Model 1207
Hand-held
Combustion
Analyser
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1. ANALYSER LAYOUT AND FEATURES

1.1 Instrument Features and Keypad

1207 shown without standard rubber boot

ON/OFF

MENU
Allows access to all menu functions

PUMP
Turns pump on and off

ENTER
Accepts a command, ie enters a menu option

UP
Scrolls up through options, ie Fuel

DOWN
Scrolls down through options

STORE
Enters data storage menu

PRINT
Prints current data
1.3 Standard Probe Configuration

Thermocouple
Stainless Steel Shaft
Depth Stop Cone
Gas Path
Thermocouple Wire
2. SAFETY WARNING

This analyser extracts combustion gases that may be toxic in relatively low concentrations. These gases are exhausted from the side of the instrument. This instrument must only be used in well ventilated locations. It must only be used by trained and competent persons after due consideration of all the potential hazards.

**Protection Against Electric Shock** (in accordance with EN 61010-1:1993)

This instrument is designated as Class III equipment and should only be connected to SELV circuits. The battery charger is designated as:

- Class II equipment
- Installation category II
- Pollution degree 2
- Indoor use only
- Altitude to 2000m
- Ambient temperature 0°C-40°C
- Maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50%RH at 40°C
- Mains supply fluctuations not to exceed 10% of the nominal voltage.

3. FIRST TIME USE

Charge the battery for 12 hours, following this an overnight charge should be sufficient for an average 8 hour day. See Main Parameter displays for Battery Indicator.

The 1207 has a rechargeable lead acid battery which uses a different charger than other analysers. **Ensure the correct charger is used or damage may occur to the instrument.**

Check that you have all the items you have ordered.
Take time to read this manual fully.
When using the analyser for the first time you will need to choose from:

- Language selection
- Calibration countdown time
- CO gas alarm
- NOx percentage for calculation
- Time and Date
- Printed header name and telephone number

The **SET UP MENU (Section 5.2.5)** gives details of how to change the above settings.
4. NORMAL START UP SEQUENCE

4.1 Every Time You Use The Analyser
BEFORE SWITCH-ON CHECK THAT:
the particle filter is not dirty
the water trap and probe line are empty of water
all hose connections, etc, are properly made
the probe is sampling CLEAN AMBIENT air
the water trap is correctly fitted and the instrument upright
the flue temperature is connected

Switch ON the instrument by pressing [O]

4.2 Automatic Calibration

During this sequence the analyser pumps fresh air into the sensors to allow toxic sensors (if fitted) to be set to zero and the Oxygen sensor to be set to 20.9%.

After switch-on the analyser will briefly display header information:

```
Dwyer Instruments Inc.
219-879-8868
```

And then show the countdown screen:

```
ZERO CAL
Time: 180
Fresh Air Purge
```

The calibration time will count down in seconds to zero. Calibration time may be changed from 2 to 6 minutes. See Set-Up menu section 5.2.5.

Note ! Three minutes is recommended to allow the sensors to stabilise fully. Anything less than this may result in drift of the toxic and oxygen sensors in clean ambient air.

To obtain the quoted specification an instrument should be calibrated with clean ambient air at standard temperature and pressure (STP).
Once the time has reached zero an audible beep will be heard and will show the selected fuel on the following display:

```
NATURAL GAS
*PRESS -MENU- KEY*
```

Press \[\text{[OK]}\]

This zeros the toxic sensor and sets Oxygen to 20.9%. The next screen is the MAIN DISPLAY of the analyser:

```
NETT C .... 0.0
O2 % ... 20.9
CO ppm ... 0000
EFF (G) % ... 0.0
```

Use \[\text{[<]}\] and \[\text{[>]}\] to change the display.

```
CO2 %....... 0.0
FLUEC....... 0.0
INLT .... NOT FITTED
AMBIENT C .... 21
```

All parameters are detailed in Appendix A - MAIN DISPLAY PARAMETERS.
4.3 Main Displays

The main display can be changed to show either 4 or 8 parameters at one time. Two options are available when 4 parameters are selected.

- 4 Page Mode displays 4 lines of data in set format, each page is predefined.
- Line scroll mode allows you to customise the display to show the data you require.
- 8 Page Mode displays 8 parameters on 4 lines in set format, the bottom two can be changed.

Changing between the different modes is detailed in Display Menu Section 5.2.4.

4.3.1 4 Page Mode

Use the and keys to change the information that is displayed on the screen. The following pages are available.

<table>
<thead>
<tr>
<th>NATURAL GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE ... 07-08-96</td>
</tr>
<tr>
<td>TIME ... 12:31:35</td>
</tr>
<tr>
<td>BATTERY % ... 54</td>
</tr>
</tbody>
</table>

| NETT C ... 0.0       |
| O2 % ... 20.9       |
| CO ppm ... 0000     |
| EFF (G) % ... 0.0    |

| CO2 % ... 0.0       |
| FLUE C ... 0.0      |
| INLT NOT FITTED     |
| AMBIENT C ... 21    |

| CO/CO2 R ... 0.0001 |
| P INDEX % ... 0.01  |
| XAIR % ... 0.0      |
| Prs mbar 0.00       |

This screen only displayed on an analyser fitted with an NO sensor

| NO ppm ... 0000          |
| NOx ppm ... 0000         |
| NOx calc% ... 5          |
| O2 ref % ... 3.0         |

TIP - In 4 page mode only turns the backlight ON and OFF.
4.4 Sampling the Flue Gas

Once the automatic calibration procedure has been completed and the specific fuel has been selected (see SELECT menu) the probe can be inserted into the desired sampling point.

