INFRARED CARBON DIOXIDE SENSORS

The carbon dioxide analysers available from Systech Instruments, use the well-defined infrared principle for accurate measurement of percent levels of carbon dioxide in most industrial processes. The infrared sensors are in a self contained unit mounted inside the analysers with the necessary electronics to process the signal from the sensor and display the carbon dioxide concentration on the digital display.

Theory

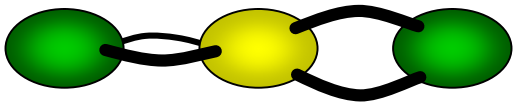
A light source emits light at a very wide range of wavelengths. Only a very narrow band is visible (400-800nm). Wavelengths longer than 800nm are infrared wavelengths. Wavelengths shorter than 400nm are in the ultraviolet region of the spectrum.

Wavelength (nm)	10-400	400 -800	800-1100	1100-2500	2500-10000
Primary Interactions	Electronic	Electronic	Vibration Overtones	Vibration Overtones	Fundamental Vibrations

Figure 1. Spectrum from a light source

When a light source is exposed to a gas stream containing carbon dioxide, energy from the infrared region of the spectrum is absorbed by the gas. The energy affects the physical nature of the carbon dioxide molecule.

A carbon dioxide molecule consists of one carbon atom and two oxygen atoms. Both oxygen atoms are chemically attached to the carbon atom by double bonds as shown in Figure 2.



Oxygen Carbon Oxygen

Figure 2. Carbon dioxide molecule.

When this molecule absorbs energy, the atoms interact with each other. The absorbed energy makes the atoms vibrate and rotate. The vibrational energy and the rotational energy required from the light source is wavelength specific. Because the carbon to oxygen double bond is so prevalent in carbon dioxide, we can focus on the wavelength that causes the vibrational interaction

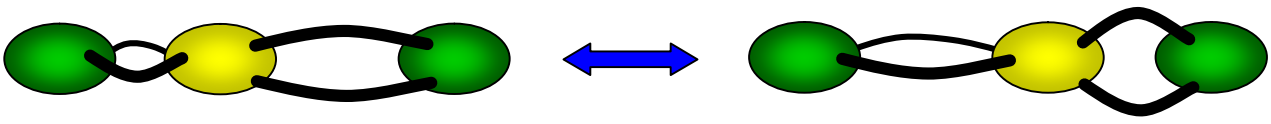


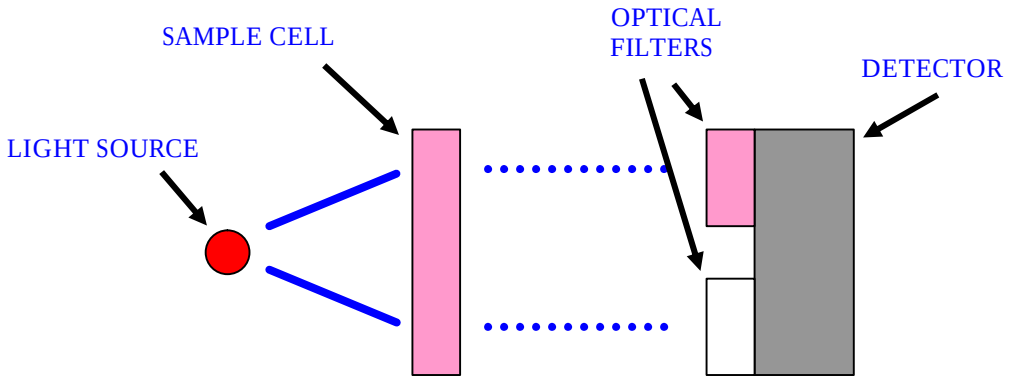
Figure 3. Vibrational interaction between carbon and oxygen molecules.

Figure 3 shows the interaction between the carbon and oxygen molecules when infrared light is absorbed. The carbon atom is vibrated between the two oxygen atoms.
The amount of light absorbed by the gas stream is directly proportional to the carbon dioxide content in the gas stream.

Principle of Operation

When light passes a gas stream containing carbon dioxide, the gas absorbs energy from the light at specific wavelengths. The remaining light is filtered to a wavelength specific to carbon dioxide. The amount of light remaining at the specific wavelength is measured. The amount of light absorbed is directly proportional to the amount of carbon dioxide present in the gas stream.

The infrared sensor offered by Systech Instruments is a single beam, dual wavelength temperature compensated sensor. It incorporates a semiconductor light source and detector which are both temperature controlled. The gas flows through a sample cell with sapphire windows.



Two optical filters are mounted on the detector surface. One filter is chosen to pass the infrared light specific to carbon dioxide (measurement filter). The second filter is a reference filter. Light at a wavelength that is not absorbed by carbon dioxide passes through the reference filter. The difference in amount of light between the two filters provides the amount of energy (light) absorbed by carbon dioxide.

The signal generated by the sensor is non-linear. The signal is then fed to the electronics where it is linearized and a digital reading of carbon dioxide concentration is displayed.

Calibration

The sensor requires a two-point calibration. First, the sensor must be zeroed. This is performed by flowing a gas without carbon dioxide through the analyser and adjusting the zero on the analyser.

Second, the span needs to be adjusted. A span gas containing an amount of carbon dioxide close to the concentration of carbon dioxide found in the sample gas should be used to span the analyser. The span gas should be of known concentration and is typically available from a gas supplier.

With span gas flowing though the analyser, the span should be adjusted to match the certified value.

Applications

The infrared analysers may be used for measurement of carbon dioxide at any level between 0-100% in gases or gas mixtures.

The applications for the Series 300 are with industrial gas producers, industrial gas users and for safety monitoring.

Gas Producers	-	for ensuring product quality either by measuring for a carbon dioxide impurity or for monitoring for carbon dioxide purity.
Gas Users	-	testing of modified atmosphere in food packaging.
	-	to ensure quality of gases used as production materials in the chemical industry.

The applications are discussed in greater detail in the applications guide.

Systech Instruments Ltd
17 Thame Park Business Centre,
Thame
OXON
UK
OX9 3XA

www.systech.co.uk
email advice@systech.co.uk
Fax +44 1844 217 220
Tel +44 1844 216 838