RADTKE
MESSTECHNIK

20 JAHRE

SWISS MADE

Manual
for CCM devices

Determination of the water content by the carbide method

Determination of moisture levels

Fast. Easy to use. Reliable.

www.radtke-messtechnik.com

Below you will find some QR-codes which guide you directly to our mobile access educational videos.
This list will be actualized without furhter notice and is therefore not actual. We do not claim to have a complete list.

(D) **VOR-ORT-KALIBRIERUNG** (siehe Seite 30 dieser Anleitung)

(E) **ON-SITE-CALIBRATION** (see page 30 of this manual)

(F) **ÉTALONNAGE SUR PLACE** (voir page 30 de ce manuel)

(I) **CALIBRAZIONE SUL LUOGO** (veda pagina 30 del´manuale)

Before carrying out measurements with the CCM device, we kindly request that you read the instructions precisely. There is no risk of an accident when using the CCM devices if the instructions are followed precisely. Therefore, please observe the following operating instructions:

The CCM device may be used only in accordance with the operating instructions.

The pressure in the CCM pressure bottle results from the formation of acetylene. An explosive air/acetylene mixture is rapidly formed. If this gas mixture is ignited during a measurement due to the generation of sparks, this will result in the destruction of the manometer as well as the loss of the measurement results.

The escaping gas is combustible:

a) Do not open the CCM pressure bottle in closed rooms.
b) Do not smoke and do not work near to open flames or electrical installations.
c) If a fire develops, smother it with sand or with a blanket; do not extinguish with water!

Following a measurement, hold the CCM pressure bottle pointing away from your face, open it and allow the gas to escape slowly (you will have fewer problems with the manometer as a result, since its mechanism is subjected to less stress).

As a matter of principle you should not use samples with more than 1.5 g water. Acetylene can decompose at a pressure of 1.5 bar or more (equivalent to 1.5 g water). This rapid process of decomposition **can lead to damage to the manometer.**

Perform measurements on the CCM device using only the materials intended. For other materials we kindly request you to send us a sample together with a description so that we can advise you. We will be only too pleased to support you.

FIRST AID MEASURES

In case of skin contact: Brush off well before rinsing with copious amounts of water.

In case of eye contact: Rinse the eyes out with copious amounts of water.

In case of caustic burns: These usually only occur if adhering calcium carbide is not removed. In all cases consult a doctor and show him/her the label of your calcium carbide box.

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FOREWORD

Our CCM devices are ideal moisture measuring instruments for the rapid determination of the moisture content of materials which themselves do not react with calcium carbide or its reaction products.

As with all measuring methods based on a chemical reaction, particular care is also required here. Please study these operating instructions before putting the device into operation and pay particular attention to the safety instructions.

Persons who are not familiar with the operating instructions may not use the measuring instrument.
In addition we do not garantee for errors occured for insufficient translations.

WARRANTY

Dr. Radtke CPM Chemical-Physical Measuring techniques Ltd. guarantees the equipment to be free from defective parts and poorly manufactured products, excluding consumables, for a period of 1 year from the date of purchase.

Important!
Please keep the operating instructions in a safe place.

Spare parts can be ordered from your dealer or directly on our website. The current version of the instructions as well as supplementary information for the interpretation of measurement results can also be found on our website and is continuously updated by us.

USE OF THE OPERATING INSTRUCTIONS

The information given in these operating instructions provides data on the components and their characteristics. The operating instructions additionally contain the basic principles of the carbide and drying oven methods, a comparison of the two methods as well as information on special measuring procedures that arise from different questions of measurement.

Particular attention must be paid **to bold** text.

Proper use and application on the basis of the operating instructions is binding for the product liability and product warranty. Attempting to repair the device yourself renders the warranty null and void.

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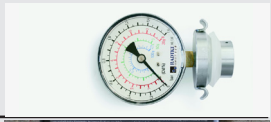
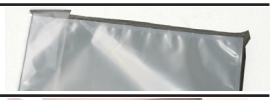
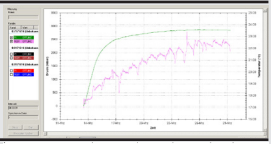
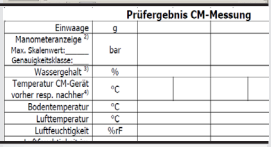
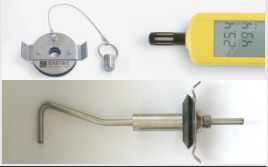
The components described in these instructions are not included in every version of the device. Different components are available, depending on the equipment option.

The following table and the parts lists provide you with a quick overview of the equipment options available for our CCM devices.

SWISS MADE Devise options / Models of devices	Alu CLASSIC	Alu CLASSIC dig	Alu Business	Alu Business Pro	CLASSIC	CLASSIC dig	Business	Business Pro	Eco	Eco dig	Eco dig dig	Eco longbo	Eco longbo dig	Eco longbo dig dig
Calibrated pressure bottle														
Surface thermometer	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Range up to 10 M-% /20g	●	●	●	●	●	●	●	●	●	●	●			
Range up to 20 % M-% /20g												●	●	●
Pressure measurement														
Damping as per EN 837-2	●	●	●	●	●	●	●	●			●			●
Business manometer (3.0bar)			●	●			●	●			●			●
CLASSIC manometer (2.5bar)	●	●			●	●								
ECO manometer (1.6bar)									●	●		●	●	
Sample weighing														
Digital scales up to 200 g		●	●	●		●	●	●		●	●		●	●
Spring scales up to 100 g	●				●							●		
Measured value logging														
Log template	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Log printer				●				●						
Data storage with PC (conditionally Business; optional)			●	●			●	●			●			●
Measuring time recording														
Business manometer			●	●			●	●			●			●
Timer/stopwatch	●	●			●	●								
Optional: Equilibrium moisture	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Calibrated pressure bottles	**Long pressure bottle (up to 20 M-% with 20 g sample)**	
	Standard pressure bottle **(up to 10 M-% with 20 g sample)**	
	Small pressure bottle **(up to 5 M-% with 20 g sample)**	
	Surface thermometer for monitoring the bottle temperature; measuring range: 7 to 33 °C.	
Pressure measurement	**Damped manometer assembly as per EN 837-2** for all versions except for CCM Set ECO and Eco dig	
	Business manometer (max 3 bar) with value storage: pressure and duration; Cl.0.1.	
	CLASSIC manometer (max. 2.5 bar) Bourdon tube made of high-quality bronze; Cl.1.0.	
	ECO manometer (max 1.6 bar) with standard screw connection on the cover; Cl.1.6.	
Sample weighing	**Precise digital CCM scale** with 100 g calibration weight for customer calibration.	
	Very robust mechanical CCM scale with 50 g check weight.	

