IKA®

Calorimeters

designed
to work perfectly

A breakthrough in the history of calorimetry!

Our new IKA® calorimeter C 1 represents a giant leap forward in the development of oxygen bomb calorimeters and sets a new standard for the future.

The C 1 calorimeter possesses a high degree of automation while maintaining the smallest footprint on the market, thus changing how calorimeters will be viewed and operated in the future. The C 1 is a calorimeter with a static jacket. The analysis of the temperature readings is done through the well known correction calculation of classical isoperibol calorimeters according to Regnault Pfaundler. A light attachable combustion chamber has replaced the traditional heavy screw threaded decomposition vessel. The C 6000 global standards and C 6000 isoperibol calorimeters follow the traditional calorimetric approach similar to our globally approved C 5000 and C 2000 calorimeter models.

Each calorimeter can be operated through a user panel and with our dedicated calorimeter software Calwin C 6040. This software opens up further features in data handling with Microsoft SQL, XML, LIMS and correction calculations that follow many globally used calorimeter standards.

2 Year warranty*

* 1+1 years after registering at www.ika.com/register, wearing parts excluded

Validation according to DIN EN 61010

CE | TÜV

C 1 Calorimeter

The traditional heavy screw threaded bomb has been replaced by a **light combustion chamber**

Automatic oxygen filling, venting and flushing

Operates with a chiller (RC 2 basic)

Interfaces for PC (USB-B), printer (serial interface), balance (serial interface)

Automatic ignition with fixed ignition wire as well as ignition energy determination for each experiment

Automatic water filling and draining

Ident. No.	Name	Description	Ident. No.
0010001045	Package 1/10	C 1	0003825000
		RC 2 basic	0004171000

IKA®+

The world's smallest calorimeter!

The oxygen bomb calorimeter C 1 is a little giant that sets new standards for the industry. The C 1 represents the smallest static jacket (Regnault-Pfaundler) calorimeter in the world. IKA® has combined modern technology with unique automation to provide the user with a never before seen experience in the world of oxygen bomb calorimeter and is defining the future for this technology.

C 6000 global standards | isoperibol

Easy and convenient
touch screen operation

SD Card slot for additional data management

Ethernet interface for data management via FTP Server

Decomposition vessel with spherical top, better heat transfer, shorter measurements times

Ident. No.	Name	Description	Ident. No.
0010001046	Package 1/10	C 6000 global standards	0003780000
		C 6010	0003770000
		RC 2 basic	0004171000
0010001047	Package 1/12	C 6000 global standards	0003780000
		C 6012	0004504000
		RC 2 basic	0004171000
0008804300	Package 2/10	C 6000 global standards	0003780000
		C 6010	0003770000
0008804400	Package 2/12	C 6000 global standards	0003780000
		C 6012	0004504000
0010001048	Package 1/10	C 6000 isoperibol	0004025000
		C 6010	0003770000
		RC 2 basic	0004171000
0010001049	Package 1/12	C 6000 isoperibol	0004025000
		C 6012	0004504000
		RC 2 basic	0004171000
0008804700	Package 2/10	C 6000 isoperibol	0004025000
		C 6010	0003770000
0008804800	Package 2/12	C 6000 isoperibol	0004025000
		C 6012	0004504000

Software provides control chart view and correction calculation of globally used standards

RFID technology used for decomposition vessel identification

Easy bomb preparation due to new “turned around” crucible holder technology

The C 6000 global standards offers a fast dynamic method, the classical adiabatic as well as isoperibol measurement modes. The C 6000 isoperibol offers the same advantages and features, with the exception of the adiabatic measurement mode.

IKA+

The classical & traditional design with advanced technology!

The software is handled through a TFT touch screen which provides many new features that make the daily operation easier and more comfortable. These units also possess a number of modern interfaces which allow connection to a balance, a network, a PC, printers or a PC mouse.

C 200 Calorimeter

The C 200 compact semi-automated combustion calorimeter is used for determining the calorific value of liquid and solid samples. Suitable for teaching and training (e.g. technical schools, universities) and for industrial laboratories with low number of samples.

