FLOW COMP SYSTEMTECHNIK SHEDS LIGHT ON GAS

Development of a New Type of Device for Measuring Gas Characteristics Based on *Infrared Spectroscopy*

As a result of the liberalisation of the natural gas market, we expect in the future a rise in the number of trade relations with a variety of partners where varying gas properties will be the order of the day. The composition and, therefore, the energy content depends largely on the origin of the gas. This means that, even in small gas metering stations, it will be necessary to measure the calorific value and other important characteristics on site.

For smaller distributors and suppliers, this development is particularly problematic.The existing devices used for measuring gas properties (usually gas chromatographs) are cost-intensive both in terms of the purchase price and the maintenance costs and are actually a little too sophisticated for the tasks they have to perform.

A cheaper and more simple method of measuring gas characteristics is, therefore, urgently required, and not only for official billing and volume correction purposes in accordance with SGERG-88. A variety of other applications are possible – e.g. measurements for regulating tasks (gas mixture, turbine control), comparative measurements for discontinuing high-precision devices or measurements for various industrial processes.

The research and development labs belonging to Ruhrgas and FLOW COMP Systemtechnik are in the process of developing innovative procedures for measuring gas characteristics. Some of these new technologies are based on an optical process whereby the IR absorption of the gas is measured spectroscopically. Two of these processes have reached the product development stage at FLOW COMP.

This article is the first in a series aimed at introducing the new optical measuring systems. The first part will deal mainly with the general physical principles and will give a brief overview of what is still to come.

The principles: How does spectroscopy work ?
Natural gas is basically composed of various hydrocarbons, carbon dioxide and nitrogen. The energy content of the gas depends largely on the amount of methane and higher hydrocarbons contained in the gas. The physical principle of the IR spectroscopic process is as follows: if you expose natural gas to white light, the energy in the light causes the molecules to vibrate. As a result of these vibrations, the light energy is weakened in certain spectral regions. This phenomenon is called absorption and, in this example, takes place in the infrared spectral region.

Certain molecular combinations characteristically contribute to light absorption in certain wavelength bands. By measuring the absorption range (how much light is “swallowed up” in which band of infrared wavelengths), it is possible to draw conclusions as to the share of the individual components and, therefore, the composition of the gas.

For example, the carbon dioxide molecules lead to a weakening of the light in a wavelength band between 2000-2020 nm. The wavelength band between 1600 and 1660 nm is dominated by the methane part of the gas and the band between 1660 and 1800 by the higher hydrocarbons.

Of all of the components to be measured, only the nitrogen part cannot be registered with the IR spectroscopic method as nitrogen is not IR active. There are, however, other methods to find out what role the nitrogen plays, either by determining the N_2 partial pressure over a precise measurement of the state of the gas or with the aid of an additional measurement of the thermal conductivity.

The spectrometer
From a metering point of view, this process is done with the aid of a spectrometer (Fig.1). The spectrometer has a measuring cell with windows which contains the gas. A simple light bulb produces white light which is passed throught the cell containing the gas. In order to analyse in which wavelength band the light is absorbed, the beam is split up by a prism or an optical grating into its wavelength spectrum. As an alternative to a prism or an optical grating, it is possible to use spectral filters to split up the beam of light. However, if this is the case, you get fixed, very large spectral ranges.

At the same time as the infrared measurement, the state of the gas in the measuring cell is also determined and included in the evaluation. By taking the calibration data into account, it is then possible to determine the calorific value, the standard density and the CO_2 content of the gas.

Practical implementation
FLOW COMP is currently working on two different metering systems based on the IR principle. These systems differ in the complexity of the measuring process, in the accuracy and in the costing. The aim is to offer the best solution in terms of price and performance for whatever metering task.

The spectrometer system
The spectrometer analyses the transmission spectrum of the light in a very high spectral resolution. To do this, the infrared wavelength spectrum is split into a number of very narrow ranges by the optical grating (Fig.2, top). The nitrogen content is determined by measuring the state of the gas. The feasibility of this method has already been proven in the laboratory.

Fig.1: The spectrometer.