S::CAN – ONLINE, REAL TIME MEASUREMENT OF COD AND SS AT LOWER MOLONGLO WQCC

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66th Annual Water Industry Engineers and Operators' Conference
Eastbank Centre - Shepparton
3 and 4 September, 2003

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ABSTRACT

The S::CAN Spectro::lyser^{TM} (S::CAN) is an inline UV-Vis instrument for measuring multiple substance concentrations in situ. The unit was trialled at the Lower Molonglo Water Quality Control Centre (LMWQCC) in the influent stream. Chemical oxygen demand (COD) and suspended solids (SS) were routinely monitored and it was found that the S::CAN data calibrated well with data from real time samples collected and analysed at the ECOWISE laboratory. There is also potential for calibrating BOD data to the spectra for online BOD measurement.

The S::CAN unit therefore offers operators real time data on COD and SS which can be used to optimise and control process units via looping instructions. The S::CAN instrument can communicate with SCADA to generate an alarm, or instigate process control changes.

KEYWORDS

S::CAN, Spectro::lyser, COD, SS, online measurement, UV-Vis absorbance, STP

1.0 INTRODUCTION

The S::CAN is a compact fully submersible online UV Vis Spectrophotometer suitable for field laboratory work or online monitoring. The unit is capable of measuring absorbances at wavelengths from 200nm to 750nm at 2.5nm intervals and at a sampling interval as short as 2 minutes. The unit can be programmed to provide quantification of a large range of parameters including COD, SS, nitrate and A_{254} in wastewater. It can also simultaneously record spectral data to provide qualitative fingerprints of the wastewater. The S::CAN used in these investigations was provided to ECOWISE by DCM Process Control.

The Lower Molonglo Water Quality Control Centre (LMWQCC) is Canberra's main wastewater treatment facility. It mostly serves a domestic population with little industrial inflow, and is the largest inland treatment centre in Australia. Located 1km upstream from the junction of the Murrumbidgee and Molonglo Rivers, LMWQCC treats more than 90 ML of Canberra's wastewater each day. The process includes physical, chemical and biological treatment processes, before the water is discharged into the Molonglo River.

The S::CAN unit was trialled at the LMWQCC from January to June 2003, installed in the inflow stream, upstream of all treatment units. The aims of the trial were:

- to determine the applicability of the unit to the influent stream at the LMWQCC;
- to assess the usefulness of the unit to ActewAGL operations, in optimising the LMWQCC;
- to assess the value of the data gathered by the S::CAN unit in operating a wastewater treatment facility.

2.0 THE S::CAN UNIT

The S::CAN has been developed to include global calibration settings for a wide range of typical application environments such as water, drinking water, and wastewater. Under the wastewater program, certain parameters are defined as ‘standard’ measurements including SS and COD. Other parameters can then be set up by the manufacturers for your waste stream, and may often become an additional global calibration parameter in future software. This can be done for example, for BOD at your site.

The ‘composite’ parameters such as SS or COD have been calculated using statistical and mathematical techniques over several years, and have been demonstrated to be robust. For example in a study across 16 STPs, and over a range of COD values from 20 to 1000 mg/L, the correlation coefficient ranged from 0.78 to 0.89. The S::CAN can also measure nitrate directly providing online continuous concentrations, however this was not investigated in this trial. SS has also been shown to have coefficients mostly above 0.98.

Communication with the S::CAN can be via a laptop, or using the CON::STAT field controller which is a full process computer providing the operator with direct touch screen operation of the unit whilst it is submerged. Both the laptop and CON::STAT options run the same software options with the CON::STAT having analogue and digital outputs allowing it to be linked to onsite SCADA systems. Data can be downloaded directly into excel for manipulation from either.