It is recommended that the sampling point be located at least two flue diameters downstream of any bend and that the probe tip is in the centre of the flue. With balanced flues and other domestic units the probe should be positioned far enough into the flue so that no air can ‘back flush’ into the probe. This will be indicated by a low oxygen reading and/or a low ‘Poison Index’ reading.

![Diagram of sampling point and probe.]

The probe depth stop cone provided with the instrument allows the probe to be used in holes whose diameters range from 8 mm to 21 mm (5/32 to 13/16 inch).

The standard probe is rated at 650°C. Temperatures of up to 1100°C (2012°F) can be accommodated using an optional high temperature probe.

**TIP** To conserve battery power, switch off the pump when you are not taking a measurement. Use the key to turn ON and OFF the pump.

4.5 Taking a Pressure Reading

With the optional pressure module fitted a flue draught measurement can be made at any time.

Connect the standard probe to the pressure sensor inlet and the probe in the flue. The pressure reading will be displayed.

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO/CO₂</td>
<td>0.0001</td>
</tr>
<tr>
<td>P INDEX</td>
<td>0.01</td>
</tr>
<tr>
<td>XAIR</td>
<td>0.0</td>
</tr>
<tr>
<td>Prs</td>
<td>0.00</td>
</tr>
</tbody>
</table>

To perform a combustion test and display draught pressure at the same time a special probe is required. Contact Dwyer Instruments Inc. or an Authorised Distributor for details.
4.3.2 Line Scroll Mode

Line scroll mode allows you to customise the display.

Use the left- and right-arrow keys to change the bottom line of the display. Once the correct line is displayed press } to confirm and move the line up. Select the next parameter and repeat until all lines display the desired parameters.

<table>
<thead>
<tr>
<th>NETT</th>
<th>C</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2</td>
<td>%</td>
<td>20.9</td>
</tr>
<tr>
<td>CO</td>
<td>ppm</td>
<td>0000</td>
</tr>
<tr>
<td>CO2</td>
<td>%</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Change bottom line using and }

| O2     | %    | 20.9|
| CO     | ppm  | 0000|
| CO2    | %    | 0.0 |

Select next parameter. Repeat above until display reads desired data

| O2     | %    | 20.9|
| CO     | ppm  | 0000|
| CO2    | %    | 0.0 |
| CO/CO2 | R    | 0.0001|

4.3.3 8 Page Mode

Displays 8 parameters on the screen at one time. Symbols used in this mode are different to those used in 4 page and line scroll modes and are detailed in Appendix A - MAIN DISPLAY PARAMETERS.

| O2     | 20.9 % | CO2   | --  |
| CO     | 0 ppm  | Eff   | --  |
| PI     | --    | ΔT    | 0°C |
| λ      | --    | Tf    | 21°C |

The bottom line of the display can be changed to display other parameters.

Use the left- and right-arrow keys to change this line.
4.6 Regular Checks During Sampling

Care must be taken at all times not to exceed the analysers operating specifications, in particular ensure the following:

- Do not exceed the maximum temperature of the flue probe.
- The analyser internal temperature does not exceed normal operating range, typically 0-40°C.
- DO NOT PLACE THE INSTRUMENT ON A HOT SURFACE.
- The water trap is vertical at all times. Water condenses in the probe line and can quickly fill the water trap when the probe is moved. Take care and watch the water trap closely.
- The in-line particle filter is clean and does not become blocked.

4.7 Normal Shutdown Sequence

DO THIS EVERY TIME YOU USE THE ANALYSER

Remove the probe from the flue - TAKE CARE! THE PROBE WILL BE HOT - and allow it to cool naturally. Do not immerse the probe in water as this will be drawn into the analyser and damage the pump and sensors.

Once the probe is removed from the flue press and the analyser will count down from 30 to switch off.

OFF 30

MENU TO ESCAPE

If you have not finished but press by mistake, you can press to return to normal operation and not switch OFF.

4.8 Electromagnetic Compatibility

The European Council Directive 89/336/EEC requires that electronic equipment does not generate electromagnetic disturbances that exceed defined levels and has an adequate level of immunity to enable it to be operated as intended. The specific standards applicable to this product are detailed in the appendices.

Since there are many electrical products in use that pre-date this Directive and may emit electromagnetic radiation in excess of the standards defined in the Directive there may be occasions where it would be appropriate to check the analyser prior to use.

The following procedure should be adopted:
Go through the normal start up sequence in the location where the equipment is to be used.

Switch on all localised electrical equipment that might be capable of causing interference.

Check that all readings are as expected. (A level of disturbance in the readings is acceptable). If not adjust the position of the instrument to minimise interference or switch off, if possible, the offending equipment for the duration of the test.

N.B. Maximum cable lengths must be less than 3 metres.

