

1 Natural gas from different sources flows into the gas network, leading to strong fluctuations in gas quality.

2 The »EcoSpectro« gas analyzer, developed for the RMA company, measures gas compositions very sensitively and is thus an alternative to widely-used gas chromatography.

COMPLEX GAS MIXTURES INFRARED SPECTROSCOPY FOR NATURAL GAS ANALYSIS

Natural gas is a natural product. It contains over 90 percent methane, along with ethane, propane, butane and other hydrocarbons. Nitrogen and carbon dioxide are also usually contained in natural gas. Gas from various countries is fed into the German grid, supplemented by biogas and, in the future, additional hydrogen, which is generated according to the power-to-gas principle as a buffer for excess electricity. The calorific value, as the decisive factor in billing, varies significantly with the gas composition. Therefore, measurements at distribution points in the gas network or at industrial consumer sites are essential and yield information about the amount of energy provided.

measuring method is comparatively expensive, quite slow and complex in general (e.g. carrier and calibration gases are required). As an alternative to GC systems, Fraunhofer IPM has developed an infrared spectroscopy based measuring system for the analysis of complex gas mixtures on behalf of an industrial customer. The spectrometer measures the individual gas concentrations every minute and requires little maintenance because no calibration gases or carrier gases are needed. Hydrocarbons up to C₆, CO₂ and N₂ are quantitatively determined with high accuracy. Additionally integrated sensors detect non-infrared active gases such as hydrogen or oxygen. The nitrogen content is determined indirectly.

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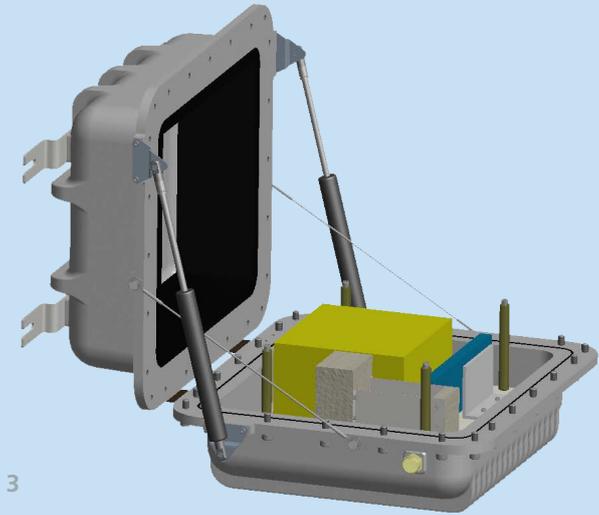
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IR-Spectroscopy instead of chromatography

By default, gas chromatography (GC) is used to determine the calorific value. This

Chemometric analysis of the gas concentration from percent to ppm

Data analysis is an integral part of the gas analyzer. New types of chemometric



methods are used for the automatic processing of the spectra. This makes it possible to determine higher-grade hydrocarbons including hexane from the spectra – very accurately and automatically. In combination with complex measures to stabilize the IR spectrometer and a correspondingly good signal-to-noise ratio, this mathematical method makes it possible to cover the enormous bandwidth of potential gas concentrations from over 90 percent for methane to the range of 100 ppm for higher hydrocarbons such as pentanes and hexanes from individual spectra. The various isomers of hydrocarbons multiply the number of gases to be detected; for example, the pentanes may be present as n-pentane, iso-pentane or neo-pentane, so that a total of more than ten different gas components must be detected spectroscopically. Fraunhofer IPM has been using chemometric methods in spectroscopy for many years in order to be able to precisely model compositions of substances mathematically – even for very complex gas mixtures with a high dynamic range.

Gas mixture analysis in industrial environments

In order to extend the device to further applications, Fraunhofer IPM is working on a streamlined and less expensive version for industrial applications and small consumers (see box). For example, with a suitable measuring system, an engine's ignition timing in Combined Heat and Power Plants (CHPPs) can be adjusted in order to optimize combustion. In energy-intensive processes such as glass processing, a fluctuating energy input can lead to undesirable results. The exact knowledge of the gas mixture allows regulating the gas supply with regard to the actual calorific value.

In many industrial areas, standardized mixtures are used as starting material for chemical reactions or processes. Despite known mixing ratios, fluctuating gas compositions may result. Monitoring the gas composition offers the possibility to control processes in a targeted manner, for example by adjusting the gas supply.

3 »EcoSpectro« with FTIR spectrometer in explosion-proof housing.

4 Fraunhofer IPM has gas measurement stations for the calibration and characterization of gas measurement systems at its disposal.

Technical specifications

Method	Infrared absorption spectroscopy by means of an FTIR spectrometer
Dimensions	56 cm x 62 cm x 32 cm (HxWxD)
Weight	approx. 70 kg (including explosion-proof housing)
Accuracy	down to the ppm range (depending on measuring time and gas)
Measuring time	typically 90 s, minimally approx. 10 s

All specifications and features are subject to modification without notice.

RegioWin project: Gas Efficiency

The fuel gas measuring system »EcoSpectro« was developed on behalf of RMA Mess- und Regeltechnik GmbH & Co. KG.

The company from Rheinau is one of the partners in the RegioWIN project »Gas Efficiency«, funded by the Ministry of Economics, Labor and Housing of the state of Baden-Württemberg and the EFRE program. As part of the project, a cost-effective spectrometer for fuel gas analysis is being developed, which is to be used in gas networks, CHPPs or in thermal processing plants. The goals are a more efficient feed-in of gases from renewable energy sources into the gas network as well as higher efficiency and lower emissions when operating CHPPs.



Baden-Württemberg