IKA® Calorimeter System C 7000 with Cooler C 7002

OPERATING INSTRUCTIONS *EN/ USA*

Vers. 07 09.07 Reg.-No. 4343-01

CE – KONFORMITÄTSERKLÄRUNG ***DE***

Wir erklären in alleiniger Verantwortung, dass dieses Produkt den Bestimmungen der Richtlinien 89 / 336 / EG und 2006 / 95 / EG entspricht und mit folgenden Normen und normativen Dokumenten übereinstimmt: DIN EN IEC 61 010-1 und DIN EN IEC 61 326-1.

CE – DECLARATION OF CONFIRMITY ***EN***

We declare under our sole responsibility that this product corresponds to the regulations 89 / 336 / EEC and 2006 / 95 / EEC and conforms with the standards or standardized documents: DIN EN IEC 61 010-1 and DIN EN IEC 61 326-1.

DÉCLARATION DE CONFORMITÉ CE ***FR***

Nous déclarons sous notre responsabilité que se prodiut est conforme aux réglementations 89 / 336 / CEE et 2006 / 95 / CEE et en conformité avec les normes ou documents normalisés suivant: DIN EN IEC 61 010-1 et DIN EN IEC 61 326-1.

DECLARACION DE CONFORMIDAD DE CE ***ES***

Declaramos por nuestra responsabilidad propia que este producto corresponde a las directrices 89 / 336 / CEE y 2006 / 95 / CEE y que cumple las normas o documentos normativos siguientes: DIN EN IEC 61 010-1 y DIN EN IEC 61 326-1.

CE – DICHIARAZIONE DI CONFORMITÀ ***IT***

Dichiariamo, assumendone la piena responsabilità, che il prodotto è conforme alle seguenti direttive 89 / 336 / CCE e 2006 / 95 / CCE, in accordo ai seguenti regolamenti e documenti: DIN EN IEC 61 010-1 e DIN EN IEC 61 326-1.

Explanation of symbols

This symbol identifies information **that is of absolute importance to ensure your health and safety.** Failure to observe this information may be detrimental to your health or may result in injuries.

This symbol identifies information **that is of important to ensure problem-free technical operation of the device.** Failure to observe this information may result in damage to the calorimeter system.

This symbol identifies information that is important to ensure problem-free operation of calorimetric measurements and for working with the calorimeter system. Failure to observe this information may result in inaccurate measurement results.

Contents

1 For your safety

In order to be able to use the appliance properly and safely, every user must first read the operating instructions and observe the safety instructions contained therein. Take care of these operating instructions and keep them in a place where they can be accessed by everyone.

intended purpose

The C 7000 calorimeter system may only be used to determine the gross calorific value of solid and liquid materials in accordance with DIN 51900 and ISO 1928. For this purpose, use only original IKA® decomposition vessels C 7010 and C 7012. For further details please see the operating instructions of the decomposition vessels C 7010 and C 7012.

Operating requirements

The maximum amount of energy input into the decomposition vessel must not exceed **30000 J** (select the weight of the sample accordingly). The permissible operating pressure of **230 bar (23 Mpa)** must not be exceeded. The maximum permissible operating temperature must not exceed **50 °C**.
Do not fill the decomposition vessel too full of the sample. Only fill the decomposition vessel with oxygen up to a maximum pressure of **40 bar (4 Mpa)**. Monitor the adjusted pressure on the pressure reducer. Perform a check before every combustion to ensure there are no leaks combustion (please observe the operating instructions of the decomposition vessels C 7010 and C 7012, chapter ”Leakage test”).

Explosive substances

Many substances tend to combust in an explosive manner (for example because of the formation of peroxide). This may cause the decomposition vessel to burst.
The standard decomposition vessels must not be used for examinations on samples that are capable of exploding. It is absolutely essential to use a special high-pressure decomposition vessel to contain the sample in these cases! This high-pressure decomposition vessel can only be used with the C 2000 calorimeter system.

Notes on the sample

Substances of which the combustion behavior is not known must be examined for their combustion behavior before combustion in the decomposition vessel C 7010 or C 7012 (danger of explosion). If you are burning **unknown samples**, leave the room or **keep a safe distance between** you and the calorimeter.
Benzoic acid must only be burned in the form of pellets! Combustible dust and powder must be compressed into pellets before combustion. Oven-dry dust and powder such as wood chips, hay, straw, etc. burn in an explosive manner! They must be moistened first! Readily combustible liquids with a low vapor pressure must not be come in direct contact with the cotton thread (for example tetramethyl dihydrogen disiloxan)!

Combustion residue, auxiliary materials

In addition, toxic residues of combustion are possible in the form of gasses, ash or precipitates on the inner wall of the decomposition vessel, for example.

Observe the accident prevention requirements applicable to the activity and the work station. Wear personal safety equipment.

When handling combustion samples, combustion residues and auxiliary materials, the appropriate safety requirements must be observed. The following are examples of substances that may cause dangers:

- corrosive
- easily flammable
- capable of exploding
- contaminated with bacteria
- toxic

Oxygen

When working with oxygen, observe the appropriate requirements.
Danger warning: As a compressed gas, oxygen promotes combustion, supports combustion intensively and may react violently with combustible substances.
Do not use any oil or grease!
Keep all gas lines and screw connections that carry oxygen free from grease.
Observe the accident prevention requirements applicable to the activity and the work station.
Close the main valve on the oxygen supply when work is complete.
Only carry out maintenance work when the system is depressurised.

Using a crucible made of stainless steel

When using crucibles made of stainless steel, their condition should be carefully checked after every experiment.
A reduction in the thickness of the material may cause the crucible to burn and may damage the decomposition vessel. For reasons of safety, crucibles must not be used any more after a maximum of 25 combustion procedures.

intended purpose

The decomposition vessel C 7010 and C 7012 are manufactured in accordance with the regulation for pressure vessels 97/ 23/ EC. This can be recognized from the **CE symbol** with the identifying number of the testing station named. The decomposition vessel is a pressure device of Category III. The decomposition vessel has been subjected to an EC prototype test. The CE declaration of conformity represents our guarantee to you that this decomposition vessel complies with the pressure device described in the EC prototype test certificate. The decomposition vessel has been subjected to a pressure test at a test pressure of **330 bar** and a leak test with oxygen at 30 bar.
Decomposition vessels are **experiment autoclaves** and must be tested by a **professionally trained person** each time before they are used.
An individual application is understood here to mean a series of experiments that are performed under roughly the same conditions in terms of pressure and temperature Experiment autoclaves must be operated in special chambers (C 7000).

Repeated tests

The decomposition vessel must be subject to repeated tests (internal tests and pressure tests) by a person with professional training. The intervals between tests must be determined by the operator based on experience, operating manner and the material used in the decomposition vessel.
The declaration of conformity loses its validity if mechanical modifications are made to the experiment autoclaves or if stability can no longer be guaranteed as a result of heavy corrosion (for example holes eaten in it by halogens).
The **threading** on the body of the decomposition vessel and cap screw in particular are subject to a high level of mechanical stress and must therefore be monitored regularly for **wear and tear**.
The condition of the seals must be checked for functionality must be ensured by means of a test for leaks (please observe the Operating Instructions for the decomposition vessel).
Pressure tests and service tasks on the decomposition vessel must only be performed by persons with professional training.

We recommend that the decomposition vessel be sent into our factory for inspection and repairs if necessary after either 1000 experiments or after one year or, depending on the application, even sooner than this.

Definition of person with professional training

A person with professional training as defined in these operating instructions is someone

1. whose training, knowledge and experience gained through practical activities ensures that that person will perform the tests in a proper manner.
2. who is sufficiently reliable
3. who is not subject to any instructions in terms of testing activity
4. who is equipped with suitable testing equipment if necessary
5. who can provide suitable proof demonstrating compliance with the requirements listed in 1.

Operating pressure containers

National regulations and laws for operating pressure containers must be observed! Anyone who operates a pressure container must maintain it in proper condition, must monitor it and perform necessary maintenance and repair tasks without delay, and must take measures appropriate for the circumstances to ensure safety.
A pressure container must not be operated if it exhibits defects that could endanger those working with it or third parties. You can obtain a copy of the pressure vessel regulation from Carl Heymann Verlag or Beuth Verlag.

2 User notes

2.1 Notes on using the operating instructions

In this section you will learn how to make the most effective use of these Operating Instructions so as to be able to work safely with the calorimeter system.

The instructions given in Section 1 “For your Safety” must be followed without fail.

Studying Sections 1 ... 10

Work through Sections 1 ... 10 in numerical order.
Section 3 "Transport, Storage, Installation Location" is particularly relevant to system reliability and ensuring high accuracy of measurements. Section 4 describes the system components and Section 5 contains the basic principles of calorimetry.

Carrying out tests

Once you have carried out the procedures described in Section 6 "Commissioning", and Section 7 "Preparing and Carrying Out Measurements" the calorimeter is ready for use.
In Section 8 the evaluation of calorific value measurements and the possibility of test simulation are explained.
Section 9 gives important information on care and maintenance, and Section 10 explains the display messages and gives advice on troubleshooting and the correction of simple problems.

Information on accessories, consumables, and the technical data for the unit are given in Sections 11 and 12. Section 13 contains the index.

The figures ①, ②, ③ etc. in the following chapters indicate actions that must always be carried out in the sequence given.

2.2 Warranty

In accordance with IKA warranty conditions, the warranty period is 12 months. For claims under the warranty please contact your local dealer. You may also send the machine direct to our works, enclosing the delivery invoice and giving reasons for the claim. You will be liable for freight costs.

The warranty does not cover wearing parts, nor does it apply to faults resulting from improper use or insufficient care and maintenance contrary to the instructions in this operating manual.

2.3 Warranty and Liability

Please read through these Operating Instructions attentively. IKA® only accepts responsibility for the safety, reliability and performance of the device if:

- the unit has been used in accordance with the operating instructions;
- only persons authorised by the manufacturer have carried out maintenance or repair work on the unit, and
- only original parts and original accessories have been used for repairs.

Parts carrying electric voltage

The calorimeter must only be opened by your Technical Service Department.
If servicing is required, we recommend that you take advantage of your Technical Service Department.

Otherwise, please make yourself familiar with the relevant safety and accident prevention regulations.
IKA® accepts no liability for damage or costs that arise due to accidents, misuse of the unit, or unauthorised changes, repairs or modifications.

2.4 System Features

The C 7000 calorimeter is used for the routine determination of the gross calorific value of solid and liquid substances. The system accessories ensure that it can be individually adapted to laboratory tasks (see also Section 11).

The system has the following important features:

- patented double-drying measuring procedure;
- short measurement time, ca. 3 minutes for one determination;
- well over a hundred determinations per day and calorimeter are possible;
- automated measurement reduces routine tasks;
- fully-integrated, independent, microprocessor-controlled calorimeter;
- film key panel provides convenient operation and protection against laboratory conditions;
- integrated fault detection with plain-text display;
- simple, well-proven operation;
- parallel port for direct connection of printer;
- memory for 100 tests;
- automatic acceptance of data from connected balance;
- calculation of calorific value under various conditions;
- four different calculation modes:
  standard, with and without titration,
  carbon, with and without titration;
- online data transfer to an external PC;
- automatic recognition of up to 8 decomposition vessels;
- maximum energy input from decomposition vessel: 30.000 J:
  this corresponds to a temperature increase in the decomposition vessel of about 25 K.

3 Transport, Storage, Installation Location

3.1 Transport and Storage Conditions

During transport and storage, the system must be protected against mechanical shock, vibration, dust deposits, and corrosive atmospheres. In addition, the relative humidity should not exceed 80%.

In case of repair the device has to be cleaned and free from any materials which may constitute a health hazard.

If you require servicing, return the appliance in its original packaging. Storage packaging is not sufficient. Please also use suitable transport packaging.

3.2 Installation Location

When installing the unit, observe the national and local regulations for the operation of pressure vessels that apply at the site selected.
To ensure high accuracy of measurement, a constant ambient temperature is an important precondition. For this reason, the chosen installation location should fulfil the following conditions:

- not exposed to direct sunlight;
- no drafts (e.g. not beside a window, door or air-conditioning vent);
- sufficiently far from heating radiators and other heat sources;
- room temperature must be between 18 °C and 30 °C: to ensure good measurement quality, there should be no variation in temperature;
- the system must be installed on a horizontal surface;
- If the C 7002 cooler is to be used, a water supply with a supply pressure of less than 9 bar is required near the installation location, or a suitable cold water supply (e.g. IKA® KV 500).

For operation of the system, a power supply corresponding to the typeplates of system components must be available at the installation location. An oxygen supply with a pressure gauge, which can supply 99.95% pure oxygen, quality 3.5 at a pressure of 30 bar is also required. A shut-off valve for the oxygen supply must be installed. Observe the instructions on handling oxygen given in Section 1 "For your safety”.

3.3 Unpacking

Please unpack system components carefully and check for any signs of damage. It is important that any transport damage is noted during unpacking. If necessary, the damage must be assessed immediately by the transport company (post, railway or transport contractor).

