heat processing

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Safeguarding thermal processes with gas measuring technology

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Control of thermal processes in the glass, ceramics, and steel industries requires accurate information about the properties of the combustion gases used. This requirement is becoming increasingly difficult to meet in light of current changes in the gas market. Modern gas measuring technology, such as a combination of calorimeter and gas analyser, offers a solution.

Quiet times are a thing of the past – this expression reminds us of supposedly better days in the past, but this is often based only on a subjective perception of the present. Nevertheless, this statement applies very tangibly today to industry sectors that are dependent on stable firing processes with high temperatures, defined air ratio, or even defined flame shapes. We are talking here about the thermal processes characteristically found in the glass, ceramics, and metallurgy industries. These industry sectors are increasingly confronted with the fact that the composition and energy-related characteristic values (gas properties) of available combustion gases are subject to fluctuation. This applies to natural gas from public supply networks as well as to process gases in steel mills and chemical parks, for example, which have mostly been flared unused up to now.

The liberalization of the natural gas market has brought significant advantages in the form of supply security and cost optimization resulting from growing competition, while introducing the disadvantage of spatially and temporally fluctuating gas properties. As a result, the days of largely constant low-grade and high-grade gases from a few sources are being supplanted by a growing number of suppliers and infeeds from predominantly renewable sources. This leads to fluctuations in the composition of the gas offered in the network and often requires correction of the gas through controlled additions to make it suitable for use in thermal processes.

The further use of process gases increases energy efficiency while reducing pollution – for example by eliminating flaring. The disadvantage of this further use is that the gas properties of the process gases can fluctuate so much, depending on their production process, that their use in subsequent processes becomes problematic. Here as well it is necessary to stabilize the gas composition through controlled addition of natural gas.

GAS MEASURING TECHNOLOGY PROVIDES ASSURANCE

An effective remedy is the integration of suitable gas measuring technology in the control systems of the gas feed. This allows timely detection of changes in the combustion gas composition so that measures for assuring process control based on control of gas additions can be taken. Combustion gases are defined by their chemical composition as well as state variables, such as density, pressure, and temperature. Key indices such as combustion value, heating value, methane number, and air requirement are derived from this. As a characteristic quantity, the "gas properties" are not derived directly from the gas composition but are described using special 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.

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, at the same nozzle pressure, without adjustments to the respective burner. The focus here is on protecting the burner from damage due to possible combustion gas variations.

A more complex situation is when the focus is not just on burner protection alone but also on the air-to-fuel ratio, which is an important process-related control value for many thermal processes. For example, this is influenced significantly by the content of alkanes (CH_4, C_2H_5, etc.) in the combustion gas because they require more air for combustion compared to the usual CO. A determination of the concentration of these components is therefore

Fig. 1: Hot-rolling mill for steel production

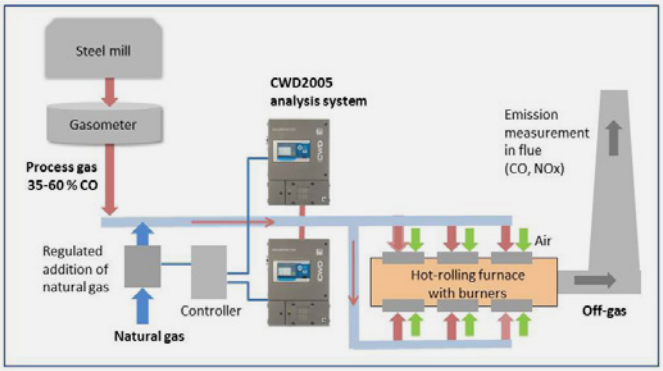

Fig. 2: Measuring setup for use of process gas in hot-rolling mill

Fig. 3: CWD2005 Calorimeter

needed for precise adjustment of the air ratio. This is possible with a gas analysis, which makes the combination of a calorimeter and a gas analyser the requisite gas measuring technology of today.

