ecom®

Creative technology made by rbr

Operating Instructions

ecom® • KD •

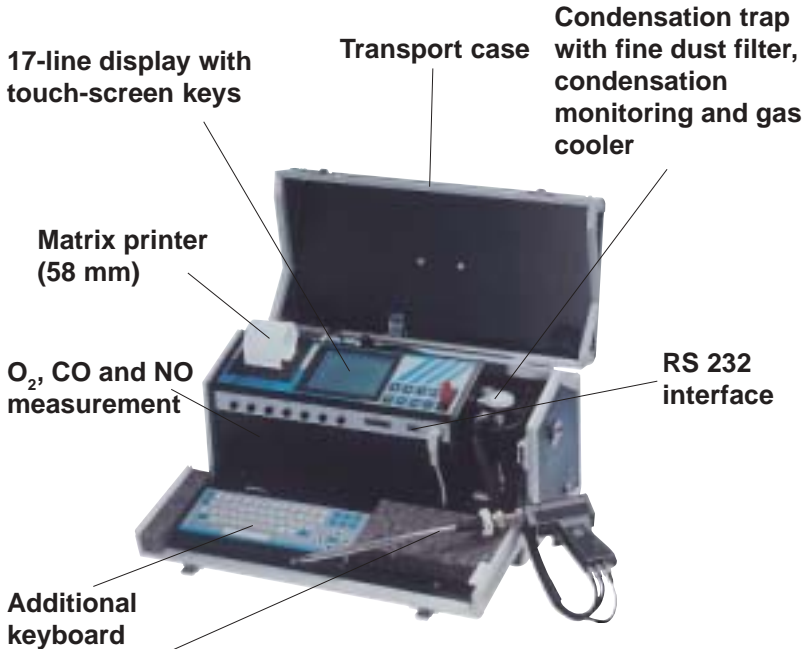# Index   Page

1. Introduction

The **ecom-KD** is a combination instrument for the analysis of the exhaust components and for the evaluation of further parameters describing the combustion process. Automatic condensation monitoring and of course those parameters required by oil and gas firing analysis belong to the standard equipment of the **ecom-KD**.

The present manual describes the simple operation of the instrument. Please read it carefully to get familiar with the instrument and use it troublefree. Please also pay attention to the service and maintenance tips.

We wish you a satisfying work anytime with the **ecom-KD** and much success in your daily job.

Your rbr Messtechnik GmbH

2. Equipment ecom-KD

17-line display with touch-screen keys

Transport case

Condensation trap with fine dust filter, condensation monitoring and gas cooler

Matrix printer (58 mm)

O_2, CO and NO measurement

RS 232 interface

Additional keyboard

Standard probe :
- suitable for combined gas, draft and losses determination
- insertion depth probe pipe 290 mm
- external diameter probe pipe 10 mm
- coaxial version
- with NiCr/Ni thermocouple (T-Gas$_{max.}$ = 500 °C)
- 3-chamber hose (length 3 m)
- fixation cone

Optional features (available also as upgrade):

CO% measurement
NO_2 measurement
SO_2 mesurement
Heated sampling system

Accessories ecom-KD

Undercase Item nr.: 52784 full height	**Data cable** Item nr.: 53532 *without picture*
Adapter cable USB / RS 232 Item nr.: 52162 *without picture*	**NOx hose** **(soot probe)** Item nr.: 10177 (3,5 m) 30001188 (5 m)
NOx hose (probe without **soot measurement)** Item nr.: 30002193 (3,5 m) 30002213 (5 m)	**Heated sampling system** Item nr.: 7000288
Filtering case **(solid** **combustibles)** Item nr.: 55810	**Gas washing** **bottle (only with** **peltier cooler)** Item nr.: 5044043
T-room stick Item nr.: 51446	**Presure sensor** Item nr.: 52730 (Gas 0-70 hPa) 52528 (Gas 0-1000 hPa) 52518 (Oil 0-35 bar)
Temperature sensor Item nr.: 10163 (Room sensor) 10172 (Contact sensor) 10173 (Dipping sensor) *ohne Abbildung*	**Additional cable line** **temperature sensor** 3 m Item nr.: 10171 7 m Item nr.: 20012077 12 m Item nr.: 20012078 17 m Item nr.: 20012079 *ohne Abbildung*

3. Instrument Design

Keys functions

Scroll Up cursor	Start draft measurement	Store values	Quit menu level
▲	Zug	M	Menü
▼	Ruß	Print	E
Scroll Down cursor	Start soot measurement	Printout	Confirm input

Connections for 2 additional sensors

Connections for 5 additional temperature sensors

Keyboard connection

RS 232 connection

Printer connection

Front view

Draft connection

Fresh air connection

Gas temperature connection

Sucking temperature connection

Ejector for RAM card

ON/ OFF switch

RAM card slot

Back view

Condensation pump

Sampling gas connection

SO_2 /NO_x filter

Heated sampling system connections

ecom-KD

4. Instrument Switch-on

Perform all necessary connections if need be and insert the electronic key inserted in the instrument.

After instrument switch-on, a 3-minute calibration phase starts and the main menu is displayed. It shows 6 sub-menus with the following functions:

ecom-KD

→ Gas analysis
Diagnosis
Data logger
Basic data
System
Press. check
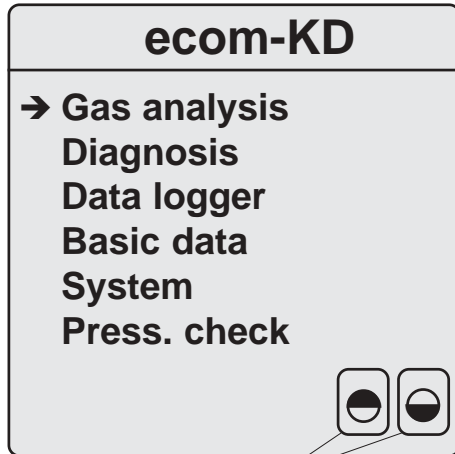
Display contraste adjustment

- Gas analysis   : Perform gas analysis
- Diagnosis   : Process weak points analysis for heating plants
- Data logger   : Record measurement series
- Basic data   : Input and process customer data
- System   : Modify instrument´s adjustments
- Pressure check   : Perform tightness check at gas pipes

Instruments fitted with the option „CxHy measurement" display additionally the function „Auto-Zero" which allows to zero the CxHy sensor during operation. This should be done at regular intervals.

For gas analysis, move the cursor on the line **"Gas analysis"** and press the key **<E>**.

5. Flue Gas Measurement

5.1. Gas analysis

Once the probe type suitable for the measurement application has been selected, fix it at the measurement point and position the temperature sensor for the sucking air.

Connect, respectively, check the correct connection of all tubing and plug connectors at the probe and at the instrument.