3.4 Delivery Scope

Description	**C 7000 Basic version, set 1**	**C 7000 Basic version, set 2**
Main unit C 7000 including - Mains cable - Electrical fuses - Benzoic acid C 723 - Carrying and venting handle C 7010.8 for decomposition vessel - Operating instruction	1x	1x
Decomposition vessel C 7010	1x	-
Decomposition vessel C 7012	-	1x
Oxygen filling station C 48	1x	1x
Cooler C 7002 including - Mains cable - Electrical fuses - Connection cable to calorimeter - 2 Water hoses with quick-connect couplings	1x	1x

4 Description of System Components

4.1 Calorimeter C 7000

C 7000
Front view

1	Display
2	Key pad
3	Control section

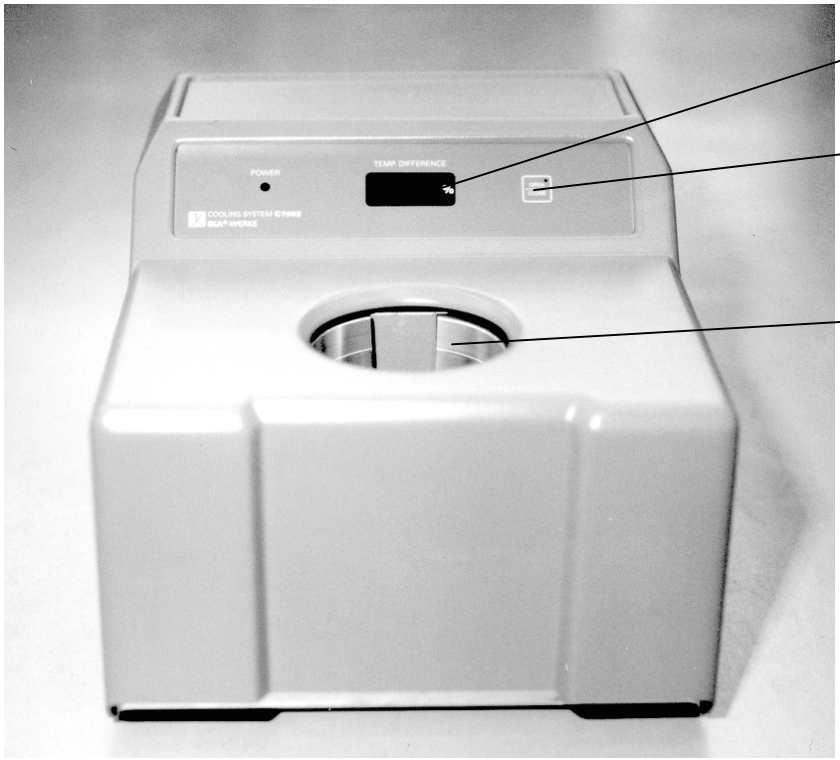
C 7000
Rear view

1	Contrast control for display
2	Typeplate
3	Connection for cooler C 7002
4	PC connection, RS 232
5	Balance connection RS 232
6	Printer connection, Centronics
7	Fuses
8	Socket for mains cable with main fuse

Commands and test parameters are entered in interactive mode using the key pad, and entries can be seen in the display.

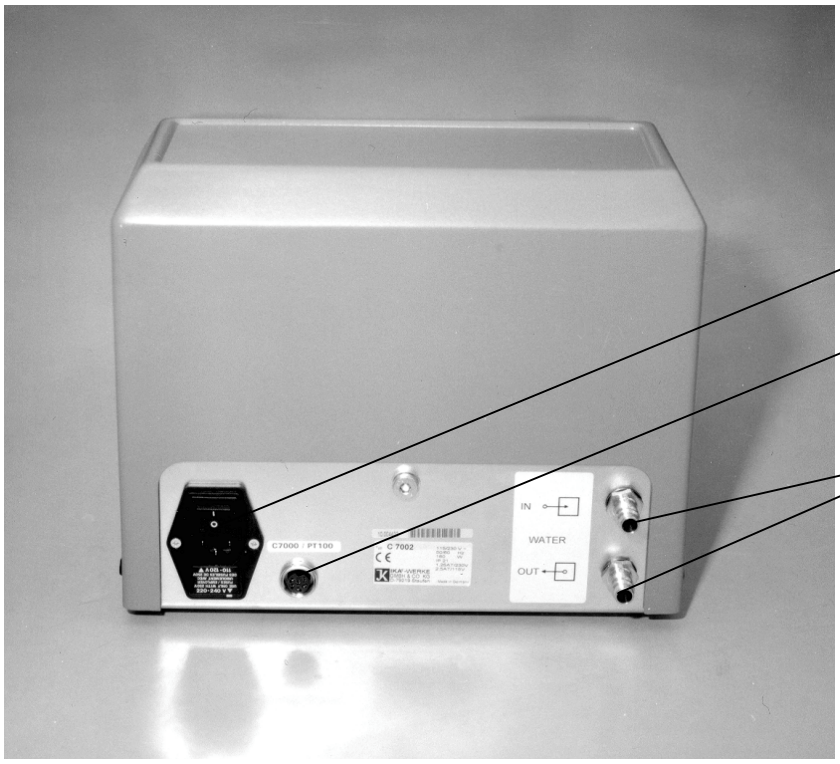
To enter parameters, there is a membrane-type key pad in the removable control section of the calorimeter. There is also an illuminated two-line display with 40 characters in each line. The display contrast can be individually adjusted using the control on the rear of the unit.
During a test, all phases of the measurement process are controlled and monitored, and the display shows the current state of the system and test data.
In the measuring cell, calorimetric tests are carried out. They involve burning a sample of combustible material under precisely defined conditions. In the decomposition vessel, there are four temperature sensors, which record its temperature.

4.2 Cooler C 7002



Cooler C 7002
Front view

1	Display giving the temperature difference from the measuring cell in percent
2	Button for manually opening and closing the cooling jaws
3	Cooling jaws



Cooler C 7002
Rear view

1	Mains connection with main fuse
2	Connection to C 7000
3	Cooling water connections with quick-connect couplings

The cooler is used to cool the decomposition vessel quickly after a test. For this purpose, the cooler C 7002 is connected using the cable supplied to the calorimeter C 7000 (see illustrations Cooler C 7002 Rear view, Position 2, and C 7000 Rear view, Position 3). During the cooling operation, the decomposition vessel is cooled to the temperature of the measuring cell. For accurate calibration and measurement, this condition must be fulfilled.

For cooling, the decomposition vessel is placed between the cooling jaws. Peltier elements are used for cooling. They are controlled completely automatically. Water is employed for removal of heat. Internal controls ensure the water consumption is kept especially low. In stand-by mode, the water is switched off automatically. The cooler does not start ist pre-cooling phase until a main test has started.

Please see Section 6.2 "Connection of Peripherals" for more information about installation of the cooler.

5 Principles of Calorimetric Measurement

To make a calorimetric measurement, a sample of a substance is burnt. In order to ignite the sample, energy must be supplied from an external source. An ignition wire, which is heated to glowing point by passing an electric current through it, performs this function. If the measurement is to be accurate, it is essential that the sample is completely burnt. For this reason, combustion takes place in an atmosphere of oxygen at a pressure of 30 bar.

5.1 Determining the Gross Calorific Value

In a calorimeter combustion takes place under defined conditions. A weighed sample of a substance is placed in the decomposition vessel, the sample is ignited, and the increase in temperature of the decomposition vessel is measured. The gross calorific value of a sample is calculated from:

- temperature increase of the decomposition vessel
- heat capacity (C value) of the calorimeter system
- mass of the fuel sample
- heat energy that is released by burning the ignition aid and auxiliary fuel, and also by the formation of sulphuric and nitric acids (external energy).

Test conditions

To optimise the combustion process, the decomposition vessel is filled with pure oxygen (99.95%). The pressure of the oxygen atmosphere in the decomposition vessel is 30 bar. The fuel sample is weighed to an accuracy of 0.1 mg using an analytical balance.

Precise determination of the calorific value of a substance demands that combustion takes place under precisely defined conditions. The relevant standards make the following assumptions:

- any water contained in the fuel, and any water formed by the combustion of compounds containing hydrogen in the fuel is present in a liquid state after combustion;
- no oxidation of atmospheric nitrogen has taken place;
- gaseous products present after combustion consist of oxygen, nitrogen, carbon dioxide and sulphur dioxide;
- solids can also be formed (e.g. ash).

Frequently, other combustion products, not foreseen by the standards, are formed. In such cases, analyses of the sample material and the combustion products are required to supply data for correction calculations. The standard gross calorific value is then determined from the measured value and the analysis data.

Gross calorific value, Ho

The gross calorific value Ho is obtained by dividing the heat energy released by burning a solid or liquid fuel by the weight of the sample. When determining the heat energy released, water-containing components of the fuel must be present in liquid form after combustion.

Net calorific value, Hu

The net calorific value Hu is the gross calorific value less the condensation energy of water contained in the sample and formed by combustion. The net calorific value is of great technical importance, because in all major applications, only the net calorific value can be exploited as energy.

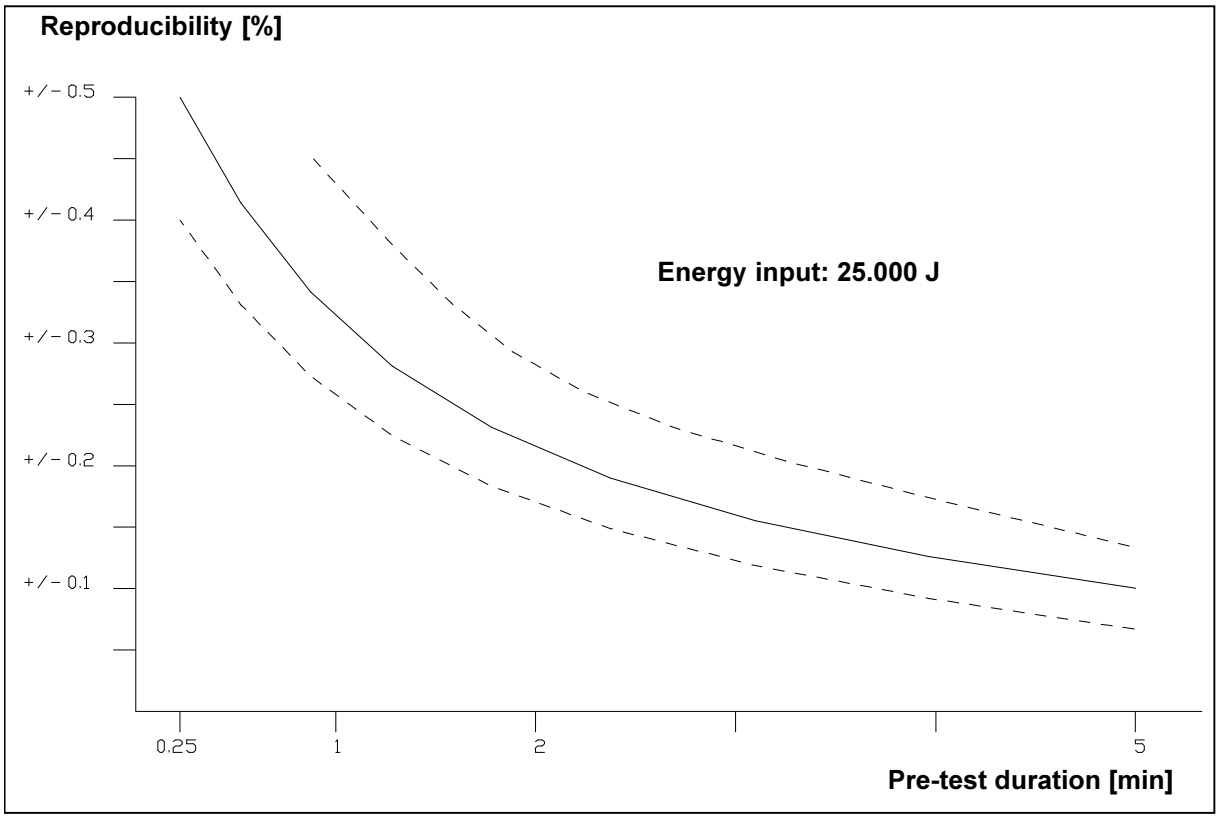
Reproducibility

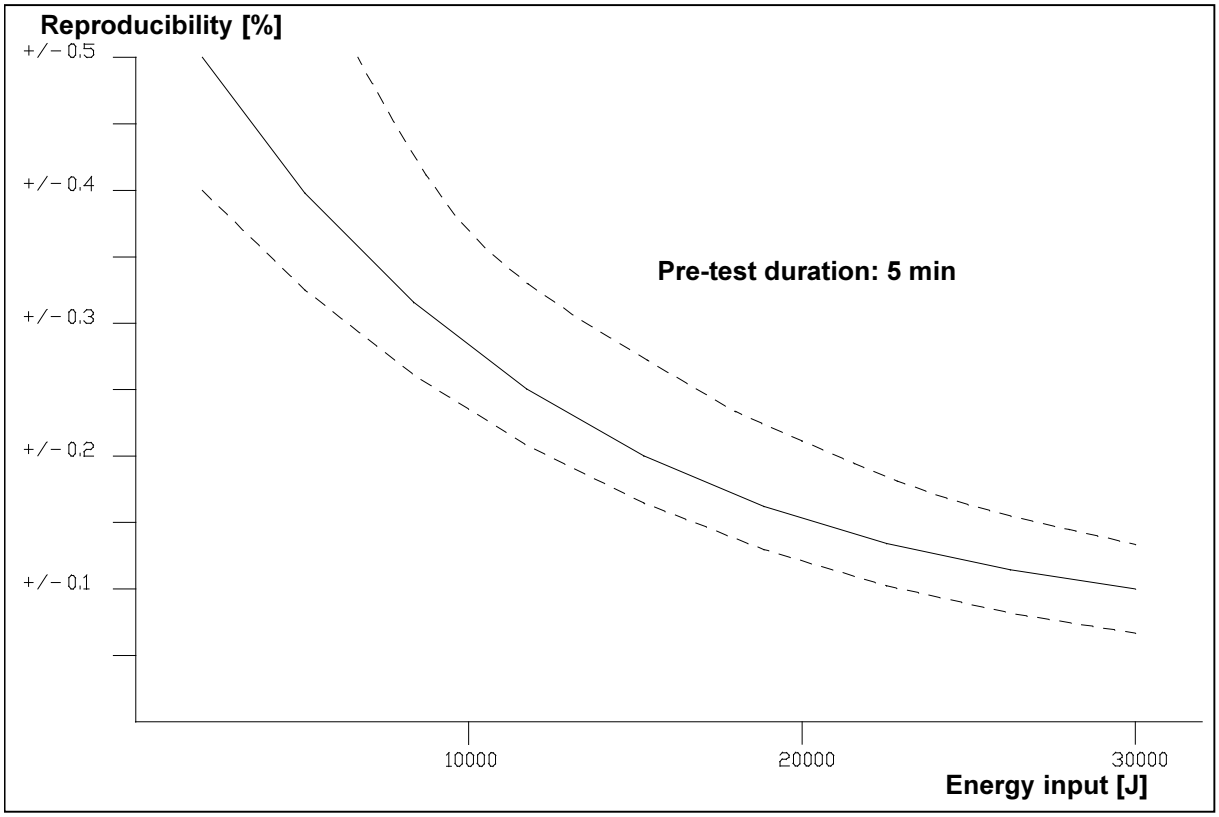
The reproducibility of the results depends to a great degree on the energy input (temperature increase) being similar to the energy input during calibration. In the same way, the oxygen pressure should be the same for measurement and calibration. Under optimum settings and conditions, the C 7000 calorimeter can achieve a measurement reproducibility of ± 0.2 percent to DIN 51900. This accuracy is guaranteed under the following conditions (they apply to both calibration and measurement):

Criterion	**Value**
Calibration substance	Benzoic acid
Sample mass	1 g ± 0.05 g
Ambient temperature	25 °C ± 1 K
Temperature of decomposition vessel before determination	25 °C ± 1 K
Oxygen pressure	30 bar
Measurement period max. (pre- and main test)	7.2 min.