GOST-certified

User-friendly software C 6040 CalWin for controlling the calorimeter (accessory)

Powered with low operating voltage 24 V DC

Automatic precise filling of inner vessel

Description	Ident. No.
C 200	0008802500
C 200 halogen resistant	0008803700

C 7000 Calorimeter | AOD 1 Decomposition system

Short measurement times result in high sample frequency

Precise and reproducible determination of calorific values according to ISO 1928

The C 7000 is the IKA® calorimeter with a completely dry system for measuring the calorific value of solid and liquid samples. The temperature is measured directly in the decomposition vessel. This results in measurement times in the range of three to seven minutes (depending on the sample). The system can manage up to eight different decomposition vessels.

Description		Ident. No.
C 7000 basic equipment set 1	230 V 50/60 Hz	0008800900
	115 V 50/60 Hz	0008800901

Description		Ident. No.
C 7000 basic equipment set 2	230 V 50/60 Hz	0008801400
	115 V 50/60 Hz	0008801401

Pressure vessel of high-corrosion resistant alloy

Control standards for Chlorine, Sulfur, included in delivery (AOD 1.11); for Fluorine and Bromine available as accessory

The AOD principle is based on the bomb method as per DIN / EN 14582, "Characterisation of waste - Halogen and sulphur content" and DIN 51727, " Testing of solid fuels - Determination of chlorine content "amongst others.

The AOD 1 Decomposition system consists of:
AOD 1.1 Decomposition vessel
C 48 Oxygen station
AOD 1.2 External ignition unit
AOD 1.11 Control standard (50 ml)

Description	Ident. No.
AOD 1 Decomposition system	0008801300

Technical data	C 1		C 6000 isoperibol | C 6000 global standards	
Maximum energy input	40,000 J		40,000 J	
Resolution of temperature sensor PT 1000	0.0001		0.0001	
Powe ON-time	100 %		100 %	
Operating oxygen pressure	30 bar		30 bar	
Display	TFT		TFT with touch screen	
Multifunctional push & turn dial	yes		–	
Measuring modes / RSD (NIST Benzoic acid 39j)	Static jacket (Regnault Pfaundler)	0.15 %	Adiabatic (Only global standards) Isoperibol (Regnault Pfaundler) Dynamic	0.05 % 0.05 % 0.15 %
Measurements per hour	Isoperibol (Regnault Pfaundler)	4	Adiabatic (Only global standards) isoperibol (Regnault Pfaundler) Dynamic	5 4 6
Jacket control	static, dry		controlled, water	
Start temperature settings	2 possible settings: 22 °C or 30 °C		3 possible settings: 22 °C, 25 °C, 30 °C	
Operator time	< 1 min		< 1 min	
Number of decomposition vessel per unit	up to 2		up to 4	
Halogen resistant and catalytic activated vessels available?	on request		yes	
Decomposition vessel ID	manual		automatic (RFID)	

Interfaces	C 1	C 6000 isoperibol | C 6000 global standards
PC	USB-B	9 pin (M) RS 232 serial
Printer	9 pin (M) RS 232 serial	USB-B
Balance	9 pin (M) RS 232 serial	9 pin (M) RS 232 serial
Ethernet	–	yes (network printer)
SD-Card	–	yes
Sample rack	–	yes
Automatic functions		
Automatic oxygen filling / venting / flushing	yes	yes
Automatic water filling / drain	yes	yes
Automatic ignition and ignition energy determination for each experiment	yes	yes
Operated with RC 2 basic		
Cooling medium temperature min.	18 °C	12 °C
Cooling medium temperature max.	29 °C	27 °C
Cooling medium permissible operating pressure	1.5 bar	1.5 bar
Cooling medium	tap water	tap water
Type of cooling	flow	flow
Flow rate min.	50 l/h	60 l/h
Flow rate max.	60 l/h	70 l/h
General data		
Languages	D, E, Fr, Sp, Chi, Rus, Pol, I	D, E, Fr, Sp, Chi, Rus, Pol, I
Dimensions opened (W x D x H)	290 x 350 x 400 mm	500 x 450 x 620 mm
Dimensions closed (W x D x H)	290 x 350 x 270 mm	500 x 450 x 420 mm
Weight	15 kg	35 kg
Ambient temperature	20 – 25 °C	20 – 25 °C
Ambient humidity	80%	80%
Voltage	100 – 240 V	200 – 240 V
Frequency	50/60 Hz	50/60 Hz
Power Input max.	150 W	2000 W
DC Voltage	24 V	–

