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Process Industry in the Liberalized Gas Market

Modern Gas Measuring Technology Safeguards Processes and Machines

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The liberalization of the natural gas market is bringing significant changes to private and commercial consumers around the world. Besides greater supply security and long-term benefits from increasing competition, a growing instability of the gas properties in the gas grid is causing difficulties for gas suppliers and in specific areas of the process industry. Here, increased use of modern gas measuring technology can help to prevent adverse effects on products, processes, and machines.

Natural gas and similar gases such as biomethane (enriched biogas, also referred to as bio natural gas) and mine gas are playing an increasingly major role in the energy supply of households, businesses, and industry. This brings economic and ecologic benefits: natural gas and the renewable gases are future-proof, because large reserves are known worldwide and new ones are being opened up, e.g., by fracking. Gases can be easily transported (using pipelines, natural gas distribution systems, LNG tankers, LNG terminals). Moreover, natural gas has the most favorable environmental balance sheet of all fossil fuels. Additionally, existing gas distribution systems form attractive infrastructures via which households, businesses, and industry can be supplied with gas.

For infeed into the gas grid, the limits on the gas properties are defined by the Wobbe index, which serves as a characteristic quantity. In view of the largely uniform infeed up to now, the permissible limits were seldom violated in either direction in gas distribution systems. This stable condition will change in the future as a consequence of the liberalization of the gas market at the expense of industrial consumers in particular.

Consequential liberalization of the gas market

In light of its economic importance, the natural gas market has become a subject of policy in many countries. The aim of these policies is largely to increase the security of supply of this energy source through liberalization in the direction of more sources of supply in more countries and through measures such as separating the supply and transportation companies, and simul-

taneously to make use of free competition for a stable price level at the very least.

These positive aspects are accompanied by difficulties, however: The increasing number of sources of supply for gases of different origin, the increase of LNG fractions, and finally the infeed of bio natural gas and possibly hydrogen from PtG (Power-to-Gas) plants will lead to heretofore unknown spatial and temporal fluctuations of the gas properties and thus the combustion value in distribution systems. This can cause difficulties, however, in some sectors of the process industry, such as glass and ceramics production as well as metal and chemical production, whose production processes are highly sensitive to temperature in some cases. Furthermore, a billing uncertainty arises, in principle, for all consumers with regard to their suppliers, since the gas composition within an agreed upon supply volume and thus the energy supplied and to be paid for can fluctuate.

Temperature-sensitive processes and gas turbines affected

In the glass, ceramics, and metal industries as well as in parts of the chemical industry, the product quality, but also the efficiency and pollutant emissions, of the individual processes can be negatively affected by fluctuations in the gas properties of the supplied combustion gas. This effect is intensified by the fact that many systems have already been optimized with regard to important parameters and therefore react with extreme sensitivity to thermal changes. In some processes, even the shape and size of the flame is an important parameter whose variation has a negative impact on product quality. Many companies have recognized this correlation and have come up with a remedy by installing suitable gas measuring technology in their control systems. It must be assumed, however, that other companies are not yet fully aware of this effect on their processes and products. This issue was recently analyzed in detail, including solution approaches, as part of a research project entitled "Analyses of the effects of gas property variations on industrial and commercial applications".

A similar situation is found in the area of electricity and heat generation by gas engines and gas turbines. These are generally already optimized by the manufacturer for operation with a certain gas quality and, thus, react to changes in gas composition with lower efficiency and increased pollutant emissions and occasionally with vibrations, knocks, and even flashbacks, which can shorten the service life and even destroy the equipment.

Remedy through gas measuring technology

The liberalized gas market thus poses challenges for certain areas of the process industry that must be solved. One option is the further development of gas burners and gas engines in the direction of greater tolerance of fluctuations in combustion gas properties. Another increasingly used solution approach, however, is the integration of suitable gas measuring technology as a field device in the open- and closed-loop control systems of process plants. This enables combustion gas changes to be detected in a timely fashion and measures to be introduced to prevent damage.

For many decades, combustion calorimeters alone defined the gas measuring technology. These devices – for example, the CWD2005 of Union Instruments – enable direct calculation of the Wobbe index without analysis of the gas composition or other calculation steps. The gas to be measured is combusted and the resulting heat of reaction is, by mixing with a heat transfer medium (e.g., air), transferred to this medium. The temperature increase of the heat transfer medium is then proportional to the Wobbe index of the gas. The relative density of the gas is measured simultaneously, and from these two values the heating value or combustion value is calculated. When a gas volumetric meter and an energy converter is added, these devices determine the amount of energy supplied during a particular time segment. A current example of this is the EMS of Union Instruments. Combustion calorimeters are easy to operate, require only a moderate investment, and function continuously, which makes them particularly well suited for integration in control systems.

Further analysis methods are now also available. These include gas chromatography, in which the measured gas is separated into its single components using separation columns. From the concentration of these components, the sought-for

The INCA gas analysis system measures the composition of natural gas – here in a biogas plant in Indonesia. (Photo: Torsten Haug)

Calorimeters of the CWD series are used, for example, in glass production. There, they monitor the energy content of the combustion gas, thereby assuring the process control.

indices can be calculated. This batch analysis method is more demanding in terms of operation as well as the purchasing and operating costs of the device compared to combustion calorimeters. In addition, the devices must be matched to the respective gas types with regard to the selection of separation columns, carrier gas, and detectors. Another very progressive analysis method uses selective sensors, often in miniature form, to continuously and automatically determine the concentration of certain gas components. This device class includes the gas analyzers from the INCA device series of Union Instruments.