The C 7000 calorimeter is designed for an energy input of up to 30 000 J, and operates reliably in ambient temperatures between 18 °C and 30 °C. For good measurement results, temperature variations must be avoided.

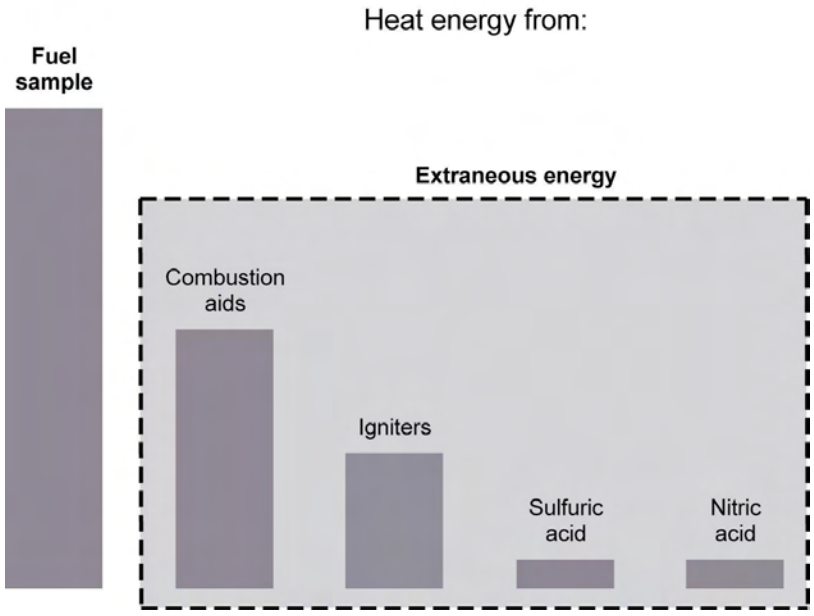
The achievable reproducibility can be estimated with the aid of the curves below. It is very dependent on the amount of energy released in the decomposition vessel, and on the duration selected for the pre-test. Apart from those factors, the results are affected by qualitative parameters such as the homogeneity and combustibility of the sample.


Reproducibility [%]
+/- 0.5
+/- 0.4
+/- 0.3
+/- 0.2
+/- 0.1
Energy input: 25.000 J
0.25
1
2
5
Pre-test duration [min]


Reproducibility [%]
+/- 0.5
+/- 0.4
+/- 0.3
+/- 0.2
+/- 0.1
Pre-test duration: 5 min
10000
20000
30000
Energy input [J]

5.2 Corrections

It is intrinsic to the method that during a combustion test heat is released from external sources as well as from the sample.
The ratio of heat from external sources to heat from the sample can vary considerably.



Heat of combustion and external energy

The heat of combustion of the cotton thread used to ignite the sample, and the electrical ignition energy would falsify the result. In the calculation, a correction must be applied to compensate for them.

Conbustion aid

Substances that are difficult to ignite and those with low flammability are burnt together with a combustion aid. The combustion aid is first weighed and then added to the sample in the crucible. The quantity of heat resulting from it can be determined from its mass and its known gross calorific value. The test result must be corrected by deducting this quantity of heat.

Combustible crucible, C 14

A combustible crucible C 14 can be used in place of a conventional crucible. The combustible crucible burns completely to leave no residue. When a combustible crucible is used, a cotton thread is not required for ignition. The crucible makes direct contact with the fixed ignition wire in the decomposition vessel, which ignites it.
The purity of the material used for combustible crucibles prevent chemical contamination of the sample.
Decomposition vessels in which combustible crucibles are to be used must be fitted with an additional part (Support C 5010.4, see Accessories). The sample is weighed in the combustible crucible in the usual way. In most cases, an additional combustion aid is not required, because the crucible itself fulfils this role.

Acid correction

Almost all substances that are tested contain some sulphur and nitrogen. Under the conditions employed for calorimetric measurements, sulphur and nitrogen burn to SO_2, SO_3 and NO_x. In combination with water from combustion and moisture from the sample, sulphuric acid and nitric acid are formed and heat of solution is developed. The influence of the heat of solution must be taken into account when calculating the standard calorific value.

To obtain a defined end condition, and to quantitatively record all acids, ca. 5 ml of distilled water or other suitable absorption liquid are added to the decomposition vessel. The gases resulting from combustion form acids with this absorption liquid and any water resulting from combustion. After combustion, the decomposition vessel is rinsed thoroughly with distilled water, to collect any condensate that has settled on the walls of the vessel. The acid content of this solution can be determined using suitable equipment.
You can obtain details of suitable equipment for the purpose from IKA® or from your authorised dealer.

5.3 Complete Combustion

To determine the gross calorific value correctly, it is of fundamental importance that the sample has burnt completely. After a test, the crucible and all solid residues must be examined for signs of incomplete combustion.

Solids

Normally, solids can be burnt directly in powder form. Substances that burn very fast (e.g. benzoic acid) must not be burnt in a loose form. Such substances tend to explosive combustion, and complete combustion cannot then be guaranteed. In addition, the decomposition vessel could be damaged. These substances must be pressed to form tablets using a special press (C 21 pelleting press, see Accessories) before testing.

Substances with low inflammibility

Substances with low flammability (substances with a high mineral content or a low calorific value) can often only be burnt completely with the aid of combustion capsules or combustion bags (C 10/C 12, see Accessories). The use of liquids to aid combustion, for example paraffin, is also possible.

Liquids, highly volatile substances

Most liquids can be weighed directly in the crucible, but highly volatile substances should be filled into combustion capsules (gelatine capsules or acetobutyrate capsules, see Accessories) and burnt together with the capsules.

All combustion and ignition aids (e.g. cotton threads) must be burnt completely. If anything remains unburnt, the test must be repeated.

Halogens

Halogen-containing substances can cause corrosion of the decomposition vessel. For such cases, decomposition vessel C 7012 should be used.

5.4 Calibration

For the most precise results, the calorimeter should be calibrated during commissioning, following service work, when parts have been replaced, and at defined intervals. The purpose of calibration is to re-determine the thermal capacity of the calorimeter system (C value).

Regular calibration is essential to maintain measurement accuracy.

Calibration is carried out by burning a known quantity of a reference substance in the decomposition vessel under test conditions. Since the calorific value of the reference substance is known, it is possible to use the temperature increase of the decomposition vessel to calculate its heat capacity.

The reference substance used internationally for calorimetry is benzoic acid from the National Bureau of Standards (NBS Standard Sample 39), which has a guaranteed calorific value.

If a calorimeter is used with several decomposition vessels, the heat capacity of the system must be determined with each vessel.

For more detailed information on calibration, please refer to the relevant standards.

6 Commissioning

Once the components of the C 7000 calorimeter have been unpacked and brought to the location chosen for the instrument (see Chapter 3, Section 3.2 "Installation Location"), the mains lead and peripherals can be connected.

6.1 Connecting the mains lead

Check that the voltage given on the typeplate of the calorimeter corresponds to your mains supply, then plug the mains lead into the socket on the rear of the calorimeter and to the mains socket.

6.2 Connecting peripherals

When connecting peripherals, the mains switch of the calorimeter must be switched off.

For all connections to the calorimeter, use only the interface cables supplied by IKA®.

Connecting a balance, printer or PC
For connection of a balance, a printer or an external PC, there are sockets on the rear of the unit marked **Balance**, **Printer** and **PC** (see Section 4.1, illustration C 7000 Rear view).

Now connect the peripherals you will be using.

Connecting the cooler C 7002
Connect the C 7002 cooler as follows:

①
Check that the voltage given on the typeplate of the cooler corresponds to your mains supply, then plug the mains lead into the socket on the cooler and to the mains socket.

②
There are two hoses with quick-connect couplings included with the cooler. Connect them to the *In* and *Out* connections on the rear of the cooler.

③
Connect the other end of the feed hose (*In*) to a water supply, water tap or to a cooling water supply (e.g. IKA® KV 500) and secure the connection. Take the drain hose (*Out*) to a suitable sink and secure it there.

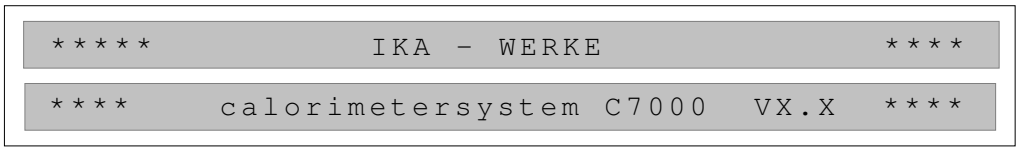
④
Use the cable provided to connect the cooler and calorimeter at the appropriate sockets on the rear of each unit (see Chapter 4 "Description of System Components").

The C 7002 cooler is now connected to the C 7000 calorimeter.

6.3 Switching the system on

When the mains switch is switched on, an introductory screen appears with the following text:

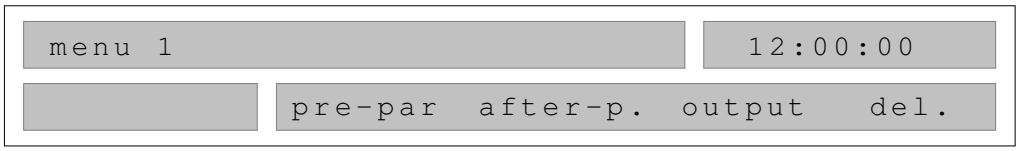
Introductory screen



The letters VX.X give the software version installed in the instrument.

After a short pause, the display changes to the main menu, *menu 1*.

Main menu, menu 1



If there is no printer connected, an acoustic signal sounds for a few seconds, and a green LED near the  button on the key panel blinks (please see the next section for a description of this button). Acknowledge the signal by pressing this button, and the signal tone and blinking will be switched off.

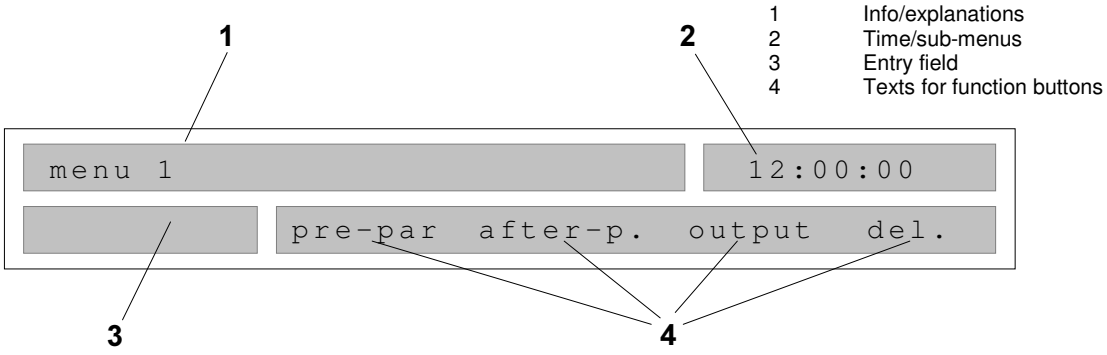
Switching on the C 7002 cooler
The C 7002 cooler is switched on at its main switch, which is on the rear face of the unit. When it is switched on, the display shows three horizontal lines. Make sure the water supply is turned on and adequate for a flow rate of 1 to 2 litre/min.

6.4 Display and control elements

The calorimeter is operated from a membrane-type key pad specially designed for laboratory use.

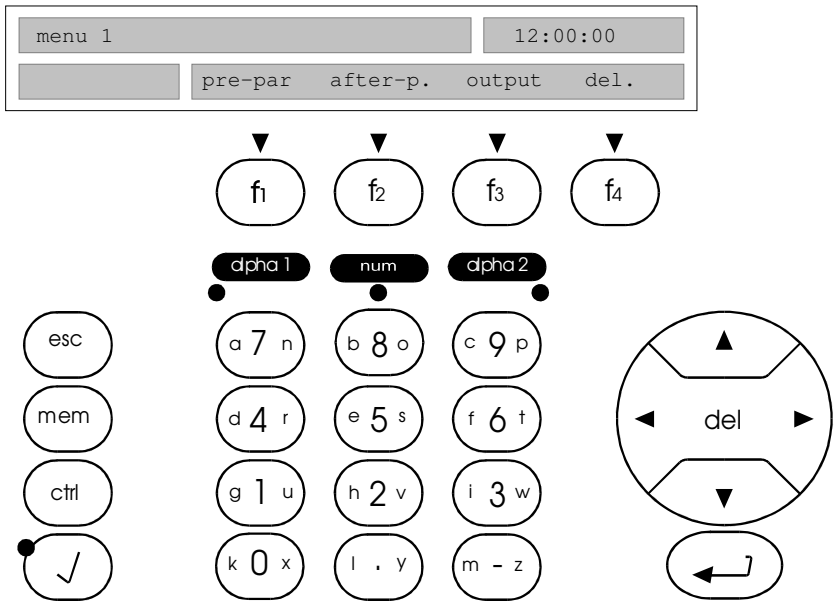
An LCD display shows system data, test data, and menus and dialog windows for entering data. It has two lines of 40 characters each, and is divided into 4 zones:

Zones of LCD display



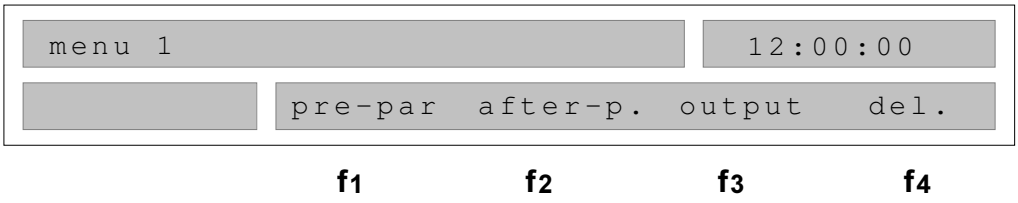
The key pad has the following buttons:

Film key pad and display



1. **Function buttons *f1*, *f2*, *f3*, *f4***: The functions of the buttons *f1, f2, f3, f4* are always indicated by the text that appears in the lower right zone of the LCD display. The relevant text in the display is directly above its button:

Relationship of function buttons to LCD display



With this arrangement, the function buttons can be used to carry out the following actions:

- selection of sub-menus in the three main menus;
- selection of a value from a list of preset values;
- switching the alpha-numeric keypad between letters and figures.