3.0 INSTALLATION, OPERATION AND MAINTENANCE

The unit was originally installed during November 2002, however the mounting mechanism failed and a new design was constructed to cope with the high influent flow rates. The probe was mounted through a bolted down plate, down a 1.5m pipe and then placed into the main influent pipe at an angle within the pipe. The unit was re-installed in March 2003 in a more stable manner. Over the coming weeks, the S::CAN was progressively commissioned to ensure a zero baseline of data when calibrated against a DI water standard. This is a critical step to guarantee quality data is being recorded, with minimal drift. The routine maintenance schedule adopted therefore involved 2-3 times weekly removal of the unit from influent stream, a wash with soap and specific scourer (teflon rated), and exposure to DI water for a zero check. This took around 15 to 30 minutes to complete, depending on how readily the zero reading was achieved. It is felt that a zero check with DI water is probably only needed once weekly. No other maintenance is required as there are no other moving parts or exposed components.

The S::CAN includes a self-cleaning mechanism based on air pressure delivered over the pathlength at a time and duration specified by the user. This cleaning always occurs prior to the taking of a sample reading as a minimum.

Commissioning also related to optimising data capture procedures using the software and hardware components.

Once the site-specific maintenance schedule was adopted, providing a zero check against the blank, collection of influent samples for laboratory analysis commenced. The aim of this data was to calibrate the laboratory produced data with S::CAN unit data to run a local calibration of the instrument. Figures 1 and 2 illustrate the calibration curves determined for COD and SS respectively and include all obtained data with no manipulation.
This curve was then applied to all future data. It can be seen that good R^2 values have been obtained for both parameters, being 0.87 for COD and 0.94 for SS, which compare well to the manufacturers data. The outlier point relates to a ‘peak’ time in the data, as described further below. Collection of more calibration data around this peak time would improve the curve and R^2.

Figure 1: ***Calibration Curve for COD***

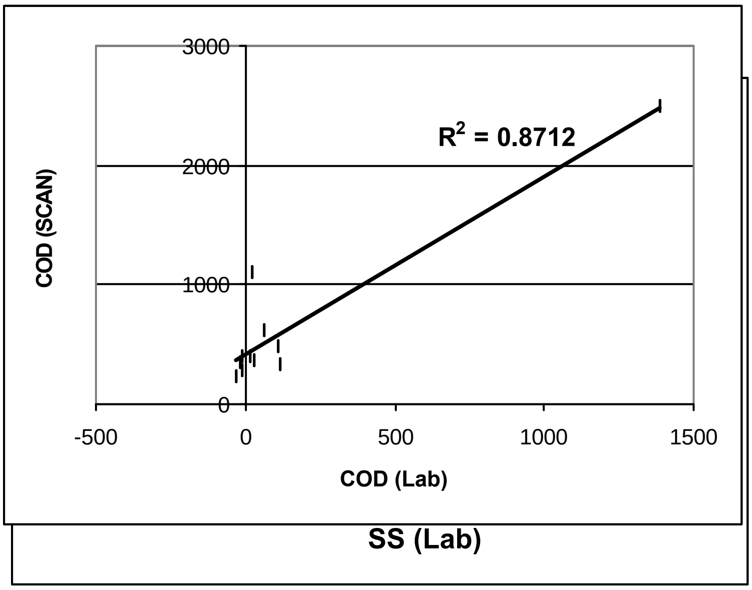


Figure 2: ***Calibration Curve for SS***

4.0 RESULTS AND DISCUSSION

S::CAN data can be investigated in many ways. You can compare generated concentrations to laboratory data to check calibration, or view raw spectral fingerprints to assess composition. You can also view concentration or spectra over a long period to check for drift or trends.

Figures 3 and 4 show selected data over a one week period comparing S::CAN data to that of samples collected and analysed by the laboratory, for COD and SS respectively. The figures clearly show that the initial calibration generated earlier holds well over time, as the two data sets trend well to each other.
In both cases, the S::CAN reads slightly higher than the laboratory data. This difference can be further refined by repeating the local calibration process, however there was insufficient time to complete this during the trial, but may continue by the operators.

The results presented here show that the S::CAN can be successfully used to measure COD or SS, in stream and online. Operators can use the instrument to monitor the incoming wastewater strength, and assess treatment requirements to deal with the wastewater entering the plant at a given time. Laboratory analysis could be minimised to only verify the S::CAN data routinely to ensure a good correlation continues.