If need be, connect a tube at the fresh air inlet for external fresh air. Also care for a collection solution for the condensation pumped out which outlet is located on the right bottom part of the transport case.

Once the 3-minute calibration phase is over, the instrument automatically enters the measurement operation. The gas path in the instrument is switched from "Fresh air" to "Gas". By selection of the sub-menu **„Gas analysis"** the display shows the fuel types selection.

The following fuel types can be selected:

Fuel types 1st BImSchV:
Fuel oil (B)
Natural gas (B)
City gas (B)
Coke oven gas (B)
Liquid gas (B)
(Other fuel types on request)

Move the cursor on the desired fuel type and press **<E>**.

Fuel types	CO2m	A1
→ Fuel oil (B)	15,4	0,50
Nat. gas (B)	11,8	0,37
City gas (B)	11,7	0,35
Coke oven (B)	10,2	0,29
Liquid gas (B)	14,0	0,42

The next display window enables a boiler temperature input as reference value (input via touch screen or keyboard).

Press **<E>** after this input. The display now shows the measured and calculated values on 4 display pages (use the cursor keys to scroll the pages).

Gas analysis		
O2	3.2	%
CO2	13.1	%
CO	12	ppm
NO	52	ppm
NO2	10	ppm
NOx	62	ppm
T.Gas	184	°C

Gas analysis		
O2	3.2	%
CO2	13.1	%
Eff.	92.5	%
Losses	7.5	%
Exc. air	1.18	
T.Air	17	°C
Dew point	49	°C

CO switch-off

CO check		
O2	17.5	%
CO	738	ppmN
CO	123	ppm
Exc. air	7.00	

ecom-KD		
T-Run in	73	°C
T-Run out	45	°C
T-Ext.	-2	°C
T-Room	22	°C
T-Free	10	°C
Gas pres.	19.50	hPa
Oil pres.	15.0	bar

Please observe:
1.) Make sure to perform the measurement in the stream core of the exhaust channel. This is point with the highest T-Gas value.

2.) Correct measurement values are displayed first after a while, necessary for the gas transport and the build-up of a stable electrochemical reaction to the sensors. This delay may amount ca. 1 to 1.5 minute. Wait for the values to be stable before recording, protocolling or evaluating anything. If the gas values keep fluctuating more than 2 ppm, so the reason for can be an unstable draft behaviou inside the exhaust channel which provides with an inconstant core stream. The draft value may give a final answer: if the value strongly fluctuates or if it is far beyond - 0,20 hPa, then the correct measurement is influenced.

3.) CO_2, efficiency, losses, excess air and the dew point are calculated values. They can only be determined when realistic measurement values for the basic parameters like O_2 and the temperatures are available.
The following must be ascertained:

$$O_2 < 20,5 \% \qquad \text{and}$$
$$\text{T-Gas - T-Air} > + 5 \text{ °C}$$

The dew point can only be calculated accurately if in the sub-menu **"System / Adjustments / Conversions"** the current barometric air pressure is inputed. The instrument cannot measure this value.

Once the values are stable and the results can be recorded, press **<M>** to transfer the values in the intermediate memory (**please note:** store separately the values for gas analysis, CO check and for the external sensors). They will be stored for a later printout and, if need be, for a final data record storing.

| Gas analysis	m
O2	3.2 %
CO2	13.1 %
Eff.	92.5 %
Losses	7.5 %
Excess air	1.18
T.Air	17 °C
Dew point	49 °C

5.2. Differential Pressure Measurement

The draft value is not stored while pressing **<M>** as the differential pressure sensor easily tends to drift because of its sensitivity. To obtain an exact measurement value, it is consequently recommended to calibrate this sensor just before documenting the value.

Start the differential pressure measurement while pressing **<Zug>**. The display shows the current value as well as the information to zero the sensor. Hereto release the draft tubing from the instrument (3-groove connector) and press **<E>**. The sensor is herewith re-calibrated.

Re-fix the draft tubing. The display shows the exact measurement value which can be stored while pressing **<M>** and also added to the values already stored in the intermediate memory. The stored value is shown on the display.

Quit the differential pressure measurement while pressing **<Menü>**.

ecom-KD
Draft **-0.10 hPa**

ecom-KD
Draft   **m** **-0.10 hPa**
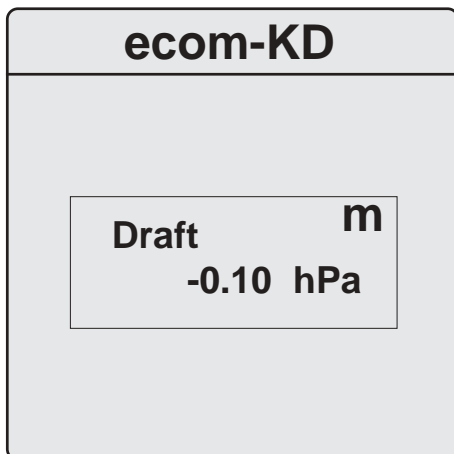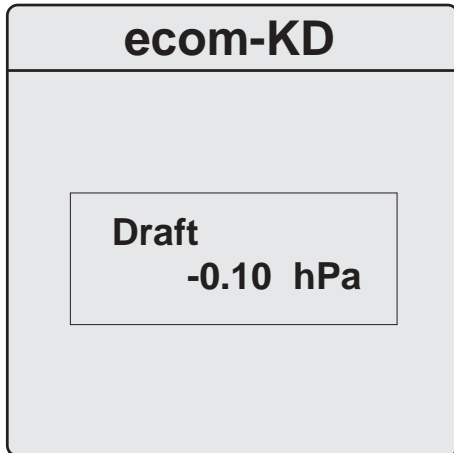
5.3. Soot Dot Measurement

The soot dot measurement at oil-fired combustion plants can be performed manually using a hand soot pump or comfortably by the ecom-KD and its integral gas pump. In this case the pump sucks exactly 1.63 litre gas volume thru the filter paper previously inserted in the slot of the probe grip.

Soot dot spot (heated)

Thermocouple

Gas channel

Draft channel

Draft

Gas   Gas temp.
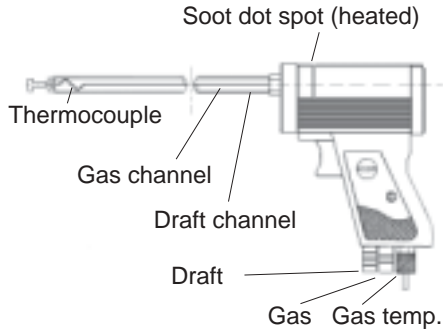
The soot test is to be performed 3 times and each sampled result must be compared with the soot scale provided with the instrument. In order to avoid any tampering of the soot dot due to humidity (condensation), the soot dot spot is heated up to ca. 70 °C. Hereto the probe heating must be switched on (Menu **„System / Internal / Probe heating: YES"**). The last adjustment still remains valid. Press **<E>** and input the analysed value using the figures keyboard shown on the display. Press **<E>** to switch between YES and NO as regarding the oil trace found or not on the soot filter.