For packages, see page 4

For packages, see page 6

C 200

Technical data	
Maximum energy input	40,000 J
Power ON-time	continuous operation
Operating oxygen pressure	–
Measuring modes / Measurements per hour	Isoperibol 3 Dynamic 5 Manual (Isoperibol) 3 Time-controlled 4
Start temperature settings	18 – 25 °C
RSD (using NIST benzoic acid 39j)	Isoperibol 0.1 % Dynamic 0.1 % Manual (Isoperibol) 0.1 % Time-controlled 0.1 %
Number of decomposition vessel per unit	up to 4
General data	
Dimensions (W x D x H)	400 x 400 x 400 mm
Weight	21 kg
Ambient temperature	20 – 25 °C (constant)
Ambient humidity	80 %
Protection class according to DIN EN 60529	IP 21

C 200: **Ident. No. 0008802500**

C 200 h: **Ident. No. 0008803700**

C 7000

Technical data	
Input power max.	0.1 kW
Resolution of the temperature sensor	0.0001
Power ON-time	continuous operation
Range of measurement	30,000 J
Reproducibility based on analysis of 1 g benzoic acid NBS 39i	0.2 % RSD
Working modes	patented double dry
Measurement time	3 – 7 min
Operating oxygen pressure	30 bar
Cooling medium (C 7002)	tap water
Flow rate (C 7002)	2 – 3 l/h
Temperature	12 – 30 °C (cooling water)
Operated at firmly installed water connection	
Max. pressure at the tap	9 bar
General data	
Dimensions (W x D x H)	310 x 490 x 395 mm
Weight	43 kg
Ambient temperature	18 – 30 °C (constant)
Ambient humidity	80 %
Protection class according to DIN EN 60529	IP 21

C 7000 basic set 1 (230 V | 115 V):
Ident. No. 0008800900 | 0008800901

C 7000 basic set 2 (230 V | 115 V):
Ident. No. 0008801400 | 0008801401

AOD 1 decomposition system

Technical data	
Decomposition time	< 3 min
Max. operating temperature	50 °C
Max. operating pressure	195 bar
Volume of decomposition vessel	210 ml
Oxygen pressure	30 bar

AOD 1: **Ident. No. 0008801300**

C 1 & C 6000 | **Chiller RC 2 basic**

The RC basic cooling temperature control instruments are designed to cool external analysis devices quickly and efficiently. The chillers offer short cooling times at a temperature stability of ± 0.1 K and a working temperature range of -20 °C to room temperature.

RC 2 basic	
Temperature	Cooling output
+ 20 °C	400 W
+ 10 °C	370 W
0 °C	320 W
- 10 °C	240 W
- 20 °C	130 W

Application example

The RC 2 recirculating chillers are ideal for cooling external analysis devices such as laboratory reactors, calorimeters, incubation shakers or rotary evaporators.

The illustration shows the RC 2 basic recirculating chiller connected to the IKA® C 1 calorimeter.

Technical data	RC 2 basic
Appliance type	recirculating chiller
Safety class	I (FL)
Cooling capacity at 20 °C	400 W
Heater capacity (230 / 115 V)	–
Temperature range	-20 °C – RT
Temperature display	LED
Temperature stability DIN 12876	± 0.1 K
Bath volume range	1.5 – 4 l
Max. flow rate (at 0 bar)	18 l/min
Max. pump pressure	0.3 bar
Min. suction pressure	0.2 bar
Dimensions (W x D x H)	220 x 475 x 525 mm
Permissible ambient temperature	5 – 32 °C
Permissible relative moisture	80%
Protection class acc. to DIN EN 60529	IP 21
USB / RS 232 interface	yes
	Ident. No. 0004171000

IKA® Pilotina | **Universal 2 in 1 mill for dry products**

IKA®+

IKA® offers solutions for the sample preparation process before determination in the calorimeter. For example the universal mill IKA® Pilotina MU for coal and wood samples.

IKA® Pilotina MU
The universal 2 in 1 mill for dry products

Your advantages: one machine, two milling principles, all this without making any compromises with regards to disintegration quality.

IKA® Pilotina MC*
The cutting mill system

The dry mill IKA® Pilotina MC is the pre-eminent choice for the disintegration of smooth, sticky, elastic or fibrous materials such as parts of plants, plastics, food pellets and much more.