Figure 3: ***Comparison of S::CAN and Laboratory Data for COD***

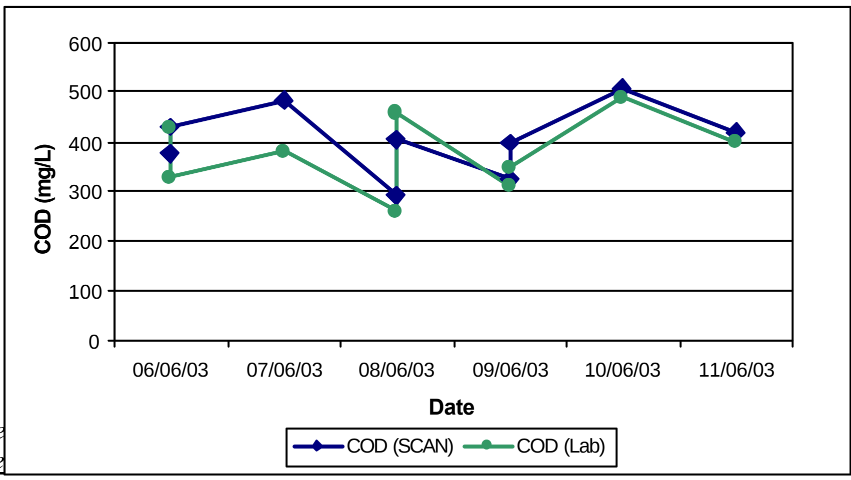


Figure 4: ***Comparison of S::CAN and Laboratory Data for SS***

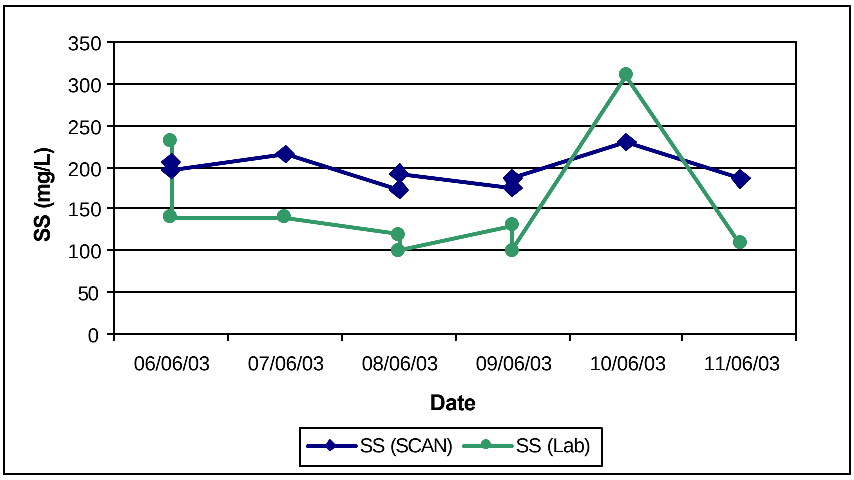


Figure 5 gives an example of spectral fingerprints of the influent at different times on the same day, namely 7.30am, 8am, 11am, 2pm and 8pm. The composition of the influent does not vary greatly over the day, with the shape of the curves for each time being relatively similar. However the concentration does vary substantially, as demonstrated by the absorbance levels. Influent entering the plant at 7.30am is much more concentrated than that at any other time. By 11am the wastewater seems to be 'diluted' with the lowest absorbance levels recorded.

S::CAN fingerprint data can therefore be used to compare concentration and composition trends, and could also be used to observe 'abnormal' influent such as that affected by trade waste.