If the soot test is performed manually, so the value input can be accessed while pressing the root symbol on the left of the display bottom. Reverse to the draft measurement, the inputed values must not be recorded extra once completed, as the inputed values are immediately transferred in the intermediate memory. Press **<Menü>** to return to the gas analysis menu.

ecom-KD

Soot dot

1st soot meas.   ---
2nd soot meas.   ---
3rd soot meas.   ---
Oil trace   ---

Mean value

Soot dot

√

5.4. CO Measurement (flue gas channel check)

The flue gas channel check also called CO measurement is used for the technical check of gas-fired plants in regards of safety aspects. Hereby the CO concentration in the gas channel is measured after the flow safety device and converted on an undiluted value (oxygen rest content in flue gas = 0 %). As the gas conditions after the flow safety device are no more homogeneous because of the flow in of secundary air and consequently the core stream mesurement can be erratic, the analysis of the exhaust gas is performed along the totality of the exhaust pipe diameter. A multi-hole probe (optional accessory) is hereby used as sampling probe. The calculated value shown on the line CO (U) corresponds to the measured CO concentration supposed the oxygen content would amount 0% by the same exhaust gas volume. It is consequently the undiluted CO content in exhaust gas. Once the value indication is stable, press **<M>** to store the result in the intermediate memory.

CO measurement	
O_2	17.5 %
CO	738 ppmN
CO	123 ppm
Exc. air	7.00
	c o

CO measurement m	
O_2	17.5 %
CO	738 ppmN
CO	123 ppm
Excess air	7.00
	c o

6. Customer Data Input
(only possible with optional external keyboard)

6.1. Basic data

If the measurement values should be attributed to a specific plant, select the submenu **"Basic data"** from the main menu and confirm with **<E>**. An input mask is displayed in which customer and plant data can be inputed.

```
       ecom-KD

➔  Basic data
    Gas values
    Issue report
    Printout page 1
    Printout page 2
    Store -> MC
```

The data inputed under „Plant owner" (3 lines) will form the head of the protocole printout. All data can be stored on a a RAM card together with the measurement results.

```
Plant owner          ■


Customer no.
Burner make
Burner type
Production year
Fuel type
Hu (kW/m3)
Nozzle size
Nozzle pressure
Boiler make
Boiler type
Production year
Nominal power (kW)
Set power (kW)
```

Note: The commands „**Printout page 1**" and „**Printout page 2**" are foreseen for special versions. They have no function by standard instruments.

6.2. Report Issue

Consumed materials and jobs performed can be documented in the menu point **"Issue report"**.

- Hereto input the article description before the vertical line.
- Use the tabulator key to jump in the price input field, behind the vertical line.
- Input the price with point and 2 digits after point.
- Once all positions are inputed, press <F3> to calculate the total sum incl. VAT.

```
┌─────────────────────────────┬────────┐
│ ■                           │        │
│                             │        │
│                             │        │
│                             │        │
│                             │        │
│                             │        │
│                             │        │
│                             │        │
├──────────┬──────────────────┴────────┤
│Calculate │  16 % VAT          0.00    │
│  F3 !    │  Sum incl. VAT     0.00    │
└──────────┴────────────────────────────┘
```

Note: The VAT rate is stored under **"System/Internal"**.
Proceed as follows to change the rate:
- Move the cursor on **"VAT"** and press **<E>**,
- Input desired rate and press **<E>**,
- Press twice **<Menü>** to return to the main menu.

6.3. Store measurements on RAM card and printout

The measurement values determined earlier (stored in the intermediate memory) can be re-checked under „Gas values". The inputs made under „Basic data" and „Issue report" can be stored together with the measurement results on a RAM card (select **„Store -> MC"** and press **<E>**).

```
┌─────────────────────────────┐
│        ecom-KD              │
│                             │
│   Basic data                │
│   Gas values                │
│   Issue report              │
│   Printout page 1           │
│   Printout page 2           │
│ ➔ Store -> MC               │
│                             │
└─────────────────────────────┘
```

To print the measurement values on the integral matrix printer of the ecom-KD, enter the menu **„Gas analysis"** and press **<Print>** (printout example on next page).

```
┌─────────────────────────────┐
│    Gas analysis  m          │
│                             │
│  O₂          3.2 %          │
│  CO₂        13.1 %          │
│  Eff.       92.5 %          │
│  Losses      7.5 %          │
│  Exc. air    1.18           │
│  T.Air        17 °C         │
│  Dew point    49 °C   ┌──┐  │
│                       │co│  │
│                       │◪ │  │
└───────────────────────┴──┴──┘
```

Values printout

```
        ═══════════════
            ECOM-KD
        ═══════════════
   -----------------------------
   Martin Jones
   Harbour Street 14
   Portsmouth PO6 1SZ
   -----------------------------
     Date         Time
   08.03.04      14:37:29
   -----------------------------
   Analysis 1
   -----------------------------
   Fuel type
   Fuel oil
   T.Air           17      °C
   T.Gas          184      °C
   T.Boiler        73      °C
   O2             3.2      %
   CO              12      ppm
   CO2           13.1      %
   Eff.          92.5      %
   Losses         7.5      %
   Excess air    1.18
   Dew point
   Draft        -0.10      hPa
   Soot dot   0.5 0.5 0.5
   Oil trace      No
   Oil press.    20.0      bar
   -----------------------------
   T-Run in        75      °C
   T-Run out       55      °C
   T-External      10      °C
   T-Room          22      °C
   T-Free          15      °C
   -----------------------------
   Peter Smith
   Heating & Bath
   Bank data :
   EUROPE BANK London
   Bank code Z 100 200 100
   Acc. no.:  123 123
   Portsmouth PO6 1SZ
   Tel.: 01705-322795
```
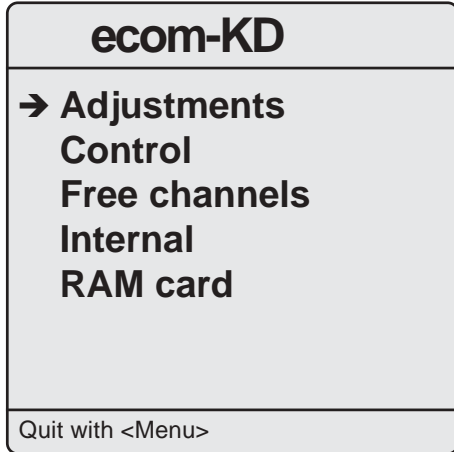
Plant owner

Company address

7. System

Additionally to those already described, several adjustments can be made at the instrument.