2. ***esc* button**: The *esc* button can be used to exit any menu without storing data. After *esc* has been pressed, the display shows *menu 1*.

3. ***mem* button**: all data for a menu level are stored by pressing the *mem* button.

After completing an entry with the ↵ button (see below), the enquiry *(mem) = save* appears for a few seconds. During this period, operating the *mem* button has no effect. Wait until *(mem) = save* has gone out before pressing *(mem) = save*.

4. ***ctrl* button**: the *ctrl* button is used in conjunction with number keys to enter special functions.

5. ✓ **button with green LED**: the ✓is used to acknowledge various messages from the calorimeter. Error messages, various signals from the instrument, and results that are displayed after a measurement all have to be acknowledged. The green LED blinks when a test has been completed. After the ✓button has been pressed, the display shows *menu 1* again.

6. **Alpha-numeric buttons and LEDs**: the alpha-numeric keys are each allotted 3 different characters, so that letters figures and other characters can be entered. Characters that can be entered are the figures *0* to *9*, the symbols "**.**" and "**-**", and the letters *A* to *Z*, with the exception of *J* and *Q*.
   The LEDs, *alpha1*, *num* and *alpha2*, arranged above the alpha-numeric keys, show which character set is currently active. The required character set can always be selected, using function buttons *f1*, *f2* and *f3*, when the system permits an alpha-numeric entry.

   Example of an alpha-numeric key: 

   When the *alpha1* LED is illuminated, pressing this key will write the letter *A* in the LCD-display. When the *num* LED is illuminated, then *7* appears in the display, and when the *alpha2,* LED is illuminated, then *N* appears in the display.

   The keys "**.**" and "**-**" have special meanings. The symbol "**.**" serves as place marker for any desired string of characters, and "**-**" as place marker for any desired character.

7. ***del* button**: operating the *del* button moves the cursor one character to the left, erasing the character as it moves. In this way, incorrect entries can be erased one character at a time. For this purpose, the cursor must be positioned **after** the character that is to be erased.

8. ▼ **button and** ▲ **button**: within a particular menu, pressing the ▼ button moves to the next menu level, and pressing the ▲ button changes to the previous menu level.

9. ▶ **button and** ◀ **button**: pressing the ▶ button moves the cursor one character to the right in the LCD-display without erasing a character, and pressing the ◀ button moves the cursor one character to the left in the LCD-display also without erasing.

10. ↵ **button**: the ↵ button confirms an entry which has been made using the alpha-numeric keys or the function keys, and concludes the current entry operation.

6.5 Menu structure

The menu structure of the C 7000 calorimeter comprises three main menus, *menu 1*, *menu 2*, and *menu 3*, which have the following functions:

menu 1	Entry of pre- and post-test parameters, output and erasure of tests. *menu 1* always appears when the instrument is switched on.
menu 2	Manual editing of tests and calibration of the calorimeter.
menu 3	Initialization of hardware and software, and setting the ignition time.

Each main menu has two sub-menus. The three levels of the menu structure are shown in the diagram below:

MENU STRUCTURE FOR C 7000 CALORIMETER

- **menu 1**
  - f1 **pre-par**
    Entry of pre-test parameters
  - f2 **after-p.**
    Entry of post-test parameters
  - f3 **output**
    Data output
    - f1 **LCD**
      Shows test data on LCD-display
    - f2 **free**
      Information about number of tests still free
    - f3 **table.**
      Prints tabular summary of tests
    - f4 **samp.**
      Sends test data to printer
  - f4 **del.**
    Erases test data
- **menu 2**
  - f1 **manual**
    For manual data entry
    - f2 **heat-cap.**
      Manual entry of C value
    - f4 **measure**
      Manual measurement (simulation)
  - f2 **edit.**
    For changing post-test parameters
  - f3 **calib.**
    For entering calibration data
- **menu 3**
  - f1 **HDInit**
    Initializes the hardware
    - f1 **ext. PC**
      Interface parameters for PC connection
    - f2 **balance**
      Interface parameters for balance connection
    - f3 **date**
      For changing the date
    - f4 **time**
      For changing the time
  - f2 **STInit**
    Initializes the software
    - f1 **realt.**
      Selection of interval for results output
    - f2 **calcul.**
      For setting calculation mode for gross and net cal. values
    - f3 **unit**
      Selection of units for results
    - f4 **pre. time**
      Selection of pre-test time
  - f3 **IGN time**
    For setting the ignition time

6.6 Configuration of the C 7000 Calorimeter

When it is first switched on, the fundamental settings of the calorimeter should be configured. This applies to all parameters that can be set in the sub-menus of *menu 3*, as follows:

- Sub-menu *HDInit*

  ext. PC
  For communication between the calorimeter and an external PC to operate correctly, the interface parameters and the software protocols of the two units must be consistent. For the C 7000 calorimeter, the following interface parameters are available in sub-menu *ext. PC* (the preset values are in bold type; they are the interface parameters when using the IKA® software *CalWin*):

baud-rate	1200, **2400**, 4800, 9600 bits/s data transmission rate
data-bits	5, 6, 7, **8** bit length of data word
stop-bits	**1**, 2 stop bits
parity	odd, even, **disable**

  balance
  For communication between the calorimeter and an electronic balance to operate correctly, the interface parameters and the software protocols of the two units must be consistent. The parameters for the balance must be taken from the balance manual.

  For the C 7000 calorimeter, the sub-menu *balance* contains the following interface parameters (the preset values are in bold type):

baud-rate	1200, **2400**, 4800, 9600 bits/s data transmission rate
data-bits	5, 6, **7**, 8 bit length of data word
stop-bits	**1**, 2 stop bits
parity	**odd**, even, disable
balan. (type)	**Sartorius AC 120 and BP range**, Mettler balance with RS 232C, Chyo balance

  It is only possible to connect another balance if it is compatible with one of the above models.

  date
  The date for the calorimeter must be entered in the form (ddmmyy). Permissible values are:

dd	day, all dates with two figures from 01 to 31
mm	month, all months with two figures from 01 to 12
yy	year, all years with two figures from 00 to 99)

  If an incorrect entry is made, the message *incorrect entry* appears. Entries may only be made as numbers.

  time
  The time must be entered in the form (hhmmss). Permissible values are:

hh	hours, values with two figures from 00 to 23
mm	minutes, values with two figures from 00 to 59
ss	seconds, values with two figures from 00 to 59

  If an incorrect entry is made, the message *incorrect entry* appears.

- Sub-menu *STInit*

realt.
The parameter *realt.* (real-time print out) is used to set the time interval in seconds for sending measured values to a printer. The values 0, 3, 12, or 24 seconds can be set. The preset value is 0 seconds . If the value 0 is selected, the transmission of readings to a printer) during a test is switched off. The presentation of data on the LCD-display is unaffected by the setting of this parameter.

☞ **If a printer is not connected, the parameter *realt.* must be set to 0.**

calcul.
In this sub-menu, you determine the calculation mode. Possible settings are:

std - t	standard without titration
std + t	standard with titration
coal - t	carbon without titration
coal + t	carbon with titration

The calculation mode must be set *before* making a measurement, because subsequent conversion to a different calculation mode is not possible.

☞ The presetting is *standard without titration*. The calculation modes *standard* and *coal* differ in that, when *coal* is set, the calculation of gross and net calorific values is carried out under various conditions. If *with titration* is selected, the energy of acid formation is determined by titration.

unit
The results for gross and net calorific values can be calculated and presented in the output protocol in several different units. The corresponding settings for the parameters *unit* are:

joule	J/g
BTU	BTU/lb
kWatt	kWh/kg
cal	cal/g

The preset unit is J/g.

pre. time
In this menu, one of four values can be set for the pre-test time:
15 seconds
60 seconds
120 seconds
300 seconds
The preset value is *120 seconds*.

☞ **The longer the pre-test time, the more accurate the result.**

- *IGN time*
The setting of *IGN time* determines the ignition time in milliseconds for the fixed ignition wire. The works setting is 1000 ms, which is normally entirely adequate to be sure that the cotton thread or the combustible crucible has ignited.
The preset ignition time should only be changed if the cotton thread or the combustible crucible do not burn properly, or if platinum ignition wire is used. In these cases, the ignition time should be increased in successive steps of not more than 100 milliseconds. However, if combustion is incomplete, first check the connections of the ignition wire to the electrodes in the decomposition vessel.

Ignition times that are too long can cause destruction of the ignition wire or increased wear and tear.

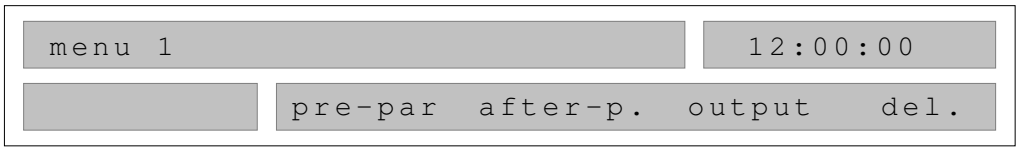
6.7 Examples of entries

For all entries that you may need to make on the calorimeter, the three examples in presented this section are representative:

- Setting the time
- Setting the time interval for output of results
- Configuration for a balance

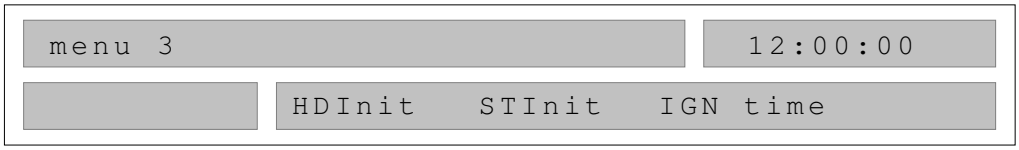
All three examples assume that the C 7000 calorimeter has been switched on, and that *menu 1* of the main menu is shown in the LCD-display:

Starting point for entry examples



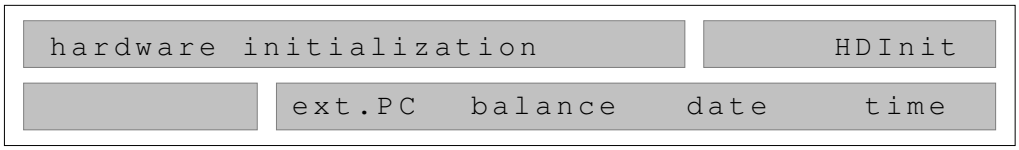
Setting the time
From the menu-structure diagram in Section 6.4, you can see that the time is set in sub-menu *HDInit* of main menu *menu 3*. To set the time, proceed as follows:

①
Operate the button ▲ once, or press ▼ twice. *menu 3* appears in the LCD-display.



f1 **f2** **f3**

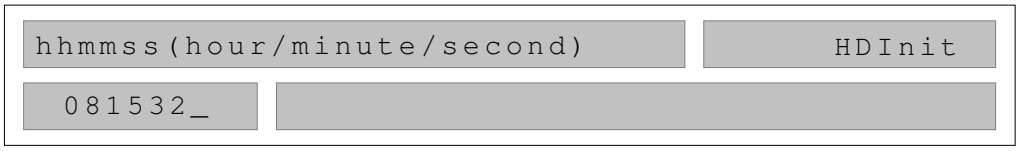
②
Press the function key *f1* to go to sub-menu *HDInit*. The system parameters for hardware initialization appear in the LCD-display.



f1 **f2** **f3** **f4**

③

Use function key *f4* to call up the sub-menu *time*; by doing so you have reached the lowest Level of the menu structure. The LCD-display is now prepared for entering the time.



④

Press the *del* button six times to erase the time currently entered (here: 8 h: 15 min: 32 sec.), which at the same time moves the cursor to the left. Use the alpha-numeric keys to enter the correct time in the format given in the first line (hhmmss). This format contains only figures and no blanks.

⑤

Confirm with the ↵ button. In the second line, the request *(mem)* = *save* appears. Wait until the request disappears again.

⑥

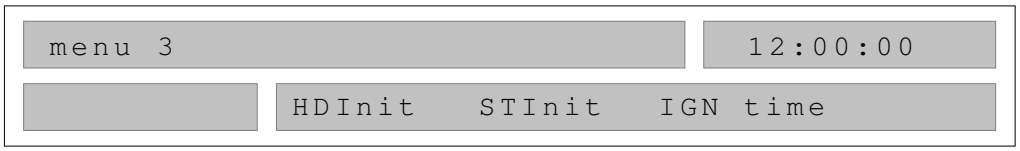
Then press the *mem* button to store your new entry. With the *esc* button, you can now go back to *menu 1* in the main menu. If you do not want to store the new time, press the *esc* button without first using the *mem* button. That will take you back to *menu 1* in the main menu without accepting the newly entered time.