Device case	Light black device case in aluminium look.	
	Sturdy blue device case made of metal.	
	Low-priced device case made of plastic.	
Sampling of test material	Classically with hammer and chisel	
	Optional: SIMPLER battery-driven chisel and further accessories	
	Optional: SIMPLER with electric chisel for long periods of use	
Sample grinding/sample homogenisation	Classically with the **grinding bowl**	
	Optional: Safer in the sample bag – ideal for homogenisation	
Carbide ampoules	Set with **25 ampoules** offers a high degree of measuring autonomy. **Suitable for the determination of readiness for covering.**	
On-site device inspection	With the **calibration ampoules** you can confirm the functionality of your CM device in a simple way or bring it up to operating temperature.	**3x** 

Measuring time recording	**Timer/stopwatch** for recording the reaction duration; in the CLASSIC version; indispensable for the determination of readiness for covering.	
	In the case of the Business manometer, recording of the measuring time begins automatically with the start of the chemical reaction.	
Measured value logging	**Optional: Log printer** with personal log header and logo.	
	Optional: recording via PC with Windows requires Business manometer.	
	Standard logging by hand: log template online and in these instructions.	 Prüfergebnis CM-Messung Einwaage g Manometeranzeige [1] Max. Skalenwert: Genauigkeitsklasse: bar Wassergehalt [2] % Temperatur CM-Gerät vorher resp. nachher [3] °C Bodentemperatur °C Lufttemperatur °C Luftfeuchtigkeit %rF
Equilibrium moisture	**Retrofit kit for equilibrium moisture:** patented CCM Hygro Combi for the determination of the equilibrium moisture (% RH)	
CPM monitor 18/30 for non-destructive location of pipes	**Optional: fast location of pipes** with newly activated heating for 3 temperature ranges. With floor thermometer	
Capacitive moisture indicator	Optional: non-destructive **location of moisture clusters** in areas close to the surface.	

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CCM Set ECO

Art. no. 110060

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Mechanical sample scale up to 100 g
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, controll weight 50g

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M ECO manometer up to 1.6 bar with lid
N Double-walled plastic case with inlay

Total weight: 7.13 kg

CCM Set ECO dig

Art. no. 110061

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Digital sample scale up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries, dig, with seals, calibration ampoules, calibration weight 100g,

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M ECO manometer up to 1.6 bar with lid
N Double-walled plastic case with inlay

Total weight: 7.13 kg
* Model may differ from the illustration.

CCM Set ECO dig dig

Art. no. 110062

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, long
4 Cleaning brush
5 Digital sample scale up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries, Business, with seals, calibration ampoules, calibration weight 100g and spare battery

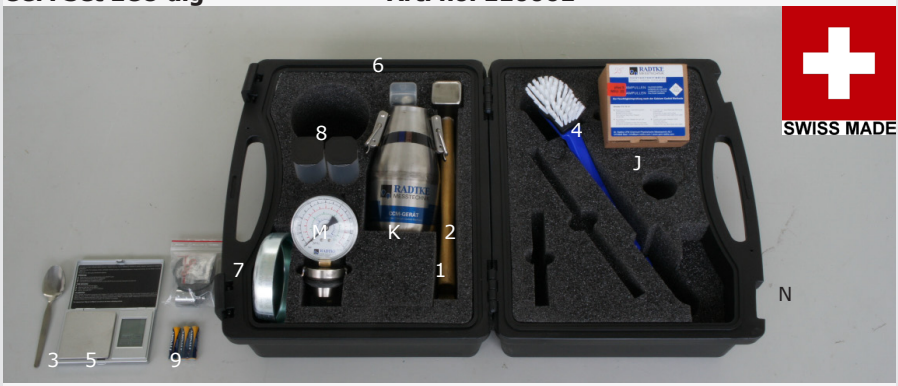
J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M Business manometer, up to 3.0 bar, with damped cover as per EN 837-2
N Double-walled plastic case with inlay

Total weight: 7.13 kg
* Model may differ from the illustration.

RADTKE MESSTECHNIK

CCM Set ECO **Art. no. 110060**

CCM Set ECO dig **Art. no. 110061**



CCM Set ECO dig dig **Art. no. 110062**

CCM device Alu CLASSIC **Art. no. 110004**

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Mechanical sample scale up to 100 g
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, controll weight 50g

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M Manometer CLASSIC, up to 2.5 bar, with damped cover as per EN 837-2
N Device case in aluminium look
O Stopwatch / timer (not illustrated)

Total weight: 8.18 kg

CCM device Alu CLASSIC dig **Art. no. 110005**

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Digital sample scales up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, calibration weight 100g

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M CLASSIC Manometer, up to 2.5 bar, with damped cover as per EN 837-2
N Device case in aluminium look
O Stopwatch / timer (not illustrated)

Total weight: 8.27 kg;
* Model may differ from the illustration.

CCM device Alu Business **Art. no. 110007**

1 Lump hammer 1000 g
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Digital sample scales up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, calibration weight 100g and spare battery

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M Business manometer, up to 3.0 bar, with damped cover as per EN 837-2
N Device case in aluminium look

Total weight: 8.36 kg;
* Model may differ from the illustration.

CCM device Alu CLASSIC **Art. no. 110004**

CCM devicet Alu CLASSIC dig **Art. no. 110005**

CCM device Alu Business **Art. no. 110007**

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CCM device CLASSIC **Art. no. 110000**

1 Lump hammer 1000 g and fitter's hammer
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Mechanical sample scales up to 100 g
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, controll weight 50g

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M CLASSIC manometer, up to 2.5 bar, with damped cover as per EN 837-2
N Device case made of sheet steel
O Stopwatch / timer (not illustrated)

Total weight: 10.78 kg

CCM device CLASSIC dig **Art. no. 113100**

1 Lump hammer 1000 g and fitter's hammer
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Digital sample scales up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, calibration weight 100g

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M CLASSIC manometer, up to 2.5 bar, with damped cover as per EN 837-2
N Device case made of sheet steel
O Stopwatch / timer (not illustrated)

Total weight: 11.04 kg

* Model may differ from the illustration.

