

Underway pCO₂ System Description

Laboratory: LDEO and Princeton

Name/Vintage: Sweeney system based on Chipman design

Reference: Chipman et al. (1993); Bates et. al. (1998)

Where installed: RVIB L.M. Gould

Location of Data: www.ldeo.columbia.edu/~pco2

Analyzer: LICOR 6251 (analog output) infrared (IR) analyzer

Method of analysis: Differential analyses relative to the nitrogen standard gas which flows continuously through the Licor reference cell. Measures dried air and equilibrator headspace gas. Gas flow stopped is stopped for 30 seconds prior to IR readings.

Drying method: Permapure dryer which uses a reverse flow of dry nitrogen reference gas as the drying agent.

Equilibrator size, flow and setup: Shower head equilibrator built by David Chipman patterned after design by Takahashi, 10 L water, and 10 L head space.

Water flow rate 10 l/min

Headspace recirculated @ 120 ml/min

Standards: 5 standards spanning expected concentrations up to 475 ppm (includes UHP nitrogen)

Source of calibration and accuracy: All standards have been calibrated at LDEO by GC are traceable to the WMO scale. Stated accuracy of the standards is 0.4%.

Standards: (number, concentration, frequency): Five standards are used with approximate concentrations of 0.00, 150, 250 360 and 475 ppm All standards are run through IR once an hour for 2 minutes at 60 ml/min

Source of calibration and accuracy: All standards have been calibrated at LDEO by GC and are traceable to the WMO scale. Each standard has an stated accuracy of 0.4%.

Standard consumption: 4 standards have last 5 years.

Operating cycle: Hourly cycle with sequence:

5 gas standards (2 minute flush @ 60 ml/min, 10 second wait (stop flow), 20 second analysis with average of 20 readings)

30 samples from equilibrator headspace (2 minute flush @ 50 ml/min, 10 second wait (stop flow), 20 second analysis with 20 IR readings averaged)

1 sample of bow air (2 minute flush @ 50 ml/min, 10 second wait (stop flow), 20 second analysis with 20 IR readings averaged)

All samples from Licor output are vented to the atmosphere.

Parameters recorded/frequency : At the end of each cycle (3 minutes) the following is recorded to disk resulting in a data file of less than 1 Megabyte per month

PHASE: water, air or standard

PC_DATE

PC_TIME

YEAR_DAY

IR_VOLTS: analyzer voltage CO₂ channel

IR_CONC: concentration determined from 2nd order polynomial fit of preceding standards

PRESSURE: pressure in laboratory

EQ_TEMP: RTD temperature determined from an empirical polynomial function determined from laboratory calibration for thermistor in equilibrator

EQ_MFM_FLOW: flow (L/min) from water flow meter in front of equilibrator

PRE_MFM_REF_FLOW: flow of all sample and standard gases after IR (from algorithm with voltage provided by manufacturer, AALBORG)

IR_TEMP_VOLTS: Licor temperature output

IR_TEMP: Licor temperature output

Hardware details

Temperature measurements: RTD positioned in top of equilibrator extended down into water reservoir 4 inches, RTD readings are frequently compared to high precision thermometer also hanging from top of equilibrator

Pressure measurements: Setra model 350 pressure transducer

Circulation pathway: Two 12 V KNF (NMP05 – special order) micro-diaphragm pumps with 0-5 V variable control (one for head space gas, one for bow air) routed through 0.5 µm inline filter (Swagelok) and a Valco 12-port valve. The Licor sample output is routed through a solenoid that allows it to be directed back to the equilibrator or to the atmosphere.

Operating software: Labview 6.1 OS

Computer interface boards and sensors read:

Boards: Omega Engineering Co., Omnibus modules for RS-232C interface

Sensors: A/D 16 bit- voltage LICOR CO₂ channel (0-5 V)

A/D 16 bit- voltage LICOR temperature (0-5 V)

A/D 16 bit- Setra model 270 (0-5 V)

A/D 16 bit- Aalborg gas flow meter on reference side of Licor (0-5 V)

A/D 16 bit- RTD

Approximate Size and Footprint

Laptop computer 10" x 15" x 2"

Equilibrator, condenser, and pump box: size 13" wide by 13 " deep by 20" high

Wall cabinet with valves, flowmeters, pressure transducer, LICOR, and interface boards:
box of 21" wide by 10 " deep by 25" high (www.ldeo.columbia.edu/~pco2)