CFC Abatement Control via Two Stream FTIR System

CFC usage in industry

Although the use of CFCs in domestic products has been widely phased out, CFCs chemicals still prove a vital ingredient in the production of insecticides and herbicides. Such products aim to increase the rate of crop production all over the world. All aspects of such a manufacturing process in relation to environmental impact must be well controlled. The use and pre-emission removal of CFCs in the intermediary steps of the insecticide production needs to be monitored with 100% efficiency.

Solution

Protea has delivered on-line process and emissions analyser systems that monitor the high level process concentrations and the low-level emission concentrations of CFC in such production plants.

Commonly, activated carbon beds are used as abatement systems – the CFC emissions being adsorbed onto the bed. The bed is purged with steam intermittently, re-vaporizing the CFC and feeding it into a condenser. The bed is then dried with air before the next adsorption cycle runs.

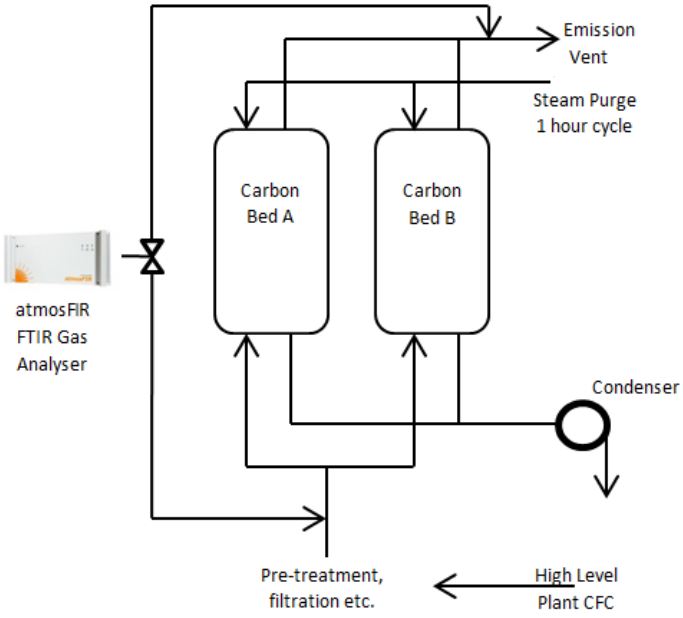

Figure 1 - Typical CFC Carbon Adsorption Bed with atmosFIR Gas Analyser Measuring Inlet and Exhaust Vents

atmosFIR Solution

The atmosFIR FTIR is a continuous running gas measurement analyser. The system can be configured with various stream inlets and analytical modelling to enable multi-samples to be measured on the one system.

The FTIR analyser is a full-spectrum analytical device that enables the whole Mid-IR spectrum to be detected in a single instrument. atmosFIR can be programmed with unique analytical models or *chemometrics*, which can enable hundreds of gases to be measured on the one instrument. Protea's unique software design allows for a separate analytical model to be made for each measurement "stream". This means we can measure different gases or different concentrations of gases depending on which measurement point the analyser is sampling from.

This design proves ideal for measurement of the inlet and the exhaust gas stream has from a carbon bed abatement system. The inlet to the carbon bed contains high levels of CFC, % Volume levels. The exhaust has levels of the order of ppm. Typical CFCs and measurement levels are given in Table 1.

CFC Species	Example Inlet /%Vol	Example Outlet /ppm	Typical Outlet LDL / ppm
R113	0 - 5	0 - 5	0.07
R113a	0 - 5	0 - 5	0.08
R123	0 - 5	0 - 5	0.06
R11	0 - 5	0 - 5	0.07
R141b	0 - 5	0 - 5	0.08
R12	0 - 5	0 - 5	0.08
R22	0 - 5	0 - 5	0.05
R32	0 - 5	0 - 5	0.04
R125	0 - 5	0 - 5	0.07
R134a	0 - 5	0 - 5	0.04
Water	0 - 5	0 - 50	0.01%

Table 1 - Typical CFC and measurement ranges either side of carbon bed

The carbon bed is commonly steam purged every hour. This results in a peak of water vapour of up to 50% Volume. Although not required for emissions reporting, this water emission needs to be accounted for in the analysis as the water infrared absorbance interferes with the CFC absorbance. The unique aspect of the FTIR gas analyser being able to measure hot wet gas, means no pre-analyser conditioning or cooling is required to cope with this water spike.

Chemometrics

Protea designs systems based around FTIR technology that are application specific. The analytical model or chemometric model that analyses the IR spectrum is at the heart of this customisation.

The chemometrics starts off with a dedicated calibration set of spectra. These are spectra that are generated in controlled laboratory conditions using traceable calibration standards.

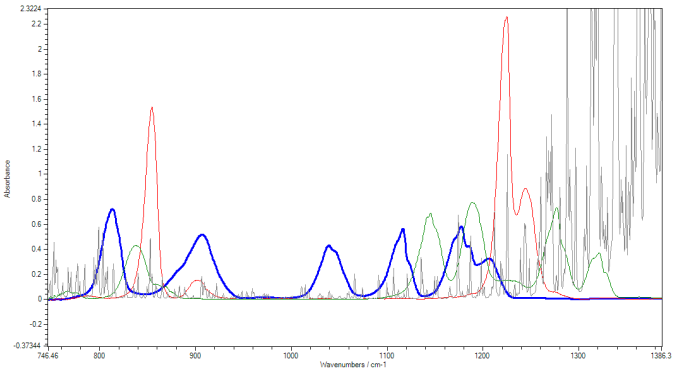

Figure 3 – Infra-red Absorption Spectra of R113, R113a, R123 and H_2O

Once calibration spectra have been collected, Protea employs standard chemometric methodology to create analytical models that target each measurement species individually. This ensures the most accurate model is built for each gas in the sample, rather than a single model that tries to model all gases.

Sampling System

As well as customisable software models, Protea also ensures the most suitable hardware is installed for any measurement project. This begins at the sample point itself.

For the extremely wet exhaust sample from the carbon beds (due to the hourly steam cycle) a heated probe with heated insertion tube is installed. This ensures no liquid droplets enter the gas sample path.

The heated probe contains a heated ceramic filter of suitable pour size to filter out carbon dust from the beds.

Due to the corrosive nature of some substances on plant, all on-plant equipment needs to be made of suitable materials. This can involve the use of materials such as Hastelloy, as opposed to standard stainless steel when required.

For the inlet to the carbon beds, a unique 3-stage probe has been designed and manufactured by Protea. This is constructed of PEEK, a polymer that provides robustness and protection against chemical attack. The 3 stages of the probe are: 1st stage span gas, 2nd stage dilution gas, 3rd stage sample gas. The probe has an integrated 1micro filter element at the tip to stop any carbon dust from the beds entering the analyser.

Figure 4– SSCM 19" rack module

The control of the sampling system – heated line and probe alarms, span gas control and sample stream selection valve is all managed via Protea's Sampling System Control Module (SSCM). This is a 19" rack mountable module containing a PLC and all relevant sampling equipment to operate the system continuously.

Active Dilution – Real-time Measurements

In order to measure the high levels of CFCs passing into the carbon bed, the atmosFIR analyser delivers a stream of dilution gas to the sample probe, regulated by a Mass Flow Controller (MFC). This enables the concentrations in the analyser to be more manageable from an analytical point of view. By active control of dilution, the system can correct the results in real-time so the readings being relayed to the plant are the actual in-stack concentrations.

Supplier: