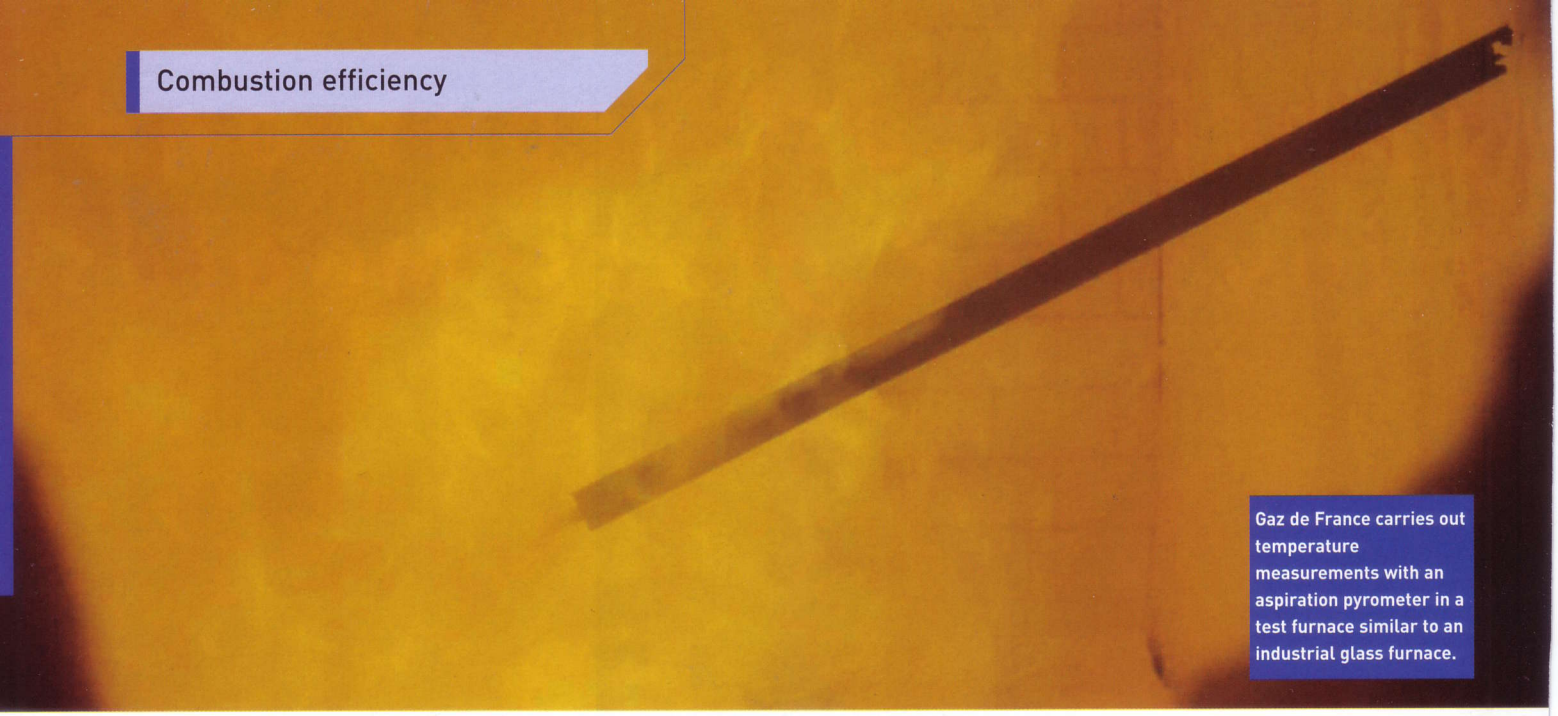

Gaz de France carries out temperature measurements with an aspiration pyrometer in a test furnace similar to an industrial glass furnace.

Measuring temperature in flames

A significant proportion of Pyro-Contrôle's* activity involves manufacturing specific sensors for the most demanding process industries. Its sensors for flame temperature measurement provide a good illustration of this knowledge. Two product families are proposed: Thin-wire thermocouples and aspiration pyrometers; both technical solutions developed by Gaz de France.