Figure 5: ***Spectral fingerprints of influent at different times on the one day***

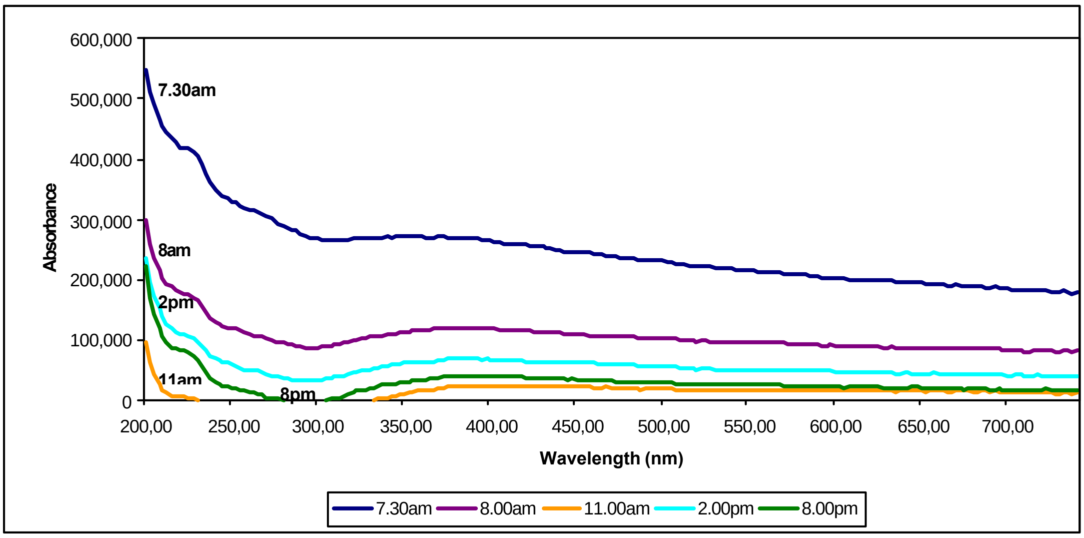
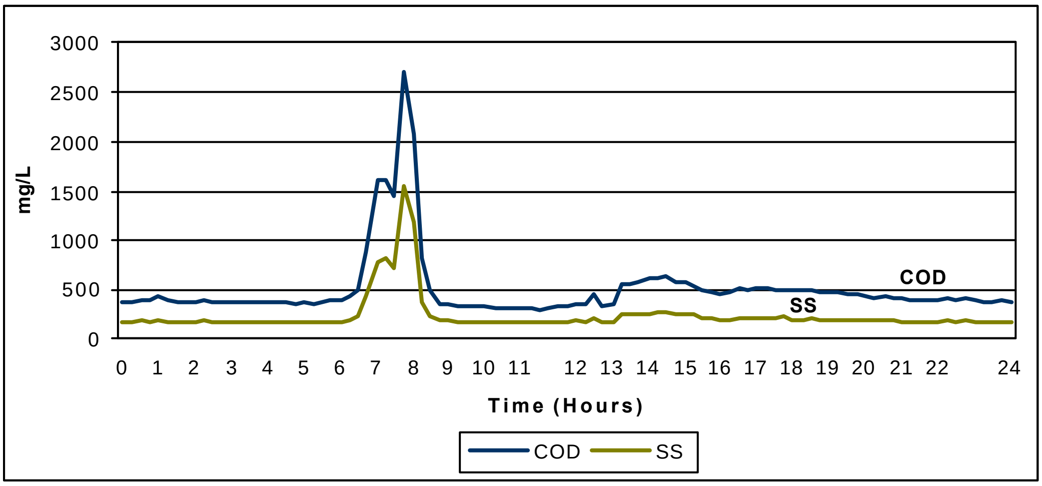


Figure 6 shows how an operator can view concentration data for COD or SS over a length of time, with a 24 hour period shown here. A significant morning peak in both parameters occurs at 7am and continues until around 8am. This correlates to the manner in which the influent upstream processes servicing the LMWQCC work. All overnight sewage is essentially held within the large detention in the sewerage scheme. This is all released at one time in the morning, and by 7am it is received at the treatment plant head works. This relates to the above finding in Figure 5 where a high concentration wastewater at 7.30am is reflected by the absorbance.