At the time of writing this manual (January 1997) Dwyer Instruments Inc. are not aware of any field based situation where such interference has ever occurred and this advice is only given to satisfy the requirements of the Directive.
5. MOVING THROUGH THE MENUS

5.1 Basic Operation

From the MAIN DISPLAY

| NETT C | .... | 0.0 |
| O2 %   | .... | 20.9|
| CO ppm | .... | 0000|
| EFF (G) % | .... | 0.0 |

Press to access the MAIN MENU

| 1 SELECT | 3. DISPLAY |
| 2 UNITS   | 4. SETUP   |

Press and to move cursor up and down

Press to access selected Menu

Press to select parameter

Use and to change setting i.e. fuel selected

Press to enter value and move to next parameter

Press to save settings and return to the MAIN MENU

Press to return to the MAIN DISPLAY
5.2 Menu Options and Settings

5.2.1 Main Menu

The MAIN MENU consists of 4 sub menus which are shown below and detailed on the following pages.

<table>
<thead>
<tr>
<th>MAIN MENU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SELECT</td>
</tr>
<tr>
<td>2. UNITS</td>
</tr>
</tbody>
</table>

All sub-menus are accessed using \( \leftarrow \) and exited using \( \Rightarrow \).

The \( \uparrow \) and \( \downarrow \) keys move the cursor within a menu and allow parameters to be changed.

TIP Holding down one of these keys scrolls through the data quicker.

5.2.2 Select Menu

<table>
<thead>
<tr>
<th>FUEL      : NATURAL GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2 Ref : OFF</td>
</tr>
<tr>
<td>SMOKE : OFF</td>
</tr>
<tr>
<td>RESET : NO</td>
</tr>
</tbody>
</table>

This menu allows selections to be made for the parameters detailed below.

FUEL: Select the fuel being used by the boiler from either a standard fuel stored in the analyser or by entering one of two user fuels. Once the correct fuel has been selected press \( \Rightarrow \) to view the fuel constants.

<table>
<thead>
<tr>
<th>NATURAL GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1g : 0.350</td>
</tr>
<tr>
<td>K_2 : 11.89</td>
</tr>
<tr>
<td>K_4 : 32</td>
</tr>
<tr>
<td>K1n : 0.390</td>
</tr>
<tr>
<td>K_3 : 9.83</td>
</tr>
<tr>
<td>O2r : 3.0</td>
</tr>
</tbody>
</table>
1.2 Instrument Layout (Rear)

*NOTE! Do not cover exhaust port as this will severely affect analyser operation
Calculation of fuel constants are detailed in the Appendix. Fuel constants will have to be calculated before a user fuel can be entered.

To enter a user fuel select 'User Fuel' and Press

<table>
<thead>
<tr>
<th>USER FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₁g : 0.00 K₁n : 0.00</td>
</tr>
<tr>
<td>K₂ : 0.00 K₃ : 0.00</td>
</tr>
<tr>
<td>K₄ : 00 O₂r : 00</td>
</tr>
</tbody>
</table>

Use ↑ and ↓ to select the correct value.

<table>
<thead>
<tr>
<th>USER FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₁g : 0.350 K₁n : 0.00</td>
</tr>
<tr>
<td>K₂ : 0.00 K₃ : 0.00</td>
</tr>
<tr>
<td>K₄ : 0 O₂r : 00</td>
</tr>
</tbody>
</table>

Use ← to move to the next parameter, repeat above until all parameters are correct. Press → to return to SELECT menu.

O₂ Ref:

Toxic gas measurements can be referenced to defined oxygen levels. Reference values can be set from 1-20%, to AUTO or more normally to the default value - OFF. Setting to AUTO uses the figure in the FUEL constants data.

Oxygen referencing is required by some regulations such as TA-LUFT. If a reference value is selected then toxic gas measurements will be displayed with the symbol (n) attached to the reading. i.e. CO(n)

What does Oxygen reference mean?

If 3 % O₂ reference is selected and 5 % O₂ is measured in the flue then toxic gas values will be recalculated as if 3 % were measured. The equation for referencing is detailed in the Appendix.

Oxygen referencing prevents false readings being submitted, e.g. allowing more air into the boiler will increase the oxygen level in the flue and hence dilute any toxic gas reading. Oxygen referencing gives readings as if they were undiluted.

SMOKE: Allows the user to enter a smoke test number from 0-9. This value will be printed on the standard printout. Default value is OFF.

RESET: Allows the user set the Oxygen to 20.9% and zero the toxic sensors without turning the analyser off.
Selecting YES and will display the following screen.

```
RESET SENSORS
O2 % : 20.9  CO & NO = 0
PRESS ENTER
MENU TO ESCAPE
```

After pressing the analyser will count down for 5 seconds and then return to the main display.

**WARNING:** The sensors must only be reset if you are sure they have been sampling fresh air for at least 3 minutes. Errors in measurement will occur if the sensors are reset during or just after sampling.

### 5.2.3 Units Menu

<table>
<thead>
<tr>
<th>TEMP</th>
<th>: C</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAS</td>
<td>ppm</td>
</tr>
<tr>
<td>PRESS.</td>
<td>mbar</td>
</tr>
<tr>
<td>EFF.</td>
<td>GROSS</td>
</tr>
</tbody>
</table>

Allows all displayed units to be changed.