Thin-wire thermocouples have been specially designed for studying the combustion and flame temperatures of gases. This type of thermocouple uses bare wires with very small diameters (tens of microns) in the hot spot. As a result, it has no effect on the flame temperature measurement and significantly reduces measurement errors by minimising losses due to radiation and heat conduction. The small size of the hot spot means that the response times of thin-wire thermocouples are extremely fast (frequency of around 1kHz).

Applications

The main application for this product, which is manufactured under licence from Gaz de France, is temperature measurement at the heart of flames for mapping at the burner jet, in order to provide an experimental database for digital combustion modelling. The high signal acquisition frequencies also allow analysis of the fluctuations in turbulent flames.

Scientific laboratories and industrial companies use these thin-wire thermocouples to facilitate the adjustment of certain burners, as well as the development of special welding processes.

The temperature range is between +400°C and +1700°C.

Three types of thermocouples are proposed:

- type S: Pt / Pt - 10% Rh
- type B: Pt - 6% Rh / Pt - 30% Rh
- type Ir: Ir / Ir - 40% Rh

The two clips supporting the thin-wire thermocouple are made of the same material.

Output from this sensor is via a male LEMO plug.

Aspiration pyrometers

It is not easy to measure the exact temperature of a gaseous mixture. The temperature indicated by a thermocouple plunged into a gas is usually different from the actual temperature of the gas. Several factors can affect the accuracy of the temperature measured: Poor

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exchange of heat between the gas and the thermocouple's hot junction and heat loss through conduction between the hot junction and the surrounding milieu, as well as losses due to conduction of heat along the thermocouple wires.

The aspiration pyrometer is designed to eliminate these effects and give the actual temperature of a gaseous mixture. The principle involves forced aspiration of part of the hot gases around the thermocouple by means of a pump. This aspiration increases the speed of the gases on the thermocouple's hot junction, thus favouring heat exchange by convection. In addition, heat loss through radiation of the hot junction is reduced by one or more sheaths placed inside the end piece of the pyrometer.

The stainless steel body of the sensor contains the water cooling circuit and the gas aspiration circuit. The gases required for measurement are sucked in through an orifice located at the tip of the end piece. Measurement output is via a compensation cable.

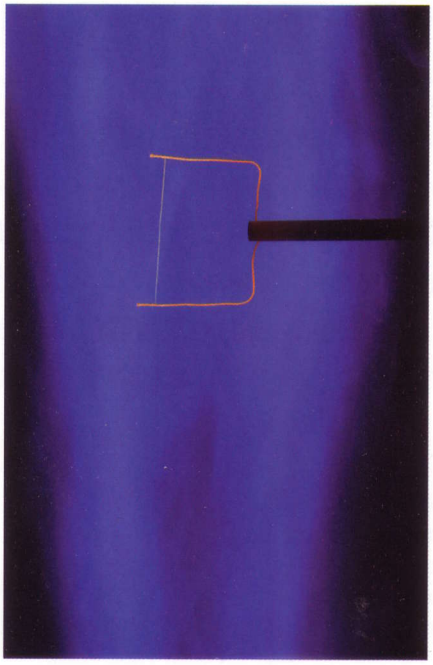
Before an aspiration pyrometer can be used, the efficiency coefficient specific to the instrument, which also depends on the gas aspiration speed, must be determined.

Three models

In practice, Pyro-Contrôle proposes three aspiration pyrometer models to meet this need for accuracy, depending on the dimensions of the furnace or stack and the temperature to be measured:

- A 'miniature' model for laboratory use, specially scaled down for extraction stacks less than 50cm in diameter.
- A 'semi-industrial' model.
- An 'industrial' model for intensive use, suitable for stacks 1 to 2m in diameter.

For detailed temperature measurements with a high acquisition frequency (monitoring over time) on industrial flames, Gaz de France has developed a technique using type S, B or Ir thin-wire thermocouples.



Several types of thermocouples are proposed, depending on the temperature to be measured: Type K up to 1100°C, type S or R up to 1500°C and type B up to 1600°C.

The removable end piece comprises two sheaths made of alumina or rhodium-plated platinum, depending on the model. It is worth noting that rhodium-plated platinum end pieces can withstand temperatures of up to 1900°C for 15 minutes.

A second 'ambient temperature' measurement output is available as an option. For laboratory applications, the miniature pyrometers are delivered with a calibration table specific to the batch of wires in order to establish the corresponding temperature/emf values for the particular thermocouple used. ■

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