CCM device Business **Art. no. 110021**

1 Lump hammer 1000 g and fitter's hammer
2 Flat chisel for sample taking
3 Sampling spoon, short
4 Cleaning brush
5 Digital sample scales up to 200 g *
6 Ball set with 4 steel balls
7 Grinding bowl for porous samples (optionally 20 plastic bags)
8 2 sample cups with lid
9 Set of sundries with seals, calibration ampoules, calibration weight 100g and spare battery

J Set of 25 carbide ampoules
K Calibrated standard pressure bottle with surface thermometer (as per Pressure Equipment Directive 97/23/EC)
L Weighing bar for precision spring scales
M Business manometer, up to 3.0 bar, with damped cover as per EN 837-2
N Device case made of sheet steel
O Stopwatch / timer (not illustrated)

Total weight: 11.04 kg

* Model may differ from the illustration.

CCM device CLASSIC **Art. no. 110000**

CCM device CLASSIC dig **Art. no. 113100**

CCM device Business **Art. no. 110021**

Calibrated pressure bottle

All of our current pressure bottles fulfill the requirements of the Pressure Equipment Directive 97/23/EC. They are made in Switzerland of high-quality stainless steel and calibrated to the company's internal standards. Each individual pressure bottle is provided with a corresponding calibration number. A surface thermometer is attached to each pressure bottle for reading the bottle temperature.

Surface thermometer

The surface thermometer has 9 temperature fields. Each field covers a temperature range of 3 °C and can indicate temperatures between 7 and 34 °C.
Each temperature field changes its colour with increasing temperature from: Black-brown-green-blue-black.
Each field is marked by a number. This number corresponds to the temperature when the field is green.
The other temperatures can be derived from it:
if the temperature is 1°C lower than the number shown, the field is brown. If it is 1°C higher, the field is blue.

Ball set

The ball set included contains 4 steel balls with a defined diameter. The free volume of the pressure bottle is calibrated with these balls, which perform four additional important tasks:

Start effect:	shattering of the carbide ampoule
Grinding effect:	grinding the sample material as well as the calcium carbide
Mixing effect:	mixing the reaction mixture
Cleaning effect:	keeping the carbide surface free from the reaction product calcium hydroxide

Sundries set

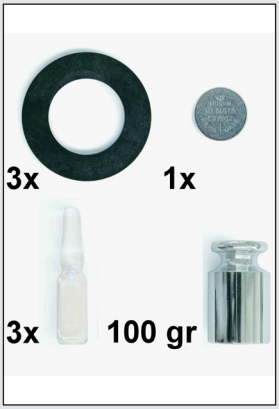
The sundries set contains spare seals for the manometer and the pressure bottle, a set of 3 calibration ampoules containing 1.0 g water for on-site calibration and a 50 g check weight.
For instructions on the use of the calibration ampoules, please refer to page 30 of these instructions or to the short video on our website.

The red seals of the manometer are so-called squeeze-type seals, which are squeezed by tightening the screw connection and seal due to this squeezing. Such a seal can usually be used only once.

Sundries set, dig

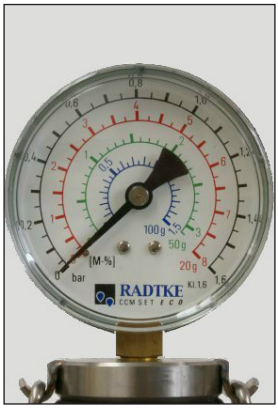
The dig sundries set contains spare seals for the manometer and the pressure bottle, a set of 3 calibration ampoules containing 1.0 g water for on-site calibration and a 100 g check weight.
For instructions on the use of the calibration ampoules, please refer to page 30 of these instructions or to the short video on our website.

The red seals of the manometer are so-called squeeze-type seals, which are squeezed by tightening the screw connection and seal due to this squeezing. Such a seal can usually be used only once.



Sundries set, Business

The Business sundries set contains spare seals for the pressure bottle, a set of 3 calibration ampoules containing 1.0 g water for on-site calibration, spare batteries for the BUSINESS manometer and a 100 g check weight.
For instructions on the use of the calibration ampoules, please refer to page 30 of these instructions or to the short video on our website.



ECO manometer

In addition to the black pressure scale, the ECO manometer has 3 coloured auxiliary scales for weighed samples of 20 g (red), 50 g (green) or 100 g (blue). Using these auxiliary scales the moisture content can be directly read off in "% by weight".
The auxiliary scales were determined at a temperature of 20 °C and are most accurate if the start and the end temperatures of a measurement correspond to this temperature.

CLASSIC manometer

The CLASSIC manometer is mounted on a damped cover in accordance with the directive EN 837-2.
It has the same accuracy as the ECO manometer, but its larger pressure range offers greater safety in the case of unexpected overpressure and in addition it is better protected by the rubber protection cap.
In addition to the black pressure scale, it likewise has 3 coloured auxiliary scales for weighed samples of 20 g (red), 50 g (green) or 100 g (blue). Using these auxiliary scales the moisture content can be directly read off in "% by weight".
The auxiliary scales were determined at a temperature of 20 °C and are most accurate if the start and the end temperatures of a measurement correspond to this temperature.

Business manometer for CCM set ECO dig dig

The digital Business manometer is mounted on a damped cover in accordance with the directive EN 837-2. It is designed as standard for weighed samples of 10, 20, 50 and 100 g. With its large pressure range of up to 3 bar it is very well protected against overpressure. In addition the manometer is equipped with a rubber protection cap, which protects it against external dirt and moisture. A printer or a measured value recording program can optionally be connected to the data output (right).

Operation of the manometer
2 operating elements: 'Menu' and 'Enter' keys

After switching on via one of the two buttons, the manometer displays the last measured value. The duration of the last measurement is displayed by pressing the 'Enter' key.

