When there is NO mains power supply…
Monitoring Water Quality sets new challenges!!

By David Precious

Measuring Water Quality in Remote Locations

When you need to measure water quality in the middle of nowhere special techniques are needed to minimise energy use and recover data remotely. Combined sewer overflows, unmanned sewage treatment plants and water treatment work's intakes are all locations that may need to be monitored. Minimising the power consumption through careful power budgeting of the overall system is the first crucial step, but alternative battery charging methods and a complete understanding of the measurements to be made are also essential. More complex analysis techniques for parameters such as ammonia, nitrate and phosphate may be possible through integrated design.

Design for Low Power

The principle of conserving power use is at the core of good low power remote system design. Systems have three modes. For most of the time the equipment is in the lowest power 'standby' mode. In this state the only function in operation is the real time clock that is set to 'wake up' the instrument at the appointed interval. During the measuring phase the sensors and main microprocessor are powered up and the measuring cycle for the particular sensor takes place. The time taken to make a set of measurements will depend on the parameters being monitored. Simple measurements such as dissolved oxygen or pH can be completed in a period of say 30 seconds whereas a specially designed ammonia monitor may take 15 minutes or more to make a measurement. The frequency at which measurements are taken is a key factor and readings at hourly or two hourly intervals will give good background information whilst reducing power drain. Closer intervals may be needed to catch short-term events and in some cases the rate of measuring can be increased automatically when an out of limit condition is detected. When calibration is required the system is powered up into service mode allowing full use of the calibration functions.

Fig.1: Carefully designed monitoring location with custom built flume.

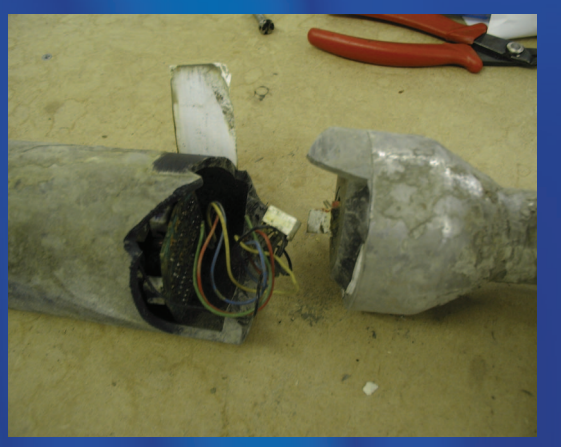

Fig.2: Terminal damage to a small 'sonde' after unexpected storm conditions.

Getting at the Sample

Many low power systems group the measuring sensors into a multi-parameter head or 'sonde'. This is either attached by a cable to a data logger that contains the batteries and controlling electronics or alternatively is incorporated into a single housing producing a totally submersible instrument. Whilst these approaches have been successfully applied under many conditions, there are issues relating to ease of access for servicing and calibration. There is also substantial risk when high cost sensors are deployed directly into a watercourse which overnight may transform from a trickle to a flood. In addition servicing and cleaning can become seriously compromised in adverse operating conditions. The temptation to leave an instrument in place beyond its service interval is very high when it is raining hard and blowing a gale.

For years wet samplers have been the first line of defence in detecting pollution incidents and their simple approach has proved reliable, even in the most difficult environments. The sample is drawn through a plastic tube, delivered to a storage bottle and then the excess sample is ejected from the same tube helping to keep the intake screen free and clear of debris. EauxSys(UK) Ltd has now applied this approach to low power monitoring systems greatly increasing the type and reliability of the measurements made whilst easing the calibration and servicing access significantly. The complete system sits beside the sample watercourse, such as a discharge flume, river or waste treatment plant and waits in low power standby mode.

At the required interval the system powers up and operates the built in pump. The sample is drawn into the system, filling the measuring cell. The sample is presented to the sensors and the measurement begins. Because this technique makes use of a discrete pumped sample, the range of parameters that can be measured increases dramatically and, in addition to pH, Redox, Dissolved Oxygen, Suspended Solids, Conductivity, Salinity and Temperature, it is now possible to consider ammonia, nitrate, colorimetric measurements, analysis for BOD and COD (using a UV surrogate method) and visible oil. The power budget has to be considered carefully as some of these methods may require significant times for developing colour or pre conditioning samples, but in each case a suitable measuring regime can be defined. The inclusion of one or more re-charging method for the battery pack can extend the operating period indefinitely.

Power Sources

Systems designed to make more frequent measurements, or which use more power as a result of the measuring technique, may require local recharging facilities to supplement the batteries. The primary power source for any low power remote system is its batteries. Modern technology has resulted in a new generation of high capacity cells based on metal nickel hydride technology. Familiar to us in mobile phones and cordless drills these batteries have great power to weigh/size ratios but must be charged with care. They are of great use in self-contained submersible or portable instruments where continuous recharging is not a requirement. The tried and trusted lead acid battery in one of its many forms is still first choice for a system to be recharged whilst in use. Three sources of charging may be available at the low power site. Solar panels are ideal for many applications, especially where power consumption has been minimised. Small wind generators are readily available and can be linked in with the solar panel for a combined charging source and small-scale water wheels are currently under development to harness the flow, in the sampled watercourse. The key to success as always with low power remote applications is to minimise the power demand both during the standby phase and the measuring phase. In the right conditions these recharging techniques can provide sustainable power supplies for the monitoring equipment.