In addition, it can be seen that COD and SS trend well together over the day, again suggesting a fairly consistent influent composition. COD generally runs at just under 500 mg/L, with SS being around 250 mg/L, typical of domestic sewage. However morning peak levels are very substantial and almost reflect industrial character at COD levels of up to 2,500 mg/L and SS at 1,500 mg/L.

This data can therefore be used by an operator to have real time concentrations, enabling plant optimisation of operations to deal with such scenarios as the 7.30am peak. For example, in this case a feed forward connection to aeration control could be alarmed such that as the COD concentration rises above 500 mg/L, DO supplied is increased.

Figure 6: ***COD and SS trend over the day***



5.0 CONCLUSIONS

The trial met its objectives with the unit proving to be applicable to the influent stream at the LMWQCC. The unit was assessed as being useful in plant operations due to the data output being real time and representative in relation to lab data. The value of the data gathered was found to be versatile, robust and able to be manipulated to give both quantitative and qualitative information that is also temporal.

From our experience, it was found that the following steps should be taken when installing a unit at a new facility.

1. Install unit safely in the stream to be monitored and ensure the setup is robust.

2. Adopt a cleaning maintenance schedule and associated self-cleaning air pressure schedule, and then check the zero reading using DI standard routinely for say 3-4 weeks.

3. View the data also during this time to look for peaks and troughs where calibration sampling should be intensified.

4. Once a stable zero is achieved with the adopted maintenance schedule, then start calibration monitoring.

5. Calibration sampling and analysis should occur for around 2-3 weeks with samples taken at all times of the day and over all 7 days. In particular additional samples should be taken where there are peaks and troughs. Of course the more data the better. A minimum of 15 samples is recommended for calibration.

6. Apply the calibration curve to the data.

7. Continue maintenance schedule including continuing to check zero base with DI water.

8. Download and view data as required.

From an operator point of view, we noted some pluses and minuses of the S::CAN based on the LMWQCC trial. The obvious advantages include online continuous data of usable parameters both quantitative and qualitative. The unit is easily installed and readily maintained as there are no moving parts. Due to its streamline design, the unit can be placed in many different areas at a treatment plant, allowing the operator to be specific in application to a stream. Another advantage is the various ways the data can be viewed and analysed. Spectral fingerprints can offer the operator information on relative concentration and composition, and the concentration data can be used to quantify calibrated parameters. All data can be viewed over time, and each individual spectral point is recorded at every measurement time, resulting in a substantial amount of information that can be viewed using excel.

Of course there are always some disadvantages to consider, however in the case of the S::CAN, they can be readily overcome with good set up and either operator training or using a good service provider. For example, the software has a few tricky matters, such as the base language being Germanic.
This means that the global setting on the laptop needs to be changed, and numbers are recorded with a comma rather than a decimal point (1,000,000 instead of 1,000.000). However, any laptop is easily configured for language, and the comma / decimal point issue can be rectified within excel prior to data manipulation. Another aspect to be considered is the site specific maintenance schedule that needs to be determined. This only has a disadvantage in time, with a few weeks of more intensive operator involvement required to get a good outcome. Some data communication issues were also apparent, however many of these have now been dealt with by the supplier.

Overall, the S::CAN generated versatile and useful information that can be immediately used to improve and optimise operations.

6.0 ACKNOWLEDGEMENTS

Firstly I would like to acknowledge the invaluable input from ECOWISE Environmental Instrument group without whose expertise, dedication and perseverance none of the results seen in this report would have been possible. The Instrument staff installed, operated, and maintained the device through rain hail and shine, carrying out the field calibrations, tests and data accumulation with a professionalism that is nothing short of commendable.

We wish to also acknowledge Rob Dexter of DCM Process Control for supply of the unit for the trial. We must also recognise ActewAGL for allowing us to trial the unit at the LMWQCC. Operators at the LMWQCC contributed by collecting samples during the calibration period. Peter Mosse also proved invaluable in technical input to the project, both in the maintenance schedule and analysis of data.

And last but never least, to my one year old son, Leilland O'Keefe who wrote this inspirational part - dyfccdyyyhhhvgyuu70dwsvcolmdsolkkkkklkli8hdjs.