In order to move through the manometer menu commands, there are three operating variants at each point:

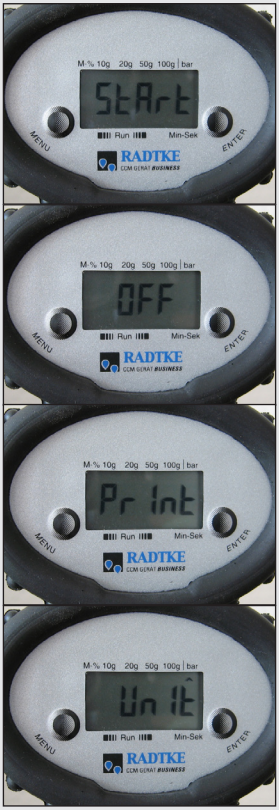
1) Do nothing: A displayed command is displayed for 7 seconds. If no further key is pressed during this period the manometer returns to its starting position.
2) Press the 'Menu' key: The next command that is possible from this position is displayed.
3) Press the 'Enter' key: The displayed command is confirmed and thus executed.

Further fundamental information:

When a measurement is running, 3 ticks flash at the bottom-left edge of the screen. In this phase the unit of the displayed measured value cannot be changed.

The duration of the measurement is usually 10 minutes. A running measurement can be terminated prematurely by selecting the STOP command with the 'Menu' button and confirming with the 'Enter' key.

The last measured value remains in memory even after a battery change. If no button is pressed for a period of 60 minutes, the manometer switches itself off automatically.



After confirmation of the Start command by pressing the 'Enter' key:

The manometer switches to measuring mode and sets the zero point at the currently prevailing ambient pressure. It now waits 5 minutes for the start of the reaction. If a pressure increase is detected during this time, the definitive measuring cycle begins. If no pressure increase is determined, the manometer returns to its starting position.

The manometer can be prematurely reset to the starting position by selecting the STOP command with the 'Menu' button and confirming with the 'Enter' key.

After confirmation of the OFF command with the 'Enter' key, the manometer is switched off.

After confirmation of the Print command with the 'Enter' key, the manometer sends the stored measurement data via the interface (metal cover) to the log printer (log printer retrofit kit art. no. 110024).

After confirmation of the Unit command with the 'Enter' key, the manometer outputs the measured value as pressure [bar] or as moisture content [M-%] (% by weight). The moisture content units [% by weight] refer to a sample quantity: 100 g, 50 g, 20 g or 10 g (according to the tick at the upper edge of the display).

Further information and videos can be found on our website.

Sample cup

The two sample cups are supplied with a lockable lid. Sample material can be simply poured in using a sampling spoon or another suitable aid. Both moist and moist-warm samples can be conveniently and securely protected against drying out inside it. If condensate forms on the inner edge of the cup after a moist-warm sample cools down, it can easily be mixed with the sample again by shaking the sample.

The sample cups have a volume of 70 ml and can accept up to 100 g of granular sample material (relative density greater than 2).

Sturdy mechanical sample scales

The precision spring scales (scales for short) are supplied in transparent plastic protective packaging. The scales allow the weighing of sample quantities up to 100 g, wherein the weight of the sample cup can be tared. The scale can be aligned to the front simply by turning the bracket. (see picture center)

Preparation:
Remove scales from the protective packaging, check free movement of the spring. Press the weighing bar into the foam material in a suitable place (see picture below). Suspend the scales on it.

Taring/reading:
Attach a clean, empty sample cup. Adjust the zero point by turning the white taring screw (black circle). Your eyes must be at the same height as the scale when doing this in order to minimise reading errors.

On-site checking:
For checking the scales a 50 g calibration weight is available which has a maximum deviation of ± 10 mg (M2). To this end the scales must be freely suspended together with the cup and tared. Subsequently, the weight is placed in the cup and the scales are read.

Precise digital sample scales

Before using for the first time, ensure that the batteries are inserted correctly.

1. Place the scales on a horizontal surface and press the ON/OFF button.
2. Wait a few seconds until the display shows [0.00].
3. Place the clean empty sample cup on the platform.
4. Press the TARE button. The reading [0.00] is displayed.
5. If necessary, change the unit of weight to GRAMS by pressing the MODE button. Fill the sample cup with the sample material up to the necessary sample quantity of 20, 50 or 100 g.
6. With the lid closed you can keep a weighed sample in the sample cup for several minutes without loss of moisture.
7. The scales automatically switch off after 120 seconds; alternatively, press the ON/OFF button for longer than 3 seconds.

Taring:

1. With the scales switched on, place the container to be tared on the platform.
2. Press TARE and wait until [0.00] is shown.
3. Add the weighing material and directly read off its weight.

Calibration (in GRAMS only):

1. Switch the scales on and, with the platform empty and clean, press the CAL button until [CAL] appears on the display.
2. Subsequently, press the CAL button again; the scales indicate [CAL] blinking and switches than to a blinking [100.00].
3. Place the 100 g calibration weight on the platform and wait a few seconds.
4. [PASS] now appears on the display, indicating a successful calibration. The scales switch to weighing mode. You can now switch off the scales.

Additional information:

[LO]: Low battery voltage, please replace the batteries
[O-LD]: Overload, reduce the load

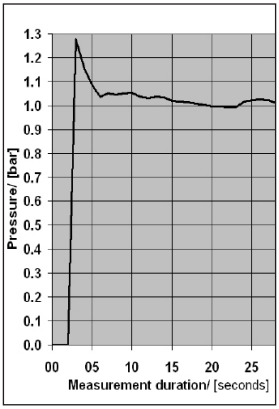
THE REACTION

The carbide method is a heterogeneous reaction involving a solid body (carbide) and a further substance (water), which is present in an arbitrary state (solid, liquid or gaseous). Water can be present as a pure substance (calibration ampoule) or as part of another substance (bulk material).

The following equation describes the reaction:

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2 \quad \Delta H: -123.6\ kJ/mol$$

Calcium carbide + Water ***Calcium hydroxide + acetylene***



MEASUREMENT PRINCIPLE

Calcium carbide reacts with water, forming gaseous acetylene and solid calcium hydroxide. For each molecule of water consumed, the same amount of acetylene is always formed; hence, this reaction is extremely well suited for the determination of a quantity of water.
Restriction: Since calcium carbide also reacts correspondingly with methanol, a sample may not simultaneously contain water and methanol.