Setting the time interval for output of results

From the menu-structure diagram in Section 6.4, you can see that the time interval for results output (*realt.*) is set in sub-menu *HDInit* of main menu *menu 3*. To set the time interval, proceed as follows:

①

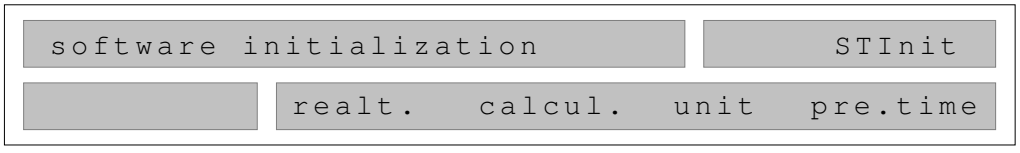
Operate the button ▲ once, or press ▼ twice. *menu 3* appears in the LCD-display.



f1 **f2** **f3**

②

Press the function key *f2* to go to sub-menu *STInit*. The system parameters for software initialization appear in the LCD-display.



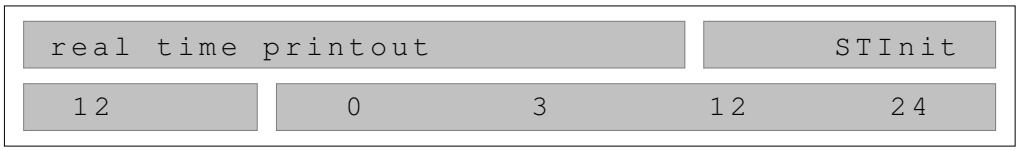
f1 **f2** **f3** **f4**

③

Use function key *f1* to call up the sub-menu *realt.*; by doing so you have reached the lowest Level of the menu structure. The LCD-display is now prepared for entering the time interval for output of readings during a test. The value currently set is shown in the left-hand zone of the second line of the LCD-display, and the values that can be selected, 0, 3, 12 and 24 seconds, are given in the right-hand zone.

④

Use one of the function keys *f1*, *f2*, *f3* or *f4* to select the desired value. Your choice is then shown in the left-hand zone of the second line of the LCD-display.



⑤

Confirm with the ↵ button. In the second line, the request *(mem)* = *save* appears. Wait until the request disappears again.

⑥

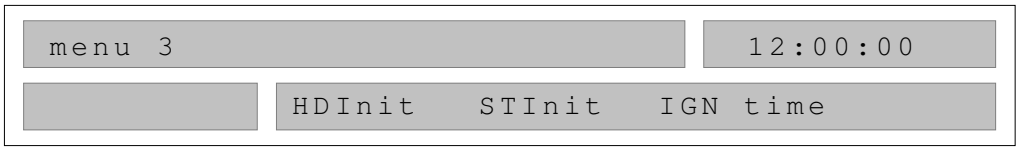
Then press the *mem* button to store your new entry. With the *esc* button, you can now go back to *menu 1* in the main menu. If you do not want to store the new time interval, press the *esc* button without first using the *mem* button. That will take you back to *menu 1* in the main menu without accepting the newly entered time interval.

Configuration for a balance

From the menu-structure diagram in Section 6.4, you can see that, to configure for a balance, you need sub-menu *HDInit* of main menu *menu 3*. To configure for a balance, proceed as follows:

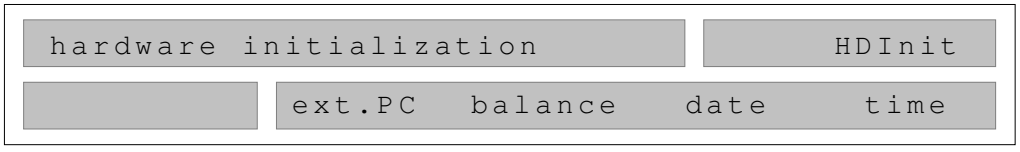
①

Operate the button ▲ once, or press ▼ twice. *menu 3* appears in the LCD-display.



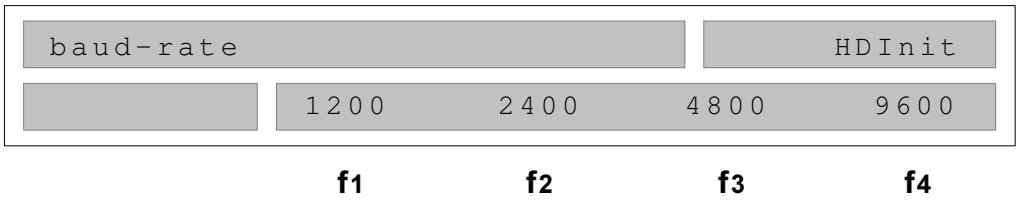
②

Press the function key *f1* to go to sub-menu *HDInit*. The system parameters for hardware initialization appear in the LCD-display.



③

Use function key *f2* to call up the sub-menu *balance*; by doing so you have reached the lowest Level of the menu structure. The LCD-display is now prepared for selecting the required *baud-rate*.



④

Use one of the function keys *f1*, *f2*, *f3* or *f4* to select the desired value. Your choice is then shown in the left-hand zone of the second line of the LCD-display.

⑤

Press the ↵ button. The selection possibilities for *data-bits* are shown in the LCD-display.

⑥

In the same way as described above, entered the required values for *data-bits*, *stop-bits*, *parity* and *balan.*

⑦

Confirm with the ↵ button. In the second line, the request *(mem)* = *save* appears. Wait until the request disappears again.

⑧

Then press the *mem* button to store your new entry. With the *esc* button, you can now go back to *menu 1* in the main menu. If you do not want to store the new data, press the *esc* button without first using the *mem* button. That will take you back to *menu 1* in the main menu without accepting the newly entered data.

6.8 Switching off

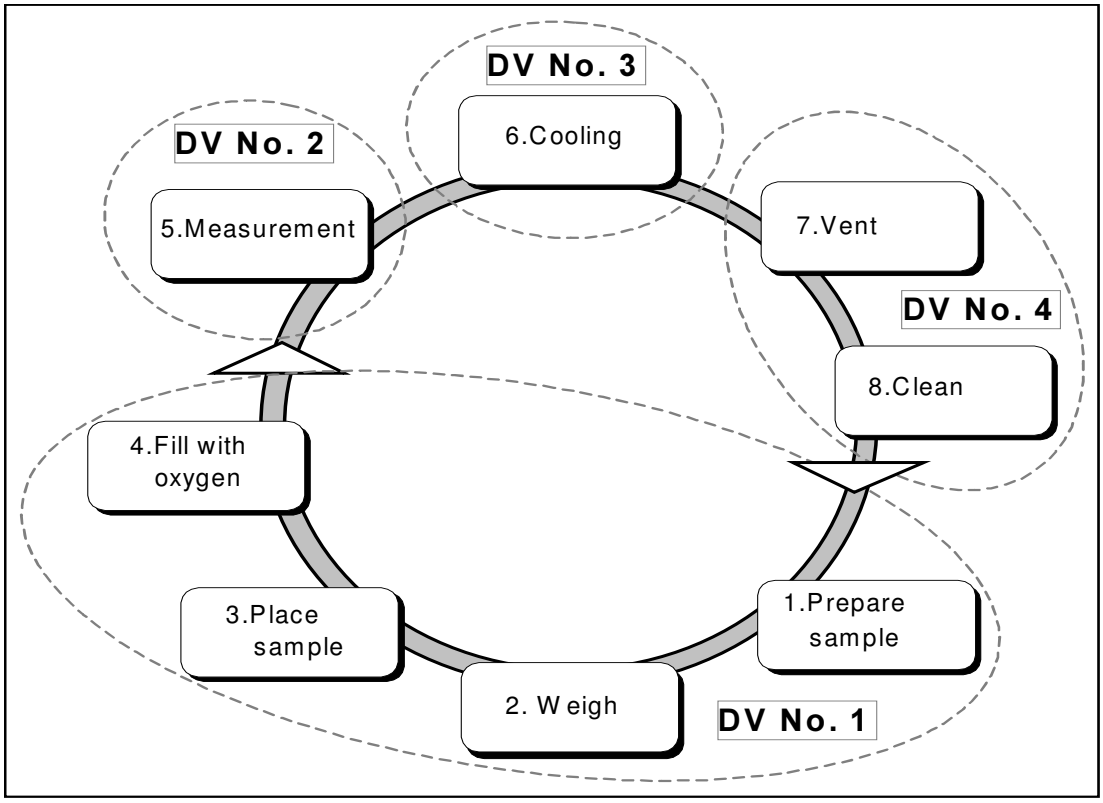
☞ **Only switch the calorimeter off when neither a test nor calibration are taking place. To prevent loss of data, the LCD-display should show one of the main menus, *menu 1*, *menu 2* or *menu 3*.**

Switch off the calorimeter and the cooler by operating their mains switches.

7 Preparation and Carrying Out Measurements

The term "measurements" as used here means both measurements for calibrating the instrument (calibration measurements) and measurements made to determine a gross calorific value. The difference lies mainly in the evaluation of the results, preparation and execution are almost identical for both types of measurement.

A complete test procedure comprises the following operations and procedures (for detailed information about the individual steps, please see further sections in this chapter):



①

Prepare sample
For example, homogenise sample material, press to form pellets, dry

②

Weigh
Weigh the sample in a crucible to an accuracy of 0.1 mg

③

Place sample
Place the sample in the decomposition vessel and close the vessel .

④

Fill with oxygen
Fill the decomposition vessel manually with oxygen at 30 bar, quality 3.5, using the IKA® C 48 oxygen filling station.

⑤

Measurement
In the C 7000 calorimeter, measurement is fully automatic.

⑥

Cooling
The decomposition vessel is removed from the C 7000 calorimeter and placed in the C 7002 cooler, where it is automatically cooled to the temperature of the calorimeter.

⑦

Vent
The decomposition vessel is vented using the C 7010.8 vent handle or venting station C 7030.

⑧

Clean
Clean and check the decomposition vessel as described in Section 7.6.

Optimising use of the calorimeter
As can be seen in the diagram, a complete test procedure can be sub-divided into several phases. To make maximum use of the calorimeter, you need four decomposition vessels (DV No. 1 to DV No. 4) which are used as follows:

As one decomposition vessel is being prepared for a test (steps 1 to 4 in the cycle of operations), a second vessel is undergoing a test (step 5 in the cycle of operations). At the same time, a third decomposition vessel is cooling (step 6 in the cycle of operations), while the fourth is being vented and cleaned (steps 7 and 8).

By using four vessels in parallel in this way, well over 100 tests can be carried out with one calorimeter in a single day. By using two or three decomposition vessels in a similar manner, a proportionately smaller time saving can be achieved.

To obtain the most accurate results, it is essential to observe the cycle of operations shown above.

7.1 Recommendations for calibration

Before precise measurements can be made with the calorimeter, it must be calibrated. To calibrate the instrument, tablets of **certified benzoic acid** (see accessories) with a known calorific value are burnt. This test is used to determine the quantity of heat required to raise the temperature of the calorimeter by 1 Kelvin. This is known as the heat capacity (C value) of the system. This constant is needed later to calculate gross calorific values.
The heat capacity is influenced both by the measuring cell and by the decomposition vessel.). It has a substantial influence on the gross calorific value being determined, and must be re-established from time to time, particularly at commissioning, following servicing and when parts are replaced.

If several decomposition vessels are used in a measuring cell, the heat capacity of the system must be determined by calibration with each decomposition vessel. A decomposition vessel must only be used in a measuring cell in which it has been calibrated.

Calibration must be carried out under conditions similar to those that will be used for subsequent tests. If combustion tests are to be carried out with absorption liquid (e.g. distilled water or a solution) in the decomposition vessel, then calibration should be carried out with the same quantity of the same substance.

Recommendations for calibration

- At a starting temperature of 25 °C, the C 7000 calorimeter has a maximum temperature increase of 25 K. For accurate results, a combustion test should yield a temperature increase of approximately 20 Kelvin. If you do not use benzoic acid for calibration, the quantity of material should be adjusted to meet this condition.

- For calibration, use benzoic acid (accessory C 723) compressed to a pellet. Weigh out approximately 1 g, this corresponds to a temperature increase of ca. 20 K.

- Calorific-value determinations must yield approximately the same temperature increase as calibration. The optimum sample quantity must be found by making several tests if necessary.

- The pre-test time should be at least 120 seconds.

- When calibrating to DIN, the C value is specified as the average of at least 5 calibration tests. Individual results should only be used in calculating the average if the difference between the highest and lowest values (scatter) is not more than 0.4% of the average.
  If the scatter is greater, then the result which is farthest from the average is discarded first. A sixth calibration test must now be carried out. The result of this determination must not deviate by more than 0.2% from the average of the four valid results. For further details, please see the relevant standard.

- In the calorimeter, the C value from the last calibration of a decomposition vessel is stored in memory. If several calibration tests are used to determine the C value (e.g. when calibrating to DIN), the calculated average C value for this decomposition vessel must be entered manually before carrying out a calorific value determination.

Notes on the C value

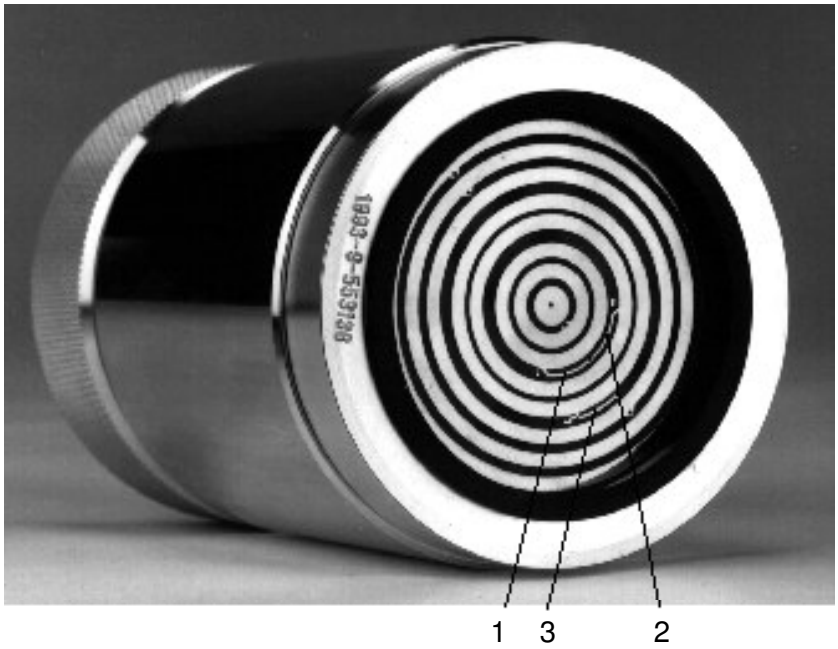
Because a calorimeter can operate in a wide range of ambient temperatures, the C value of a system must be seen as **temperature dependent**. This fact must be taken into account both during calibration and during normal testing. The calibration values printed out use 25 °C as reference temperature. This applies also to manually entered C values. When carrying out combustion tests, the C value must be corrected to the current ambient temperature (temperature of the metal casing at the start of combustion). This also explains why the C value printed after a test does not agree with the value entered manually by the user.

