OPERATION MANUAL

OXYMETER - O2 concentration measurement unit
LAMBDA O₂-METER: O₂ concentration measurement unit

LAMBDA OXYMETER (O₂-METER) allows the measurement of the concentration of O₂ gas (0 - 25%) in the outgas / exit gas of the MINIFOR fermentor and bioreactor and the digital transfer of the data to the PC achieved through its RS-485 interface. The measured data can be visualized and recorded for example by the industrial fermentation software SIAM.

It does not require any additional connector, cable or side neck. Connected to the glass or Peltier outgas condenser of the MINIFOR laboratory fermentor and bioreactor, the O₂-METER measures the concentration of the O₂ in the outgas.

With SIAM industrial fermentation software, the RQ (respiratory quotient) from the OUR and CPR (obtained from LAMBDA CO₂-METER) during the fermentation process can be calculated.

LAMBDA Laboratory Instruments

LAMBDA Laboratory Instruments develops innovative, high quality lab-scale instruments with an excellent price to performance ratio for biotechnology, microbiology, food and agricultural, chemical and pharmaceutical industries, research and development as well as for general laboratory and research applications.

LAMBDA MINIFOR – highly innovative and compact fermenter/bioreactor system for laboratory scale fermentation and cell cultures

LAMBDA OMNICOLL – fraction collector-sampler for unlimited number of fractions

LAMBDA PRECIFLOW, MULTIFLOW, HIFLOW, MAXIFLOW AND MEGAFLOW peristaltic pumps – reliable, precise and extremely compact

LAMBDA SAFETY POWDER DOSER AND HI-DOSER – allows automatic feeding of powders without spoon. Safe operation with hazardous material (GLP)

LAMBDA VIT-FIT (HP) polyvalent syringe pump with extremely robust mechanics – programmable infusion and filling from micro syringes to large volume syringes of 150 ml without adapter

LAMBDA MASSFLOW – precise gas flow measurement and control with data acquisition option

LAMBDA PUMP-FLOW INTEGRATOR – with LAMBDA pumps and doser allows the visualization and recording of the pumped volume
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1 SETTING UP THE O₂-METER

1.1 Power supply

The LAMBDA O₂-METER is powered by MINIFOR Fermentor-Bioreactor. The O₂-METER is connected with the corresponding 8-pole remote control cable (art. no. 4810) to the “PUMP” - socket at the rear of the MINIFOR laboratory fermenter-bioreactor.

The other end of the 8-pole remote control cable (art. no. 4810) is plugged into the “REMOTE” - socket at the rear of the O₂-METER.

When used independently of the MINIFOR laboratory bioreactor-fermentor, a universal plug-in power supply (100-240 V AC/50-60 Hz, 12 VDC, 12 W) is used (art. no. 4820).

Connected to the power supply, all LEDs and the display of the O₂-METER light shortly. This allows a function control of all signal elements.

1.2 Measurement of O₂ concentration in the outgas / exit gas

The gas tubing from the outgas / exit gas condenser (glass or Peltier outgas condenser of MINIFOR fermentor-bioreactor) is connected to the IN nozzle at the rear of O₂-METER to measure the concentration of O₂ (0-25%).

The concentration of O₂ in the outgas / exit gas can be measured in terms of 0 - 9.99% and 10.0 - 25%.

The gas tubing from the OUT nozzle of O₂-METER can be connected to the other gas concentration measurement instruments like CO₂-METER, CH₄-METER (IN nozzle) or measure total gas flow with a MASSFLOW gas flow meter.

1.3 Control panel of O₂-METER

The O₂-METER also measures the total pressure, O₂ partial pressure and the temperature (T) of the outgas / exit gas.

The control panel of the O₂-METER displays:

- O₂ concentration of the measured outgas and the LED of O₂ [%] button is switched ON
- Total pressure of the measured outgas in terms of mbar (500 - 1200 mbar), when the button P [mbar] is pressed
- O₂ partial pressure (ppO₂) of the measured outgas in terms of mbar (0 - 250 mbar), when the button O₂ [mbar] is pressed
- Temperature of the measured outgas is displayed in terms of degree Celsius (0 – 60.0 °C), when the button T [°C] is pressed
### 1.4 Overview of O₂-METER connections