From the main menu select the sub-menu **"System"** and press **<E>**. The displays offers 6 sub-menus serving to the adjustment resp. the check of instrument parameters.

```
      ecom-KD

➔ Adjustments
   Control
   Free channels
   Internal
   RAM card


Quit with <Menu>
```

7.1. Adjustments

"Adjustments" enables the following changes:

Fuel type (press **<E>** to enter menu selection):
- Modification of adjusted fuel type (e.g. by measurements at combi-plants).

```
      ecom-KD

➔ Fuel type
   Conversions
   Boiler temp.
   Oil/Gas sensor
   Aux. sensor
   Fuel types <- PC
```

Conversions:
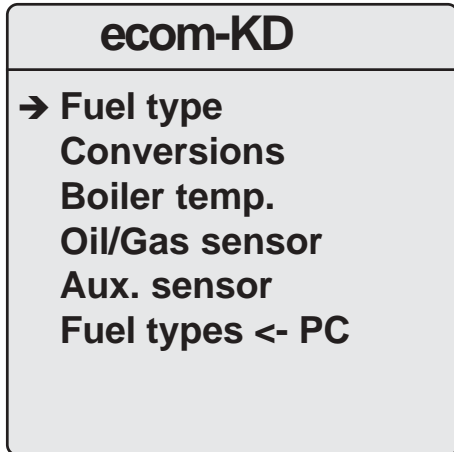Unit (use **<E>** to adjust):
- Conversion of gas concentrations in:
      - ppm   = volume concentration (parts per million).
      - mg/m³   = mass concentration per volume unit.
      - mg/kWh = mass concentration per performance unit.
Undiluted (use **<E>** to adjust):
- Conversion of gas concentrations on inputed ref. oxygen (adjustment **"Yes"**):
      - Formula for conversion:

$$E_{ref} = E_{meas} * \frac{21 - O_{2ref}}{21 - O_{2meas.}}$$

O$_2$ reference (press **<E>** and then input):
- Input of reference oxygen value O$_{2ref}$.

Air pressure (press **<E>** and then input):
- Input of barometric air pressure for dew point calculation.

Boiler temperature (press **<E>** and then input):
- Input of boiler temperature as reference value.

Oil/Gas sensor (press **<E>** and then select):
- Sensor selection for **"Oil/Gas"** connection.

Aux. sensor (press **<E>** and then select):
- Sensor selection for **"Aux 1"** connection.

Fuel types <- PC
- Loading of additional fuel types (for service centres only)

7.2. Control

Electrochemical sensors are submitted to a wearing process and consequently age. Along the operation period, they alter their output values depending on gas concentration, flow duration and soiling degree of the measured gases. The programme controls the sensors and corrects drifts. If the drifts and the correlated mesurement errors increase, an error message is displayed. In this case, the corresponding sensor must be changed by an authorised service centre.
The control menu informs about the current status values for the sensors.

Information is also available about:
- the accu voltage (charging state),
- the operation hours passed,
- the serial number,
- the address of the next service centre.

Control V. 2.0			
O2	20205 mV	NO	-71 mV
CO	2 mV	NO-R	-2547 mV
NO	-1 mV	NO2	-13 mV
Draft	-34 mV	CO-%	--- mV
Accu	12.34 V		

Operation hrs	:	25.11 hrs
Serial number	:	KD 1

-rbr-
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Am grossen Teich 2
58640 Iserlohn
Tel.: (49) 2371/945-5
Fax: (49) 2371/40305

7.3. Free Channels

Besides the standard labelling on the front foil, the additional temperature channels can be renamed in the case of a different application. Hereto just input an other description in the input mask of the menu. This input will remain stored until the next change.

7.4. Internal

A row of adjustable parameters is available which can be modified acc. to the application.
Set the cursor on the desired line and press **<E>** to call up or modify the adjustment.

In detail:

Set clock (press **<E>** and then input):
- Correction of internal date and time.

INTERNAL	
➔ **Set clock**	
Key	
Probe heat.	**No**
Baud rate	**9600**
RAM card	**512 kB**
VAT	**16.0%**
Form mask	

Key
Programming of company address:
The modification of the key content can be initiated only with the red key. Insert the red key in the instrument, select the line „**Key"/"Edit text"** and input the desired text (max. 8 lines with 20 characters each). Then select **"Operator key"** to programm a black key respectively **"Duplicate"** if only the content of the red key should be modified.
In the first case, just exchange the red key against a black key and confirm the scheduled programming with **<E>**.

Probe heating (use **<E>** to adjust):
- Switch ON/OFF probe heating

Baud rate (use **<E>** to adjust):
- Adjustment of transfer speed:
    - When using rbr additional programmes: 9600 Baud

RAM card (use **<E>** to adjust):
- Adjustment of total capacity RAM card. As the RAM card type is not automatically recognized by the instrument, it is recommended to harmonize the KD with the type used by initial use.

VAT (press **<E>** and then adjust):
- Modification of VAT rate for calculation of total invoice amount.

Note: The menu point „**Form mask"** is scheduled for special versions. It has no function by standard instruments.

7.5. RAM Card

The menu **"System" / "RAM card"** covers the function for data transfer and data care:

Cancel field
Cancels the last recorded file.

Format card
Prepares the RAM card for data record with the instrument.
All data on the card will be deleted (only necessary by initial process of the RAM card).

```
┌─────────────────────────┐
│  R A M   C A R D        │
├─────────────────────────┤
│ → Format card           │
│   Delete field          │
│   Card -> RS 232        │
│                         │
├─────────────────────────┤
│ RAM field  :    0       │
│ Free       :    511 kB  │
│ Card type  :    512 kB  │
│ Battery    :    OK      │
└─────────────────────────┘
```

Card -> RS 232
Transfer of data logger and diagnosis files:
To transfer these files use the programme „**ecomDatenloggerKD**" (downloadable from website: **www.rbr.de**).

Transfer of basic data and measurement results:
To transfer these files use the programme „**Rd-kd**" (only DOS version available from rbr-Computertechnik GmbH on request).
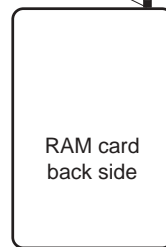
The bottom indication on the display informs about:
- RAM field = number of recorded files
- Free   = free memory capacity for data logger/diagnosis records
- Card type = RAM card volume
- Bat   = State of RAM card battery

Important:
Please make sure that the write protect switch is **not** set on "Write Protect", as otherwise no data record would be possible!

