Testo
Whitepaper

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Use of electrochemical sensors in portable exhaust gas analyzers for emission measurements in industrial applications.

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Introduction: Reasons for using gas analysis for industrial flue gases

Gas analysis (i.e. measurement technology for determining the composition of gases) is an indispensable tool for ensuring economical and safe process management in virtually all areas of industry. The focus is on combustion processes, although this is a generic term that encompasses a large number of different processes. In figure 1, the progression of a combustion process is presented in sections, beginning (left) with the input of fuel and combustion air into a combustion chamber, via the actual combustion and the different processes driven by it, to the exhaust gas cleaning and finally the emission testing.

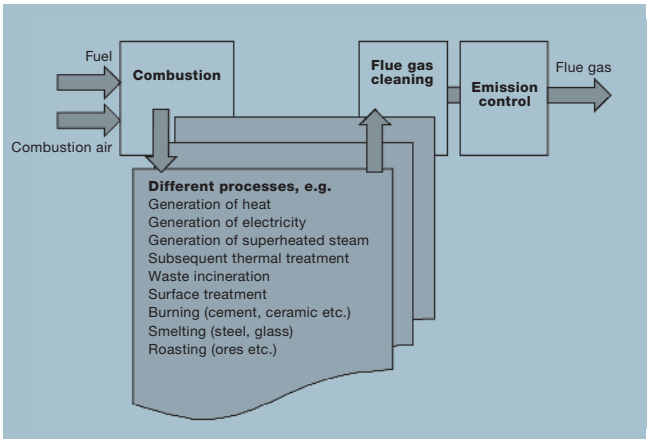

Fig. 1: Variety and procedural stages of combustion processes

Gas analysis provides information in all levels of this procedural chain on the composition of the combustion and exhaust gases, allowing the economic, safe operation of the plant, in compliance with the legal stipulations, and is thus also crucial to the quality and efficiency of production.

Gas analysis instruments are used in the analysis of combustion gases in industry in a variety of applications which are absolutely not limited to the partial area of emission monitoring alone. With a certain degree of overlapping, the following areas of application can be differentiated:

1. Setting and service work for general checking, for example after plant maintenance, for error detection in the event of unstable processes, in preparation for official measurements, following repairs etc.
2. Process measurements for the optimization of consumption, at the fuel, combustion air and burner stages, as well as in the combustion chamber, with the objective of saving fuel, improving efficiency and extending the working lifetime of the plant.
3. Process measurements for monitoring a defined gas atmosphere in the combustion chamber or in special combustion chambers or furnaces during processes such as burning, roasting, surface treatment etc.
4. Process and emissions measurements for monitoring the correct functioning of flue gas cleaning equipment.
5. Emissions measurements for monitoring compliance with limit values for pollutants in the flue gas upstream or in the chimney.

Fig. 2: testo 350 exhaust gas measurement at the engine

Fig. 3: testo 350 exhaust gas measuring instrument with flue gas probe

Use of combustion heat

In general, combustion plants are systems which exploit the heat arising from the combustion of solid, liquid or gaseous fuels for a certain purpose. In households, combustion plants are used mainly for producing heat. The possibilities for use in industrial operations are various.

Typically, combustion plants are used in industrial applications for

- Heating purposes (heating plants and building heating systems)
- Generating electrical energy
- Generating steam or hot water (e.g. use in process plants)
- Production of various materials (e.g. use in the cement, glass or ceramics industry)
- Thermal surface treatment of metallic workpieces
- Burning waste and salvaged materials (waste, used tyres etc.).

Exhaust gas/flue gas and its composition

The transformation of the primary chemical energy in the fuel into secondary thermal energy by the process of oxidation is described as combustion, during which combustion temperatures up to over 1000 °C are reached. The necessary oxygen is supplied as part of the combustion air. In combustion, a considerable volume of exhaust gas is produced as a by-product, in addition to the main product, heat. The exhaust gas is also referred to as flue gas, and contains reactive substances from the fuel and the combustion air as well as residual substances – above all dust, sulphur oxides, nitrogen oxides and carbon monoxide. In the combustion of coal, HCl and HF can be contained in the exhaust gas, and in the combustion of salvaged materials, their component substances (such as HCl and HF, but also various hydrocarbons, heavy metals etc.) are also contained in the exhaust gas.

For this reason, industrial combustion plants are equipped with extensive and often very complex exhaust gas cleaning systems such as dust filters and various flue gas scrubbers. These remmove the pollutants to a large extent from the raw gas. Raw gas is the term used to describe the flue gas in its original composition after combustion; pure gas is the exhaust gas which is emitted into the atmosphere after passing through the cleaning stages. For pure gas, the strict permitted limit values stipulated in the framework of environmental protection apply for the air pollutants such as dust, sulphur oxides, nitrogen oxides and carbon monoxide.

In Germany, the requirements are laid down individually in the 13th and 17th German Federal Immission Directive (BImSchV) and the Technical Instructions on Air Quality Control (TA Luft).

The most important flue gas components are explained next.

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