**Table 1** Connection overview of O₂-METER: Stand-alone instrument, with MINIFOR fermentor-bioreactor or PC software

<table>
<thead>
<tr>
<th></th>
<th>O₂-METER (stand-alone)</th>
<th>O₂-METER with MINIFOR</th>
<th>O₂-METER with PC software</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remote control</strong></td>
<td>-</td>
<td>Pump remote control (analog and digital) cable (8 poles)</td>
<td>-</td>
</tr>
<tr>
<td><strong>RS-interface</strong></td>
<td>-</td>
<td>RS-485 interface (incorporated with O₂-METER)</td>
<td>RS-485 interface (incorporated with O₂-METER)</td>
</tr>
<tr>
<td><strong>PC connection</strong></td>
<td>-</td>
<td>Please refer MINIFOR operation manual</td>
<td>USB or serial port</td>
</tr>
<tr>
<td><strong>MINIFOR connection</strong></td>
<td>-</td>
<td><strong>PUMP</strong> - socket at the rear of MINIFOR control unit</td>
<td>-</td>
</tr>
<tr>
<td><strong>1. REMOTE</strong> (rear of O₂-METER)</td>
<td>-</td>
<td>o Connect one end of 8-pole remote control cable to the <strong>PUMP</strong> - socket at the rear of the MINIFOR control unit</td>
<td>o Connect the <strong>RS-485 connection kit</strong> to the PC with the help of the USB connector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Other end of the 8-pole remote control cable to <strong>REMOTE</strong>-socket at the rear of O₂-METER</td>
<td>o Plug-in the other end of the connection kit (RS-485 connection cable) to the <strong>REMOTE</strong> socket of O₂-METER</td>
</tr>
<tr>
<td><strong>2. POWER</strong> (rear of O₂-METER)</td>
<td>o Plug the connector of power supply cable into the <strong>POWER</strong> - socket (12 V) at the rear of O₂-METER</td>
<td>-</td>
<td>o Plug the connector of power supply cable into the <strong>POWER</strong> - socket (12 V) at the rear of O₂-METER</td>
</tr>
<tr>
<td></td>
<td>o Universal plug-in power supply (100-240 V AC/50-60 Hz, 12 VDC, 12 W) to mains</td>
<td>o Universal plug-in power supply (100-240 V AC/50-60 Hz, 12 VDC, 12 W) to mains</td>
<td></td>
</tr>
<tr>
<td><strong>3. IN nozzle</strong> (rear of O₂-METER)</td>
<td>Connect the gas tubing from the <strong>outgas</strong> / <strong>exit gas condenser</strong> to the <strong>IN nozzle</strong> of O₂-METER and secure it with clamps</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4. OUT nozzle</strong> (rear of O₂-METER)</td>
<td>Connect tubing to the <strong>OUT nozzle</strong> of O₂-METER to lead the measured gas to CO₂-METER / CH₄-METER / measure total gas flow or others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 PC CONTROL & SOFTWARE

The measured O₂ outgas concentration data can be visualized and recorded, for example by the industrial fermentation software SIAM.

2.1 Setting up the address of O₂-METER

To look up/modify the instrument address:

- Disconnect the 8-pole remote control cable from O₂-METER (when used together with the MINIFOR fermentor-bioreactor) or the power supply (stand-alone or PC)
- Press the O₂ [%] button continuously and at the same time connect the 8-pole remote control cable to O₂-METER (when used together with the MINIFOR fermentor-bioreactor) or the power supply (stand-alone or PC)
- The message “A” and two numbers will appear on the display. This number from 00 to 99 is the current address of the O₂-METER
- To change the address, press the buttons Λ Λ Λ under the display until the desired number is obtained.
- To confirm and save the address, press the OK button.

2.2 PC connection

O₂-METER with PC software: O₂-METER with the RS-485 connection kit (includes: RS-485 connection cable, RS-232/485 converter, Power supply for RS-232/485 converter and USB to RS-232 converter) is connected to the USB port of the PC (when used independently of MINIFOR fermentor-bioreactor) for the control by software.

O₂-METER with MINIFOR: O₂-METER is connected to the “PUMP” – socket at the rear of MINIFOR fermentor-bioreactor. MINIFOR fermentor-bioreactor is connected to the SIAM industrial fermentation software with the help of PC connection kit.

2.3 SIAM industrial fermentation software

The SIAM industrial fermentation software is intended for the automation of fermentation and cell culture processes at laboratories.