IKA® Pilotina MI*
The impact milling system

The dry mill IKA® Pilotina MI is the foremost option for the disintegration of hard and brittle materials e.g. coal, glass, ore and/or seeds.

Technical data	IKA® Pilotina MU	IKA® Pilotina MC	IKA® Pilotina MI
Motor power	3 kW	1.5 kW	1.5 kW
Speed range	1,500 – 4,500 rpm	1,500 rpm	3,000 rpm
Capacity (depending on the final fineness)	approx. 60 – 80 kg/h	approx. 60 kg/h	approx. 80 kg/h
Circumferential speed	9 – 34 m/s	9 m/s	22 m/s
Dimensions (L x W x H)	495 x 830 x 740 mm	495 x 830 x 670 mm	495 x 660 x 740 mm
Weight, approx.	80 kg	70 kg	70 kg
	Ident. No. U105421	Ident. No. U106466	Ident. No. U106465

*** Mounting example on the basis of Pilotina MU**

C 1 & C 6000 | **Accessories and consumables**

IKA®+

The halogen resistant decomposition vessels C 5012, C 6012 and C 7012 are equipped with a catalytically active surface, which enhances the on-going reactions during the combustion. As a result, higher recovery rates for halogens and sulfur are achieved.

C 1 Accessories and consumables

Name	Description	Ident. No.
C 1.50	Dot matrix printer	0004500600
C 1.10	Combustion chamber, standard combustion chamber, upper and lower part	0004500300
C 1.30	Venting station, to vent the combustion gases in a controlled manner into an absorption solution for further analysis	0004500900
C 1.1012	Organizer	0004500700
C 1.101	Set of spare partes, apporximately 1000 experiments. Contains standard consumables, wearing parts for the C 1 calorimeter series and the combustion chamber C 1.10 for approximately 1000 experiments.	0004502200

C 6000 Accessories and consumables

Name	Description	Ident. No.
C 1.50	Dot matrix printer	0004500600
C 6010	Decomposition vessel, standard	0003770000
C 6012	Decomposition vessel, halogen resistant	0004504000
C 6030	Venting station	0004504100
C 60.1012	Organizer	0004504200
C 6000.10	Set of spare parts, approx. 1000 experiments	0004504300
C 6000.12	Set of spare parts, approx. 1000 experiments	0004504400

Structured capabilities of connections on backside of the C 1 and C 6000.

IKA®+

To get customized and additional accessories, please visit
www.ika.com/service

Calorimeters | **Accessories**

C 200 accessories

Name	Description	Ident. No.
C 248	Oxygen station	0003520000
C 200.1	Measuring cup, 2000 ml	0003548900
C 200.2	Conversion kit for C 5012	0004028800

C 200, C 2000, C 5000 accessories

Name	Description	Ident. No.
C 5010	Decomposition vessel, standard	0007114000
C 5012	Decomposition vessel, halogen resistant	0007215000
C 5030	Venting station	0007198000
C 5010.4	Attachment for combustible crucible C 14	0003016900
C 26	Prep stand	0008804000

C 2000, C 5000, C 6000 accessories

Name	Description	Ident. No.
C 5020	Sample rack	0007145000

C 1, C 2000, C 6000 accessories

Name	Description	Ident. No.
C 25	Pressure regulating valve	0003197200

C 7000 accessories

Name	Description	Ident. No.
C 7000	Measurement cell	0003008000
C 7010	Decomposition vessel, standard	0003015000
C 7012	Decomposition vessel, halogen resistant	0003017000
C 7002	Cooling system	0007011000
C 48	Oxygen station	0001560000
C 7030	Venting station	0003013300
C 7010.8	Venting handle	0007095000
C 5010.4	Attachment for combustible crucible C 14	0003016900
C 5010.5	Crucible holder, big	0003055900

Accessories for all Calorimeters

Name	Description	Ident. No.
C 27	Calorimeter preparation set	0004579700
C 29	Pressure gauge, oxygen	0000750200
C 21	Pelleting press	0001605300
C 5010.8	Crucible holder, small	0004579800
C 5010.5	Crucible holder, big	0003055900

Protective device AOD 1.3

As per Pressure Vessel Directive
97 / 23 / EC
(not included with delivery)

Oxygen filling station C 48

For filling decomposition vessel
with oxygen, 30 bar

Important information:
If protective device AOD 1.3 is not used, an AOD 1.13 remote ignition head is required.

