

Gas Analysis System using Full Vacuum Type FT/IR (Trace amount of H₂O in N₂ gas)

Introduction

The analysis of low concentration gases using long pathlength gas cells has been reported previously, however, it can be difficult to accurately quantitate gases at low concentrations when the absorption peaks of the target gas overlap with the peaks of atmospheric water vapor or, when the target gas itself is H₂O or CO₂, which are present in the atmosphere. This is because even with a vacuum FT-IR instrument, it was not possible to evacuate the sample chamber with the long pathlength cell present. The full vacuum gas analysis system introduced in this application note has a special gas cell integrated into the sample chamber, allowing the entire light path to remain under full vacuum with the gas cell in place. This full vacuum model makes it possible to quantitate concentrations of H₂O even at the 0.1 ppm level.

Instrument and Measurement

For the measurement, there are separate vacuum lines for evacuation of the FT-IR instrument and the gas cell, with independent evacuation capability for the separate components. Adding a vacuum gauge on the gas cell makes it possible to control extremely low concentrations of the gas samples.

Cell specification

Cell type:	Multi-pass 'White' cell
Pathlength :	10 meters
Cell body:	Stainless steel
Mirror material:	Stainless steel
Mirror surface:	Gold coated
O-ring :	Viton
Window:	CaF ₂
Heating:	Possible, max. 100°C
Cell capacity:	Approx. 2 L
Gas in/output port:	1/4 inch VCR



Fig. 1 Full vacuum type FT-IR gas analysis system (10 meter cell)

Measurement example

The quantitation of a trace amount of water vapor (H₂O) within nitrogen gas was attempted. Water vapor with a concentration of 100 ppm was diluted by monitoring the pressure gauge during dilution of the standard samples with concentrations of 0.0, 0.51, 1.02 and 2.48 ppm. Figure 2 shows the IR spectra of water vapor for each concentration. For the 0 ppm concentration, there was no absorption due to water vapor observed in the spectrum. The calibration curve in Figure 3 was created using the absorption peak at 1653 cm⁻¹.

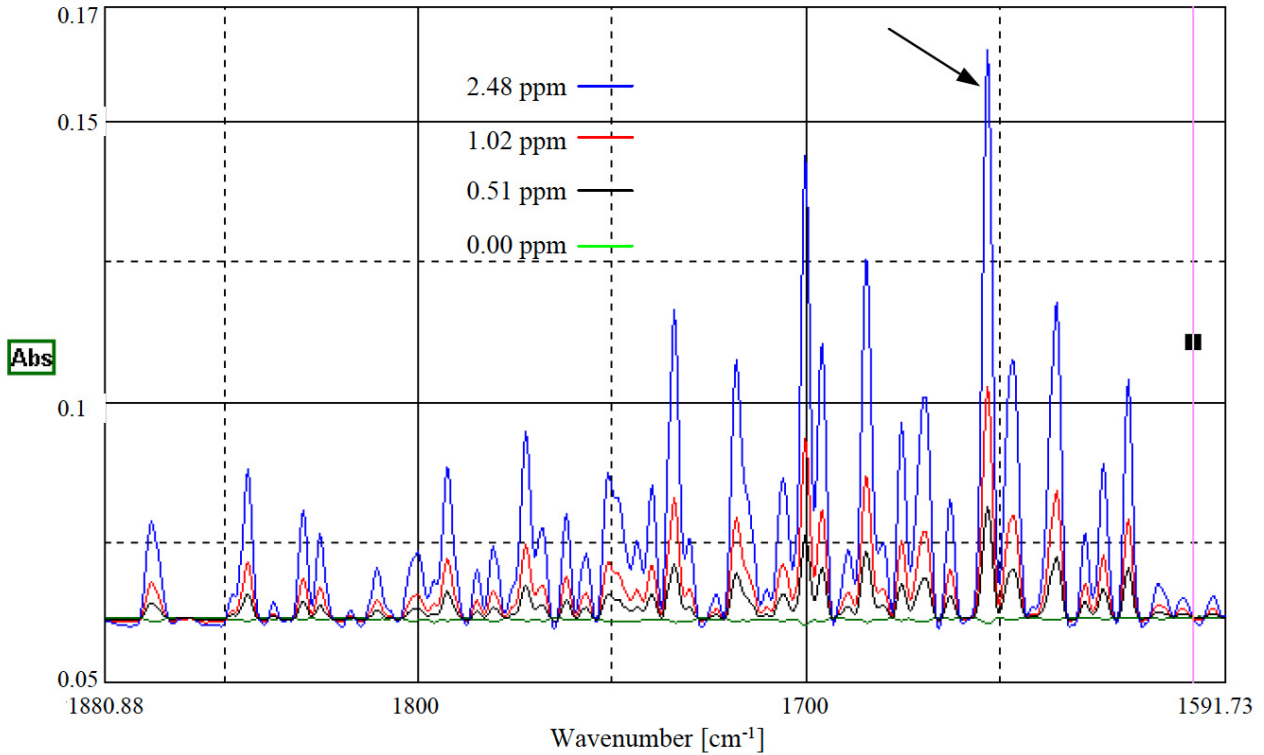


Fig. 2 Expanded region for spectra of low concentration H₂O

Condition

Instrument : FT/IR-6100
 Accumulations : 200
 Resolution : 2 cm⁻¹
 Apodization : Cosine
 Gain : Auto (1)
 Aperture : 1.8 mm
 Scan speed : Auto (4 mm/sec.)
 Light source : Standard
 Detector : MCT

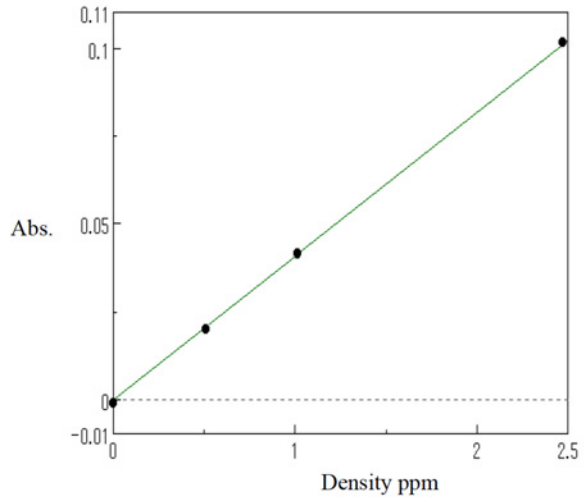


Fig. 3 H₂O calibration curve