FACTS REGARDING THE REACTION

1. The reaction takes place **on the surface of calcium carbide**. (see picture above)

2. Both reaction partners must be able to **contact each other**. **Note** from our quality assurance (see picture above): The carbide ampoules can be stored indefinitely as long as they are tightly sealed.

3. The **intensity of the contact** between the reaction partners as well as the concentration of **the reaction partners essentially determines the speed of the increase of pressure**. In the case of intensive and direct contact between calcium carbide and water (liquid and solid in equal concentrations) **the reaction is rapid and violent**. If a calibration ampoule with fine carbide (see picture, centre) is made to react, the **increase of pressure takes place within fractions of a second**. The heat development that occurs is easily visible due to the excessive increase of pressure.

In the case of a **lower concentration of water on the surface of carbide due**, for example, to less intense mixing (standing pressure bottle), or if water can only contact the carbide via the gaseous phase, **the pressure increase takes place much more slowly. The speed of the pressure increase is immediately limited by transport processes** (saturated air at 20 °C contains 17.28 mg/l water, partial pressure of water: 23.1 mbar, equivalent to approx. 2 % by vol.).

4. **Water is consumed by the reaction with carbide; a sample with a corresponding surplus of carbide is dried out.** (See pictures, left): A slice of apple and carbide under the glass cover at the start and after 47 hours.

5. The end point of the reaction is determined by the so-called reaction equilibrium: Either nearly all the carbide or nearly all the water is consumed. In a scientific sense, "nearly all" means: in every reaction a small remainder of the starting materials remains in a closed system (closed pressure bottle). In this reaction, a residual partial pressure of water of 1.87×10^{-10} mbar is established in the case of a surplus of carbide in the reaction equilibrium.

This is an extremely dry condition! In comparison, saturated air cooled to -100°C is 10,000 times moister!

MEASURED VARIABLE: PRESSURE

The quantity of acetylene formed can easily be determined by measuring the pressure.

Ideal gas law:	**$\Delta p \times V = \Delta n \times R \times T$ => $\Delta p = \Delta n * K$**	
where:	**Δp**	Pressure increase in the bottle
	V	Bottle volume
	Δn	Amount of material formed in the bottle
	R	Gas constant
	T	Temperature in the bottle
	K	Combined constant at constant temperature and volume

The acetylene formed corresponds to the amount of substance, 'Δn', by which the number of molecules increases in the gaseous phase of a closed system.

The ideal gas law establishes the relationship between pressure and the quantity of gas formed. The variables of volume and temperature necessary for a quantitative determination of the consumed quantity of water are fixed according to the specific system and the influence of these variables is briefly discussed below.

FACTORS NOT INFLUENCING THE MEASURED VARIABLE

The **gas constant 'R'** is a constant whose numerical value changes only with the definition of the physical units.

The **volume 'V'** is determined by the size of the bottle and is in principle constant. The pressure bottle is designed in such a way that one gram of water develops an acetylene pressure of one bar (assuming a complete ball set). All of our pressure bottles are calibrated to this nominal volume.

FACTORS INFLUENCING THE MEASURED VARIABLE

The **temperature 'T'** is an environmental variable that occurs in the case of normal use. Our **conversion tables are based on a reference temperature of 20 °C**.
The use of a correction factor can be meaningful if measurements take place at other temperatures. **As a matter of principle, the temperature only needs to be considered in the case of low moisture contents or very precise measurement results.** The start and end temperatures of the measurement must be known in order to evaluate the size of the correction factor.

The temperature at the moment of closing the pressure bottle is designated **the start temperature.** From this moment on the equipment is deemed to be a closed system and a pressure change takes place only if the influencing variables change (ideal gas law).
The temperature prevailing at the moment of reading the pressure is designated **the end temperature**.

This variable can be evaluated using the surface thermometer on our pressure bottles!

Case	Start	End	Ruling
I	20°C	20°C	Reference temperature: No correction necessary
Relevance: No			
II	26°C	26°C	Reduce the pressure by 1% for every 3°C too high.
Example:			(26 - 20 = 6) => - 2% (pressure reading*0.98)
Relevance: Not critical when not in critical moisture range			
III	5°C	20°C	Subtract 3mbar from the read pressure for each 1°C difference.
Example:			(20 - 5): Δ15°C hence – 45 mbar
Relevance: Critical when other conditions are also critical			

Case II
If **the start and end temperatures are equal** but differ from the reference temperature, then the correction factor for the pressure can be corrected in accordance with case II in the above table. If the measurement takes place at higher temperatures than 20 °C, the pressure reading is too high and must be corrected downwards. The pressure would have been correspondingly lower at 20 °C.

Case III
If **the start and end temperatures are different**, it is necessary to know the current ambient

pressure in order to precisely evaluate the correction factor. If an ambient pressure of 1 bar is assumed, a correction factor can be determined from the difference between the two temperatures. To do this, 3 mbar must be subtracted from the pressure reading for each 1 °C increase in temperature.

In the example the bottle is closed at a temperature of 5 °C and the measurement result is read off at an end temperature of 20 °C. This results in a temperature difference of 15 °C. 45 mbar must be subtracted from the pressure reading before determining the moisture content in the conversion table. In the reverse case the pressure must be corrected upwards.

At a measured pressure of approx. 1 bar and higher a temperature correction can usually be dispensed with. We will shortly be offering a small program for the evaluation of the temperature correction on our website for download.

To avoid a cold bottle you can perform an on-site calibration to bring the bottle to its operation temperature.

CONVERSION: PRESSURE – WATER CONTENT

A moisture range of 0.19 % by weight (sample quantity: 100 g) to 50 % by weight (sample quantity: 3 g) can be covered by appropriate calibration curves for defined sample quantities.

The lower the moisture content of a sample is, the more important the accuracy of the manometer and the evaluation of the temperature become. Please refer to page 43 for the evaluation of the error of a manometer. The measuring range can be extended to approximately 0.01 % by weight with the digital manometers offered, wherein it can be meaningful to develop your own calibration curves for samples with strongly deviating specific densities.