Venting station C 7030

With DIN 12596 gas wash bottle,
for gas absorption
(not included with delivery)

Control standard AOD 1.11

For sulfur and chlorine
(more information on page 21)

Decomposition vessel AOD 1.1

High-alloy, halogen-resistant
stainless steel

External ignition unit AOD 1.2

Ignition triggered by pressing the
Ignite button
Cable length: 5 m

Name	Description	Ident. No.
AOD 1.1	Decomposition vessel	0003303000
AOD 1.2	External ignition unit	0003348000
AOD 1.3	Protective device	0003308000
AOD 1.13	Remote ignition head (required where AOD 1.3 is not used)	0003348100

IKA®+

Sample Analysis!

Send us your sample and we will process and analyze it for you within 48 hours!

Send your sample with a data sheet to:
IKA®-Werke GmbH & Co. KG,
Janke & Kunkel-Str. 10, 79219 Staufen, Germany.

Data sheet download: **www.ika.com/application**

- Data management with Microsoft SQL Server 2008 R2 possible
- Clearly arranged layout of all measurements, results, and connected calorimeters on one screen
- Printing and saving calibration protocols with control chart view
- Library and grouping functions with extended data filtering options
- Correction calculations to obtain the net calorific value according to various ISO, ASTM, DIN, GB, GOST standards
- Data transfer to XLS- and CSV-format

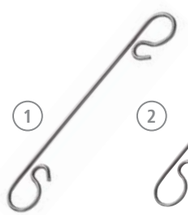
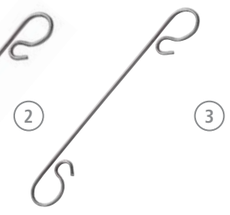
Ident. No. 0004040500

Modern Calorimetry requires modern Data handling…

Calwin C 6040 - PC control and evaluation software for the IKA® calorimeters.
The new IKA® calorimeter software Calwin C 6040 follows in the footsteps of our Calwin C 5040 with a vast array of modern solutions, ideas and possibilities for managing the measurements from our calorimeters. This software can be connected with the C 5000 (firmware 2.22), C 2000 (firmware 2.22), C 200 (firmware 2.0) as well as the new calorimeters C 6000 global standards, C 6000 isoperibol and C 1.

System requirements

Windows XP (SP2), Windows Vista, Windows 7, Windows 8 and at least one free USB or RS 232 (9 pin Sub-D (M)) serial interface. Processor with min. 1.6 GHz (single core-Processor); 2 GB RAM; 2.5 GB free hard-disc space; DVD-ROM-drive













C 1 and C 6000 consumables

	Name	Description	Ident. No.
1	C 1.103	Ignition wire, standard Kantal, 5 pcs., material: Kantal	0004579300
2	C 1.123	Ignition wire, platinum, 2 pcs. Material: Platinum; These wires are recommended when your samples contain chlorine	0004500200

C 200, C 2000, C 5000 and C 7000 consumables

	Name	Description	Ident. No.
	C 5010.3	Ignition wire, spare, 5 pcs.	0007122800
	C 5012.3	Ignition wire, platinum, 2 pcs.	0002994900
	C 14	Combustible crucible, 100 pcs.	0007224500
3	C 5003.1	Aqua Pro Stabilizing agent, 40 ml. Adjusts the conductivity of the water to achieve optimal performance of the calorimeter. Prevents growth of algae.	0007207700

