FTIR Industrial Monitor

- Highly compact (100 cm X 50 cm) and stable unit for industrial use
- Capable of monitoring multiple species (> 30) simultaneously
- All measurements done hot/wet at 185°C eliminating condensation issues
- Reference library containing over 200 individual absolute reference standards
- No calibration requirements and no calibration gases needed
- Very low overall maintenance with only annual preventative maintenance needed.
- Modular system - user configurable to different measurement scenarios including open-path and stack/process applications

Imacc system configured with heated 10 m cell accessory

The FTIR is a relatively new technology to industrial monitoring although it has been a mainstay in analytical labs for years. It is now approved by the US EPA for use in industrial monitoring.

The FTIR monitor developed by Imacc is a very rugged system designed for use in industrial environments. It uses a ***dynamic alignment*** FTIR, which actively aligns the optics hundreds of times per second during data collection, and a ***dash pot*** movement, which only allows the optics to move in the direction they are supposed to. This combination provides for very stable operation even in environments with high vibration and large temperature swings.

The unit is totally NEMA enclosed and can be fitted with Z-purge for use in explosive environments. Shock mounting as well as vortex cooling is available for really harsh environments.

The Imacc system can operate with one of several different accessories providing detection limits from high ppm-levels to ppb-levels. These accessories are ***user interchangeable,*** permitting a variety of measurements with one base unit.

For industrial monitoring the system typically operates in extractive mode, although open-air measurement accessories are also available. In the extractive mode it uses a 185°C extraction line and a 185°C nickel-plated cell so process streams can be monitored hot/wet without the risk of condensation. All optics are gold coated and are impervious to most caustic and acidic gas flows.

All data is processed with an embedded or external computer which outputs tabular and graphical data to the user. System output can be with 4-20 mA current loops, RS-232 digital links, Mod Bus, or voltage loops. The software supports alarms for each compound individually and can be configured to perform any desired operation upon an alarm condition.

Specifications

Operational Modes

The Imacc system is typically used in its extractive mode for industrial monitoring. This uses an extraction line heated to 185°C to carry the sample to the analyzer and through a cell in the analyzer also maintained at 185°C. The sample line can be hundreds of feet long, allowing the analyzer to be placed where needed.

Typical Detection Limits

Detection limits of all FTIR systems are dependent on the gas mixture of the sample stream. This is because of the inferences possible with various mixes of gases. However, typical detection limits for industrial environments are shown here. Imacc guarantees detection limits as agreed upon with the client for their specific compounds and measurement environment at the time of delivery of each system. The upper detection limit is typically in the high %-range.

Species	Point Sampling	
	(ppmv*m)**	32 m Cell* (ppbv)
Ammonia	0.3	9
1,3 Butadiene	0.3	9
Carbon Monoxide	0.4	12
Chloroform	0.2	6
1,4 Dioxane	0.3	9
Formaldehyde	0.8	25
Hydrogen Chloride	0.4	13
Hydrogen Fluoride	0.3	9
isobutylene	0.4	13
Isopropanol	1.0	31
Methylene Chloride	0.8	25
Methyl Methacrylate	0.5	16
Nitric oxide	0.2	60
Ozone	0.5	16
Phosgene	0.2	6
Silane	0.1	3
Sulfur Dioxide	2.5	80
Trichloroethylene	0.3	9
1,1,1 Trichloroethane	1.0	31
Vinyl Chloride	0.5	16

* some detection limits assume sample preparation

All delivered instruments are set up to cover the compounds and range of concentrations required by the individual client. The FTIR software has special algorithms to provide for linearity to better than 4% throughout the specified range (ppm to % levels) and to correct for interference from other compounds over their full concentration range.

Dimensions

Base FTIR unit:
17" (43 cm) X 20" (51 cm) X 10.5" (27 cm) high
weight 65 pounds (29 kg)

Heated extractive 10 m cell attachment:
20" (51 cm) X 20" (51 cm) X 10.5" (27 cm) high
weight 35 pounds (16 kg)

Heated extractive 32m cell attachment:
20" (51 cm) X 42" (107 cm) X10.5" (27 cm) high
weight 45 pounds (20 kg)

Power Requirements

120/240 volts 50 to 60 Hz
FTIR & Computer: 900 Watts
Heated Cell: 1.0 kW
Extraction line: 2-3 kW max (depending on length)

Data Output Formats

All spectral data is saved in compressed digital format, compatible with Nicolet software, on the hard drive of the control computer, allowing for reprocessing as desired. Gas concentration data is saved in ASCII format readable by Excel, Lotus, Access, etc. Graphical and tabular real-time displays are available on the control computer and accessible via any external computer via modem or LAN link. Current loop, RS232, and voltage loop links are also available to interface to plant data systems.