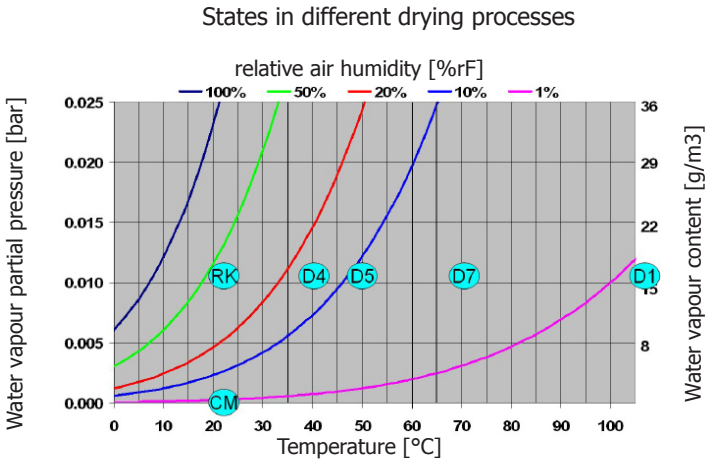
PURPOSE AND ADVANTAGE OF THE BALL SET

The ball set is used in order to improve the contact between water and calcium carbide under these circumstances.

4 effects are achieved with the ball set:
1. **Start:** the glass ampoule containing the calcium carbide is shattered.
2. **Grinding:** if used properly, the material containing the water is ground.
3. **Mixing:** The different materials present are mixed with one another and contacting solid product is shaken off.
4. **Reaction acceleration:** The reaction progress is accelerated by intensive shaking, since carbide and water can contact each other faster.

STANDARD MOISTURE METHODS

Oven-drying, which is described in DIN 18121-1 among others, is considered to be the standard moisture determination method. In this very simple method the test material is dried in an oven at a



certain temperature (usually 105 °C) as evaporable water until its weight is constant. By weighing the sample before and during the drying process, the water content is determined from the weight loss. The criterion for aborting the test is a weight change of less than 0.1 % by weight within 24 hours.

In addition to oven-drying, also known as kiln-drying or the drying oven method, further direct methods for determining water content are also used in practice. What all of these methods have in common is that the water is extracted from a sample by means of storage in an environment with a relatively low air humidity (e.g. freeze drying, drying in a desiccator).

PRINCIPLES OF THE DRYING OVEN

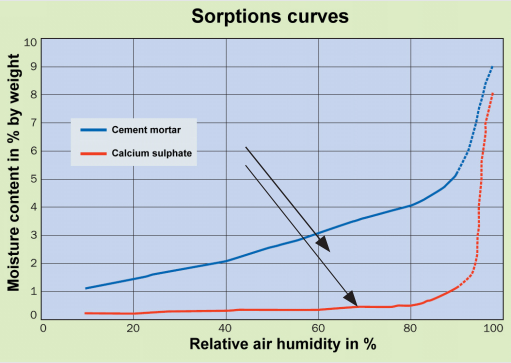
In the drying oven the relative air humidity is reduced by increasing the temperature (see example diagram above). This makes use of the following relationship:

Warm air can adsorb more water until it is saturated than cold air.

The consequence of this is that if arbitrary air with a defined humidity (e.g. laboratory air) is warmed up, its original relative humidity is reduced.

In addition the mobility of the water molecules is increased by the increased temperature in the drying oven. This is one of the main reasons why drying at 105°C in the oven is much faster compared to the other drying processes (desiccator etc.).

Depending on the oven temperature (40 °C, 50 °C, 70 °C or 105 °C) as well as the water content of the room air drawn in (RK), a corresponding relative air humidity is established in the oven. This relative air humidity (and also the temperature) corresponds to the equilibrium condition for the sample, which gives off moisture (loses weight) until it is in equilibrium with the conditions prevailing in the oven. Once this state is reached the weight of the sample does not change any further. (In



a state of equilibrium the sample adsorbs just as much water from the air as it gives off to the air.)

This equilibrium relationship between the water content of a sample and the relative air humidity is described in so-called sorption isotherms and is characteristic of the capability of a sample to store water. In the case of building materials, the sorption isotherms are said to depend very little on the temperature and proceed slightly differently if a sample gives off water, i.e. dries, or if it adsorbs water. The giving off of water is known as desorption, hence desorption isotherm, and the taking on of water is known as adsorption, hence adsorption isotherm. The deviation between the equilibrium values during the water adsorption and the water desorption is called hysteresis.

In addition to its composition and its property of entering into a covalent bond with the water molecule, the ability of a material mixture or a substance to store water essentially depends on the size of its inner surface, i.e. its pore structure.
Cement-based systems exhibit a large number of very small, so-called gel pores. This is contrary to calcium sulphate-bound systems, for example (see sorption isotherms in the diagram at the top of this page). Cement-based systems therefore store more water at the same relative air humidity.

In the drying oven method, air is drawn in from the surrounding room and heated up. If the relative air humidity in the room changes over the duration of the drying process, then the relative air humidity in the oven is also changed as a result.
The influence of this change of the equilibrium condition leads to a relevant change of the equilibrium moisture of a sample, in particular when the sample is strongly hygroscopic. A strongly hygroscopic sample exhibits a large inner surface and is capable of storing large quantities of water even when the air humidity is low (e.g. gel pores in the cement).
However, the influence of the laboratory air drawn in lessens as the drying temperature increases.

COMPARISON OF THE DRYING OVEN TO THE CM METHOD

The two methods can be compared on the basis of a comparison of the equilibrium conditions. In the adjacent diagram the equilibrium conditions for the two methods are compared to one another with the names (D4 for drying at 40 °C etc. or D1 for 105 °C respectively as well as CM for the carbide method).

COMPARISON OF THE DRYING OVEN TO THE CM METHOD

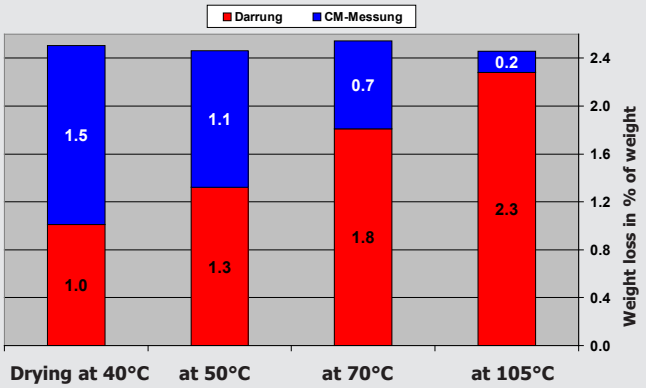
In the drying oven method the degree of drying is primarily determined by the choice of drying temperature. The air humidity established in the oven at the specified temperature depends on the air conditions in the room surrounding the oven and decreases as the temperature increases. It represents an open system.