Consumables for all Calorimeters

	Name	Description	Ident. No.
4	C 1.104	Water bath additive, 30 ml	0020003598
5	C 710.4	Cotton thread, cut to length, 500 pcs.	0001483700
	C 710.8	Cotton thread, cut to length, thick, 500 pcs.	0004579900
6	C 4	Quartz dish	0001695500
7	C 5	Set of VA combustion crucibles, 25 pcs.	0001749500
8	C 6	Quartz dish, big	0000355100
9	C 710.2	Set of VA combustion crucibles, 25 pcs.	0001483500
10	C 9	Gelatine capsules (Qty. 100 pcs.)	0000749900
11	C 10	Acetobutyrate capsules. The non-hygroscopic capsules are recommended for samples containing volatile components and are mainly used for solvents. In addition, the capsule prevents splashing of the sample when igniting and supports decomposition through their additional energy (Qty. 100 pcs.)	0000750000
	C 12	Combustion bags, Polyethylene (PE), 40 x 35 mm, 100 pcs.	0002201400
	C 12 A	Combustion bags, Polyethylene (PE), 70 x 40 mm, 100 pcs.	0002201500
	C 15	Parafilm strips, 45 x 3 mm, 600 pcs. for hard flammable or water containing samples	0003131100
	C 16	Parafilm tape, 1000 x 50 mm	0003801100
12	C 17	Paraffin, liquid, 30 ml	0003801200
13	C 43	Benzoic acid, NIST 39j, 30 g High purity benzoic acid powder. Must be pressed into pellets before decomposition! Standard Reference Material with certificate from the "National Institute of Standards & Technology (NIST), USA"	0000750600
14	C 723	Benzoic acid, blister package, 0.5 g, 50 pcs. Pelleted and blister packaged IKA® standard benzoic acid tablets with IKA® - certified gross calorific value for the calibration of the calorimeter	0003243000
	C 723 Big pack	Benzoic acid, blister package, 0.5 g, 450 pcs. Pelleted and blister packaged IKA® standard benzoic acid tablets with IKA® - certified gross calorific value for the calibration of the calorimeter	0003717400
15	AOD 1.11	Control standard, 50 ml, for sulfur and chlorine. Mineral oil with known sulphur- and chlorine content. Includes detailed work-instructions and a certificate. Recommended for the following: to check the handling, decomposition procedure and the respective peripheral detection devices	0003044000
16	AOD 1.12	Control standard, 50 ml, for fluorine and bromine. Mineral oil with known bromine and fluorine content. Includes detailed work-instructions and a certificate. Recommended for the following: to check the handling, decomposition procedure and the respective peripheral detection devices	0003080200

Industries & Applications

> Coal and Coke / Power Plants

Anthracite coal
Hard coal
Brown coal
Bituminous coal
Coke

> Petroleum

Jet fuel
Kerosene
Liquid fuels
Gasoline
Oil
Bio-fuels

> Cement

Coke
Tires
Animal flour
Mixed waste material

> Waste Management / Recycling

Tetra-pack
PVC powder
Printed circuit board
Lacquer
Waste solvent

> Food

Noodles
Dried fruit
Fish
Milk
Chocolate
Cheese

> Universities and Research Institutes

Teaching thermodynamics
Enthalpy studies
Airplane covering
Ecological studies

> Agriculture (Fodder)

Forage crops
Fodder for cats, dogs, cows, sheep, pigs, chicken
Animal urine and droppings

> Construction and Building Materials

Fleece
Insulation material
Styrofoam
Mortar
Rock wool

> Biomass

Wood
Wood pellets
Saw dust
Grass
Corn
Bio-fuels

Calorimeter Standards | **History**

Examples for calorimeter standards

GB/T 213	Calorie testing method of coal
ASTM D240	Standard test method for heat of combustion of liquid hydrocarbon fuels by bomb calorimeter
ASTM D4809	Standard test method for heat of combustion of liquid hydrocarbon fuels by bomb calorimeter (precision method)
ASTM D5865	Standard test method for gross calorific value of coal and coke
ASTM D5468	Standard test method for gross calorific and ash value of waste materials
ASTM E711	Standard test method for gross calorific value of refuse-derived fuel by bomb calorimeter
JIS M 8814	Coal and coke: determination of gross calorific value by the bomb calorimetric method and calculation of net calorific value
ISO 1928	Solid mineral fuels Determination of gross calorific value by the bomb calorimetric method and calculation of net calorific value
ISO 1716	Reaction to fire tests for building products
DIN EN ISO 9831	Animal feeding stuffs; animal products - feces or urine determination of gross calorific value
DIN EN 14582:2007	Characterization of waste - halogen and sulfur content oxygen combustion in closed systems and determination methods
DIN 51900 – 1	Testing of solid and liquid fuels - determination of gross calorific value by the bomb calorimeter and calculation of net calorific value Part 1: Principles, apparatus, methods
DIN 51900 – 2	Method using isoperibolic or static jacket calorimeter
DIN 51900 – 3	Method using adiabatic jacket

Calorimeter basics and brief history

A bomb calorimeter is used to measure the heat created by a sample burned under an oxygen rich atmosphere in a closed vessel, which is surrounded by water, under controlled conditions. The measurement result is called the combustion, calorific or BTU-value. The result allows one to make certain decisions regarding the quality, physiological, physical and chemical, as well as financial conclusions about the product.

