Infrared Sensors

Most of us are by now familiar with the applications where an infrared sensor is used. This is just a short article to sum it up for the record.

Carbon dioxide CO_2:
For many years we were satisfied with the calculated value of carbon dioxide supplied by the average flue gas analyser. One of the very simple reasons for this was that there was no low cost method of measuring CO_2. The direct measurement of CO_2 was attempted by some manufacturers of electrochemical sensors, but without significant success. Carbon dioxide proved to be very difficult to measure in this way. The Kyoto Protocol and an increased public interest in carbon dioxide as a greenhouse gas generally fuelled research into affordable methods of assessing the concentration of CO_2. Of course, there have always been mass spectrometers and other laboratory equipment perfectly capable of carrying out these measurements, but that is not really something you can carry with you into the field! The price is just slightly outside the range of most companies interested in flue gas analysis.
The advent of small, low cost infrared sensors such as those produced by madur electronics has changed all that and the IR sensor used for carbon dioxide fits easily inside the existing flue gas analyser housing with no mechanical changes. The advantages of directly measuring CO_2 are perhaps not instantly apparent: This is essential in cases where the fuel cannot be adequately defined or no information is available. Oil refineries burning process gas are one good example, as are waste incinerators. Biogas plants need the measurement of carbon dioxide for two reasons: To assess the quality of the biogas before combustion, and to measure the products after combustion. Since the biogas contains some CO_2 anyway, there is no way of calculating the quantity produced after combustion. The carbon dioxide present in the biogas is not a product of combustion, and should not be included in the combustion gas equation.

Methane CH_4:
It is not readily obvious that methane will be present in flue gases from burner systems. It is a highly combustible gas and there is no reason to expect CH_4 to survive at high temperatures in the presence of oxygen. The fact is, it does, if only in small quantities. There was earlier no efficient way of measuring the concentration of methane in these gases. The only technology commonly available was the Pellistor sensor, which is a highly inaccurate and not particularly reliable method of measuring CH_4. The Pellistor sensor operates by catalytically burning all carbon compounds found in the gas and comparing the temperature between the non-catalyst side and the catalyst side of a pair of elements. The catalyst side will have a higher temperature and hence higher resistance than the non-catalyst side. This means that the two elements must be correctly balanced as a Wheatstone bridge measuring circuit before use, since the differences are very small. Whilst the sensor will only catalytically burn carbon compounds such as methane and carbon monoxide, the initiation of combustion will automatically affect all other combustible compounds such as H_2S which might be present. The result of this is an unstable cross-sensitivity: In the presence of methane or carbon monoxide there is an cross-sensitivity to other combustibles, without these gases there is no answer from the sensor. This type of cross-sensitivity is impossible to predict and can not be removed by calculation. Furthermore, the Pellistor sensor consists of two very this wires exposed to the gas being measured. Vibration will cause fluctuations in the readings and failure is common after slight knocks. The Pellistor sensor is designed for fixed installation for safety measurement, which it does very well. A Pellistor is not a sensor for portable equipment. Methane can only really be effectively measured using a dedicated infrared sensor. Care must be taken to dry the gas efficiently, since the sensor will react slightly to the presence of water vapour as well as CH_4. Although it is generally believed that an infrared sensor is completely dedicated to one component, all the alkanes have a wavelength similar to methane and the sensor is so constructed that it will react to their presence as well. Naturally, since it is calibrated for methane, the reaction

to the longer chain alkanes will not be as accurate, but the correspondence is still better than that produced by a Pellistor sensor. Methane is now recognised as one of the major contributors to the greenhouse effect, so a measurement of CH_4 is now essential.

Sulphur dioxide SO_2:

It is possible to measure sulphur dioxide with electrochemical sensors relatively accurately, but there are certain disadvantages. SO_2 measurement can also be carried out using infrared or ultraviolet sensors, both types of sulphur dioxide sensor being roughly equal in popularity. One of the major problems with SO_2 is its extremely corrosive nature and the affinity for sulphur dioxide for water. The presence of any condensate will quickly remove all traces of SO_2 from a measuring system. The infrared sensor for sulphur dioxide has the advantage of lower cost, but at the expense of greater size. Nevertheless, infrared sensors are one of the preferred methods of measuring SO_2 in the field.

General infrared measurement:

The infrared sensors manufactured by madur work on the NDIR (Non Dispersive InfraRed) principle. Light of a certain wavelength is absorbed by a particular gas, the amount of absorption proportional to the number of molecules of the gas present in the path of the light. By measurement of this absorption the concentration of the gas can be determined with great accuracy.