Conditioning systems upgraded by HORN's extractive oxygen measurement

Glass conditioning should always be kept in mind when factoring in for melting furnace heating technologies. Here, as the team at HORN will attest, extractive measurements constitute a useful tool for stable and defined combustion, being an important parameter in glass for both quality and colour. It certainly comes in handy in the tin bath - reducing operating costs while increasing operational safety.

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After merging with Horn in 2021, Eurox's product line is now two-tiered: a directly-inserted, high temperature sensor system for oxygen measurements in glass furnace flue gas and a heated sensor system for extractive measurements. With its focus on extractive oxygen measurement in glass conditioning systems, this latter system for extractive measurements is dedicated to gas analysis for both glass conditioning and in the protective tin bath atmosphere. Founded in 1993 by Rainer

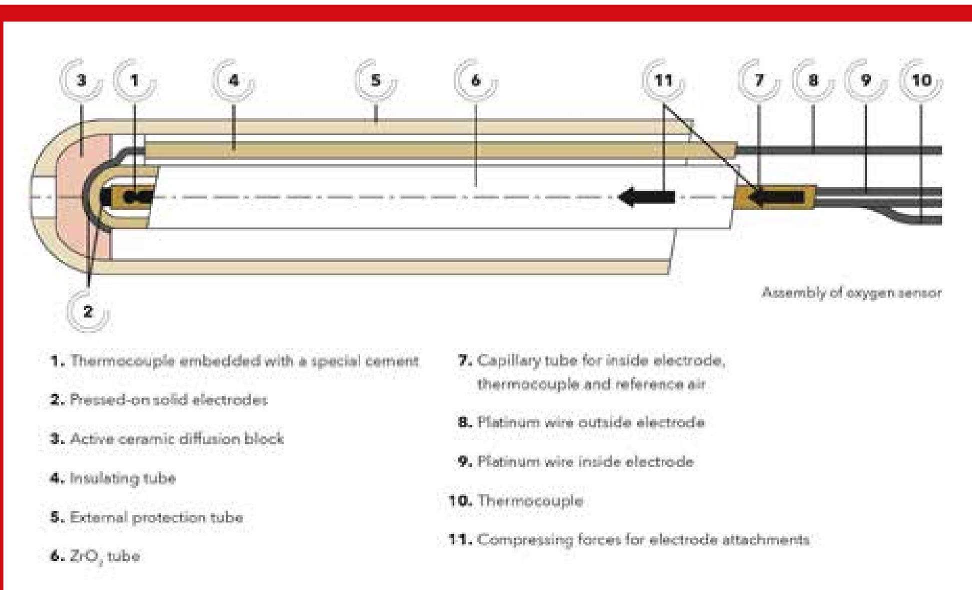


Fig.1 Assembly of oxygen sensor

Gorris in Wiesbaden, Eurox initially focused on zirconium oxide-based oxygen measurement systems. Then from 2011 onwards its products became specialised for use in the glass industry. It integrated as a subsidiary of Horn in 2014.

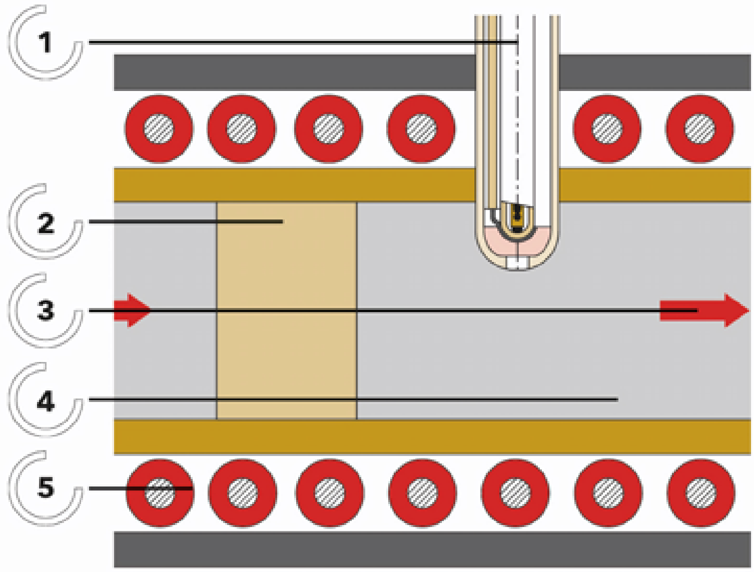
PRINCIPLE OF MEASUREMENT

The oxygen sensor setup:

The measurement of the gas to be analysed is done against reference air (ambient air). (Fig. 1).

