Real-Time Measurement of Greenhouse Gases at Small-Scale Wastewater Treatment Plants

Dr Peter Schouten
Introduction – Greenhouse Gases

• N$_2$O and CH$_4$ are both known to be enhancers of the greenhouse effect

• Specifically, N$_2$O is estimated to be 310 times more effective than CO$_2$ based on a 100 year timeframe

• N$_2$O also removes ozone (O$_3$) from the atmosphere

• CH$_4$ is roughly 20 times more effective in trapping atmospheric infrared radiation in than CO$_2$ over a 100 year timeframe

• N$_2$O and CH$_4$ must be adequately measured and monitored in order to both quantify and better control their release into the atmosphere

• Very important now with the AU Government bringing in a pollution trading/tax scheme
Methods and Instrumentation

- Gas analysis follows a technique similar to that employed by Tremblay et al (EM-1 project)

- Methods such as ex-situ gas chromatography, thin boundary layer analysis and eddy covariance were ruled out due to cost, complexity and logistical reasons

- In-situ gas collection is made with a flux hood combined with a NDIR gas analyser
  - *Chosen due to its ease of use, portability and rapid flux calculation capability*

- The use of a flux hood with an NDIR unit allows for multiple sites within an WWTP to be sampled in one day

*EM-1 Project GHG collection system*  
• The NDIR gas analysis unit employed is the Horiba VA/VS 3000 series

• The advantage of the Horiba system is that it contains an inlet pump and gas conditioner that removes water vapour, particulates and acids

• The gas conditioner is connected directly to the flux hood outlet

• Gas exiting the analyser is sent back into the flux hood in order to continuously mix the trapped air

  • This provides a much more accurate determination of the gas concentration (given in ppm) (Tremblay et al, 2005)
Measurement of various water quality parameters are made simultaneously to the GHG flux measurements using a sewer sentinel system (CSIRO)

Measurements with the sentinel required the operation of a masticating pump

Logistically difficult to use the sentinel and pump

Has since been replaced by a hand-held Aquameter and sonde system

More water quality data is obtained from the WWTP operators as necessary

Water quality parameters being measured includes:

- Temperature;
- pH;
- Dissolved oxygen;
- Conductivity.
Sunshine Golf Course - Photos

A) Screen

B) Buffer tank

C) Aeration tanks

D) Aeration tank 1

E) Settling tank
Monbulk - Photos

A) Aeration tank

B) Inside Aeration tank

C) Settling tank

D) Clarifier

E) UV treatment
Mt Martha - Photos

A) Sedimentation

B) Aeration tank

C) Effluent holding basin

D) Sludge processing

E) Sludge drying pan
Operator = Capo di Monte Retirement Village
Function = Wastewater treatment for retirement village
Equivalent Population = 100 (quoted)
Yearly Inflow = 5 ML (estimate)

Basic MBR configuration
Capo di Monte - Photos

A) Analyser on MBR Reactor
CH$_4$ flux measured throughout a day across the aeration tank system at each treatment plant (autumn and winter)

N$_2$O flux measured throughout a day across the aeration tank system at each treatment plant (autumn and winter)
CH$_4$ flux averaged over a day (and converted to the equivalent CO$_2$ output) across the aeration tank system at each treatment plant (autumn and winter)

N$_2$O flux averaged over a day (and converted to the equivalent CO$_2$ output) across the aeration tank system at each treatment plant (autumn and winter)
Percentage of total $\text{CH}_4$ release from the aeration tank system with respect to influent total COD at each treatment plant over autumn and winter.

Percentage of total $\text{N}_2\text{O}$ release from the aeration tank system with respect to influent total N at each treatment plant over autumn and winter.
Thank you

CSIRO Land and Water
Dr Peter Schouten
Postdoctoral Fellow

t  +61 2 9252 6089
e  peter.schouten@csiro.au