

Operating Handbook

METROTEC

Systems for oxygen measurement

C-Sensor

CSE, CME, CMM, CSM

Carbonsensors

*** Version 1.7 ***

EC Declaration of Conformity

for
Carbonsensors

CSE, CME, CMM, CSM

This device has been designed for industrial purposes in accordance with:

EN 61000-6-4
EN 61000-6-2

It is compliant with the directives:

EMC Directive: 2014/30/EU
Low Voltage Directive: 2014/35/EU
RoHS: 2011/65/EU

This device complies with following standards:

EN 61010-1
EN 61000-6-4
EN 61000-6-2
EN 63000

Description of measures taken to assure compliance:

Quality management system DIN EN ISO 9001:2015, No. 12 100 27736 TMS

This declaration becomes invalid if changes are made without
our consent.



Kirchheim/Teck, 07.10.2019

Place, Date

Signature

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1 Safety instructions



Please read through this operating manual very carefully before installing and commissioning the unit.

Incorrect utilisation will invalidate the guarantee!



Correct functioning and the operating safety of the unit can only be guaranteed if the ambient conditions specified in the Specifications chapter are maintained.



Only qualified specialists are permitted to commission and operate the unit. The owner of the unit must ensure that the installation complies with the relevant laws and directives. These include, for example, the EU Directives covering safety in the workplace, national safety in the workplace regulations and the prevention of accidents regulations, etc.



You must ensure that the power supplies concur with the details listed on the nameplate. All of the covers needed to ensure that the unit cannot be touched when operating must always be fitted. You must consider the effects of the overall operation and take the necessary precautions if the unit will be linked up with other equipment and/or devices before you switch on.



Parts and surfaces will occasionally become and remain hot during the installation or de-installation. Suitable precautions must be taken in order to prevent injuries or damage to the unit from occurring.



If the unit shows signs of having been damaged and you are of the opinion that that safe operation is no longer possible then you must not run the unit. We recommend that periodical inspections are carried out at our factory or by our customer service department at least once a year.



Future disposal must always comply with the legal regulations.

2 Introduction

The oxygen monitor and its accessories were subjected to constant quality control and tests in the course of their construction.

All locally applicable regulations and codes of practice should be complied with in the course of their installation and use. In Germany these particularly include VDE and DVGW codes of practice.

The function and accuracy of the measurement system needs to be checked regularly at intervals depending on the application concerned. Such a check must be effected when the system is installed and put into operation for the first time.

3 Measurement principle

Oxygen Measurement Units are designed to process signals from a stabilised zirconium oxide sensor. Zirconium oxide is a ceramic material, also characterised as a solid-state electrolyte, that has outstanding properties as an oxygen-ion conductor at high temperatures.

Within a certain temperature range, that depends on how the material is doped, such ionic conductors are able to fill the open spaces in their crystal grating with oxygen ions. The oxygen ions form on a conductive contact surface, generally of platinum, and thus the degree of oxygen activity is determined by the concentration of oxygen in the gas that is measured.

In principle, the sensor is in the form of a solid-state electrolyte that is contacted on both sides, on the one side by a reference gas such as air and on the other by the gas to be measured. The sensor is so formed mechanically that the two gases are kept apart so that there is no possibility of them mixing.

Depending on the application concerned, the sensor may be heated or unheated. Unheated sensors are chiefly used within furnaces while heated sensors are used where the gas to be measured has a temperature below 650 degrees Celsius, since the measurement principle necessitates the sensor being at a temperature of at least around 650 degrees.

Heated sensors are provided with electronic temperature regulators to keep them at a predetermined temperature. The electronically measured temperature of both heated and unheated sensors is an important factor in the calculation of the oxygen content (oxygen partial pressure).

Calculation is effected in accordance with the equation:

$$EMF = \frac{R \cdot T}{4 \cdot F} \cdot \ln\left(\frac{P_1}{P_2}\right)$$

whereby:

R	=	8.31J/mol K
T	=	Temperature in Kelvin
F	=	96493 As/mol
P ₁	=	Oxygen partial pressure on reference side at 0.20946 bar
P ₂	=	Oxygen partial pressure on the measurement gas side
EMF	=	Electromotive force in Volts

4 Construction

The sensors, that are designed for direct insertion in a hot reaction chamber, comprise a head-piece and an insertion element. The head-piece accommodates the connections for cleaning air and reference air and the electrical connections for EMF and temperature measurement. The threaded insertion element is equipped with external ceramic or metallic sheaths (electrodes).



Sensor CMM and CSM

Type	outer electrode	reference-fitting	purge-fitting
CME....	metal	¼ inch straight	¼ inch angle, brass
CSE....	ceramic	¼ inch straight	¼ inch angle, brass
CMM...	metal	quick-connector marked with „R“	quick-connector marked with „S“
CMS...	ceramic	quick-connector marked with „R“	quick-connector marked with „S“

Table: Differences of types

5 Installation

The sensors are installed in the furnace in a position that will not cause them to hinder the passage of material.

The initial installation should be effected while the furnace is cold so that location and freedom of passage can be checked, making sure that adequate allowance is made for thermal expansion.

if it should only be possible to effect initial installation in a hot furnace then the sensor should first be warmed to around 30 - 50 °C. This can be done by leaving the sensor for about one hour on a suitable hot part of the furnace.

Subsequent insertion of the sensor in the furnace should be effected at a rate of around 5 cm per minute if the temperature in the furnace exceeds 800°C.

6 Connections

6.1 Reference air

It is recommended that the sensors more than 500 mm long be fed with reference air at a rate of 30 litre per hour. The air concerned must be dry and free of oil and grease.

6.2 Cleaning air

As means of cleaning the electrodes, sensors can be supplied with cleaning air at a rate of about 50 -80 litre per hour. This air causes any soot on the electrodes to burn off and so the electrodes are cleaned. During this process, measured values must not be used for measurement purposes. Suitable steps thus need to be taken to adapt automatic control systems accordingly.

Just how often cleaning air needs to be fed will depend on the process concerned and thus needs to be adjusted accordingly.

6.3 Electrical signals

The sensors transmit a voltage (EMF) to indicate the oxygen partial pressure and the thermal current from a Type S thermocouple (Pt10PtRh) as means of temperature measurement.

It should be noted that the positive pole of the EMF is connected to the negative pole of the thermocouple and so the evaluation circuit should not be called upon to work with negative inputs.

7 Connection-plan

Sensor plug		Cable VPK-S
Pin 1	EMF -	blue
Pin 2	EMF +	orange
Pin 3	Thermocouple -	white
Pin 4	Thermocouple +	red