8. Data Logger Operation

Data logger

➔ **Parameter**
Automatic   : No
Send data : No

The design of the ecom-KD with its operation-safety, self-monitoring additional elements like e.g. the condensation pump, the gas cooler or the magnetic valve technique allow a long-time operation of the instrument. The measurement data are gathered in a data record which is outputed and printed out via the interfaces.

Respecting the programmed time intervals for measurements, the instrument automatically switches to fresh air after the termination of a measurement phase and performs a calibration phase for the sensors. In data logger operation, the measurement values for all connected channels are recorded, no calculation values will be managed in the data record.

Once the instrument is installed at the measurement point, select in the main menu the line „Data logger" for data logger operation.
Set the parameters for operation as well as for data record and output.

Time intervals can be set for data output via:

1.) the data carrier (SRAM cards up to 4 MB)

```
┌─────────────────────────────────────┐
│          Time intervals              │
├─────────────────────────────────────┤
│  ➜ Store RAM card    :       2 sec   │
│    RS 232 output     :       2 sec   │
│    Print Centronics  :      10 sec   │
│    Print ECOM-KD     :     1:00 min  │
│    Automatic time    :    60:00 min  │
│    Mesurement time   :    45:00 min  │
│                                      │
│                                      │
└─────────────────────────────────────┘
```

2.) the serial interface RS 232 for PC or Laptop respectively external apparatus with serial input

3.) the parallel interface (Centronics)

4.) the internal printer

The time intervals for the proper measurement duties mean:
Automatic time
> Time period from one calibration phase to the next excepting the latest.

Measurement time
> Time period within the automatic time during which the instrument stores data, it means during which the gas is sampled. If there is a difference between the measurement and the automatic time, so the instrument sucks fresh air to purge the sensors during this time and switches to the calibration phase after the automatic time.

Once a cycle is over, the next starts. Start the data logger operation while placing the cursor on the line **"Automatic : NO"** and press **<E>**.

Setting the line **Send data : NO** results in the instrument to process all measurement values according to the adjusted parameters but it is not pulsed in automatic operation. This corresponds to the uninterrupted continuous operation and should not occur longer than ca. 1-2 hours without fresh air phase (otherwise sensors may drift).

During measurements, the sampled data are provided in the following data records:

RS 232 (ASCII data)	RAM card (Data logger)	RAM card (Diagnosis)	Internal printer
Time	Time	Time	Time
O_2	O_2	O_2	T-Air
CO	CO	CO	T-Gas
NO	NO	NO	O_2
NO_2	NO_2	NO_2	CO
T-Gas	T-Gas	CO_2	NO
T-Air	T-Air	Losses	NO_2
T-Run in	T-Run in	Excess air	NO_x
T-Run out	T-Run out	T-Run in	Oil/Gas
T-External	T-External	T-Run out	T-Run in
T-Room	T-Room	T-External	T-Run out
T-Free	T-Free	T-Room	T-External
Aux 1	Aux 1	T-Gas	T-Room
Oil/Gas	Oil/Gas	T-Air	
SO2	SO2	Aux 1	
CO2	CO2	Oil/Gas	
Efficiency	Efficiency		

The data record is stored on the RAM card in the preset intervals times respectively sent via the interfaces. A semicolon (;) serves as separation mark between the data fields. The length of a data record amounts ca. 100 Byte.

Herewith a rough estimation can be made regarding the time duration volume of a long-time measurement stored on the data carrier:

RAM card 512 kB = 512.000 Byte
512.000 / 100 = 5.120 data records
5.120 / 6 = 853 minutes by a recording pulse of 10 seconds
853 / 60 = 14,2 hours

The measurement data can be recorded on a PC/Laptop and processed. As they´re available as ASCII data, this allows an universal further processing in the most various current programmes.

Besides the above listed possibilities for measurement series recording, the data can also be transferred online to the programme **„ecomDAS"** (downloadable from website **www.rbr.de**).

12. Diagnosis (Weak points analysis)

The weak points analysis is the evaluation of sampled measurement values in their context with further, inputable parameters over a longer time period (12 hours minimum) within a heating period.

Conditions hereto are:
1) The use of the complete temperature sensors set for water run-in, water run-out, external and heating room / reference room temperature.
2) The ecom-KD must be operated with heated hose in order to continuously evacuate the forming condensation.
3) The weak points analysis has to take place during the heating period (September to May) and must have a duration of 12 hours at a minimum and 24 hours at a maximum.
4) There is no difference made between the heat calorific needs and the heat water needs, only the total heat consumption is determined.

The results of the heating diagnosis form a basis for the evaluation of the control behaviour of the combustion plant, of its emission behaviour, the adaptation of burner, boiler and chimney and also the consumer´s behaviour during the diagnosis time. They are no final statement as a comprehensive valuation can only be gained under consideration of further building-related and climate specific data (e.g. building type and age, altitude, wind conditions, living space).

Adjustments and Inputs

To determine the emission behaviour of the combustion plant, connect the ecom-KD to the sampling spot via the heated hose. The condensation evacuated by the peristaltic pump must be collected properly, respectively if possible, directly evacuated. The temperature sensors for water run-in and run-out as well as the heating room temperature sensor must be positionned at the foreseen respectively suitable measurement points (representative measurement points).
The external temperature sensor is also to be placed at a representative measurement point (generally by the sensor for the external temperature-depending regulation system). In any case it must be protected against direct sun beam and other possible influencing factors sources which would tamper the measurement value.

Switch on the ecom-KD, select the field **Diagnosis** and input:
- the boiler nominal power (kW)
- the burner nominal power (kW)
- the volume of the warm water reservoir (ltr.)
- the regions´ standard external temperature
- the duration of the diagnosis (hrs.).

These data are needed for calculations made during the values recording.

Measurement values recording
Once the diagnosis has been started, the ecom-KD performs a calibration phase provided the latest hasn´t already been initiated in preparation of the diagnosis. The further control of the instrument runs programme-driven and according to the following schedule:

```
┌─────────────────────────────────────┐
│          D i a g n o s i s           │
├─────────────────────────────────────┤
│ ➔ Boiler nominal power       20 kW   │
│   Burner nominal power       20 kW   │
│   Reservoir volume           80 ltr  │
│   Norm external  temp.       -12 °C  │
│   Duration diagnosis         12 hrs  │
│   Start diagnosis?             No     │
│   Evaluation                          │
│                                       │
│   Rest time :          23:59 hrs     │
└─────────────────────────────────────┘
```

The ecom-KD identifies the operation state of the combustion plant (burner ON/OFF).

The measurement values recording starts immediately after the calibration phase for a duration of 30 minutes at a minimum.

If after this time the burner is ON so the values recording will be prolongated until the turn-off moment of the burner, but of 10 minutes at a maximum.