Coding

When working with the calorimeter, up to a maximum of 8 decomposition vessels can be used. This is made possible by giving the decomposition vessels code numbers from 0 to 7. The calorimeter then recognises automatically which vessel is being used for a test, and selects the correct calibration parameter.

Coding is carried out by separating the narrow printed-circuit conductors on the board mounted on the base of each decomposition vessel. The conductors are marked I, II, and III. When separating the narrow conductors, it is vital to avoid damaging the broad conductors. The conductors are separated at spacings of ca. 2 mm using a sharp knife, and the intermediate segment removed.

Coding decomposition vessels



1 Conductor I
2 Conductor II
3 Conductor III

The table below indicates which conductors must be separated for a particular code number. For example: for code number 0, no conductors have to be separated, for code number 3, conductors II and III must be separated.

Code number	Conductors to be separated		
	I	II	III
0			
1			⊗
2		⊗	
3		⊗	⊗
4	⊗		
5	⊗		⊗
6	⊗	⊗	
7	⊗	⊗	⊗

7.2 Notes on samples

Decomposition vessels C 7010 and C 7012 are not permitted for experiments on fuel samples capable of exploding! Note in this regard Chapter 1 “For your safety”.
The individual parts, and in particular the threading of the decomposition vessel must be checked regularly for wear and corrosion. Note in this regard Operating Instructions C 7010 or C 7012.

The C 7000 calorimeter is a precision instrument for routine measurement of the gross calorific value of solid and liquid substances. Accurate measurement is only possible if the all the individual steps in a test are carried out with care. The procedure as it is described in Chapter 1 “For your safety” and in the sections below must therefore be followed precisely.

If more than one decomposition vessel is being used, the respective individual parts must not be exchanged between the various decomposition vessels (see the engraving on the individual parts).

Notes on the sample

Substances of which the combustion behavior is not known must be examined for their combustion behavior before combustion in the decomposition vessel C 7010 or C 7012 (danger of explosion). If you are burning **unknown samples**, leave the room

Solids

Normally, solid fuels can be burnt directly in powder form. Fast-burning substances (e.g. benzoic acid) must not be burnt in a loose form.
Benzoic acid must only be burned in the form of pellets! Combustible dust and powder must be compressed into pellets before combustion. Oven-dry dust and powder such as wood chips, hay, straw, etc. burn in an explosive manner! They must be moistened first! Readily combustible liquids with a low vapor pressure must not be come in direct contact with the cotton thread (for example tetramethyl dihydrogen disiloxan)!

Fast-burning substances tend to explosive combustion. Complete combustion is then no longer certain. In addition, the inner wall of the decomposition vessel may be damaged. Such substances must be pressed to form pellets before they are burnt.

The IKA® C 21 pelleting press is suitable for this task.

Liquids

Most liquids can be weighed directly into the crucible. Liquids that are cloudy or with separable water must be dried or homogenised before weighing. The water content of such samples must be determined.

Highly volatile substances

For highly volatile substances, gelatine or acetobutyrate capsules (see accessories), which are filled with the fuel, must be used. The calorific value of the capsules must be known, so that the heat of combustion resulting from them can be taken into account as external energy.

Combustion aids

For low flammability substances and those with low calorific value, the capsules mentioned above, or combustion bags made of polyethylene (see accessories) are used. The C 14 combustible crucibles can also be employed.
Before the capsules or combustion bags are filled with the substance whose calorific value is to be determined, they must be weighed, so that from their mass and calorific value, the amount of external energy they contribute to combustion can be cal-

culated. The quantity of this external energy must be known for the calculation, and must be entered with the pre-test parameters (*pre-par*) as *q-extr. /1/*. The quantity of combustion aid used should be kept as small as possible.

Acid formation, heat of solution

Almost all substances to be analysed contain some sulphur and nitrogen. Under the pressure and temperature conditions in the decomposition vessel, they burn to form SO_2, SO_3 and NO_x. In combination with water formed during combustion, they form sulphuric and nitric acids, and produce heat of solution. This heat of solution is taken into account in the calculation as described in DIN 51900. To be sure that all acids formed are quantitatively assessed, ca. 5 to 10 ml of distilled water or other suitable absorption liquid can be added to the decomposition vessel before the test.

In such cases, calibration of the system must be carried out with this liquid!

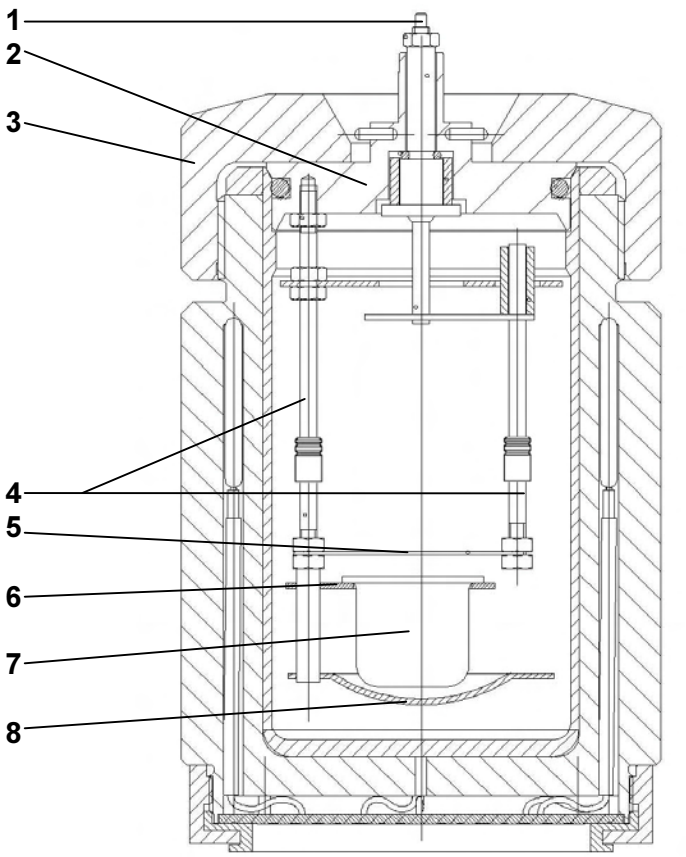
After combustion, the water is collected and the decomposition vessel thoroughly rinsed with distilled water. The rinsing water and the collected water are mixed, and their acid content investigated. If the sulphur content of the fuel and the nitric acid correction are known, analysis of the water is unnecessary.

To increase the working life of parts subject to wear and tear (O-rings, seals, etc.), we recommend that water is always added.

Substances containing halogens

When working with substances containing halogens, decomposition vessel C 7012 must be used.

7.3 Preparation for measurement



Components of the decomposition vessel

1	Connection for filling with oxygen
2	Lid
3	Screw-on cover
4	Electrodes
5	Ignition wire
6	Crucible holder
7	Crucible
8	Support for combustible crucible

For protection against corrosion, the lining of the decomposition vessel is made of stainless steel. The decomposition vessel must be clean and dry, because all foreign materials, in particular water, affect the heat capacity and thus the results.
You can now load the sample into the decomposition vessel.

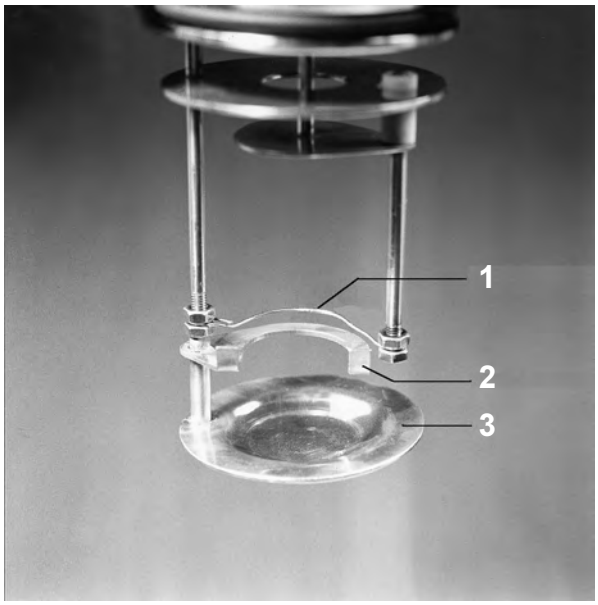
If several decomposition vessels are being used, it is important not to mix up their parts (see embossing on the parts).

The following steps are required to prepare the decomposition vessel:

①

Open the decomposition vessel

Unscrew the cover and take out the lid. To do this, engage the carrying and venting handle, C 7010.8, and lift the lid vertically upwards.



Internal parts of the decomposition vessel

1 Ignition wire
2 Crucible holder (part of C 5010.4)
3 Crucible dish (part of C 5010.4)
(C 5010.4 is not in scope of supply)

②

Securing cotton thread

Tie the cotton thread to the centre of the ignition wire. The cotton thread is not required when using a combustible crucible C 14, because the crucible is then in direct contact with the ignition wire.

Securing the cotton thread

1 Cotton thread

③

Weigh the sample (with combustible crucible if used).

As a rule, the quantity weighed should be such that the maximum permissible energy input of 30.000 J is not exceeded. Failure to observe this rule may result in damage to the calorimeter system.

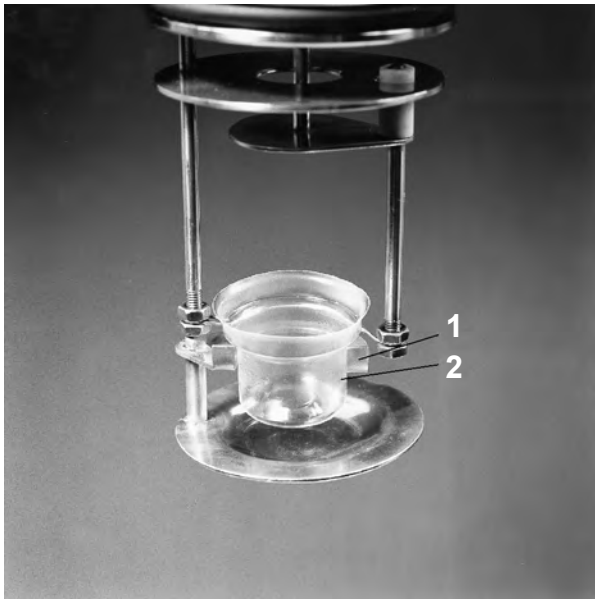
The temperature increase during a test should be as close as possible to the temperature increase during calibration.

If the decomposition vessel is damaged, there is a danger of it bursting! Follow the operating instructions for the decomposition vessel!

When working with unknown substances, start with a very small sample so that you can safely determine its energy potential. If you are burning unknown samples, leave the room or keep a safe distance between you and the calorimeter.

After the sample has been weighed (with combustible crucible if used), the crucible can be placed on the crucible holder.

Placing the combustible crucible



1 Crucible holder (part of C 5010.4) (not in scope of supply)
2 Combustible crucible (not in scope of supply)

If distilled water or other liquid is added to the decomposition vessel for the test, then calibration must be carried out with the same quantity of the same liquid.

④

Positioning the cotton thread

Use a pair of tweezers to arrange the cotton thread so that it hangs in the crucible and as far as possible contacts the sample. This ensures that during the ignition phase the burning thread falls on the sample and ignites it.

⑤

Close the decomposition vessel C 7010 oder C 7012
Place the cover onto the lower section and push down until it presses against the stop piece in the lower section.

C 7010/ C 7012

Place the union nut onto the lower section and tighten by hand.

The decomposition vessel can now be filled.

⑥

Finally, the decomposition vessel is filled with oxygen at 30 bar using the C 48 IKA® oxygen filling station. Follow the operating instructions for the C 48 oxygen filling station.

The oxygen pressure should be 30 bar and must not exceed 40 bar. Use quality 3.5 oxygen (99.95% pure oxygen).

Following preparation of the decomposition vessel, it will be subjected to either a calibration or a calorific value determination. The two procedures are very similar, so that they are described together below. Where there are differences these will be explained.
When the decomposition vessel has been prepared, a calibration or a calorific value determination is prepared by carrying out the following steps:

①

Starting from *menu 1*, for a calibration, press the ▼ button once to go to *menu 2*. Then press function key *f3*, to enter the sub-menu *calib*. For a calorific value determination, press function key *f1* in *menu 1* to go to sub-menu *pre-par*. In both sub-menus, the enquiry *sample code* appears.

②

The *sample code* identifies a test. Use of this code word will later provide access to the test data. A specified sample code will appear in the upper left zone of the LCD-display for all further entries. The calorimeter generates a sample code automatically when it is switched on, which consists of the date and the number of the current test (00 to 99). The number increases by 1 for every new test. If you do not wish to use these automatic sample codes, use the alpha-numeric keys to enter your own code word for the test. Up to 9 consecutive alpha-numeric characters can be entered. Confirm by pressing the ↵ button. The enquiry *user* appears in the LCD-display.

③

Use the alpha-numeric keys to enter the name or initials of the operator. Here too, up to 9 consecutive alpha-numeric characters can be entered. Confirm by pressing the ↵ button. The enquiry *q-extr. /1/* appears in the LCD-display.

