Absorption of Infrared Radiation

A large number of materials absorb infrared radiation (wavelengths of 0.7 to 300 µm) due to intramolecular vibrations and for any specific material the strength of absorption varies with the wavelength of the impinging radiation (the absorption spectrum). The absorption spectrum is different for every material.
The figure below shows the absorption spectra for a number of typical materials.

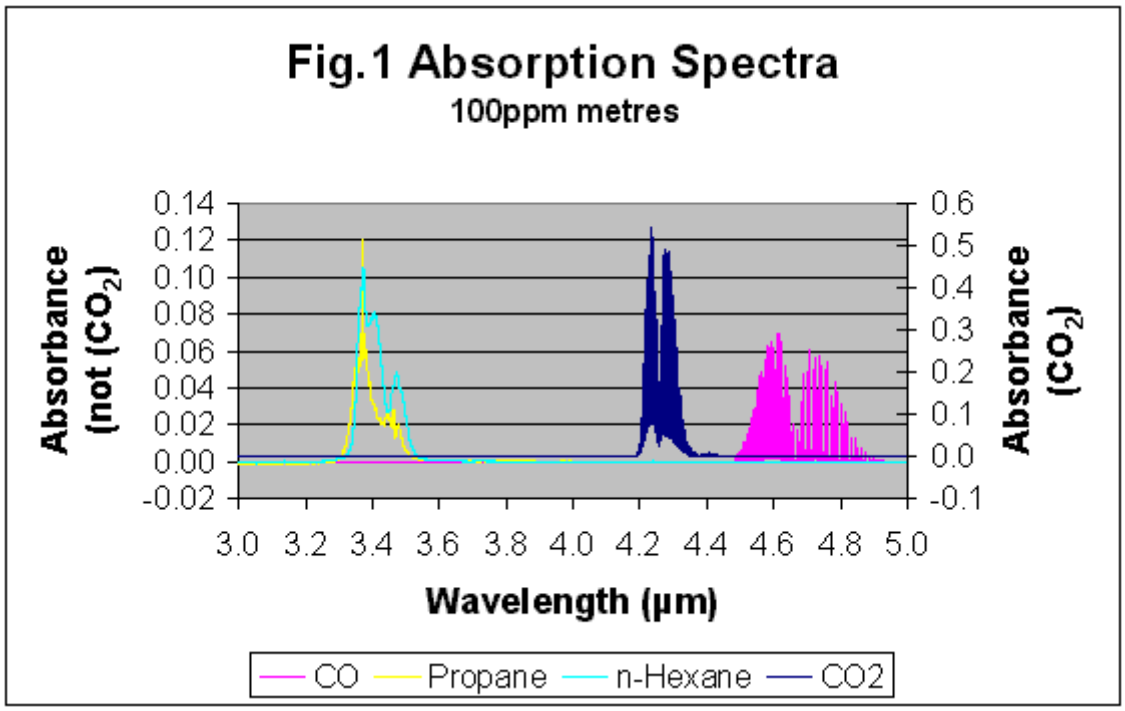

Figure 1 - Absorbance of infrared radiation (absorption spectra)

There are certain components that are common to all infrared gas sensors. These include: an infrared source such as a simple incandescent lamp, a detector, generally pyroelectric detectors, a means to select the desired wavelengths (band pass filters) and a sample chamber. Radiation from the source passes through the sample chamber and band-pass filter. The choice of wavelength and "width" of the band-pass filter are basically responsible for the relative selectivity of the sensor. The radiation NOT absorbed by the sample is then detected and the ratio of this radiation to the zero level provides a measure of the concentration of target gas in the sample. A zero level is taken using a gas that does not contain any of the target gas and hence will absorb or pass all wavelengths equally.

A further component needed for good performance of IR gas sensors is a temperature sensor. All these components have temperature dependencies which must be compensated to provide an accurate measure of gas concentration. This temperature sensor should be sited in close proximity to the chamber.

Infrared sensors basically give a measure of the number of target gas molecules in the light path between source and detector. As a result, the output signal not only varies with concentration but also with pressure, they are partial pressure devices. For high measurement accuracy, compensation for pressure is, required. This dependency also infers that sensors with a longer optical path length (the distance travelled by radiation between source and detector) will have increased resolution and tend to have a lower dynamic range.

Using a single target gas, fixed optical path device at constant pressure, the signal output decays with increasing concentration roughly exponentially, so infrared gas sensors are inherently non-linear. The measurement accuracy decreases with increasing concentration.
The components described above form a typical infrared gas sensor. However, some supporting electronics are essential to build a practical system. The common detector technologies provide extremely small analogue signal outputs that require a lot of amplification. Basic analogue filtering of the amplified output signal is generally necessary to improve measurement accuracy.

The source also requires a power driver circuit. It is usual practice to modulate the source output by pulsing. This creates periodic variations in the emitted intensity and so allows the use of synchronous detection techniques.
The temperature and pressure compensations are generally computed using sophisticated algorithms in a microprocessor. This first requires the analogue signals to be converted into digital signals. The compensated data is then made available to the signal display or processing unit.