The **CM method**, on the other hand, represents a **closed system**, in which the air humidity drops at room temperature to **1.87×10^{-10} mbar** due to the reaction of water to form acetylene. Water is consumed as long as it can move to the surface of carbide.

In the test series below, 4 samples of a cement-based screed were **initially dried in the drying oven** in accordance with the table below **at different temperatures until their weight was constant** and then cooled down to room temperature in a closed system. **The relative humidity of the air in this closed system was measured**. **The remaining amount of mobile water molecules was determined according to the CM method up to the reaction equilibrium with 50g in each case**. We selected this order of the combined drying process, since in the oven drying the degree of drying of a sample can be specified by selecting the drying temperature. As opposed to the carbide method, a sample can thus also be only partially dried.

The individual results of the two successively executed drying methods and their totals are illustrated in the table below.

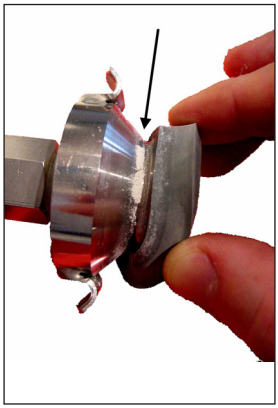
Sample designation	**CT_S1**	**CT_S2**	**CT_S3**	**CT_S4**
Drying temperature	**40 °C**	**50 °C**	**70 °C**	**105 °C**
Equilibrium moisture of the sample [% RH]	19.1	10.6	4.1	2.8
Loss of weight through kiln-drying [% by weight]	1.0	1.3	1.8	2.3
Moisture content by subsequent CM method up to reaction equilibrium [% by weight]	1.5	1.1	0.7	0.2
Total of both methods [% by weight]	**2.5**	**2.4**	**2.5**	**2.5**



DISCUSSION

All in all, the two methods applied lead to the same result with small deviations.
Despite the high drying temperature of 105 °C, a further 100 mg water is converted in the subsequent CM method, which is equivalent to a mass content of 0.2 % by weight.
This quantity of water converted thus corresponds to the water content that would be present in a volume of 10 litres of air (at 20 °C; 50 % RH). Since the sample was only in contact with the laboratory air for a few seconds following removal from the drying oven, it can be ruled out that this quantity of water was adsorbed from the air. A check measurement with a sample dried at 125 °C resulted in a proven quantity of water of only 20 mg.
In the case of strongly hygroscopic samples, higher moisture contents are determined with the carbide method than with the drying oven at 105 °C. Hence, this method allows a more precise determination of the mobile water content of a sample.

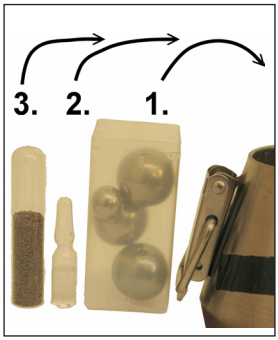
Because of the unchanged equilibrium condition (residual water vapour partial pressure of approx. 10^{-10} mbar), a higher reproducibility is possible in the comparison with the drying oven, whose equilibrium condition can vary between 1 and 3 % rH depending on the moisture content of the laboratory air.



Calibration check of the CM device
The calibration ampoules contained in the sundries set can be used to check the CM device as a complete system with regard to its accuracy (manometer) and its suitability (tightness). This calibration check can be performed in any shady and ventilated place.

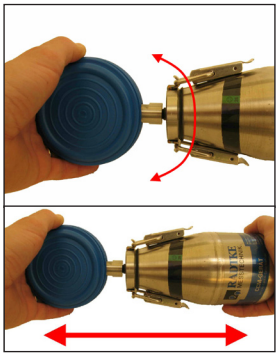
Preparation:
You require the cleaned (see picture above) and dried CM device, including cover and manometer, the complete ball set, a calibration ampoule and a carbide ampoule (see picture, centre).

Execution:
The balls, the carbide ampoule and the calibration ampoule are placed in the pressure bottle in this order and the bottle is subsequently closed with the manometer cover.



The ampoules are shattered by shaking the CM device and the reagents released can react with one another (see picture below). **The reaction is usually completed after 2 to 3 minutes and the final pressure must be 1.00 bar ± 0.05 bar.**

[The permissible 5% deviation includes summarily the volume variance (± 1%), the water quantity tolerance (± 1%), the permissible manometer accuracy of ± 2.5% (25 mbar at 1 bar) as well as the possible temperature derivation of ±1% for each 3 °C deviation from 20°C.]



(IMPORTANT: While shattering the ampoules, splashes of water may be deposited on the inside of the bottle)

Remark:
Too low a pressure can be indicated if you don't wait long enough, or if splashes of water have collected under the cover. These are formed by shaking too violently at the start of the measurement. These splashes can be made to react with calcium carbide by **'laying the bottle flat' and horizontally rotating and rocking it.** This is shown here with the CCM CLASSIC device.

Mobile access to: **ON-SITE-CALIBRATION**

General information
The CM method is **suitable for the determination of the moisture content of all sample materials** which themselves do not react with calcium carbide or the reaction products and which contain no methanol. These include fuels, building materials, salts and minerals as well as ore concentrates and ores.

For arbitrary materials with a sample quantity of more than 10 g or samples with a particularly low density (less than 1 kg/m³) it is advisable to carry out a separate calibration.
The careful determination of the moisture content of a sample requires that a representative selection be made from the existing sample material.

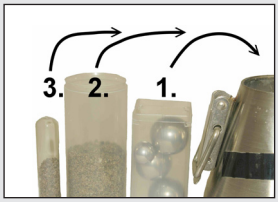
The preparation of a sample therefore plays a significant part!