In Eurox sensors an additional protection of the measuring cell by diffusion component is carried out. The gas is fed into the reaction chamber and catalytically decomposed at 1000 °C. The picture below shows the schematic reaction and measuring chamber. (Fig. 2).

Several measuring points -or heating zones- are connected via a valve unit with the heated sensor. So only one system is needed for up to 12 measuring points.



1. Oxygen sensor
2. Catalytic mass
3. Flow direction of the gas to be examined
4. Measurement chamber
5. Heating coil

Fig.2

$$\lambda = \frac{\text{actual air volume}}{\text{minimum air demand}}$$

Fig.3 Lambda value

REASONS FOR MEASUREMENT

The atmosphere in forehearth and distributor has a great influence on glass quality. Therefore fluctuations or even the wrong atmosphere can lead to glass defects. This is why a stable and correctly set combustion condition is important in glass conditioning. A correctly-set Lambda value is an important parameter for the combustion condition. It is a safe indicator if the combustion is under- or over-stoichiometric. (Fig. 3).

Actual air volume can be set though the minimum air demand cannot be controlled directly. Influencing factors here are the stoichiometric oxygen demand of the fuel and the O2 content provided by the oxidiser. (Fig. 4).

In practice the NG/Air mixture is often analysed with a normal hand-held O2 metre by measuring the O2 content in the mixture. Here, a Lambda value is assigned to an O2 value that originates from theoretical calculations or based on experience. So, for example it is assumed that you have a Lambda value of 1.0 at 18.9 percent O2 in your premixed gas. However, it only states that you have a gas mixture of 18.9 percent O2. The assumption is only correct if natural gas H with approx. 8600 kcal/Nm3 and a normal O2 value prevails in the air. But the first problem in practice is that the oxygen content in air is not constant at 20.9 percent. As can be seen in the below graph it depends on various factors, such as humidity. (Fig. 5).

A further problem in practice is the chemical composition of the fuel gas, which influences the air requirement and thus the combustion state. In future, greater and more frequent fluctuations in the gas composition are to be expected due to the different gas sources. (Fig. 6).