④

q-extr. /1/ is the sum of **all** sources of external energy. The preset entry here is 50 Joule. This is the calorific value of the cotton thread C 710.4, which you can purchase from IKA®. Use the key panel to set this value correctly for the current test.

When using combustible crucibles or other combustion aids, their weight in grams can be entered manually using the key panel, or read automatically from a connected balance. Manual entry is made using the alpha-numeric keys after selecting the menu level *manual* with function key *f3*. The calorimeter accepts only values greater than zero. For automatic input from the balance, use function key *f4* to call up the menu level *balance*. The mass of the sample as determined by the balance will be read in automatically.

It is now necessary to enter the calorific value of the combustion aid. The last value entered always appears here as a default value. If necessary, erase this value by pressing the *del* button repeatedly. Once these two entries are completed, the calorimeter automatically calculates the external energy supplied by the combustion aid.

☞ **If a cotton thread is used in addition to a combustion aid, the external energy supplied by the cotton thread must be added manually.**

Confirm by pressing the ↵ button. The enquiry *sample mass* appears in the LCD-display.

⑤

Here the user also has the choice of manual entry or automatic input from a connected balance. Manual entries are made directly in this window using the alphanumeric keys, or automatic input is called up by pressing function key *f4*. The mass weighed by the balance is automatically accepted. After entry, confirm by pressing the ↵ button. If you are preparing for a calibration, the LCD-display asks for the reference calorific value, *H0-stand.* If you are preparing for a calorific-value determination, the second line of the LCD-display briefly shows the enquiry *(mem)* = *save*. When it has disappeared, pressing the *mem* button stores the data entered and closes the entries for a calorific-value determination.

If you want to check the values before you store them, you can select each parameter using the arrow and function buttons and make corrections if necessary. Once the parameters have been stored, it is no longer possible to change them.

If you are carrying out a calorific-value determination, omit the next step.

⑥

Only when preparing for a calibration: enquiry for reference calorific value, *H0-stand*. A charge-related pre-setting in the order of 26450 J/g will be displayed. This is the calorific value of the benzoic acid tablets supplied by IKA®. If you are going to use a different substance for calibration, use the key panel to enter the correct value; the units must be J/g. Confirm by pressing the ↵ button. The second line of the LCD-display briefly shows the enquiry *(mem)* = *save*. When it has disappeared, pressing the *mem* button stores the data entered and closes the entries for a calibration.

The message "Bomb securely closed?" will appear. Ensure that the decomposition vessel is properly closed and confirm with OK.

⑦

You can now place the decomposition vessel in the calorimeter. Use the carrying and venting handle, C 7010.8. Place it on the decomposition vessel and turn it anticlockwise until the handle engages. Take care not to accidentally press the vent knob, which will cause oxygen to escape. Guide the decomposition vessel into the measuring cell, until it is standing vertically and centrally in the cell. Remove the carrying and venting handle by turning it clockwise. Close the cover by drawing the complete upper section of the instrument over the measuring cell. The LCD-display then shows the text *sample code* and the parameters just entered.

Activate *Start*

Each time 1000 ignitions have been performed using a given decomposition vessel, the following message will appear:

1000 ignitions performed with Bomb x
Inspect decomposition vessel
or contact IKA service

This indicates that the decomposition vessel has reached a maintenance point and that a safety check must be carried out. Confirm this message by pressing *"7", TAB* and *OK* in sequence.
This message does not release the user from the responsibility of also continuously checking the decomposition vessel for wear and carrying out safety inspections as required.

7.4 Carrying out a measurement

When a calibration or a calorific value determination has been prepared as described above, the measuring process can be started. The *sample code* shown on the LCD-display informs you of the test parameters which will be used for the measurement. Pressing the ↵ button starts the calibration or calorific value determination.

From now on, the C 7000 calorimeter takes control. The measurement process is made up of a pre-test and the main test. The current phase of the test is shown on the LCD-display. During both the pre-test and the main test, you can follow the temperature changes in the decomposition vessel on the LCD-display. From the start of the test, they are updated every 1.5 seconds. In the second line of the LCD-display you can also see the duration of pre-test or main test, which is indicated by an extending bar.

End of the test
The end of the test can be seen on the LCD-display or on the print out. As long as the value *0* has not been entered in the sub-menu *realt.* (Real time printout), during the test the printer will print the current temperatures at the set time intervals and the result at the end of the test. In the first line, the LCD-display shows the temperature increase in Kelvin and, for a calibration, the provisional C value in the second line.

The following steps must be carried out when the test has been completed:

①
The green LED blinking near the ✓ button indicates the end of the test. Acknowledge this by pressing the ✓ button. If the button is not pressed, an acoustic signal sounds after about five seconds, as an additional means of making you aware that the test has ended. It sounds for about 30 seconds if it is not acknowledged. After that, the LCD-display returns to *menu 1* in the main menu.

②
Open the cover of the measuring cell by lifting the upper section of the instrument and pushing it backwards. The result of the test just carried out then appears on the LCD-display. Use the carrying and venting handle, C 7010.8, to lift the decomposition vessel out of the measuring cell.

③
So that the next test can take place under the same temperature conditions, the energy absorbed by the decomposition vessel must be removed again. The C 7002 cooler fulfils this function. Place the decomposition vessel vertically in the cooler. The cooling jaws close automatically. The display shows the temperature difference between the decomposition vessel and the calorimeter in percent. During the cooling process, this value progressively approaches zero. When the temperature of the decomposition vessel is the same as the calorimeter temperature, this is indicated by repeated, short acoustic signals. The cooling jaws open at the same time. Remove the decomposition vessel using the carrying and venting handle, C 7010.8.

The cooler can be manually controlled using the *open/close* button. Pressing the *open/close* button during the cooling process opens the cooling jaws. If the button is operated again, the jaws close again and cooling is continued. Cooling only continues as long as the decomposition vessel is at a higher temperature than the calorimeter.

④

Venting the decomposition vessel, which may contain poisonous gases should be carried out using the venting station, C 7030, which is available as an accessory. If the decomposition vessel is vented using the handle, C 7010.8, this must be done in a fume cupboard. Make sure the decomposition vessel is completely vented to atmospheric pressure, otherwise it cannot be opened.

⑤

Open the decomposition vessel and check the crucible for signs of incomplete combustion. If combustion was incomplete, discard the result and repeat the test.

⑥

Clean and inspect the decomposition vessel as described in Section 7.6.

7.5 Manual recording of the C value

The C value that was determined the last time a decomposition vessel was calibrated is always stored in the calorimeter. If several calibration runs were used to calculate the C value (e.g. when calibrating to DIN), the calculated C value for the decomposition vessel must be entered manually before making a calorific value test. The C value is dependent on the decomposition vessel used. If the coding is used, up to eight decomposition vessels can be automatically recognised by the calorimeter. Then the instrument selects the appropriate C value for the current configuration.
Starting from *menu 1*, follow the steps below to enter the C value manually:

①

Press the ▼ button once. *menu 2* appears in the LCD-display.

②

Press the function key *f1* to go to the sub-menu *manual*. The LCD-display shows the sub-menus *heat-cap.* (C value) and *measure.*

③

Use function key *f2* to select the sub-menu *heat-cap.* The LCD-display shows the enquiry *bomb-no.*

④

Use the alpha-numeric keys to enter the number of the decomposition vessel you have used for the calibration. Later, this number will be printed on every measurement protocol. Confirm by pressing the ↵ button, and the enquiry for the C value appears in the LCD-display.

⑤

In the second line of the LCD-display, the last C value entered is given. Erase this entry by pressing the *del* button repeatedly. Use the alpha-numeric keys to enter the C value for the decomposition vessel previously specified.

⑥

Confirm by pressing the ↵ button. In the second line of the LCD-display, the enquiry *(mem)* = *save* appears briefly. Wait until this enquiry disappears again.

⑦

Then press the *mem* button to store your new entry, and use the *esc* button to return to *menu 1* in the main menu.

The C value for the decomposition vessel you have specified is now stored in the calorimeter, and will be called up automatically when you make a measurement with this vessel.

Repeat the above procedure to enter the C value for all the other decomposition vessels you are using.

7.6 Cleaning and checking decomposition vessels

If there is a suspicion that a sample, or the residues or gaseous products of combustion could present a health hazard, then protective personal equipment (e.g. gloves, breathing mask) must be worn. Combustion residues which are a hazard to health or the environment must be disposed of as hazardous waste. We refer you explicitly to the valid regulations.

For accurate measurements it is absolutely essential that the decomposition vessel is clean and dry. Contaminants modify the heat capacity of a decomposition vessel and so cause inaccurate results. After every test, the inner walls of the vessel, the internal fittings (mountings, electrodes etc.) and the combustion crucible (internally and externally!) must be thoroughly cleaned.

Inner walls of the vessel

In most cases it is only necessary to remove condensate from the inner walls and internal fittings. It is then sufficient to wipe the parts carefully with an absorptive, lint-free cloth.

If the decomposition vessel cannot be properly cleaned using the measures described (e.g. burning, pitting, corrosion etc.), contact your Technical Service Department. Please also note the instructions given in Section 1 "For Your Safety"

Crucible

Combustion residues in the crucible, e.g. carbon or ash, must also be wiped off carefully with an absorptive, lint-free cloth.

8 Evaluation of Calorific Value Tests

When a calorific value test has been completed, you can proceed to evaluating the results. Section 8.1 explains how stored tests can be listed in a table, how you output or erase test results, and how you can list information about free memory for storing new tests. You will find these functions in the sub-menu *output*. The test results are dependent on the post-test parameters; their meaning and how to enter them are described in Section 8.2. Section 8.3 deals with the possibility of test simulation.

8.1 Output and treatment of test data

Before stored data can be issued and processed, the user must first state which tests are to be called up from memory. After the appropriate menu has been activated, you will be requested, in succession, to enter selection criteria for the date, sample code and sample status.

A particular test is called up by the user entering appropriate values for the date, sample code and sample status. With the aid of the two place markers "**.**" and "**-**" it is, however, also possible to select several tests at the same time. The symbol "**.**" serves as a place marker for any desired string of characters, while the "**-**" symbol functions as place marker for any desired single character. Both symbols can be used in the date and sample code fields, whereas sample status only considers one of four fixed, preset values.

When the symbol "**.**" is entered in one of the two fields, the selection criterion is not defined in more detail, all tests in the memory meet this criterion.

On the other hand, the symbol "**-**" stands for just one character within a string. It can, however, be used several times.

The sample status can have the following values:

- *all*
  all stored tests are selected, independent of sample status
- *afterpar*
  selects only tests for which post-test parameters have been entered (see Section 8.2)
- *edit.*
  selects only edited tests
- *printed*
  selects only tests that have already been printed.

The individual data for date, sample code and sample status are logically linked by an AND relationship. This means that only tests that fulfil all three specified criteria will be selected.

Example: selection of all test data for the month of December in the year 2000:

- the selection criterion for the date is "**- -**1200". In this way, all the days of the month, the 12th. month, and the year 2000 will be selected;
- the selection criterion for the sample code is "**.**", so that the sample codes of all the tests stored in the instrument will be selected;
- the selection criterion for the sample status is *all* so that, as before, all the tests stored in the instrument will be selected.

Printing a tabular summary of tests

By taking the following steps, you can print a tabular summary of all tests stored in the instrument:

①

Make sure that the printer is connected and switched on.

②

Change from *menu 1* to the sub-menu *output* by pressing the function button *f3*, and then use function button *f3* to select the sub-menu *table.*

③

Enter selection criteria for the date, sample code and sample status as described above, and close your entries by pressing the *mem* button. The printer will now start to print.

The print-out has six columns:

- *sample code* sample code, under which all data for the test are stored
- *B-No.* number of the decomposition vessel used for the test
- *date* date on which the test was carried out
- *m [g]* sample mass in grams
- *Ho [J/g]* gross calorific value in Joules per gram
- *Hu [J/g]* net calorific value in Joules per gram

If no post-test parameters have been entered (see Section 8.2), the remark *PT parameters missing* will be printed instead of the net calorific value; The net calorific value can only be calculated with the aid of post-test parameters. If pre-test parameters have been entered but a test not yet carried out, the remark *no measurement performed yet* will be printed.

At the end of the summary of tests, the C values of the decomposition vessels will be printed. If a decomposition vessel has not been calibrated, or if the data were entered manually, this is indicated.

Information about free memory

The calorimeter can store a maximum of 100 tests. Using the following procedure, you can find out at any time how much memory is still available for further tests.

①

Change from *menu 1* to the sub-menu *output* by pressing the function button *f3*, and then use function button *f2* to select the sub-menu *free*. The message *x tests free* appears, where *x* is the number of tests still free. An acoustic signal sounds at the same time.

②

Acknowledge this message by pressing the ✓button.

Output of test data
It is only possible to calculate net calorific values and publish them by printing or on the LCD-display after all pre-test and post-test parameters have been entered *and* the measurements carried out. The output contains all the parameters entered, the automatically recorded data, and the calculated results. The latter are dependent on the calculation mode selected. In addition, the output contains notes about the test, if appropriate.

To print test results, proceed as follows:

①
Make sure that the printer is connected and switched on.

②
Change from *menu 1* to the sub-menu *output* by pressing the function button *f3*, and then use function button *f4* to select the sub-menu *samp.*

③
Enter selection criteria for the date, sample code and sample status as described above, and close your entries by pressing the *mem* button. The printer will now start to print.

To show test results on the LCD-display, proceed as follows:

If there is no printer connected, or if the printer is not switched on, you can only show test data on the LCD-display if the parameter *realt.* in the sub-menu *STInit* of *menu 3* is set to *0*.

①
Change from *menu 1* to the sub-menu *output* by pressing the function button *f3*, and then use function button *f1* to select sub-menu *LCD*.

②
Enter selection criteria for the date, sample code and sample status as described above, and close your entries by pressing the *mem* button. The parameters appear in the LCD-display in two lines, in the same order as the printed output. The upper line contains the name and units of the parameter, and its value is shown in the lower line. To see the next parameter, use the arrow buttons ▲ or ▼ (in this case, both have the same effect). After all parameters have been shown, the display returns to the main menu.