When used together with MINIFOR fermentor-bioreactor, the SIAM industrial fermentation software allows to calculate the RQ (respiratory quotient or respiratory coefficient) from the OUR (Oxygen Uptake Rate) and CPR (obtained from LAMBDA CO₂-METER) during the fermentation process.
3 CALIBRATION PROCEDURE FOR THE O₂-METER

The O₂ concentration can be calibrated on the LAMBDA OXYMETER (O₂-Meter). The calibration is a two-point calibration consisting of zero-setting and sensitivity setting:

3.1 Zero setting

Connect a source of nitrogen (N₂) gas to the OXYMETER input barb. The gas flow rate should be around 200 ml/min.

Unplug the power supply and continuously press the ▲ button located below the lowest order digit of the display and reconnect the power supply.

The display shows “NUL” and a value, which is gradually stabilizing and approaching zero.

When the reading is stable, press button P [mbar]. The value of the display is saved, the display shows “0.00” and the OXYMETER is switched to operation mode. The saved value is subtracted from the value measured by the sensor, thus correcting the zero setting. This correction applies to both parameters, the concentration O₂ [%] and the partial pressure O₂ [mbar].

If you do not want to save this new zero setting, disconnect the power supply and reconnect it again (without pressing any button). The zero value is now corrected by the setting that was previously stored in the memory.

If you want to disable the zero setting, unplug the power supply and continuously press the ▲ button located below the lowest order digit of the display and reconnect the power supply.

End the calibration mode by pressing simultaneously the buttons T [ºC] and O₂ [mbar]. By doing this the value zero is saved in the memory and the actual sensor value is displayed in operation mode.

3.2 Sensitivity setting

Connect a source of air to the OXYMETER input barb. The gas flow rate should be around 200 ml/min.

Press the O₂ [%] button. The display will stabilize with the actual value of oxygen concentration. After the actual value of oxygen concentration has stabilized the correction factor can be calculated as the ratio between the real oxygen concentration (e.g. 21.0 %) and the actual measured oxygen concentration.

Unplug the power supply and continuously press the ▲ button located below the highest order digit of the display and reconnect the power supply.

The display shows “SLP” and then the value of the correction factor. Use the ▼ buttons under the display to set the desired value of the correction factor and press button P [mbar]. The correction factor is saved, the display shows the actual O₂ concentration and the OXYMETER is switched to operation mode.
4 TECHNICAL SPECIFICATIONS

4.1 General specification

Type: LAMBDA OXYMETER O₂ concentration measurement (0-25%)
Accuracy: ± 2%
Measurement range:
- O₂ concentration: 0 – 9.99 % and 10.0 – 25.0%
- Total pressure: 500 – 1200 mbar
- O₂ partial pressure: 0 – 250 mbar
- Temperature: 0 – 60.0 °C
Interface: RS-485
Power supply: 90–240 V/50–60 Hz AC plug-in power supply with DC 12V/12W output
Dimensions: 10.5 (H) x 8 (W) x 17 (D) cm
Weight: 0.6 kg
Safety: CE, meets IEC 1010/1 norm for laboratory instruments
Operation temperature: 0–40 °C
Operation humidity: 0-90% RH, not condensing

For safety reasons the voltage of the external signal must not exceed 48 V to earth!

5 ACCESSORIES

<table>
<thead>
<tr>
<th>Art. No.</th>
<th>Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>4817-kit</td>
<td>RS-485 connection kit (for connection to a serial port or USB port)</td>
</tr>
<tr>
<td>4810</td>
<td>Pump remote control (analog and digital) cable, 8 poles connector</td>
</tr>
<tr>
<td>800202</td>
<td>Quadruple plug box (power and RS-connection for up to 4 LAMBDA laboratory instruments)</td>
</tr>
<tr>
<td>4820</td>
<td>Plug-in power supply (12 V / 12 W) [Plug-type: AU, CH, EU, UK, US]</td>
</tr>
<tr>
<td>4815</td>
<td>Silicone tubing 3/5 mm (10 m)</td>
</tr>
<tr>
<td>800202</td>
<td>Quadruple plug box (power and RS-connection for up to 4 LAMBDA laboratory instruments)</td>
</tr>
<tr>
<td>800083</td>
<td>Electronic Peltier air output condenser (no water connection required)</td>
</tr>
<tr>
<td>8080</td>
<td>OXYMETER (O₂-METER) O₂ concentration measurement (0-25%)</td>
</tr>
<tr>
<td>8081</td>
<td>CARBOMETER (CO₂-METER) CO₂ concentration measurement (0-100%)</td>
</tr>
<tr>
<td>8082</td>
<td>METHAMETER (CH₄-METER) CH₄ concentration measurement (0-100%)</td>
</tr>
</tbody>
</table>
6 GUARANTEE

LAMBDA provides a two-year guarantee on material and manufacturing defects, if the instrument was used according to the operation manual.