By burner´s turn-off, the instrument switches to a 3-minute calibration phase at a minimum which will be prolongated if a purging of the sensors on a pre-set minimal concentration couldn´t be ascertained. Then a new values recording with burner stand identification starts. This process recurs until expiry of the pre-set diagnosis duration.

Caution: Is the diagnosis performed at a plant in continuous operation, so the burner ON/OFF identifications must be subtracted from the number of the start cycles straight after the calibration phases (diagnosis duration (in hrs) * 60 (minutes) / 43 (minutes); Example for 12 hours: 12*60=720/43=16,7 -> substract 16 start strokes).

The data output occurs according to the pre-set options (exception: RS 232 and Centronics provide no data).

The current measurement results can be displayed in the menu **Gas analysis**.

If the electronic key is removed, no keyboard input is possible anymore. The instrument operates automatically and self-controlled.

The measurement values received continuously are integrated in different intervals (emission values and gas temperature every 30 seconds, temperature values every 30 minutes) and processed consecutively by the calculator. Maximal, minimal and average values are stored.

The final protocole (sub-menu **Diagnosis**) provides with the following data:

Error percentage	xx	%	(1)
Increased standstill losses	xx	%	(2)
Ideal level	xx		(3)
Ideal boiler power	xx	kW	(4)
Min. warm water temp.	xx	min	(5)
Ø DT. Run in/out.temp	xx	°C	(6)
Ø Run out temperature	xx	°C	(7)
Ø External temperature	xx	°C	(8)
Total power rate	xx	kWh	(9)
Max. heating room temp.	xx	°C	(10)
Number of cycles	xx		(11)
Burner operation hours	xx	hrs	(12)
Ø Exhaust losses	xx	%	(13)
O2min xx % O2Ø	xx	%	(14)
COmax xx ppm COØ	xx	ppm	(15)
NOmax xx ppm NOØ	xx	ppm	(16)
TGmax xx °C TGØ	xx	°C	(17)

The sub-menu **Heating curve** illustrates the real heating curve course for the duration of the diagnosis. This diagramme takes into account the ratio run-in temperature to external temperature under consideration of the standard external temperature valid for the region.

Evaluation of the measurement results

The results sampled during the diagnosis time are no absolute statements but assessments about the dynamic control and emission behaviour of the heating plant within the test time.
They must be interpretated for the given plants, buildings and consumers conditions.

```
┌─────────────────────────────┐
│   D I A G N O S I S          │
├─────────────────────────────┤
│ ➜ Heating curve             │
│   Diagnosis                  │
│   Print    ➜ Centr.         │
│   Print    ➜ Matrix pr.     │
│                              │
│                              │
└─────────────────────────────┘
```

Such an interpretation is based on your experience and your knowledge of the facts in hand. Consequently only a general interpretation can be given as example. Assuming the ideal state that a heating plant delivers 100% performance by external temperature = standard external temperature and 0% by external temperature = standard room temperature, an idealized heating curve curse merges according to the ratio diagramme run-in temperature to external temperature. This idealized heating curve is adjusted during the installation and start up of the heating plant and its progression and steepness are set to the requirements in hand. Especially by older plants checking the real heating curve course now allows to draw conclusions if this adjustment is still up-to-date, if constructional or other changes in the conditions are considered respectively if the plant size is suitable at all.

The following diagramme illustrates the idealized heating curve of a plant with a run-in temperature TR-max. for a standard external temperature of -10 °C.
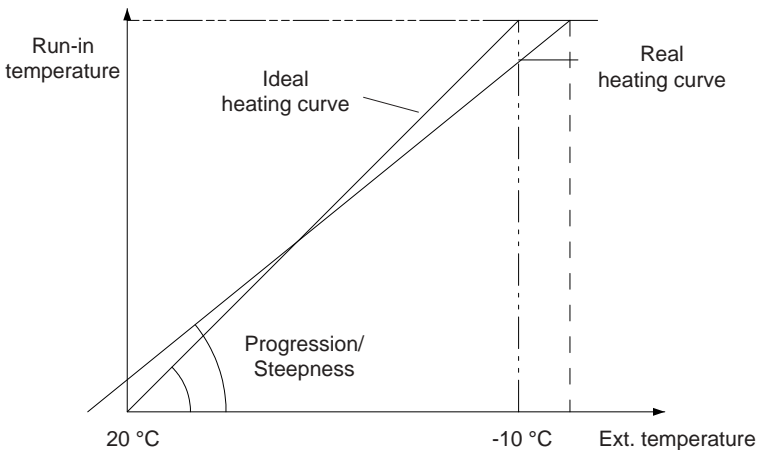
The real heating curve is illustrated in this diagramme and will show by definition other intersection points with the diagramme axles. Considering its parameters, this real heating curve can be interpretated with the following statements:

1. *What is the maximal water run-in temperature by the lowest external temperature (standard external temperature)?* Generally this temperature will be lower as the calculated (ideal) curve because the majority of installed plants are designed with reserve capacity respectively, especially old plants are often oversized.

2. *Are progression and day temperature adjustment (parallel shift) in accordance with the requirements and conditions in hand?*

3. *Related to the ideal heating curve by the given conditions how many percents under-/oversize does the heating plant show (mismatching = line # 1)?* The percent result of the protocole line # 1 shows with a negative figure oversizing. This means that a plant with a mismatching of e.g. -15 % provides already by 85% performance with the necessary heat supply according to the ideal heating curve. It has consequently 15 % oversize.

4. *How high are the additional (increased) standstill losses of a plant because of its oversize (# 2)?* As an oversized plant needs less time to provide with the required heat volume its standstill times consequently increase. The balance of the total losses of a heating plant as sum of exhaust losses and operability losses (standstill losses, radiation losses) clearly shows an increase of this losses type. The result (# 2) is no absolute value of the losses volume but relative to the given radiation losses of the boiler.

5. *How would the ideal level of the heating plant be by the heat decrease # 3 and # 4) recorded during the measurement?* This factor (protocole result # 3), offset with the boiler nominal power of the plant, represents the ideal boiler performance (protocole result # 4). These values are determined, as mentionned earlier, without consideration of correction values for building- and climate-specific conditions and can consequently only serve as parameters for an object-related interpretation. They show the available room for manoeuvre by an energy or plant consultation.

6. *What is the minimal time for availability of warm water (# 5)?* Heating plants being usually sized according to the most unfavourable weather conditions and the latest occurring only some days a year, unused performance reserves are available which are used for water heating.

Result # 5 shows the necessary minimal time related to the reservoir volume. Depending on the users consumption (on an average and by peaks) further interpretations are herewith possible.

