may be required but Envitech's tests did show such a system can be implemented without any significant problems.

Operational Experience

The BIOX monitor demonstrated both during the trial period and since the new version was installed in May 96 that reliable operation with minimal maintenance requirement is achievable. Typical normal maintenance requirements have been ½ to 1 hour per week. at most with at times several weeks passing with no operator intervention at all- Envitech have provided a telephone link, which enables them to kept a remote check on the operation of the unit and this has helped significantly in providing a speedy response in terms of fault diagnosis/ implementation of changes in settings. In addition BOD data is available immediately for assessing the analysers performance and preventative maintenance can be suggested which aids greatly in ensuring a minimum of downtime. With the new version BIOX-1010 remote calibration, autoflush, change of data of data parameters is also possible without the need for any intervention from Gatwick's operators.

Envitech provided a service contract of two service site visits where the unit was checked, tested and cleaned. No significant problems were found during these visits.

Since the new unit has been installed this is a summary of required maintenance procedures:

Procedure	Time required for maintenance	Frequency	Costs of parts each use	Cost per year`
Clean O ₂ probe	5 minutes	2 – 8 weeks, typically 8 weeks	-	-
Refurbish O ₂ probe	15 minutes	3 months	£20	£80
Calibrate pumps	5 minutes	P1 – not required P2 – 4 weeks	-	-
Clean bypass	10 minutes	4 months	-	-
Clean Circulation pump	20 minutes	4 months	-	-
Clean bioreactor lid	10 minutes	6 months	-	-
Replace P1 tube	5 minutes	2 –3 months	£10	£50
Replace P2 gear	30 minutes	1 – 2 years	£150	£75
Reagent usage	Not required	-	-	-
Sample pump change	2 hours	2 years	-	£250
Other?				
Total annual running costs				£455

Due primarily to the large diameter pipework/tubing and the easy to use computer guided maintenance procedures the BIOX is simple to operate and maintain with very low running costs. A few faults/problems have occurred this year:

- In July 1996 the temperature controller malfunctioned – the manufacturer’s upgraded the software within the temperature controller at no cost – they were aware of this fault occurring in certain situations. This unit has operated without fault since.
- After tube replacement (1-3 times in the year) some problems have occurred with the peristaltic tube not sitting in the tube guide correctly -with operator practice this should not be a problem to overcome.
- After the unit was installed Gatwick supplied its own submersible pump which in hindsight was too small for the duty - leading to some problems with pump failures. Recently a pump supplied by Envitech which has a higher flow and this ensures less built up of solids within the bypass and should be more reliable long term. Such a pump should operate continuously for 2-3 years before needing to be replaced.

However a review of the years operation have shown that overall 99% availability was realistically achievable.

BOD-M3 versus BOD-5

A. Trial Period

Overall confidence was found with the output from the BIOX monitor with observation that known events that would lead to higher levels of BOD were generally reproduced by the analyser. However during the trial period samples were taken for analysis for parameters COD, TOC . BOD as well as comparison with the existing on-line TOC unit. Generally there was a lack of correlation of any of this data - not simply between lab and analyser but also lab to lab data did not show sensible correlation between the different parameters. Such problems with reliability of lab data where effluent samples are concerned is not unusual. Hence with sufficient correlation during certain periods and with the confidence in observed responses to known changes this led to the view that the most likely cause of such differences as being error in sampling/storage/solids/lab procedures.

B. Operational Period

A large amount of on-line data has now been generated with a greater degree of confidence that the output from the BIOX BOD monitor correlates well to BOD-5. Graphs comparing comparative data between A.On-Line TOC versus Lab TOC and B.On-Line BOD versus Lab BOD clearly shows that the BIOX monitor is a far truer measure of real events. A major reason for this is that the sample flow to the BIOX and the flow for analysis is far greater volume and so does not suffer from the fouling and blockage problems that not only result in breakdowns but also falsifying of data. In addition on many occasions known event such as the switching on of pumps changing the organic strength of the flow to the BIOX analyser can be clearly reflected in the measured output. Periods of de-icing are rapidly detected confirming that the BIOX biomass can respond rapidly and reproducibly to such changes in organic strength.

Summary

Within the environmental sector there has been much discussion concerning the need to measure continuously discharges to water courses and also benefits of such measurement are significant in process control applications. Much investment has been made to monitor remotely and link such measured data into control and alarm systems. However the ‘Achilles heel’ for many years has been the lack of sensors for the key organic parameters BOD, COD and TOC providing reliable and meaningful data that can be integrated into such control systems with a high degree of confidence. The years operational experience of the BIOX BOD monitor has demonstrated that with the right equipment for the task it is possible to obtain a sensor measuring the key parameter required to ensure minimum environmental damage and compliance with legislation.