TDLAS System

Summary of Method

1.1 The Aerodyne Dual Tunable Diode Laser is based on high resolution infrared spectroscopy of gas phase molecules. Ambient air is sampled through an inlet into a 5 l multipass sampling cell with 153 m total pathlength. The sample is maintained at reduced pressure (typically 20 – 40 Torr) by a Busch vaccume pump with a flow rate of ~5l/sec. This results in a residence time of ~1 second in the cell. The TDLAS system utilizes infrared radiation from two individually operated lead-salt tunable diode lasers. The lasers follow independent paths through the sample in the multipass cell and then on to separate infrared detectors. The amount of light absorbed by the trace gases in the sample cell is monitored.

1.2 The light from the two lasers detected at the infrared detectors is monitored with a well developed data acquisition system. The data acquisition method is an advanced form of sweep integration which is carried out by a software package developed at ARI, TDL Wintel. The program sweeps over the full infrared transition or group of transitions, then integrates the areas under the transitions using nonlinear least square fitting to the known spectral line shapes and positions. Absolute species concentrations are obtained directly, tied to the absolute data found in available database such as the HITRAN data base. Calibration gas is not required.

1.3 The concentrations of monitored trace gases are reported and stored by the data acquisition and controlled computer. The data system provides a real-time disply of the collected data.

Cautions

During the standard operation the entire TDLAS unit, including optical and electronic units, is housed inside a hard-sided Harding box.

2.1 The TDLAS unit requires liquid nitrogen (LN2) for operation, Standard safe handling of this cryogen should be used.

2.2 The Harding case housing the TDLAS is fitted with heat exchangers and fans. The TDLAS is temperature stabilized by heaters mounted on the bottom of the optical breadboard and on its metallic cover. The temperature of the TDL must be monitored as failures in the heaters can cause temperatures to rise dangerously and potentially damage the system.

2.3 Verify that the modulation waveform in TDL Wintel will not damage the laser. The selected modulation waveform must not exceed the accepted range of input voltage for the laser.

2.4 Verify that the temperature of each of the lasers is stable. There should be an approximated constant heater output at each laser.

2.5 Avoid oil contamination of multiple pass cell. Never pump on the cell without a flow of at least 1 lpm when using an oil sealed mechanical pump. Always vent the cell from the inlet side; Never from the pump end.

2.6 Read the TDL Wintel manual.

Sample collection

3.1 Ambient air is sampled through an inlet connected to tubing, which should be kept as short as practical. PFA ¼'' tubing is used to minimize wall interactions. In general ¼" tubing will not used for sticky gases, instead a specially designed inlet will be utilized.

3.2 Fill LN2 before start of measurement period. Typical hold time of dewar is 15 hours with 2 lasers running at 20% heater output.

3.3 Open 2 versions of TDL Wintel (1for side A and a second for side B). Turn on the heater and current of each laser with TDL Wintel interface.

3.4 Check line positions with reference cells. Atmospheric species can also be used to verify the frequency.

3.5 Confirm that menus have correct information (HITRAN files, peak positions, etc.) and that correct fit markers are in place.

3.6 For each of laser systems, if the fingerprint is used, verify that the tuning rate is appropriate. The tuning rate is typically set by means of an etalon during initial characterization of laser. If the features in the spectral fit do not line up with their corresponding features in the reference spectrum and varying the tuning rate parameters until corresponding features line up in the spectra. The tuning rate parameter can be found under the Edit menu. A second option for correction of the tuning rate is to use the "tuning rate from the single peak" routine in TDL Wintel to recalculate the tuning rate (see TDL Wintel manual for details).

3.7 Turn on Busch pump and verify that the pressure is 20-40 Torr in the cell.

Turn on procedure:

1. close main valve
2. open small vent valve
3. push "on" switch on pump

4. close small valve
5. open main valve
6. verify that ventilation fans are turned on

Pump shut-down procedure

1. close main valve
2. push “off” switch
3. open vent valve

3.8 Set-up automatic reference locking (“rlk4”). The frequency of invoking reference locking feature depends on the laser stability. Typical time interval is 1 to 3 minutes (see TDL Wintel manual)

3.9 Set-up automatic background subtraction in field 3 (“ab3”). The frequency of invoking background subtraction depends on the stability of fringes as well as how often one is willing to have measurements interrupted briefly (~20 seconds).

3.10 Note laser temperature and current setpoints, and detector levels in an electronic notepad file. A new file should be opened each day.

3.11 Start streaming the fits and collecting mixing ratio data. Turn on data saving (“wd”) button toggle the write to disk option.

Troubleshooting

This instrument is designed to run with minimal intervention by a trained operator. Since this is a “research-grade” instrument, problems that might arise will require specialized diagnostics from the trained operator. Some routine checks of instrument performance include the following: vacuum pressure, diode laser stability (i.e., stability of spectral line position), verification of automatic reference locking and background subtraction; liquid nitrogen fill and temperature at designed locations.