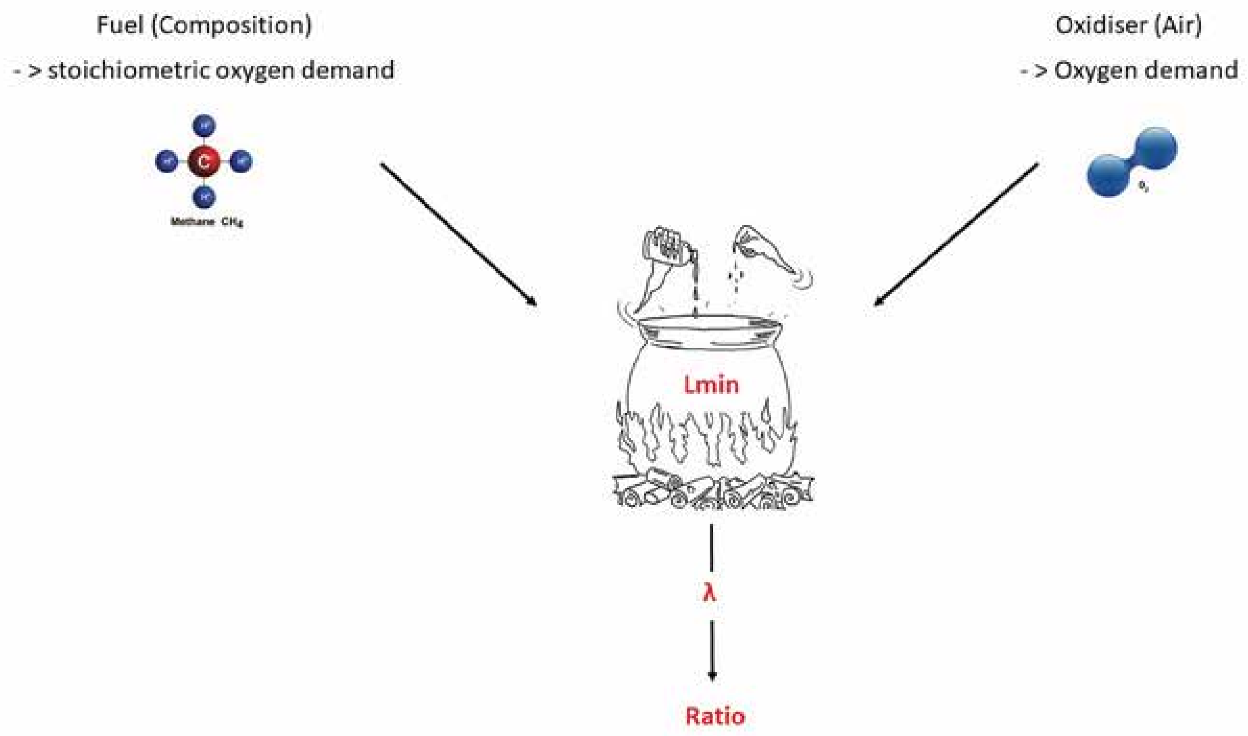


Fig.4 Factors influencing minimum air demand

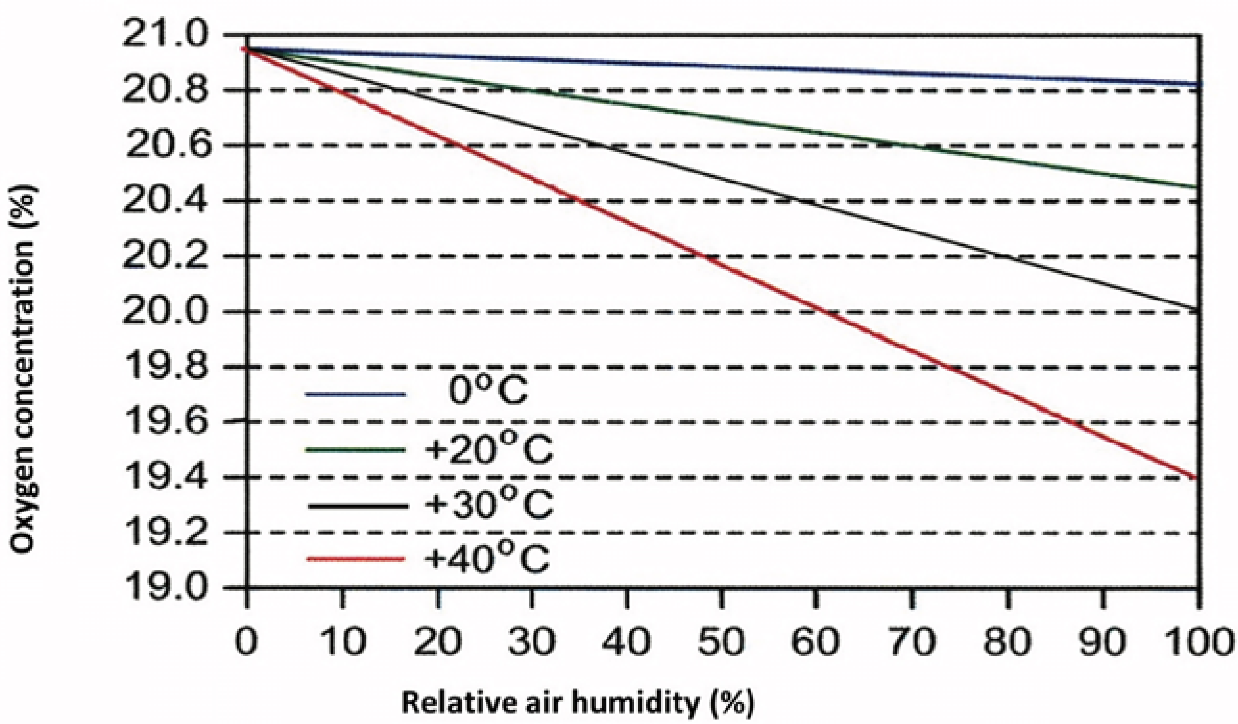


Fig.5 Change in O2 content as a function of humidity

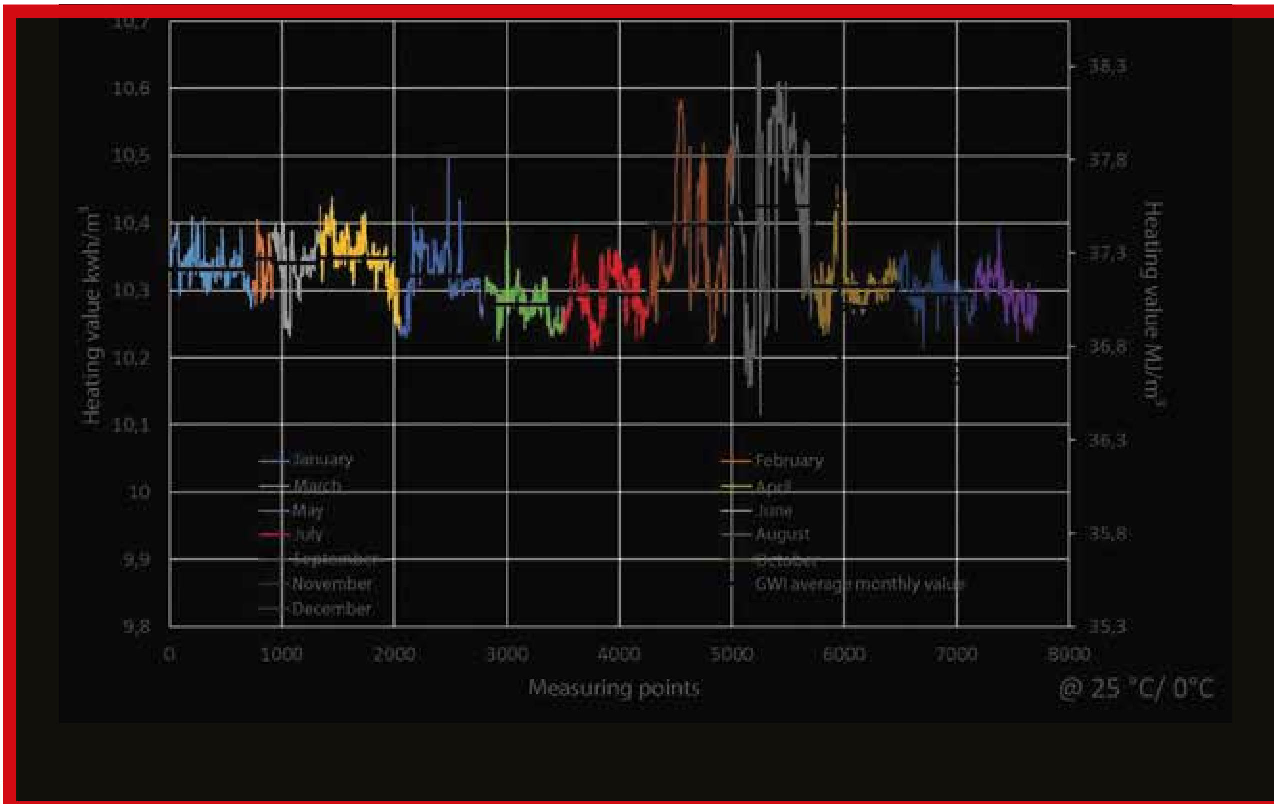


Fig.6 Example of calorific value change in Central Europe within one year

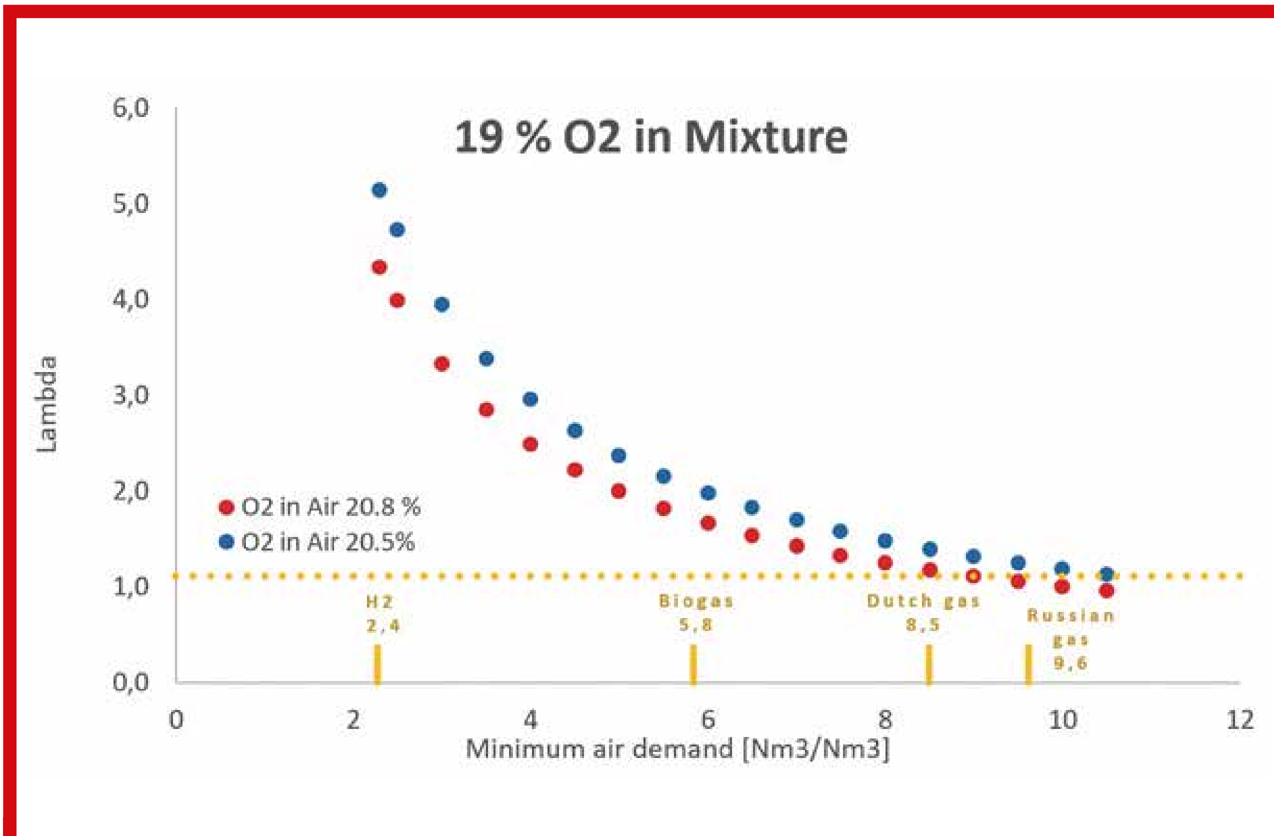


Fig.7 Influences to minimum air demand

In the following graph, the influence of the oxygen demand of the NG and the oxygen content in air to the calculated minimum air demand and to the Lambda value is shown. Also some examples for different burning gases are shown. Calculation here was carried out simply. (Fig. 7).

As can be seen here, Lambda value represents a more precise and reliable value for describing combustion condition as compared with oxygen content measurement in premixed gas alone. Determining the actual lambda value provides information about the actual combustion state of each measured zone.

MEASUREMENT SYSTEM

Each zone to be monitored is connected to the sensor via a valve unit. An integrated control unit carries out control and evaluation of the measurement system. (Fig.8).

Together with a control system, a defined and stable combustion state can be achieved. Each sensor is calibrated before shipping. A typical calibration curve of a heated sensor is shown below. (Fig. 9).