**TEMP:** Choose selections from Centigrade °C or Fahrenheit °F.

**GAS:** Changes the toxic gas measurement units. Select from volumetric readings, parts per million (ppm) or mass flow reading milligrams per cubic meter (mg/m³).

**PRESS.:** Flue draught can be displayed in millibar (mbar), hectaPascals (hPa), millimeters water gauge (mmWG) or inches water gauge (in WG).

**EFF.:** Efficiency can be selected for Gross or Net values. Gross efficiency assumes latent heat of vapourisation is lost in the boiler and hence will be lower than Net efficiency. For Natural Gas the difference will be approximately 11%.
5.2.4 Display Menu

| LIGHT   | OFF |
| MODE   | 8-PAGE |
| CONTRAST  | DEFAULT |

Allows the configuration of the display to be changed.

LIGHT : Choose from ON or OFF.

MODE : Select 4 or 8 Page Mode or Line Scroll Mode as detailed in section 4.3 Main Displays.

CONTRAST : The contrast is set to a DEFAULT value or can be adjusted
† LIGHTER or ↓ DARKER. Use the ↖ and ↙ keys to adjust.

5.2.5. Set-Up Menu

The set up menu allows the following parameters to be set / altered.

- Language.
- Automatic calibration time
- CO gas alarm
- NOx percentage for calculation
- Date and time
- Printout Header

| LANG     | ENGLISH ZERO : 3 |
| CO ALARM | 400 NOx% : 5 |
| CALENDAR | HEADER |

Parameter | Description | Settings
---|---|---
LANG : | Changes the analysers displayed and printed language. | ENGLISH
| | | SPANISH
| | | DUTCH
| | | FRENCH
| | | ITALIAN

ZERO : | Allows setting of the Autocalibration time in minutes. Care must be taken when changing this parameter as sensors may drift from zero if too short a time is used. Dwyer Instruments Inc. advise a 3 minute countdown. | 2-6 minutes

CO ALARM : | Allows an alarm level to be set on for the CO reading. This is set as a default at 1000 ppm. | OFF
| | | 0-4000 ppm
Once an alarm has been exceeded the display will flash every two minutes warning the user of an alarm state and display the gas concentration. A similar display will be shown during a RECHARGE BATTERY and PUMP OFF alarms.

\[
\text{NO REF:} \quad \text{Displayed on the Nitric Oxide unit only. Allows the percentage P in the following calculation to be set. The default value set is 5%. Note the percentage allows for NO}_2 \text{ in a typical boiler.}
\]

\[
\text{NO}_x = \text{NO} + \text{P} \% \text{ NO}
\]

\[
\text{CALENDAR:} \quad \text{Allows the user to change the date and time. (24 hour clock). The following screen will be shown once the parameter is entered:}
\]

\[
\begin{align*}
\text{TIME:} & \quad 13 : 53 : 26 \\
\text{FORMAT:} & \quad dd : mm : yy \\
\text{DATE:} & \quad 03 : 01 : 96
\end{align*}
\]

\[
\text{FORMAT:} \quad \text{Changes the date format for display and printing.}
\]

\[
\begin{align*}
\text{dd : mm : yy} \\
\text{yy : mm : dd} \\
\text{mm : dd : yy}
\end{align*}
\]

To change the time position the cursor on Time and press \( \rightarrow \). The cursor will now be to the left of the 13 as shown below:

\[
\begin{align*}
\text{TIME:} & \quad 13 : 53 : 26 \\
\text{FORMAT:} & \quad dd : mm : yy \\
\text{DATE:} & \quad 03 : 01 : 96
\end{align*}
\]

Using \( \uparrow \) and \( \downarrow \) scroll through the setting options i.e. 0-23.

Once the correct hour is set press \( \leftarrow \) to move to the next parameter, the cursor will move to the left of minutes (33). Move to each parameter until the correct time is set. Pressing \( \rightarrow \) after setting the seconds will return the cursor to the left of the screen.

Format and Date are set in a similar manner.
Header: Allows two lines of 20 characters to be programmed into the analyser. The header appears on the top of the standard printout. This can be used to print your company name and/or phone number.

Name/Phone
Dwyer Instruments Inc.
219-879-8868
'LEFT' USE STORE KEY

The screen above shows the standard header setting with the cursor now shown underlining the D in Dwyer. By using these keys, any letter or number can be chosen.

Once the correct character is displayed, use to move right to the next. Move along until all characters spell the desired name or phone number. If you need to go back and change a character use to move left.

Press to return to the SETUP menu.
6. PRINTING INFORMATION

Supplied as accessories for the 1207 are an infra-red thermal printer or a dot matrix serial printer. Read the manual supplied with each printer prior to operation. Connections to the 1207 are detailed below:

- **Infra-red thermal printer** - this does not require a cable to transmit the data but uses an infra-red (IR) link similar to a TV remote control. The IR emitter is positioned on the top of the 1207 and the bottom of the printer. Ensure they are pointing at each other and within 300 mm, with no obstructions in the way. Data may be lost if transmission is interrupted. Keep the 1207 pointing at the printer until the printout has finished.

- **Dot matrix serial printer** - requires the supplied serial cable to transmit data. Connect the cable to the 8 pin DIN socket on the top of the 1207 and the 25 pin D-connector on the printer.

Data can either be printed from a 'live' test or from stored data. Printing of stored data is detailed in STORING AND RETREIVING DATA.