Operators of process-related plants thus have the advantage of being able to select from alternative gas measuring technologies, depending on the task and available budget. All of the mentioned procedures have their specific performance profiles and are suitable for integration in control systems of the process industry. As a result, they provide a means for detecting changes of gas properties in a timely manner during plant operation and thus for protecting processes and machines.

Measuring technology for all application areas

With its modularly designed CWD, EMS, and INCA device series, Union Instruments is one of the leading providers of devices and systems for analysis of natural gas, biogas, and biomethane as well as process gases of the iron and steel industry.

The continuously measuring CWD2005 combustion calorimeter consists of a base unit, which can be equipped for certain application areas through add-ons and/or special approvals. For example, variants are available for custody transfer measurements (CWD2005 CT) and for operation in hazardous areas (CWD2005 DP) as is a version with special certification for use on oil drilling rigs (CWD2005 DPC). Special features of these devices include time- or event-controlled automatic calibration, high-precision acoustic density measurement, low-pressure gas metering, and a large selection of communication interfaces, including Modbus, Profibus, and Profinet. Thousands of CWD devices and their predecessor versions are in operation worldwide.

Custody transfer measurement of the energy content using innovative technology.

The modularly designed INCA gas analyzers are used particularly in the natural gas and biogas markets. The highly integrated sensors use the NDIR method as well as electrochemical or paramagnetic cells for detection of the components CH4, CO, CO2, C2+, H2S, O2, and H2. Three operating modes enable measuring point switchover, a gentle operation for moving parts (pumps), and operation with a patented mechanism for an extended use period of the electrochemical cells. Depending on equipment, use inside or outside of hazardous zones and for dry or moist measured gas is possible. A variety of interfaces are available for data communication, including Modbus, Profibus, and Profinet. INCA Devices are calibrated before delivery according to the highly accurate multipoint principle; the calibration curves are stored directly on the sensor module. INCA devices can be found in large numbers in biogas, biomethane, and mine gas plants as well as in installations of gas turbines.

The EMS2005 Energy Measuring System is used for direct determination of an energy quantity transported during a particular time period. It consists of a combustion calorimeter from the CWD series combined with a gas volumetric meter and a quantity converter. Based on the values measured by the calorimeter (Wobbe index) and volumetric meter, the

quantity converter calculates the amount of energy transported under the current state variables and provides the result via standard interfaces. The EMS2005 is approved for custody transfer measurements and is used, for example, by municipal utilities for determining the actual amount of energy obtained and to be paid for. Development and initial installations of this new technology has been and will continue to be accompanied by the board of weights and measures and PTB (German Institute of Physics and Metrology).

Conclusion

The liberalization of the gas market and resulting instability of gas properties in the gas grid puts new demands on consumers. The related fiscal and technological difficulties can be counteracted through use of modern gas measuring technology. Union Instruments provides suitable devices and systems for this purpose.

About UNION Instruments

UNION Instruments GmbH, founded in 1919, is a specialized supplier of measuring instruments in the areas of calorimetry and gas composition. Its user and customer base includes biogas producers, the chemical industry, and energy and water suppliers. The company has its headquarters in Karlsruhe and a subsidiary in Lübeck. With 20 international distributors, UNION Instruments operates worldwide (e.g., USA, China, Russia, Brazil, Belgium). The company's core businesses include production and development as well as maintenance, service, and support.

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Gas properties and Wobbe index

In principle, combustion gases are defined by their chemical composition as well as pressure and temperature. In the case of natural gas, the composition is dependent on the production area and subsequent treatment processes. In the case of biogas, blast furnace gas, and mine gas, it is dependent on the production process. From the chemical composition, indices such as combustion value, heating value, air requirement, and methane index (index for ignition behavior/knock resistance of an engine during combustion of gas mixtures) are derived. For practical reasons, the important characteristic quantity – namely, the gas properties – is not derived directly from the gas composition but is described using suitable characteristic values. In Europe, this is the Wobbe index, which is the ratio of combustion value to the square root of the relative density of the gas. Actually, an upper and lower Wobbe index is also referred to, depending on whether the combustion value or heating value of the gas is used for the calculation. The functional importance of the Wobbe index lies in the interchangeability of gases in combustion devices: Gases with the same Wobbe index can be used interchangeably – with the same nozzle pressure – without adjustments to the respective burner.

Characteristic value	Combustion gases						
	The Netherlands L-gas	Russia H-gas	North H-gas	Denmark H-gas	Nigeria LNG	Egypt LNG	Bio natural gas (biomethane)
Combustion value [kWh/m³]	10,3	11,2	11,6	12,1	12,2	11,3	10,6
Relative density	0,646	0,574	0,629	0,630	0,624	0,569	0,587
Wobbe index	12,8	14,8	14,7	15,3	15,5	15,0	13,9
Methane index	86	92	79	73	71	92	103

Permissible Wobbe index range for H-gas according to G 260: 13.9 to 15.7

Source: Gasqualitäten im veränderten Energiemarkt, DIV 2014 [Gas qualities in modified energy market]