Parameters can only be displayed in the forwards direction, it is not possible to page backwards. The *esc* button can be used at any time to break off the procedure.

Editing test parameters
The subsequent editing (changing) of parameters is only possible if the test results have been issued at least once by printing or on the LCD-display. This is to prevent values being changed unintentionally.

To edit the parameters of a particular test, proceed as follows:

①
Change from *menu 2* to the sub-menu *edit.*, by pressing function button *f2*.

②
Enter the sample code to identify the test you wish to change.

③
Use the ▲ or ▼ buttons to go to one or more parameters and make the desired corrections.

④
Store the new entries by pressing the *mem* button. If you want to break off the procedure, press the *esc* button. Changed values will then not be stored.

Erasing test data
To erase selected test data, proceed as follows:

①
Change from *menu 1* to the sub-menu *del.*, by pressing function button *f4.*

②
Enter selection criteria for the date, sample code and sample status as described above.

③
Close your entries by pressing the *mem* button. The tests you have selected will be erased from the memory.

By entering the following criteria, you can erase those tests that have already been printed once:
- selection criterion for date: "**.**"
- selection criterion for sample code: "**.**"
- selection criterion for sample status: "*printed*"

8.2 Evaluation of tests

Evaluation of test data is dependent on the post-test parameters, which can only be entered after a measurement. However, before making a measurement, the calculation mode must be selected (*menu 3 / STInit / calcul.*). The available settings are (see Section 6.6):

- *std - t* standard without titration
- *std + t* standard with titration
- *coal - t* carbon without titration
- *coal + t* carbon with titration

The formulae used for calculation are mostly drawn from DIN standards. They are described in detail in the relevant standards.

The sub-menu *after-p.* has input fields for parameters which are dependent on the calculation mode selected. Parameters that are determined with the sample in the

as delivered condition are marked "raw", and parameters that refer to the analytically moist condition are indicated by "an".

By calling up the sub-menu *after-p.* under *menu 1*, the various parameters can be entered in order in the same way as the pre-test parameters (see Section 7.3). The values entered must be stored by pressing the *mem* button. After they have been stored, the data can only be changed by using the *edit.* menu. However, the post-test parameters can only be changed after the test has been either printed or shown on the LCD-display.

The meanings of the parameters and the calculation modes to which they belong are given in the following list:

Post-test parameters

sample code	The sample code is the means of identifying a test. Use of this code word gives access to the test data. Applies to all calculation modes.
remark	For documentation purposes, a text of up to 10 characters can be entered. Applies to all calculation modes.
q-extr. /2/	For entering any desired external energy for calculation of gross and net calorific values. Applies to all calculation modes.
total H_2O	Percentage of total water in the combustion sample as determined by element analysis. Calculation mode: *std - t*
hydrogen (an)	Percentage of total water in the combustion sample. Calculation modes: *std + t, coal - t, coal + t*
Na_2CO_3 vorg.	Amount of sodium carbonate solution placed in the decomposition vessel (according to DIN: 20 ml; 0.05 N). Calculation modes: *std + t, coal + t*
$Ba(OH)_2$ verbr.	Titrated quantity of 0.1 N barium hydroxide solution (titration of the distilled water used to rinse the decomposition vessel after a test). Calculation modes: *std + t, coal + t*
HCl verbr.	Titrated quantity of 0.1 N hydrochloric acid (titration of the distilled water used to rinse the decomposition vessel after a test). Calculation modes: *std + t, coal + t*
gr. moisture (raw)	Percentage of water from rough moisture. Calculation modes: *coal - t, coal + t*
ash (an)	Percentage of ash. Calculation modes: *coal - t, coal + t*

hygr. moisture (an)	Percentage of water from hygroscopic moisture Calculation modes: *coal - t, coal + t*
sulphur (an)	Percentage of sulphur Calculation mode: *coal - t*

8.3 Test simulation

In some cases, it is helpful to run through calorific-value tests or to calculate possible test results without actually carrying out a combustion test. Under *menu 2 / manual / measure* you can enter the temperature increase of a test manually.

This is especially useful if a calibration has been accidentally carried out instead of a calorific-value determination or vice versa. By using the measured temperature increase, a misinterpreted measurement can be corrected by simulation.

To enter a temperature increase for a particular test, proceed as follows:

①
In *menu 1*, enter the pre-test parameters (*pre-par*) for the test.

②
From *menu 2*, go to the sub-menu *manual*, and from there to sub-menu *measure*. You will be asked for the *sample codes*.

③
Use the alpha-numeric keys to enter the code for the test that is to be simulated, and then press the ↵ button. The LCD-display shows the enquiry *increase in temperature*.

④
Use the number keys to enter the required temperature increase, and then press the ↵ button. The enquiry *bomb-no.* appears in the LCD-display.

⑤
Use the number keys to enter the number of the decomposition vessel, and then press the ↵ button. In the second line of the LCD-display, the enquiry *(mem)* = *save* appears briefly. After it has disappeared, pressing the *mem* button stores the data entered. The green LED near the ✓ *button* blinks to indicate the end of the simulated test. Acknowledge this with the ✓ *button*, and exit this program.

9 Care and Maintenance

9.1 Maintenance

To ensure proper functioning of our instrument in continuous use, it is essential that it is maintained at regular intervals. We can offer you a special maintenance contract to meet this need. You can obtain further information direct from our Service Department.

For maintenance of the decomposition vessel, see the C 7010/C 7012 operating instructions!

9.2 Recommendations for cleaning

Clean your IKA® instrument only with these IKA®-approved cleaning agents:

Contaminant	Cleaning agent
• Dyes	Isopropanol
• Building materials	Water with detergent, isopropanol
• Cosmetics	Water with detergent, isopropanol
• Foodstuffs	Water with detergent
• Fuels	Water with detergent
• Other substances	Please consult IKA®

Notes

Electrical equipment must not be immersed in a cleaning agent.
Stainless steel can be cleaned with commercially-available stainless steel cleaners, but do not use those containing abrasives.
We recommend the wearing of protective gloves during cleaning.
The operating authority is responsible for ensuring that appropriate decontamination measures are taken if hazardous materials are spilt on or in the instrument.
Before using any method for cleaning or decontamination other than those recommended by the manufacturer, consult the manufacturer to make sure that the intended method will not damage the instrument.

When replacing the mains cable, use a product of equivalent quality and performance.

10 Messages and Troubleshooting

The C 7000 calorimeter is subjected to stringent quality checks during manufacture, should malfunctions occur despite this care, you will find in this section a selection of corrective measures for dealing with a range of fault situations. Most messages and fault indications appear on the LCD-display. They should be acknowledged with the ✓button. If your attempts to correct a fault are not successful, please contact your authorized IKA® Technical Service Department.

10.1 Messages from the C 7000 Calorimeter

Message	Cause	Remedy
printout not complete yet	It is not possible to display a result on the LCD if the unit still has a print order to process.	Check that the printer is online, otherwise wait until the printer has finished.
cover was opened, test aborted	The cover was opened during a measurement.	If the cover was opened during the pre-test period, the same test can be restarted. Opening the cover during the main test invalidates the measurement. Repeat the measurement.
printer timed out	No data can be sent to the printer.	Check that the printer is online. Set the period for a real-time printout (sub-menu *realt.*) to any value other than zero. Check the printer cable.
end of entry [mem] = save	Makes you aware that all parameters in this menu have been entered. To store the entries, you must press the *mem* button as soon as this message has disappeared.	
calibration test	You have attempted to enter post-test parameters after a calibration test. This is not possible.	

Message	Cause	Remedy
no increase in temperature	12 seconds after the start of the main test, the temperature increase is less than 0.2 K.	Faulty ignition or vessel not filled with oxygen. Open vessel and check these points. If the sample has burnt, the sample was too small. Then increase size of sample.
measurement range exceeded	During a measurement, the permissible temperature has been exceeded.	Reduce mass of sample.
	Contacts of the decomposition vessel (contact board) or the calorimeters (contact pins) dirty or damaged.	Clean contacts, if damaged inform Technical Service Department.
	Measurement PCB defective.	Inform Technical Service Department.
measurement card defective	Hardware fault on measurement PCB	Inform Technical Service Department.
measurement already performed	A sample code has been entered for which a temperature increase is already stored (by measurement or manually).	Enter sample code that has not yet been used.
Measurement started	This indicates the start of a measurement.	
post-test parameters already entered	Under this sample code, post-test parameters are already entered.	To change parameters, you can use sub-menu *edit.* in *menu 2*.
no measurement performed yet	Post-test parameters can only be entered after a test has been made.	First carry out measurement or enter temperature increase manually.
sample code is assigned	Under this sample code, parameters are already entered.	Enter sample code that has not yet been used.
sample code not found	The sample code entered could not be found.	Enter valid sample code.
memory for tests full	The available memory is full (100 tests).	Erase tests no longer needed (*menu 1*, sub-menu *del.*).

Message	Cause	Remedy
test not yet printed	You have attempted to change the parameters of a test that has not yet been printed out.	Print test at least once, and then edit.
loss of power supply	An interruption in the power supply has been detected.	Possibly too many consumers are connected to a single socket, which has caused a brief voltage drop. Connect C 7000 to a separate socket.
PT parameters missing	A test can only be carried out after pre-test parameters have been entered.	Enter pre-test parameters. Check that you have not entered the wrong sample code.
V.24 timed out	Data could not be sent through the V24 interface to the PC.	Check interface parameters and connection cable. Make sure that external PC is ready.
scale timed out	Data could not be sent to the balance, or the balance does not respond.	Balance reading has not yet stabilised. Check interface parameters and connection cable.
memory has been reinitialized	After the program was started, a memory error was detected, and the memory reinitialized. Test data have been erased.	If this problem occurs frequently, the battery on the MC board must be changed (by the Technical Service Department or an instructed specialist).
problem with clock storage	After the program was started, a memory error was detected in the clock unit.	Check date and time, and reset if necessary. If this problem occurs frequently, the clock unit must be changed (by the Technical Service Department or an instructed specialist).
clock battery dead	The clock unit battery is empty.	The clock unit must be changed (by the Technical Service Department or an instructed specialist).

10.2 Fault without signal from Calorimeter

Fault	Cause	Remedy
calorimeter in undefined status	Power supply failure	If a test was not being carried out, switch the system off and on again to restart it. If a test was in progress, adopt the following procedure: • switch the system off and restart correctly; • remove the decomposition vessel, release the pressure in it, and prepare for a new test.
incomplete combustion	Quantity of oxygen in bomb was not sufficient.	Check the filling pressure at the oxygen filling station (30 bar).
	Low flammability sample	Use combustion aid

10.3 Signals from the C 7002 Cooler

Message	Cause	Remedy
continuous acoustic signal from C 7002 cooler	Inadequate water supply. When a critical temperature is reached, the Peltier elements are automatically switched off and the cooling jaws opened to prevent damage to the cooler.	Restore water supply. When the temperature falls below the critical level, the acoustic signal is switched off, and cooling is resumed.

11 Accessories and Consumables

11.1 Accessories

Ordering description

C 7010	IKA® decomposition vessel, standard
C 7012	IKA® decomposition vessel, halogen resistant
C 5010.4	Support for disposable crucible
C 48	Oxygen filling station
C 7002	Cooler
C 7010.8	Venting handle
C 7030	Venting station
C 5040	Calorimeter software for PC (CalWin®)
C 21	Pelleting press
C 29	Pressure reducer for oxygen
KV 500	Cooling water supply

11.2 Consumables

Ordering description

C 710.4	Cotton threads, cut to length (500 pieces)
C 5010.3	Ignition wire (5 pieces)
C 5012.3	Platinum ignition wire(2 pieces)
C 5010.5	Crucible support, large
C 4	Quartz dish
C 5	Set of VA combustible crucibles (25 pieces)
C 6	Quartz dish, large
C 9	Gelatine capsules (100 pieces.)
C 10	Acetobutyrate capsules (100 pieces)
C 12	Combustion bags, 40 x 35 mm (100 pieces)
C 12A	Combustion bags, 70 x 40 mm (100 pieces)
C 43	Benzoic acid (NBS 39i, 30 g)
C 43A	Benzoic acid (100 g)
C 723	Benzoic acid tablets (50 pieces, ca. 25 g)
C 14	Combustible crucibles (100 pieces)
C 15	Paraffin strips (600 pieces)

12 Technical Data

12.1 Technical data for C 7000 Calorimeter

Operating voltage		100 V-120 V / 220 V-240 V
Operating frequency		60 / 50 Hz
Power consumption		100 W
Fuses	for 230 V supply:	2 x 1.0 AT 1 x 630 mAT 1 x 250 mAT
	for 115 V supply:	2 x 2.0 AT 1 x 1.3 AT 1 x 500 mAT
Degree of protection to DIN 40 050		IP 21
Protection class		1 (with protective earth)
Over-voltage category		2
Contamination level		II
Ambient temperature		18°C ... 30°C (constant)
Max. relative humidity of environment		80 %
Use above sea level		max. altitude 2000 m
Dimensions (B x D x H)	unit closed: unit open:	310 x 490 x 395 mm 310 x 490 x 460 mm
Weight		25 kg
Measuring range		30 000 J
Interfaces		2 x serial (RS 232) for PC and balance 1 x parallel for printer 1 x connection for C 7002 cooler

12.2 Technical data for C 7002 Cooler

Operating voltage		100 V-120 V / 220 V-240 V
Operating frequency		60 / 50 Hz
Power consumption		160 W
Fuses	for 230 V supply: for 115 V supply:	2 x 1.25 AT 2 x 2.5 AT
Degree of protection to DIN 40 050		IP 21
Protection class		1 (with protective earth)
Over-voltage category		2
Contamination level		II
Ambient temperature		18°C ... 30°C (constant)
Max. relative humidity of environment		80 %
Use above sea level		max. altitude 2000 m
Dimensions (B x D x H)		360 x 290 x 245 mm
Weight		12.3 kg
Interface		1 x connection for C 7002 calorimeter
Cooling power (only Peltier elements)		80 W (with cooling water supply at 2 l/min)
Water inlet pressure		max. 9 bar

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