6.1 Printing a 'Live' Test

During a combustion test the 1207 will print data on request. With the analyser showing the MAIN DISPLAY press [9] and current data will be sent to the printer.

The display will show the following until data transmission is complete.

```
***** Printing *****
```

6.2 Standard Printout

The standard printout is shown below:

```
1207

Dwyer Instruments Inc.
219-879-8868

TEST 36
DATE: 01-01-96
TIME: 15:46:02
NATURAL GAS

NET C . . . . . . . . 2
O2 % . . . . . . 20.3
CO ppm . 02 > 20%
EFF % [Fe] . . . . 87.0
CO2 % . . . . . . 0.3
FLUX C . . . . . . 24
INFL C * NOT FITTED
AMBIENT C . . . . 22.0

COXCO2 R . . . . . . . . 0.0000
P INDEX % . . . . 0.00
XAIR % . 02 > 20%
Pr molar . . . . 0.0
```

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7. STORING AND RETRIEVING DATA

The 1207 can store up to 100 combustion tests. Once stored, the data can be viewed on the display or downloaded to a PC or printer.

7.1 Storing a ‘Live’ Test

While performing a test and viewing the data on the MAIN display access the STORE menu as follows:

Press \[ \text{ } \] to access the STORE MENU

STORE MENU
MODE: STORE
LOCATION: 3
PRESS ‘STORE’ TO LOG

Mode: Select from the following:

- STORE - Allows data to be stored in memory.
- VIEW / PRINT - Stored data can be viewed or printed.
- DELETE - Clears all data in memory.

Location: Automatically allocates a location in the memory of the instrument for the next test. On the display shown above the next location will be 3.

To store a test set MODE to STORE and press \[ \text{ } \] The current readings will be stored in the analysers memory.

Tip: Make a note of the location number for your particular test as it may be useful when downloading or printing.

7.2 Viewing and Printing a ‘Stored’ Test

Press \[ \text{ } \] to access the STORE MENU

STORE MENU
MODE: VIEW / PRINT
LOCATION: 1 TO 10
PRESS ‘MENU’ TO VIEW

Move the cursor to Mode and press \[ \text{ } \]. The cursor will move to the first number, use the \[ \text{ } \] and \[ \text{ } \] to select the location and start viewing.

Press \[ \text{ } \] to move the cursor to the second number, select the last location to view.
To print the data press \[\text{Print} \]. In the screen shown above locations 1 to 10 will be printed or displayed.

Once the correct location is set press \[\text{View} \] to view the stored data as follows (Note the column of * indicating stored data):

- LOCATION ... 1
- DATE ... 07-08-96
- TIME ... 12:31:35
- NATURAL GAS

Use \[\text{Next} \] and \[\text{Previous} \] to page through data as in MAIN DISPLAYS.

Press \[\text{Back} \] to return to the MAIN MENU.

While viewing the stored data, as above, a printout can be obtained by pressing \[\text{Print} \].

**TIP:** Stored and displayed with the data are actual time and date of the test.

### 7.3 Deleting Data

To delete the data in stored memory press \[\text{Delete} \] to obtain the STORE MENU (as above):

Press \[\text{Mode} \] to access the STORE MENU

STORE MENU

- MODE : DELETE
- LOCATION : 3
- PRESS ‘ENTER’ TO DELETE

Press \[\text{Enter} \] to access delete data screen

ENTER to ERASE DATA

MENU to ESCAPE

Press \[\text{Back} \] to delete data in memory, press \[\text{Exit} \] to exit delete data screen.
8. MAINTENANCE

8.1 Emptying and Cleaning the In-line Water Trap

The in-line water trap should be checked and emptied on a regular basis. Water vapour will condense and gather in the probe line. This may move suddenly to the trap when the probe is moved. Care should be taken at all times.

Emptying of the water trap is detailed below:

Carefully remove the end cap from the in-line housing. Dispose of the condensate in a suitable drain, care must be taken as it could be acidic. If condensate spills onto the skin or clothing, clean off immediately using fresh water, seek medical advice if problems occur.

8.2 Changing the Particle Filter

This is a very important part of the analyser and should be changed regularly. It prevents dust and dirty particles entering the pump and sensors and hence causing damage. The filter MUST be changed when it is discoloured.

Remove the end cap from the in-line filter housing. Carefully remove the paper filter element and dispose of it. Clean the inside of the filter housing with a suitable soft cloth. Insert a new filter element onto the spigot in the filter housing and carefully replace the end cap.
9. PROBLEM SOLVING

The following is a list of problems that may occur on the instrument through its operating life. If the cause of the fault is not easy to identify then we advise you contact Dwyer Instruments Inc. for expert advice.