Enclosures:

All systems are NEMA enclosed and air tight for use in explosive environments or outdoors. Optional vortex cooling and/or Z-purge are available for use in adverse or explosive environments using compressed air.

Interconnections

All sample lines are connected with Swagelock vacuum tight connectors (typically 3/8"). Custom fittings are available to meet the needs of any client.

Environmental Operating Conditions

Ambient temperatures: 0 to 40°C without Vortex cooling, 0 to 65°C with cooling

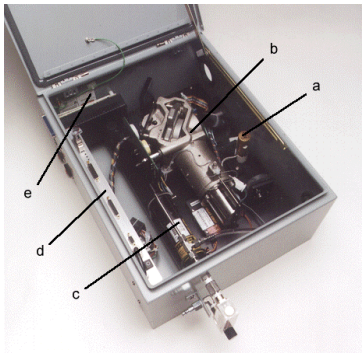
External relative humidity & dust not critical with sealed NEMA enclosure.

Instrument has optional shock mounting for high vibration environments.

Details of the Imacc FTIR System

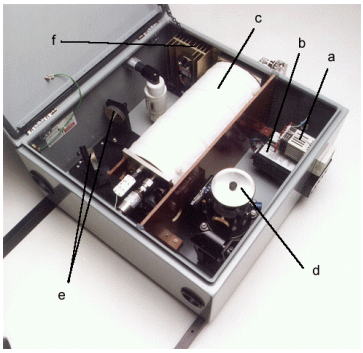
The Hardware

The Imacc Base Unit shown in the figure below contains the infrared source (a), the FTIR modulator (b), the laser controls (c), the on board computer for FTIR control (d), and the power supply (e). It is totally self-contained and NEMA enclosed so it can be used in adverse environments or even outdoors.



Imacc Base unit in its NEMA enclosure.

The Base unit couples to one of several attachments for doing extractive stack or process monitoring. These are cell based accessories that can utilize cells with optical path lengths from 10 cm to 150 m. The figure below shows a typical 10 m cell system which can provide detection in the 0.1 ppm range for most compounds. This attachment contains a temperature controller (a), a pressure meter (b), a nickel coated multi-pass cell with gold optics (c), an infrared detector (d), gold coupling optics (e), and the heater control systems (f).



10m cell attachment for the Imacc Monitor

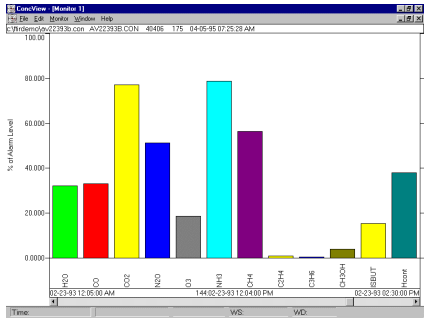
The 10 m path cell is physically 10" (25.4 cm) long and is heated up to 200°C to avoid condensation or polymerization of gases. The sample gas is flowed through the cell using a heated extraction line up to several hundred meters long with a circulation pump.

Infrared radiation from the source is modulated by the FTIR and sent through the cell containing the sample. This radiation is then detected with the infrared detector that can be an ambient temperature detector or a high sensitivity liquid nitrogen cooled detector. Ambient temperature detectors are typically used for industrial monitoring unless low ppb-level concentrations need to be detected. The signal from the detector is sent to the FTIR control computer where it is processed to yield gas concentrations. These concentrations are then stored, displayed on the computer monitor in real time, and optionally transmitted to external data systems.

The Software Systems

The Imacc system has several unique software features that allow it to produce accurate results in very harsh industrial process streams. These include: 1) correction for spectral shift induced by vibration or system instability, 2) interference by other compounds producing bias, and 3) non-linearity produced by the finite resolution of the instrument (much less severe on 0.5 cm^{-1} instruments like the Imacc system than in 1.0 cm^{-1} instruments). The combination of these provides for accurate and precise data in even harsh environments. One Imacc system currently operating in New Orleans, LA monitors organics in a 70% water and 30% CO_2 process stream. This system operates outdoors with high vibration from adjacent pumps and motors in ambient temperatures as high as 120°F and relative humidity as high as 98%. The system has operated well in this stressful environment for years.

The software also provides for real-time alarms on each compound with user-selectable alarm thresholds. There are also numerous graphical displays for data interpretation. These include bar charts showing concentrations as a function of alarm thresholds (as shown below), time series plots showing concentration as a function of time of day, and correlation plots showing correlation between compound concentrations.


Concentration versus alarm threshold