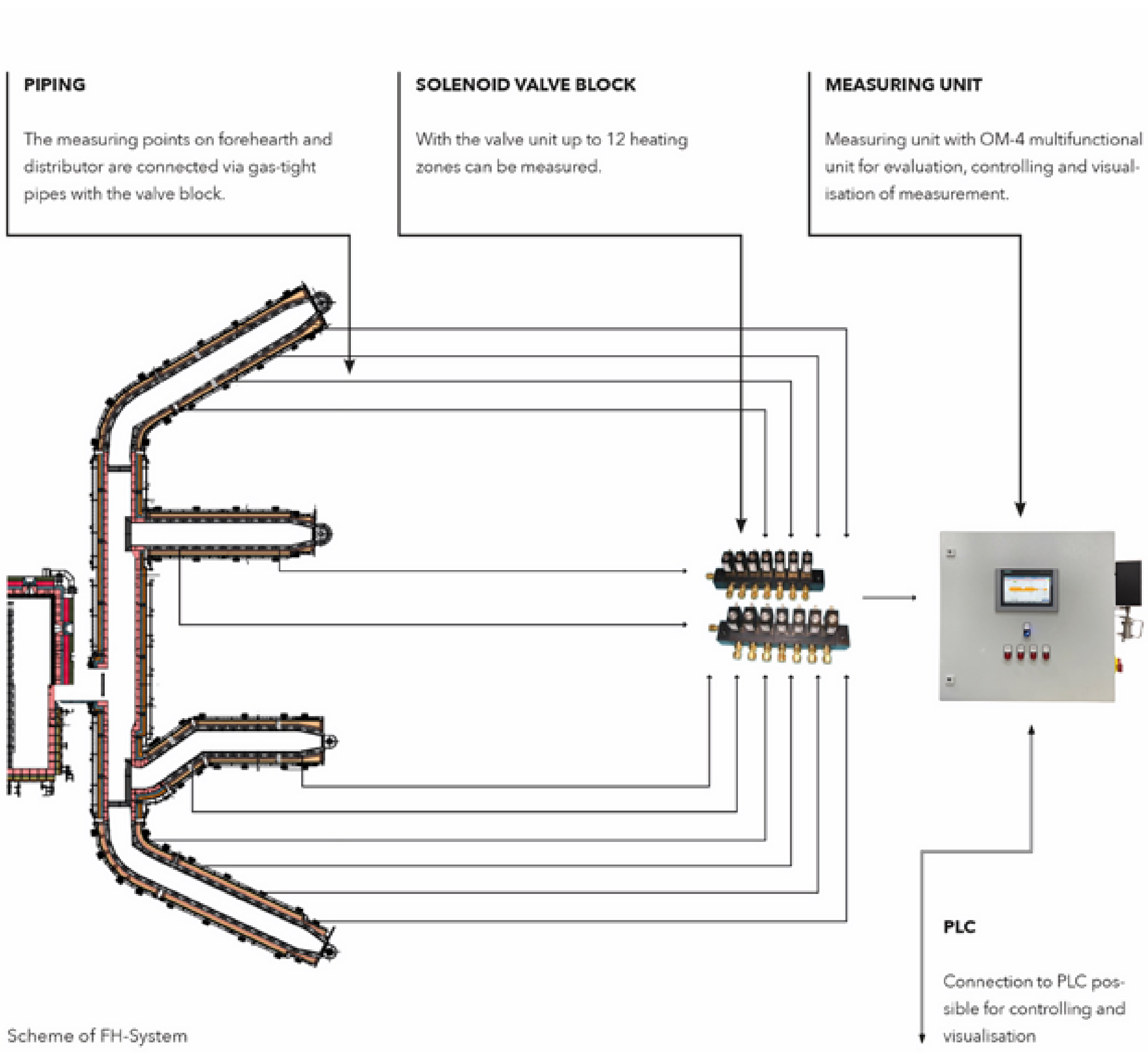


Fig.8 Extractive measurement system - conditioning system

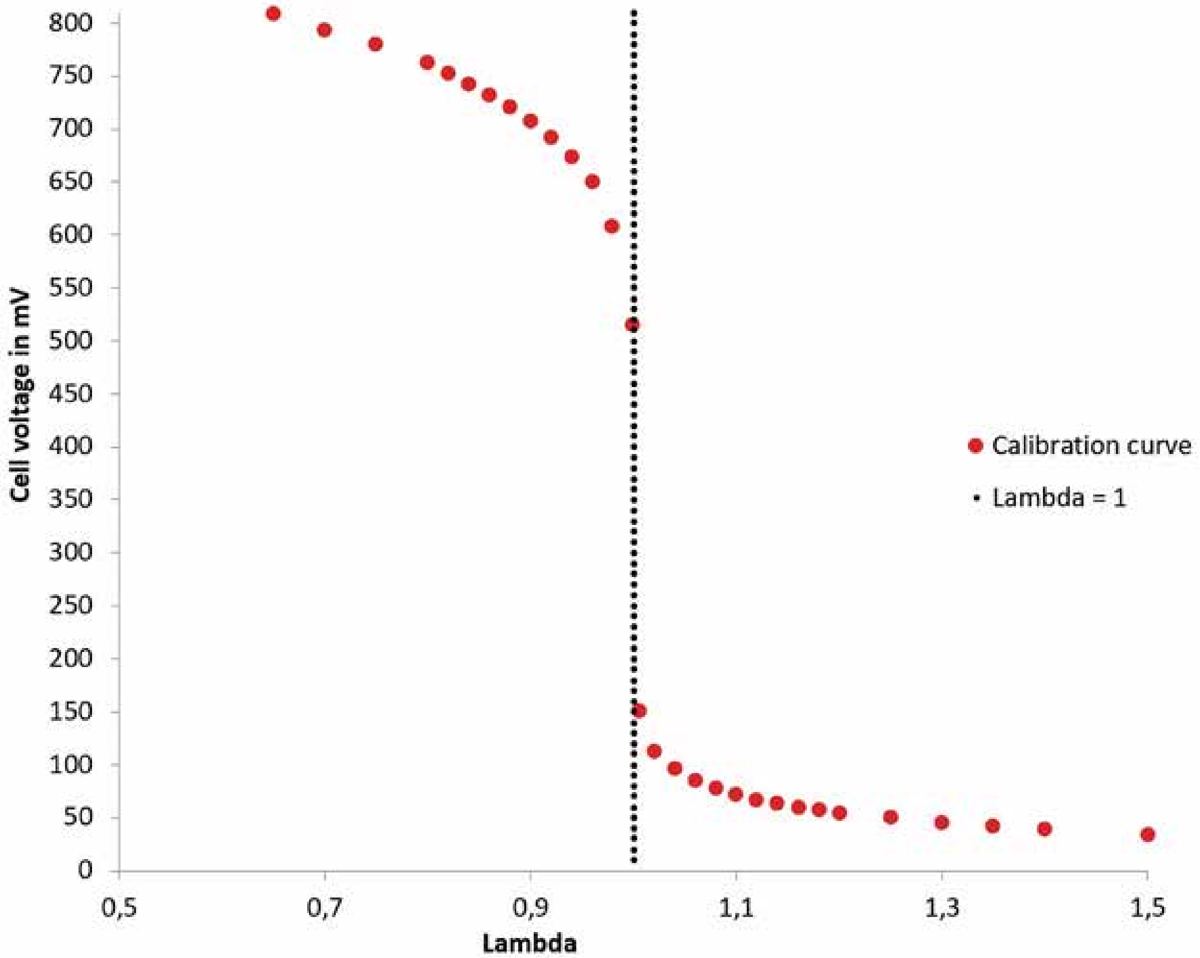


Fig.9 Calibration of heated sensor curve

Portable EpRox measurement system

Fig.10 Portable solution for extractive measurement system

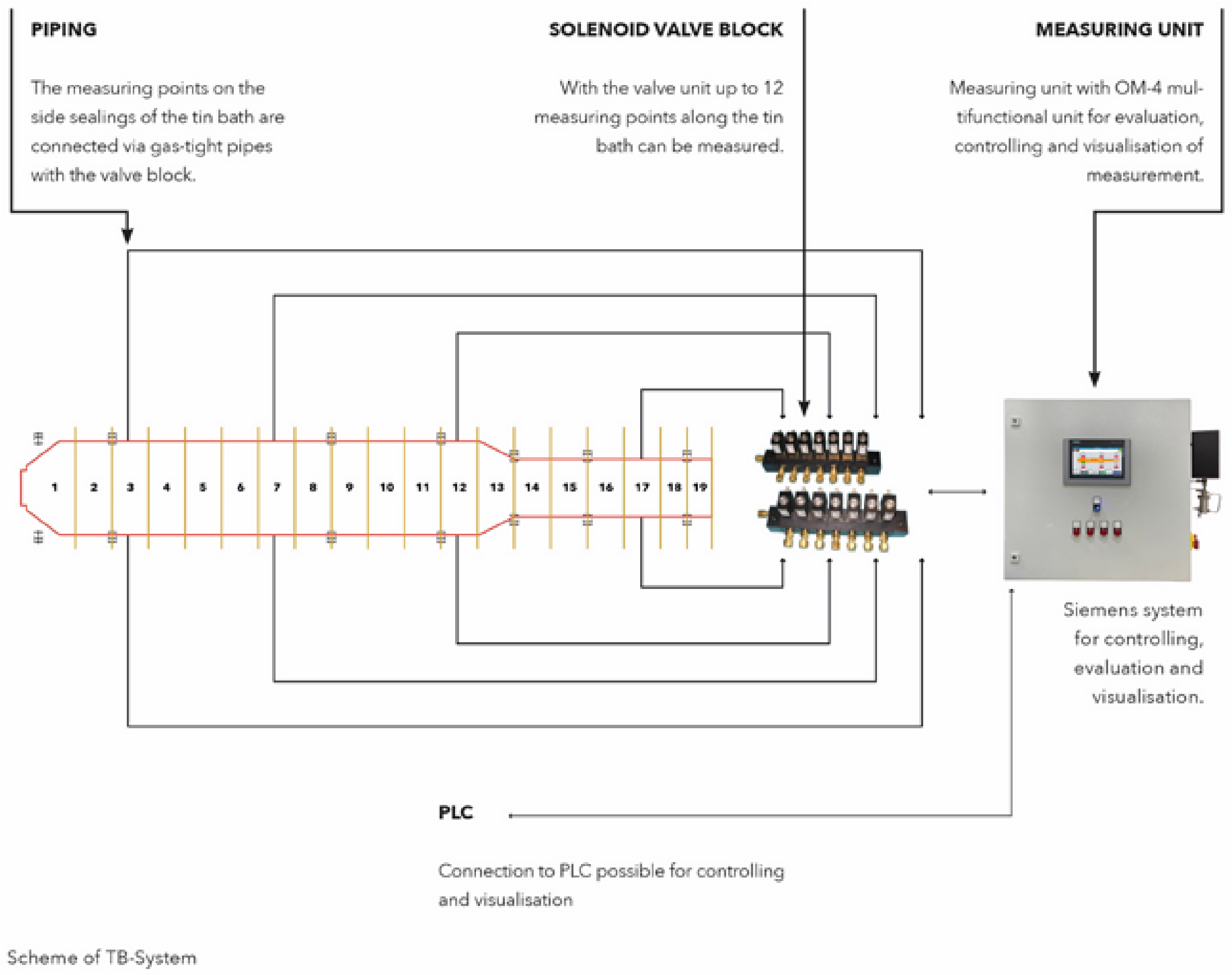


Fig.11 Extractive measurement system - tin bath

As output value the Lambda value is provided, but also the calculated O2 content in the pre-mixed gas before combustion (because of historical reasons).

PORTABLE SOLUTION FOR EXTRACTIVE MEASUREMENTS

A portable measurement unit can be used for commissioning or short-term measurements. All relevant parts for extractive measurement, as well as internal memory, are stored in a transportable box. The unit can be used on both glass conditioning systems and tin baths. (Fig. 10).

TIN BATH EXTRACTIVE OXYGEN MEASUREMENT

To prevent oxidation of the liquid tin, a protective gas atmosphere is created in the tin bath. A critical point of oxidation should not be exceeded, while a high degree of protection is negative for operating costs. This is why constant monitoring of the tin bath is essential for safe operation. The bays are connected to the valve unit at equal intervals along the left and right of the tin bath. The tin bath measurement scheme is shown above. (Fig. 11). ■

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