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SPECTROSCOPY AND PROCESS ANALYTICS

Infrared spectroscopy facilitates highly accurate analysis of combustion gases

Major fluctuations in the quality of natural gas are now widespread in Germany, making the regular and reliable analysis of gas composition increasingly important. Fraunhofer IPM has developed the »EcoSpectro« measuring system for RMA Mess- und Regelungstechnik GmbH & Co KG, which quickly and accurately detects the quality of natural gas.

Fluctuations in gas composition and therefore in the quality of natural gas are growing ever larger. This is due to the fact that various suppliers are feeding gases of different quality into the German natural gas grid. 90 percent of the natural gas consumed in Germany comes from abroad, with the majority originating in Russia, Norway and the Netherlands. This mix is supplemented with the feed-in of biogas and in the future will also be supplemented with hydrogen, which serves as temporary storage for excess power from volatile energy sources such as wind and photovoltaic plants in accordance with the power-to-gas principle.

Calorific value is a significant factor in determining gas quality. For customers, the gas price is calculated based on the volume of gas supplied and the calorific value. The latter is not constant and varies depending on gas composition – after all, natural gas is a natural product. Previously, the calorific value of gas was determined through combustion in a calorimeter. Today, distribution points on the gas grid and industrial consumers rely on gas chromatography,

a method with many drawbacks: Not only are gas chromatographs expensive to purchase and complicated to use, they are also relatively slow and require carrier gases.

Spectral measurement – chemometric analysis

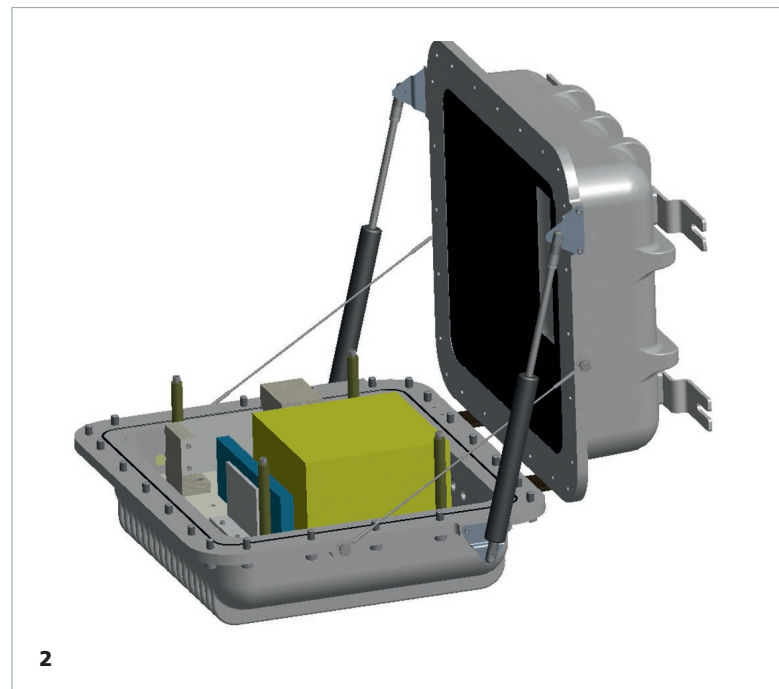
Fraunhofer IPM has developed an innovative combustion gas measurement system based on infrared spectroscopy that offers many advantages over traditional gas chromatographs. The »EcoSpectro« measurement system, developed for RMA, is capable of analyzing the quantity of hydrocarbons up to C6+, CO₂, N₂, and also offers options for detecting hydrogen and oxygen. Any gases in the mixture that are not infrared active are detected by additional integrated sensors. Other advantages of the system: The »EcoSpectro« measures gas quality at one minute intervals, and because it does not need carrier gases, it is much cheaper to maintain than a gas chromatograph.

The system uses an innovative chemometric process to automatically evaluate the spectra. This process also makes

it possible to very accurately and automatically detect higher hydrocarbons up to hexane in the spectra. With extensive measures to stabilize the infrared spectrometer, spectra with a good signal-to-noise ratio are recorded and it is possible to use the mathematical algorithms to determine the high dynamic of gas concentrations. They range from more than 70 percent (methane) to only 100 ppm (higher hydrocarbons such as pentane and hexane) in individual spectra. The various hydrocarbon isomers multiply the number of gases to be detected, for example pentanes can be present as n-pentane, isopentane or neopentane, so that spectroscopic detection of more than ten different gas components is necessary. Fraunhofer IPM has been using chemometric processes in spectroscopy for many years to create exact mathematical models of the composition of substances – even with very large amounts of data.

A new generation of gas measurement technology

As scientists at Fraunhofer IPM have repeatedly noted in recent years, gas is the key to the economic and environmental success of the energy transition. Systems for the continuous analysis of gas composition and gas quality such as »EcoSpectro« are important elements of sustainable, economic gas supply.



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1 Natural gas from various sources is fed into the natural gas grid. The calorific value of gas fluctuates depending on its composition.

2 »EcoSpectro« analyzes concentrations of hydrocarbons, nitrogen, carbon dioxide, hydrogen and oxygen in gas mixtures at one minute intervals.

WHAT IS OUR NATURAL GAS MADE OF? Natural gas is a natural product. It is 70 to 90 percent methane and also comprises ethane, propane, butane and other hydrocarbons. Natural gas typically contains nitrogen and carbon dioxide. One of the clear advantages of natural gas over crude oil or coal is its significantly lower pollutant emissions during combustion as well as its lower CO₂ emissions. After mineral oil, natural gas is the second most important primary energy source in the German energy mix.