CALORIMETRY AND GAS ANALYSIS IN COMBINATION

Union Instruments, the specialist in innovative gas measuring technology for many decades, has taken these circumstances into account in its new developments. Accordingly, the modularly designed INCA gas analyser series was introduced as a complement to the proven CWD2005 combustion calorimeter, which determines the Wobbe index from the heat of combustion and the simultaneously measured gas density. The INCA modules can also be integrated directly in the calorimeter, resulting in a very powerful combination device that is especially well-suited for monitoring thermal processes. Another innovation is the combination of the CWD2005 with a gas volumetric meter and an energy converter, which enables the amount of energy delivered over a certain time interval to be determined, e.g. for accounting purposes.

USE OF PROCESS GAS IN HOT-ROLLING MILLS

A typical concept in the steel industry is to operate a hot-rolling mill adjacent to a steel mill. With energy efficiency and pollution reduction in mind, process gases from the furnace have recently started to be used in the neighbouring hot-rolling mill (**Fig. 1**) for operating the burners there.

The combustion gas properties must meet two very different requirements for this. A certain amount of excess air must be ensured in the various zones of the hot-rolling line to achieve the desired steel quality. Simultaneously, the CO concentration in the off-gas from the flue must not exceed a defined limit since the plant will otherwise be shut down automatically pursuant to the applicable Emissions Directive. The plant operator must quickly and accurately detect the changing composition of the process gas with strongly fluctuating CO content and, on this basis, add natural gas in a controlled manner to continuously meet the two requirements. This is only possible using gas measuring technology with corresponding performance capability (**Fig. 2**).

The measuring system configured for this by Union Instruments consists of two redundant CWD2005 calorimeters (**Fig. 3**) with direct-measurement capability together with integrated gas analysis and special measurement processing. The system directly determines the Wobbe index and gas density values as well as the concentrations of the CH_4 and C_2+ components of the gas. The heating value and air requirement are also calculated from this. These data are the basis for precise closed-loop control of the natural gas addition. At the same time, the higher

air requirement for combustion of alkanes compared to CO, which was mentioned previously, is also taken into account. A sufficiently fast response time of the measuring technology for the closed-loop control is also important. Special measures are needed for this due to the plant size and the mixing operations of the gases taking place in the pipe system. Union Instruments has developed a computational model for this based on delay elements that can be adapted to different plant dimensions by assigning parameters.

USE OF NATURAL GAS IN CERAMICS AND GLASS PRODUCTION

For firing porcelain and ceramics, the kiln atmosphere must meet certain conditions during passage of the fired goods to ensure high product quality: oxidating, i.e., with excess of air during heating to remove interfering hydrocarbons and other components from the fired goods, but reducing, i.e., with deficiency of air during subsequent melting of the glaze In addition, the CO content in the exhaust gas should be kept as low as possible for cost and environmental reasons. In light of the increasingly fluctuating qualities of combustion gas purchased from the natural gas network, compliance with these requirements requires a fuel/air control system with corresponding measuring technology.

The continuously operating CWD2005 combustion calorimeter has been well-proven as the measuring device in the fuel/air control loop in many installations in the porcelain industry. It determines the Wobbe index and thus the quality of the combustion gas entering the kiln – directly and with short response time control of the required kiln atmosphere by adding more or less air is thereby guaranteed. The benefit lies in the assurance of product quality and avoidance of high financial penalties due to production, or even delivery, of faulty products. Compliance with emission limits for CO is also ensured.

CONCLUSION

Liberalization of the gas market together with efforts to increase energy efficiency and decrease pollution is impacting industries that rely on thermal processes such as the glass, ceramics, and steel industries. This is due to the unprecedented fluctuations in the composition of utilized combustion gases, which is jeopardizing process flows and product quality. This situation can be remedied by the use of modern gas measuring technology that has been optimized to the application in the control system for gas additions.

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