The term “calorimeter“ was first mentioned by Josef Black in 1770. One of the first calorimeters (ice-calorimeter / phase transition calorimeter) was developed by Lavoisier and Laplace around 1780. The calorimetric bomb is also called “Berthelotsche Bomb“. Marcellin Berthelot developed the combustion of samples in a closed pressure resisting vessel into a standard method. He was the first to use pure oxygen at higher pressures to get a faster and more complete combustion (1885). In 1892, the first patent for a calorimeter to measure the heating value of gaseous fuel was given to Hugo Junkers, a German inventor and aircraft engineer. IKA® introduced their first bomb calorimeter in the 1920’s. Since then our calorimeters have been continuously developed according to the latest standards and technologies.

There are many different types of calorimeters available on the market: Solution, DSC - Differential Scanning, Titration, Gas and Reaction Calorimeters.

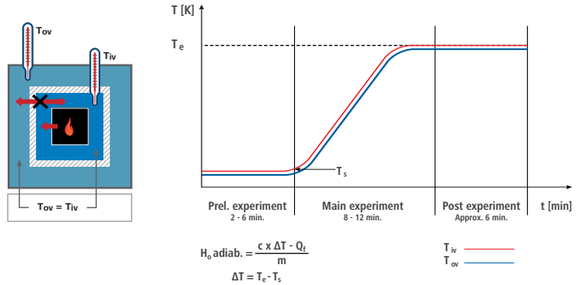
IKA® manufactures so called oxygen bomb - or combustion calorimeters.

About 1 g of solid or liquid matter is weighed into a crucible and placed inside a stainless steel container. The decomposition vessel or bomb is filled with 30 bar of oxygen (quality 3.5: technical oxygen 99.95 %). The sample is ignited for example through a cotton thread connected to a solid ignition wire inside the decomposition vessel and burned. During the combustion the core temperature in the crucible can reach 1000 °C, and the pressure rises as well. All organic matter is burned and oxidized under these conditions.

The heat created during the burning process can be determined using the static jacket, isoperibol, adiabatic or dynamic measurement procedure.

Adiabatic calorimeter

In an adiabatic calorimeter, the temperature in the outer vessel (T_{ov}) is equal to the temperature of the inner vessel (T_{iv}) throughout the experiment. This is as close to a "perfect isolation" as possible. The influence of the environment has to be minimized using air-conditioning to keep the room temperature as constant as possible. No correction calculations need to be done when compared with the isoperibolic calorimeter.



$$H_o\,adiab. = \frac{c \times \Delta T - Q_f}{m}$$

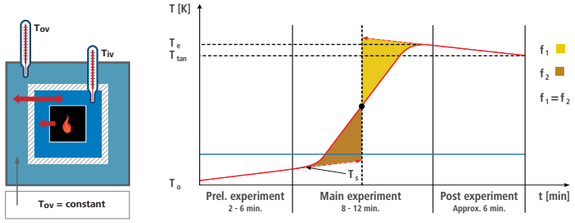
$$\Delta T = T_e - T_s$$

Isoperibol calorimeter

In an isoperibol calorimeter the temperature in the outer vessel (T_{ov}), is kept constant throughout the experiment. This does not allow a "perfect isolation". There are still small temperature fluctuations. The influence of the environment has to be minimized by using air-conditioning to keep the room temperature as constant as possible. A correction factor (Regnault-Pfaundler = ξ) will be calculated after the experiment that takes these temperature fluctuations into account.

$$\xi = \theta \left[\Delta_z \left[\frac{t_s + t_e}{2} + \frac{z_e - \Delta_z}{\sum t} \right] - \left(z_e + z_a \right) \frac{t_s - t_e}{2} \right] - \left(z_e - z_a \right) \frac{t_s - t_e}{z_s - z_e}$$

term 1 | term 2 | term 3



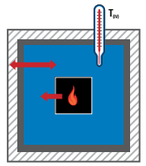
$$H_o\,isop. = \frac{c\,(dT + \xi) - Qf}{m}$$

Dynamic calorimeter

The dynamic IKA® designed modes are basically short versions of the original adiabatic and/or isoperibolic measuring modes. The measurement results still conform to the required Relative Standard Deviation (RSD) of the official standards.