Fig.3: An integrated flow cell minimises the sample volume and maximises the ease of servicing.

Issues of Security and Servicing

A sensor package that is immersed directly into the watercourse, discharge or other sample is at risk. A high cost instrument, often with extensive electronics is placed into an uncontrolled sample flow that could vary between a trickle and a raging torrent. Unfortunately there is also an increasing risk of damage from vandalism. There may be safety implications relating to the recovery of the equipment for servicing and in bad weather, the human 'misery' factor comes into play. All in all what appears to be the neatest solution may have serious drawbacks. For some applications the 'sonde' type package will be the best solution. For example, applications requiring complete submergence of the sensors, sub-sea data loggers, instruments mounted on floating buoys or where space is at an absolute premium. It will always be easier however, to clean and service a water quality monitoring system that is not submerged into the watercourse. The exposed part of the equipment is limited to the plastic sampling tube, whilst the majority of the system is secured inside an enclosure. The

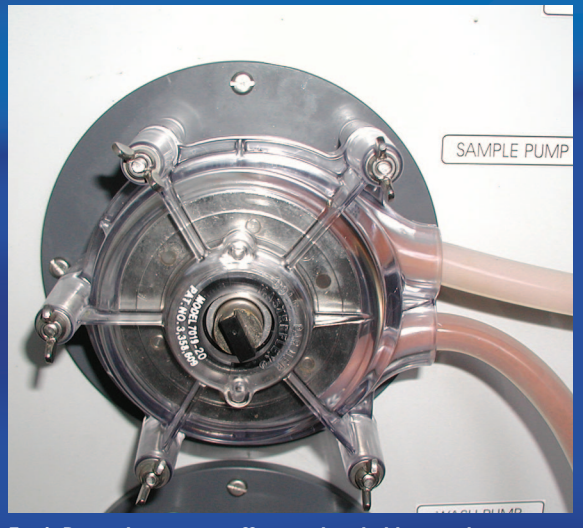

Fig.4: Peristaltic pumps offer simple reliable sample recovery and can be used on integrated low power monitoring systems as an alternative to a submersible 'sonde'.

Fig.5: Suspended Solids Sensor showing the efficiency of mechanical wiping after six months operation.

sensors can then be serviced and calibrated entirely without the need to recover electronic equipment from the watercourse. Operator safety is enhanced and service costs reduced. It is no longer necessary to dismantle a submersible 'sonde' assembly with the associated o-ring seals and watertight connections.

Keeping Things Clean

Without clean sensors the best measuring system will not work well. The immersed 'sonde' may use an integrated wiping system to keep biological fouling to a minimum. When the system uses the pumped sample method similar to a wet sampler in conjunction with a flow through cell, mechanical wiping is still the preferred choice for automatic cleaning but the area in contact with the sample is limited to the sensors, dramatically reducing gross fouling of the complete assembly.

Getting at the Data

Most remotely located water quality monitors have some form of data logging incorporated but the need to identify out of limit conditions and view the data on a regular basis means that the expensive option of visiting the site frequently, has been replaced by remote data recovery. Over the years various transmission media have been used including fixed telephone line, satellite communications, meteor burst and cellular telephone. The best method will depend entirely on the location of the site but as the mobile phone network becomes more and more widespread this is rapidly becoming the preferred choice wherever possible. With any communications option there is always a conflict between minimising the power consumption whilst providing access to the data on a fairly free basis. Over the years various methods have been tried to 'wake up' the remote system. Pagers have been used to initiate 'power up', and 'time access' windows have been set to allow inward communications. In both these cases the onus is on the operator to acquire the data rather than the system to provide it. In order to retrieve the data, special software has been produced to pole the remote sites and collect the data, making a base station computer a dedicated part of the system.

Use of Email and Text Messaging

With the advent of reliable, wide coverage by GSM and GPRS systems for mobile telephones and by linking to the internet using a dial-in connection, we can now deliver the data directly to the end users by email. In order to keep costs down and keep the system secure a 'pay as you go' SIM card is used. The mobile phone modem links with any internet service provider (including free ones), the email is sent to one or many destinations at anywhere on the internet. With broadband connection the data is delivered promptly at the time of day to suit the users. If an alarm condition is detected a text message is sent to a selected mobile phone and the emailed data is updated at the same time. A glance at the message or a visual check of the emailed spreadsheet compatible data gives a high level of confidence in the operation of the equipment.

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