<table>
<thead>
<tr>
<th>Fault symptom</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Oxygen too high</td>
<td>• Air leaking into probe, tubing, water trap, connectors or internal to instrument.</td>
</tr>
<tr>
<td>• CO₂ too low</td>
<td>• Oxygen cell needs replacing.</td>
</tr>
<tr>
<td>• Oxygen Error (FAULT)</td>
<td>• Calibration time set too short and instrument not allowed to stabilise</td>
</tr>
<tr>
<td>• Toxic sensor Error (FAULT)</td>
<td>• Instrument has been stored in a cold environment and is not at normal working temperature.</td>
</tr>
<tr>
<td>• Analyser not holding charge</td>
<td>• Oxygen cell or toxic sensors needs replacing.</td>
</tr>
<tr>
<td>• Analyser not charging</td>
<td>• Battery exhausted.</td>
</tr>
<tr>
<td>• Analyser does not respond to flue gas</td>
<td>• AC charger not giving correct output.</td>
</tr>
<tr>
<td>• Analyser does not respond to flue gas</td>
<td>• Fuse blown in charger plug.</td>
</tr>
<tr>
<td>• Flue temperature readings erratic</td>
<td>• Particle filter blocked.</td>
</tr>
<tr>
<td>• Analyser automatically switches off</td>
<td>• Probe or tubing blocked.</td>
</tr>
<tr>
<td>in operation</td>
<td>• Pump not working or damaged with contaminants.</td>
</tr>
<tr>
<td>• Display shows dark lines and no</td>
<td>• Probe connected to pressure connector.</td>
</tr>
<tr>
<td>reponse from ON/OFF key.</td>
<td>• Temperature plug reversed in socket.</td>
</tr>
<tr>
<td></td>
<td>• Faulty connection or break in cable or plug.</td>
</tr>
<tr>
<td></td>
<td>• Battery below alarm level.</td>
</tr>
<tr>
<td></td>
<td>• Ambient temperature above 50°C.</td>
</tr>
<tr>
<td></td>
<td>• Battery quickly discharging and is faulty.</td>
</tr>
<tr>
<td></td>
<td>• Fault has occurred on the instrument electronics and requires resetting. Contact Dwyer Instruments Inc. or a Distributor.</td>
</tr>
</tbody>
</table>

10. ANNUAL RE-CALIBRATION

Whilst the sensors have an expected life of more than two years in normal use it is recommended that the analyser is re-calibrated at least annually. This is so that long term drift on the sensors and electronics can be eliminated. Local regulation may require more frequent re-calibration and users should check with appropriate authorities to ensure they comply with relevant guidelines.
## 11. PRODUCT SPECIFICATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Resolution</th>
<th>Accuracy</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp Measurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flue Temperature</td>
<td>1.0°C/F</td>
<td>±2.0°C ±0.3% reading</td>
<td>0-600°C/32-1112°F</td>
</tr>
<tr>
<td>Inlet Temperature</td>
<td>0.1°C/F</td>
<td>±1°C ±0.3% reading</td>
<td>0-50°C/32-122°F</td>
</tr>
<tr>
<td>Gas Measurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.1%</td>
<td>±0.2%&quot;¹</td>
<td>0-21%</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>1ppm,mg/m³</td>
<td>±20ppm &lt;400ppm &quot;¹</td>
<td>0-4000ppm, 0-5000mg/m³</td>
</tr>
<tr>
<td>Carbon Monoxide, H₂ compensated</td>
<td>1ppm,mg/m³</td>
<td>±20ppm &lt;400ppm &quot;¹</td>
<td>0-10,000ppm, 0-12,000mg/m³</td>
</tr>
<tr>
<td>Nitric Oxide (optional)</td>
<td>1ppm,mg/m³</td>
<td>±5ppm &lt;100ppm &quot;¹</td>
<td>0-5000ppm, 0-6700mg/m³</td>
</tr>
<tr>
<td>Pressure (optional)</td>
<td>0.1 mbar</td>
<td>±5.0% full scale</td>
<td>150 mbar</td>
</tr>
<tr>
<td>Carbon Dioxide &quot;²</td>
<td>0.1%</td>
<td>±0.3% reading</td>
<td>0-99.9%</td>
</tr>
<tr>
<td>Losses &quot;²</td>
<td>0.1%</td>
<td>±1.0% reading</td>
<td>0-99.9%</td>
</tr>
<tr>
<td>Efficiency &quot;²</td>
<td>0.1%</td>
<td>±1.0% reading</td>
<td>0-99.9%</td>
</tr>
<tr>
<td>Excess Air &quot;²</td>
<td>0.1%</td>
<td>±0.2%</td>
<td>0-2885.0%</td>
</tr>
<tr>
<td>Temp (Netu) &quot;²</td>
<td>1.0°C/F</td>
<td>±2°C ±0.3% reading</td>
<td>0-600°C/32-1112°F</td>
</tr>
<tr>
<td>CO2/CO₂ ratio &quot;²</td>
<td>0.0001</td>
<td>±0.001</td>
<td>0-0.9999</td>
</tr>
<tr>
<td>Poison Index &quot;²</td>
<td>0.01%</td>
<td>±0.01</td>
<td>0-99.99</td>
</tr>
</tbody>
</table>

| Pre-programmed Fuels               | Natural gas, Town gas, Gasco, Light Oil, Heavy Oil, Propane, Butane, Anthracite, Coke, Coal, Kinsale Gas. |

### Dimensions

| Weight | 1kg |
| Handset | 220mm x 55mm x 120mm |
| Probe  | L40mm x Dia8mm with 285mm long stainless steel shaft, type K thermocouple and 1.5m long neoprene hose |

### Ambient Operating Range

-60°C to +40°C/10% to 90% RH non condensing

### Power Supply (battery charger)

| Input: | 110Vac/220 Vac nominal |
| Output: | 12 Vac off load |

### Battery Life

> 8 hours from full charge

¹ Using dry gases at STP
² Calculated
APPENDICES

A - Main Display Parameters

The parameters and their meanings are detailed as follows:

**DATE:** Analysers date. See Set-Up menu section 5.2.5 to change.

**TIME:** Analysers time. Use Set-Up menu section 5.2.5 to change.

**BATTERY (BAT):** Displays the battery level from 0-100%. The analysers will flash RECHARGE BATTERY at less than 10% of charge. With the charger connected the display shows AC ON.