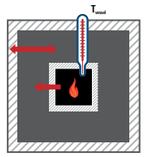
Static jacket calorimeter

In the C 1 static jacket calorimeter the outer vessel is a combination of the pressure chamber, insulating air and the housing of the unit itself. The jacket is not controlled nor filled with water. It acts static. Looking at the temperature profile of (T_{iv}), the C 1 behaves similar to an isoperibol calorimeter. The same correction calculations as in an isoperibol calorimeter according to "Regnault Pfaundler" can be applied.



Double Dry calorimeter

In the double dry calorimeter, the temperature increase is measured directly in the decomposition vessel. It is surrounded by a large aluminium block. The heat of combustion is thus measured directly, and not transferred as in the classical calorimeters into water in the inner vessel, which primarily takes time. This results, depending on the chosen preliminary-test-time, in a measurement time of down to 3 minutes per experiment. The methodology is complying to ISO 1928. The actual measurement process is similar to an isoperibol measurement, but with a relatively large drift. The applied correction calculations here are IKA® specific.



Which calorimeter is most suitable for my application and requirements?
The main questions that should be answered are as follows:

1. How many experiments do you plan on conducting in a day?
2. Are there any standards that have to be followed, such as ISO, ASTM, DIN, GB, GOST etc.?
3. Do samples contain halogens and sulphur and in which concentration approximately?
4. Is it required to analyze the halogens and sulphur content after the calorimeter experiment has concluded?
5. Do you prefer any of the following methods: adiabatic, isoperibol, static jacket isoperibol, dry or dynamic?

How do I know my calorimeter is still in calibration?
Most customers operate their calorimeters with control charts. After calibrating the unit, check runs are performed with benzoic acid, for instance. The results of these check runs have to match the certified calorific value of the benzoic acid within a defined range. The definition of the range is laid out in standards and the frequency of doing these checks differs from one a day, to one after and before every sample. The control charts show the performance of the unit under the previously described circumstance over a long period of time.

How often do I have to calibrate the calorimeter?
The control chart also shows when a new calibration might be required.

Which is the max and min calorific value that I can measure with the calorimeter?
The max. allowed energy input into our calorimeters is 40,000 J. The calorific value of a sample is always expressed in energy per weight (J/g). Based on that information, you can adjust the weight of your sample such that it does not exceed 40,000 J. The energy amount created by the sample should not be significantly higher than the one obtained during calibration with benzoic acid. Our calorimeters do have a high measuring sensitivity and can detect low quantities of energy. For example, the ignition energy of 70 J can be measured with an absolute error of ± 20 J. The relative error rises naturally (± 30%) hyperbolically the smaller the energy input is. If your sample has a very low calorific value you can also use combustion aids, since they add energy to the calorimeter to minimize the error.

When do I have to send the decomposition vessel to the high pressure inspection at IKA®?
We recommend checking the vessel after 1000 experiments or after 1 year of operation, whichever comes first. During the overall inspection process we perform both a high pressure and an operating pressure test. A new certificate will be issued for the vessel after it has passed both of these tests. More detailed information can be found in the manual of your calorimeter and/or the manual of your decomposition vessel. Alternatively, you can always contact our service department for further information and assistance.

Where do I find a list of spare parts and how many of these do I need?
We offer sets of spare parts that include parts for 1000 experiments e.g. 1 year operation. The actual amount of spare parts can vary based on the application. If a specific spare part is required, you can find further information in the service section of the instruction manual. In addition, on our website (www.ika.com) in the service section you can download service drawings with detailed descriptions of each part. Alternatively, you can always contact our service department for further information and assistance.

How can I get the gross and net calorific value - easily explained?
A calorimeter measures the preliminary gross calorific value of the sample. To get the gross calorific value, correction calculations are required for the acids formed during the combustion. For instance, the method of titration used to obtain the amount of nitric acid and sulphuric acid are described in detail in the standard ISO 1928. To get to the net calorific value, further corrections need to be applied concerning the amount of water that was formed during the combustion from hydrogen. Based on the state (dry, analytical moisture, as received) your sample was in before combustion, further corrections may apply. Moistures are determined by drying the samples. The Hydrogen content is usually measured with an elemental analyzer. For a more detailed explanation, we ask you study the standards you might have to use depending on your application requirements.

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