Conditions of guarantee:

- The instrument must be returned with a complete description of the defect or problem. In order to send back the equipment for repair, you will need a returns authorization number from LAMBDA.
- The customer will send the instrument to our service office.
- Damage or loss of items during transport will not be compensated for by LAMBDA.
- Failure to fulfil these requirements will disqualify the customer from compensation.

Serial Number: _______________________________
Guarantee from: ______________________________

7 APPENDIX

7.1 RS communication protocol of LAMBDA CO₂-METER AND O₂-METER

7.1.1 Communication settings:

- Speed: 2400 Baud
- Data format: 8 bit, odd parity, 1 stop bit
- Transmit-Receive switching: DTR (usually automatic switching)
- Transmit-Receive interval: 10 ms

7.1.2 Data format for transmission from the computer (master):

# ss mm z qs c send data

where:

ss is the address of the slave receiver
mm is the address of the transmitter (master)
z command
qs Checksum
c carriage return CR (ASCII 0D)
7.1.3 Commands for CO₂-METER

#ssmmKqsc  send concentration of CO2 [%]
#ssmmHqsc  send humidity value [%]
#ssmmTqsc  send temperature [°C]
#ssmmGqsc  send the measure value of the concentration of CO2 [%]
#ssmmVqsc  send the measure value of the concentration of CO2 [%]

* Commands G and V allow MASSFLOW simulation in SIAM

7.1.4 Commands for O₂-METER

#ssmmKqsc  to send the value of the concentration of O₂ [%]
#ssmmOqsc  to send the value of O₂ partial pressure [mbar]
#ssmmPqsc  to send the value of the total pressure [mbar]
#ssmmTqsc  to send value of temperature [°C]
#ssmmGqsc  to send the measure value of the concentration of O₂ [%]
#ssmmVqsc  to send the measure value of the concentration of O₂ [%]

* Commands G and V allow MASSFLOW simulation in SIAM

7.1.5 Data format for transmission to the computer (master):

<mm ss a xxxx qs c

where:

a      indicator variables (1 character ASCII)
xxxx    data (4 ASCII number 0......9 - transmission from high to low)
qs      checksum in hexadecimal format (2 ASCII symbols 0......9 A B C D E F)
c      carriage return CR (ASCII 0D)

<mmssKxxxxqsc  value of O₂ or CO₂ concentration (xx.xx) [%]
<mmssOxxxxqsc  value of the partial pressure of O₂ (xxx.x) [°C]
<mmssPxxxxqsc  value of the total pressure (xxxx) [mbar]
<mmssTxxxxqsc  value of temperature (xxx.x) [°C]
<mmssHxxxxqsc  value of humidity (xx.xx)

Simulation of MASSFLOW in SIAM (commands G and V):

<mmssrxxxxqsc  value of the concentration of O₂ or CO₂ (xx.x) [%]
7.2 Remote control and RS-connection scheme

The 8-pole DIN connector “REMOTE” is used for the remote control and RS-485 connection.

<table>
<thead>
<tr>
<th>No.</th>
<th>Colour</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>yellow</td>
<td>(+) input remote speed control 0-10V *)</td>
</tr>
<tr>
<td>2</td>
<td>grey</td>
<td>not used</td>
</tr>
<tr>
<td>3</td>
<td>green</td>
<td>earth, 0 V</td>
</tr>
<tr>
<td>4</td>
<td>brown</td>
<td>+ 12 V</td>
</tr>
<tr>
<td>5</td>
<td>white</td>
<td>(+) input remote ON/OFF; 0V = ON, 3–12 V = OFF (this logic can be inversed on demand)</td>
</tr>
<tr>
<td>6</td>
<td>pink</td>
<td>earth, ground (GND)</td>
</tr>
<tr>
<td>7</td>
<td>red</td>
<td>RS 485 B (-)</td>
</tr>
<tr>
<td>8</td>
<td>blue</td>
<td>RS 485 A (+)</td>
</tr>
</tbody>
</table>

*) (zero line connected to the contact no. 3)