**NETT:** Net temperature calculated by deducting the internal AMBIENT temperature from the measured FLUE temperature. Displays in either °C (C) or °F (F) and will display NOT FITTED (N/F) if flue probe is not connected.

If an external INLET probe is used then INLET is deducted from FLUE.

**O2:** Oxygen reading in percentage %.

**CO:** Carbon Monoxide reading indicated in ppm or mg/m3. If the figures are referenced to oxygen then the display will show CO(%) - see SELECT menu 5.2.2 for oxygen reference. The display will read 'O2 > 20%' if referenced values selected and instrument is in clean ambient air.

**EFF (G):** Combustion Efficiency calculation displayed in percentage. Gross G or Net N can be selected - see SELECT menu 5.2.3. The calculation is determined by fuel type - see Appendix B for calculation. The efficiency is displayed during a combustion test, '-' is displayed while in fresh air.

**CO2:** Carbon Dioxide calculation determined by the type of fuel. This only shows a reading when a combustion test is being carried out. '-' '-' is displayed while in fresh air.

**FLUE (TT):** Temperature measured by flue gas probe in Centigrade or Fahrenheit. Will show ambient temperature after fresh air calibration and NOT FITTED (N/F) or FAULT (FLT) if probe disconnected.

**INLET (TT):** Temperature measured by the optional inlet air probe. This probe is plugged into the instrument through the RS232 socket. This figure is used to calculate the NET temperature instead of AMBIENT when fitted.
**AMBIENT:** Temperature measured by the internal sensor, used in the NET temperature calculation if an INLET probe is not fitted.

**CO/CO₂:** The CO/CO₂ ratio, is the ratio of measured CO divided by calculated CO₂.

It gives an indication of the following:-

- How good a gas sample the instrument is reading.
- How clean the boiler is running.

For example: A new or clean domestic boiler will display a ratio of less than 0.004, a unit in need of cleaning 0.004-0.008 and a unit in need of major overhaul will show greater than 0.008.

This only shows a reading when a combustion test is being carried out. ‘- -’ is displayed while in clean ambient air.

**P INDEX:** The CO/CO₂ ratio expressed as a percentage %, called the 'Poison Index' i.e. P INDEX % = 100 x CO/CO₂. ‘- -’ is displayed while in clean ambient air.

**XAIR %:** Excess air calculated from the measured oxygen and type of fuel used. During a combustion test 'O₂ > 20%' will be displayed while in clean ambient air.

**Prs:** Flue draught pressure reading. Displayed when pressure sensor fitted. See UNITS menu 5.2.3. for scales.

**NO:** Nitric Oxide reading in ppm or mg/m³. Displayed when Nitric Oxide sensor fitted. Also displayed as NO (ₖ) when referenced to oxygen. The display will read ‘O₂ > 20%’ if referenced values selected and instrument is in clean ambient air.

**NOₓ:** Calculated total Nitric oxides displayed in ppm or mg/m³. Where NOₓ = NO + P%NO, note P can be set from 0-9%, default = 5%. See SELECT menu 5.2.2. Also displayed as NOₓ (ₖ) referenced to oxygen. The display will read ‘O₂ > 20%’ if referenced values are selected and instrument is sampling clean ambient air.

**SO₂:** Sulphur Dioxide reading in ppm or mg/m³. Displayed when Sulphur Dioxide sensor fitted. Also displayed as SO₂ (ₖ) referenced to oxygen. The display will read ‘O₂ > 20%’ if referenced values selected and instrument is in clean ambient air.

**O₂ ref %:** Toxic gas measurements can be referenced to defined oxygen levels. See SELECT menu 5.2.2 for details.
B. COMBUSTION EFFICIENCY CALCULATION

The efficiency calculation is based upon British Standard BS845.

This identifies three sources of loss associated with fuel burning:

**Losses due to flue gasses:**
- Dry Flue gas loss,
- Moisture and hydrogen
- Sensible heat of water vapour
- Unburned gas

**Losses due to refuse:**
- Combustible in ash
- Combustible in riddlings
- Combustible in dust

**Other losses:**
- radiation
- convection
- conduction
- other unmeasured losses

Net efficiency calculations assume that the energy contained in the water vapour (formed as a product of combustion and from wet fuel) is recovered and the wet loss term is zero. Gross efficiency calculations assume that the energy contained in the water vapour is not recovered.

Since the fuel air mixture is never consistent there is the possibility of unburned/partially unburned fuel passing through the flue. This is represented by the unburned carbon loss.

Losses due to combustible matter in ashes, riddlings, dust and grit, radiation, convection and conduction are not included.