7. *What is the average temperature difference between water run in and water run out temperatures (# 6)?* The evaluation of the real, average temperature expansion compared with theoretical or mathematical guidelines allows plenty of interpretations related to the specific firing plant in the building and the users behaviour:
- are pump/mixer designed suitably?
- is the heat output via the radiator surface suitable?
- how is the heat demand behaviour of the users?
- does the night decrease work (recognisable on the curve course of the measurement series)?

8. *How high is the average water run-out temperature (# 7)?* Is the run-out temperature too low, so the condensation in the boiler increases thus leading to increased wearing.

The results protocole further covers partly statistical, informative data which interpretation enable statements regarding e.g. the emission behaviour over a longer time period. The maximal emission values give e.g. information about the toxic emission during the starting strokes. Related to the determined number of these ON and OFF switch processes, further average values are determined differing from those e.g. a punctual emission measurement would deliver.

The immediate protocole after the adjusted diagnosis time enables a limited number of statements concerning the heating plant. Hereto average as well as maximal/minimal values and calculated parameters form the basis. The diagnosis becomes expressive with a further evaluation of the values course using the measurement series and their time order. Hereto the values stored on the RAM card must be processed on the PC and the dynamic course of the single parameters must be interpretated.

10. Pressure Check

The ecom-KD enables the connection of pressure signal transmitters which enable to check if pipes networks are tight or pressure-proof.

In its course the measurement mode **Pressure check** is leant to the pipes check procedure of the TRGI 86.

A pressure signal transmitter suitable for the pressure range to be checked (item doesn´t belong to the standard delivery set) as well as a device to create the test pressure in the pipe (pump) are required.

- Switch on the ecom-KD and select in the main menu the option **Pressure check**.
- Select with the cursor the corresponding sensor resp. measurement range.
- Plug the electrical connection of the pressure sensor in the connection "Oil/Gas" on the KD, it gets calibrated while being plugged in.
- Create a pressure in the pipe to be checked and close the system.

Pressure check		
➜ Oil pressure	35.0	bar
Gas pressure	70.00	hPa
Pressure	1000	hPa
Random	20.0	mA
Random	10.00	V
pH value	10.00	pH
Pressure 1	35.0	
Pressure 2	35.0	

Select sensor at GAS/OIL plug

Once the pressure indication is stable, press **<E>**. The values measured by the signal transmitter are permanently scanned during 10 minutes and displayed every 30 seconds in the diagramme.

Two lines contain the current information about:

Gas press. - Max. drift (hPa)
Rest time - Max. drift (%)

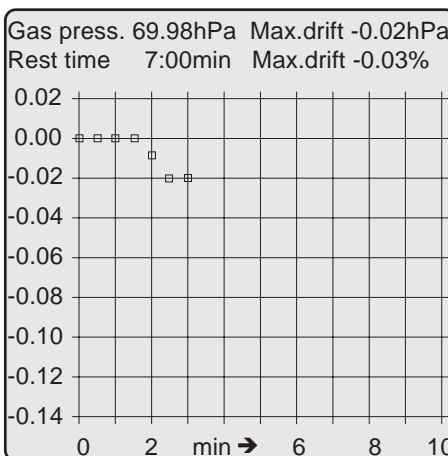| **Pressure check** |
| :---: |
| **Gas press.   70.00 hPa** |
| **Build up pressure only if indication is OK !** |
| **If sensor´s values are stable ➜ key <E>** |

After the 10 minutes a printout of the measurement is automatically started:

```
     Date   /      Time
     ---------------------------
        Pressure check
     ---------------------------
     Start value   xx.xx hPa
     End value     xx.xx hPa
     Max. drift    -x.xx hPa
     Max. drift    -xx.xx %
```


Gas press. 69.98hPa   Max.drift -0.02hPa
Rest time   7:00min   Max.drift -0.03%

11. Maintenance Tips

We recommend to send your instrument for maintenance to the next authorised service centre one time a year, however after max. 400 operation hours and let the sensors checked and the internal tubing cleaned. Do not use other sensors or feelers from other manufacturers and keep in mind that service made by service centres not authorised by rbr-Computertechnik GmbH will result in a complete and immediate lost of warranty.

The following advices will be of help for the daily check and maintenance of single parts or assemblies:

The instrument is fitted with filters protecting the sensors and the gas paths which need a regular check. These filters are:

Fine dust filter at the gas cooler
Screw off the cover of the gas cooler and check the state of the particle filter. Change it once the filter has a dark grey colour at the gas flow area (= number 2-3 of the soot comparison scale).

Fine dust filter

SO_2/NO_x filter
Fitted on the back side of the instrument and placed in the tubing leading to the CO sensor, there is a chemical filter catching SO_2 and NO_x particles out of the flue gas. The filter material consists of manganese IV oxide granules. The latest should be changed once they turned grey (colour change: pink = genuine state > brown > black > grey > white).

Sensors
After switching on the instrument, the sensors are calibrated with fresh air. The instrument permanently checks the sensors status. New sensors age due to the reagents being consumed (oxygen sensor) and due to dirt respectively to concentration exposures above their nominal range (toxic sensors). The output values for sensors are (menu "Control"):

Oxygen	ca. 18000 mV
Toxic sensors	0 mV (+/- 150)

By any error message displayed during calibration and which cannot be eliminated while re-calibrating the instrument a couple of times, the latest should be checked by an authorised service centre. The oxygen sensor must have a value >7000 mV otherwise it must be replaced. The internal programme controls the sensors checking a pre-set a limit value which exceeding will activate a magnetic valve and flow the sensor with fresh air. This value is set to 4.000 ppm for the CO sensor.

Power supply
Rechargeable accumulators with a capacity of 3 Ah provide with mains-free operation. The batteries are recharged by simple connection to mains power (charging time ca. 10 hours). The batteries should be recharged in any case when the voltage displayed (menu "Control") is lower than 11 V (the critical level stopping any operation amounts 10.5 V).

Probe and tubing
Depending on the frequency of use the tubing and the probe should be cleaned regularly thus in order to remove dirt and to avoid timely wear due to corrosion. The tubing can be cleaned once all connections at the instrument and at the pistol grip probe have been removed (use warm water, dry resp. blow through).