**Efficiency Calculation:**

**Known Data - Fuel:**
- $Q_{gr}$ = Gross Calorific Value (kJ/kg)
- $Q_{net}$ = Net Calorific Value (kJ/kg)
- $K_1$ = Constant based on Gross or Net Calorific Value:
  - $K_{lg} = (255 \times \% \text{Carbon in fuel})/Q_{gr}$
  - $K_{ln} = (255 \times \% \text{Carbon in fuel})/Q_{net}$
- $K_2$ = Max theoretical $\text{CO}_2$ (dry basis)
- $K_3$ = % Wet Loss
- $H_2$ = % Hydrogen
- $H_2O$ = % Water

**Measured Data:**
- $T_f$ = Flue Temperature
- $T_i$ = Inlet Temperature
- $O_{2m}$ = % Oxygen in flue gas
- $O_{2r}$ = Oxygen reference %
Calculated data:

- $T_{net} = \text{Net Temperature}$
- $\% \text{ CO}_2 \text{ content in flue gas}$
- $\% \text{ Dry Flue Gas losses}$
- $\% \text{ Wet losses}$
- $\% \text{ Unburned carbon loss}$
- $\% \text{ Efficiency}$

$T_{net} = \text{Flue Temperature} - \text{Inlet Temperature}$

**Dry flue gas loss %**

$= 20.9 \times K_1 \ln x (T_{net}) / K_2 \times (20.9 - O_{2m})$

**Wet loss %**

$= 9 \times H_2 + H_2O / Q_{gr} \times [2488 + 2.1T_f - 4.2 T_i]$

simplified

$= [(9 \times H_2 + H_2O) / Q_{gr}] \times 2425 \times (1 + 0.001 \times T_{net})$

$\text{Wet loss %} = K_3(1 + 0.001 \times T_{net})$

Where $K_3 = [(9 \times H_2 + H_2O) / Q_{gr}] \times 2425$

**Net Efficiency %**

$= 100 - \text{dry flue gas losses}$

$= 100 - 20.9 \times K_1 \ln x (T_{net}) / K_2 \times (20.9 - O_{2m})$

**Gross Efficiency %**

$= 100 - [\text{dry flue gas losses} + \text{wet losses}]$

$= 100 - [20.9 \times K_1 \ln x (T_{net}) / K_2 \times (20.9 - O_{2m})]$

$+ [K_3 \times (1 + 0.001 \times T_{net})]$

**Excess Air**

$= [(20.9 / (20.9 - O_{2m})] - 100$

**CO₂ %**

$= [(20.9 - O_{2m}) \times K_2 / 20.9]$

**Unburned fuel Loss %**

$= K_4 \times CO / (CO + CO₂) \quad \text{Note: CO scaled in %}$

Where $K_4 = 70 \quad \text{for coke}$

$= 65 \quad \text{for anthracite}$

$= 63 \quad \text{for Bituminous coal}$

$= 62 \quad \text{for coal tar fuel}$

$= 48 \quad \text{for liquid petroleum fuel}$

$= 32 \quad \text{for natural gas}$

The formula for $K_4$ is based on the gross calorific value $Q_{gr}$. To obtain the loss based on net calorific value multiply by $Q_{gr}/Q_{net}$. Since this loss is usually small this conversion has been ignored.

**Oxygen Reference**

$CO(n) = CO \times \frac{(20.9 - O_{gr})}{(20.9 - O_{2m})}$
C. CALCULATION OF FUEL DATA

For any fuel not specified by Dwyer Instruments Inc., the net calorific value, gross calorific value and composition should be obtained from the fuel supplier.

The following fuel data has been calculated with reference to the efficiency calculation.

Example 1:

Chemical composition:   C       25%
                        H_2       3%
                        H_2O     50%
                        Q_{nor}  8.35 MJ/kg
                        Q_f      9.3 MJ/kg
                        Max CO_2 20.4%

\[ K_{1n} = \frac{(255 \times \% \text{ carbon in fuel})}{Q_{nor} (kJ/kg)} \]
\[ = \frac{(255 \times 25)}{8350} = 0.763 \]

\[ K_{1g} = \frac{(255 \times \% \text{ carbon in fuel})}{Q_f (kJ/kg)} \]
\[ = \frac{(255 \times 25)}{9300} = 0.685 \]

\[ K_2 = \text{Max } \% \text{ CO}_2 = 20.40 \]

\[ K_3 = \text{Wet Loss} = \frac{(9 \times \% H_2 + \% H_2O)}{9300} \times 2425 \]
\[ = \frac{(9 \times 3 + 50)}{9300} \times 2425 \]
\[ = \frac{(77 \times 9300)}{2425} = 20.08 \]

\[ K_4 = 65 \text{ (an approximation for wood)} \]

The fuel values to program into the Analyser are as follows:

<table>
<thead>
<tr>
<th>NATURAL GAS</th>
<th>( K_{lg} ) : 0.763</th>
<th>( K_{1n} ) : 0.685</th>
</tr>
</thead>
<tbody>
<tr>
<td>( K_{3} ) : 20.4</td>
<td>( K_{3} ) : 20.08</td>
<td>( K_{4} ) : 65</td>
</tr>
<tr>
<td>( O_{2r} ) : 8.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Assumed values in the absence of supplied data. See previous appendix for other fuels.