12. Technical Data

General data

Power supply	Mains 230 V / 50 Hz
	Accu 12 V / 3,4 Ah (lead)
Accu autonomy	> 1 hour by operation of all sinks
	Low charge protection 10.5 V
Charging time	ca. 8 - 10 hours
	Charging current limit
	Overcharge protection
Display	17-line touch-screen display (backlit)

Options

- Heated sampling system (length 3.5 m) with heated probe
  head and pre-filter (hot gas filter; T-Gas max = 200 °C)

- RAM card data carrier (standard 512 kB; PCMCIA standard)

- Undercase for additional tools

Dimensions and weight

Dimensions (L x H x W): 520mm x 300mm x 260mm
Weight   : ca. 14 kg complete with standard
                         probe 300 mm

Measured values

Value	*Range*	*Principle*
O_2	0 ... 21 vol.-%	Electrochemical
CO	0 ... 4.000 ppm	Electrochemical
NO (option)	0 ... 2.000 ppm	Electrochemical
NO_2 (option)	0 ... 200 ppm	Electrochemical
CO% (option)	0 ... 10 Vol.-%	Electrochemical
C_xH_y	0 ... 2000 ppm	Infrared
Draft	0 ... +/- 20 hPa	DMS bridge
T-Gas	0 ... 500 °C	Thermocouple NiCr/Ni
T-Room	0 ... 100 °C	Semiconductor

Calculated values

Value	*Range*	*Formula*
CO_2	0 - CO_{2max}	$CO_2 = CO_{2max} * \left(1 - \dfrac{O_{2\ measured}}{21} \right)$
Losses	0 - 99,9 %	$q_A = \left(\dfrac{A2}{21 - O_2} + B \right) * (T_{Gas} - T_{Room})$
Efficiency	0 - 99,9 %	$Eff. = 100 - q_A$
Excess air	$1 - \infty$	$\lambda = 1 + \dfrac{O_2}{21 - O_2}$

Fuel types

CO2max values and factors

Fuel type	A1	A2	B	CO2max
Fuel oil (B)	0,50	0,68	0,007	15,4
Natural gas (B)	0,37	0,66	0,009	11,8
City gas (B)	0,35	0,63	0,011	11,7
Coke oven gas (B)	0,29	0,60	0,011	10,2
Liquid gas (B)	0,42	0,63	0,008	14,0

Conversions and factors (ppm - mg/m3 - mg/kWh)

Gas	ppm in mg/m3	mg/m3 in ppm	Fuel type	CO	NOx	SO2
O_2	1,429	0,699	Nat. gas L	1,092	1,795	
CO	1,25	0,8	Nat gas H	1,073	1,762	
NO	1,34	0,75	Propane	1,05	1,722	
NO_2	2,05	0,49	City gas	1,002	1,647	
SO_2	2,86	0,35	Fuel oil EL	1,105	1,816	2,587
			Fuel oil S	1,12	1,847	2,63

Dew point calculation

The dew point calculation uses the approximation formula of the DIN 4705 Part 1.

Humidity content burnt gases   in %

$$\chi_{H_2O} = \frac{100}{1 + \dfrac{f_W}{CO_2}} + 1,1$$

f_W is a fuel type specific factor

Natural gas = 57
City gas = 53
Liquid gas = 77
Fuel oil = 111
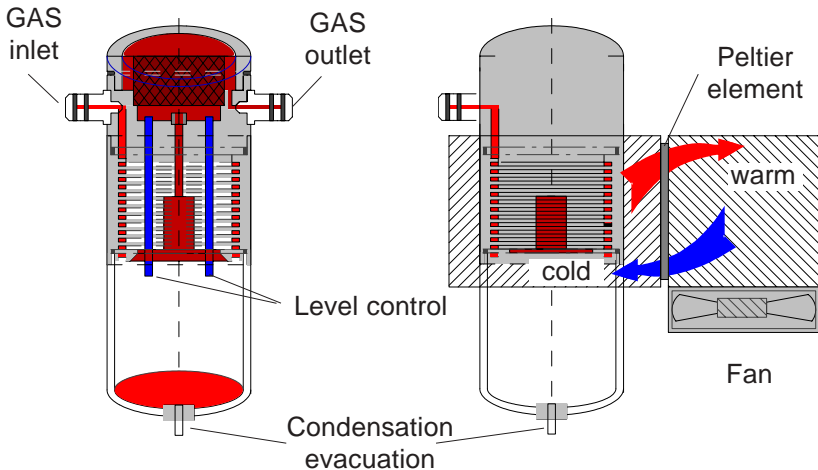
Calculation of steam partial pressure   in Pa

$$P_D = \frac{\chi_{H_2O}}{100} * P_{Luft}$$

P_{Air} = atmospheric air pressure (900...1100 mbar)

Dew point calculation   in °C

$$TP = \frac{4077,9}{23,6448 - \ln P_D} - 236,67$$

Gas cooler (illustration)

GAS inlet   GAS outlet   Peltier element   warm   cold   Fan

Level control

Condensation evacuation

Exhaust gas with a temperature beyond the steam dew point (35 - 65 °C) is flown spiralwise via a long gas path thru a surface coated metal body with good thermal conductivity. The gas radiates its heat to this metal body. A PELTIER element (semiconductor cooling element) flown by a continuous current is thermically connected with this body and with a second metal body with cooling ribs and ventilation slots. The flow thru the PELTIER element creates a heat transfer from WARM to COLD, drains the heat of the metal body flown by gas and conveys it to the outer cooling body. This heat is conveyed thru a vertical forced ventilation to the surrounding air.

The condensation issued by the heat loss of the gas drops in a receptacle and is pumped out on request (either by the user or due to the level control system).

The sucking capacity of the gas conveying pump avoids a sufficient dwell time of the gas with the condensate, so that wash out reactions ($NO_2+H_2O > H_2NO_3$) do not take place.

At the cooler outlet the gas has a temperature of ca. 5 °C with a relative saturation of nearly 100 % relative humidity (corresponds to a water vapour content < 7 g/m^3).

Coaxial probe
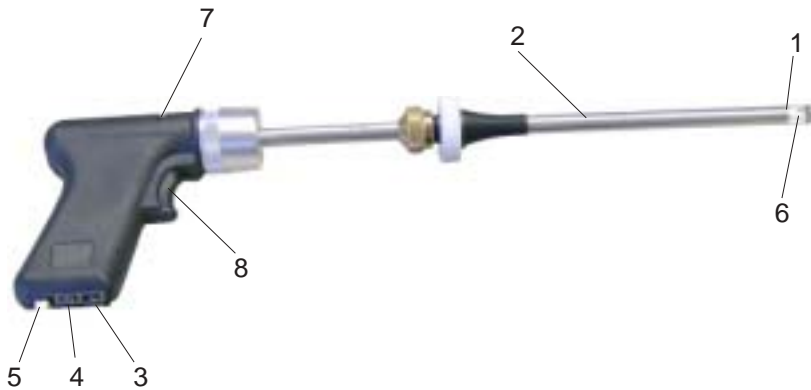
1. Inner tube (gas)   inner Ø = 6 mm
                          outer Ø = 8 mm

2. Outer tube (draft)   inner Ø = 9 mm
                          outer Ø = 10 mm

3. Draft connection

4. Gas connection

5. Connection for T gas

6. Temperature sensor for T gas (NiCr/Ni)

7. Slot for soot filter with pressure piston

8. "Trigger" for the piston

Subject to technical modifications
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