The following measuring procedure (pictures with the CLASSIC manometer) is designed for bulk materials or granular samples as well as for liquids and paste-like materials. **The reaction ends with the reaching of the reaction equilibrium.**

1 The test material must be homogenised in order to be able to take an average sample.

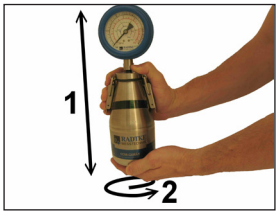
2 Depending on the assumed water content, the necessary quantity is weighed out according to the following table:

Assumed water content	Necessary weighed quantity
1 %	100 g
2 %	50 g
5 %	20 g
10 %	10 g
20 %	5 g
50 %	3 g

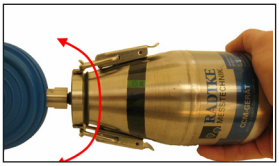


3 Place the complete ball set (1) and, depending upon the expected moisture content, the accurately weighed, representative sample (2) in the pressure bottle.
Then hold the bottle at an angle and carefully let a glass ampoule containing carbide slide in (3).

4 The pressure bottle is closed with the cover and the carbide ampoule is then shattered by vigorously shaking the bottle. The chemical reaction begins with the shattering of the ampoule. Now start the time measurement with the stopwatch (included in the CLASSIC equipment).



5 Afterwards circular movements are made with the bottle for one minute in order to mix the reaction mixture. In the case of liquid or paste-like samples it is recommended to hold the pressure bottle flat and to rotate it several times around its own longitudinal axis (see picture below). This way, sample material adhering to the inner wall can also be made to react. This procedure is repeated after approximately 3 minutes.



The reaction ends with the reaching of the reaction equilibrium.

This is typically reached after 10 minutes. The pressure bottle is shaken again to check. If the pressure remains unchanged, the measurement can be regarded as final. Be aware that not shaking or less shaking leads to an incomplete reaction with a result being to low.

The water content can be directly read off from the manometer for the usual sample weights of 20 g (red scale), 50 g (blue scale) or 100 g (green scale). The conversion table can be used for smaller sample weights (higher moisture contents).
Draw up a handwritten log or use the template available on our website in order to record the measurement results.

Since the calibration curves are calculated for a reference temperature of 20 °C, you should pay attention to the display of the surface thermometer on the pressure bottle. In case of deviations, evaluate the possible error in accordance with the chapter entitled 'Principles of the carbide method'.

CONVERSION TABLE: PRESSURE MATERIAL MOISTURE CONTENT

Pressure	Sample weight					
Bar (black)	3g	5g	10g	20g (red)	50g (green)	100g (blue)
	Watercontent in % by weight in relation to the dry wreight					
0	0	0	0	0	0	0
0.2	6.3	3.8	1.9	0.9	0.38	0.19
0.3	9.7	5.8	2.9	1.5	0.58	0.28
0.4	13.0	7.8	3.9	2	0.78	0.38
0.5	16.3	9.8	4.9	2.5	0.98	0.47
0.6	19.7	11.8	5.9	3	1.18	0.57
0.7	23.0	13.8	6.9	3.5	1.37	0.66
0.8	26.3	15.8	7.9	4	1.57	0.76
0.9	29.7	17.8	8.9	4.5	1.76	0.85
1	33.3	20	10	5	1.96	0.95
1.1	36.7	22	11	5.5	2.16	1.05
1.2	40.0	24	12	6	2.35	1.14
1.3	43.3	26	13	6.5	2.55	1.23
1.4	46.7	28	14	7	2.74	1.33
1.5	50.0	30	15	7.5	2.94	1.42
Acetylene can decompose and damage the manometer above this pressure!						
1.6	53.3	32	16	8	3.13	1.51

Measurements with the Business manometer:

The Business manometer is designed in such a manner that it retains the last measured value until a new measurement has definitely begun.
In order to start a new measurement, the manometer is switched on by pressing any button. The sample weight is adapted if necessary. This step can also take place following the measurement.
The manometer is 'zeroed' and prepared for a new measurement by selecting the **'Start'** command with the **'Menu'** button and confirming with the **'Enter'** button. On the display you can see a timer which counts down from 5:00 minutes and the current relative pressure is displayed every 5 seconds. In this condition the manometer is ready for the measurement and can be used like a mechanical manometer. In order to abort the definitive start of the measurement at this point, the **'STOP'** command must selected with the **'Menu'** button or the timer must be allowed to run down without an increase in the pressure.
In this condition the manometer constantly checks whether the pressure is increasing and automatically sets the time to **'0:00'** if a pressure increase of 20 mbar is determined. At this moment a new measurement has definitely begun. The maximum duration of the measurement is set to 10 minutes and can be terminated prematurely with the **'STOP'** command.

'SPECIAL' MEASUREMENT PROCEDURES: DETERMINATION OF READINESS FOR COVERING

In the case of building materials such as screeds or concrete, knowledge of the 'free' damage-causing water content is of primary interest, but not that of the total water content.

The term readiness for covering describes the dampness of a screed, which, if it were to be covered by a top covering, would cause no moisture damage to the covering

Such damp damage can occur if the moisture profile in the screed under the top covering can balance itself faster than the moisture can pass through the top covering and be given off to the ambient air. Such an accumulation of moisture under the top covering can lead up to the condensation of the water. Depending on the resistivity of the used adhesive on the water pressure. Apart from the influence of the temperature on the accumulation of moisture under the top covering, no further potential parameters have been investigated so far. The values for the readiness for covering are therefore empirical limit values (experience values), which have continually changed over the course of time.

For questions of readiness for covering, special measuring procedures apply that differ in part from country to country and are prescribed by different associations: In Germany by the IBF (BEB) and the ZVPF, in Switzerland by the SIA, and a standard also exists for it in Italy.
Some of these special measuring procedures are described below.

For Germany a measuring procedure for the determination of the water content in concrete has likewise been specified in the ZTV ING. This will not be dealt in this version of the operating instructions.

No liability whatsoever is accepted for the quoted excerpts of the described measuring procedures, which are taken from the available information. We refer with these quotes to the information available to us, which we assume to be up to date and correct.

QUOTE...

Measurement of the moisture content

1 General information

The measurement of the moisture content for evaluating the readiness for covering takes place on the building site using the calcium carbide method.

NOTE Alternative measuring methods (e.g. dielectric methods) serve exclusively for preliminary testing and for the containment of damp surfaces.

2. Test equipment

2.1 **CM device**, calibrated pressure bottle according to directive 97/23/EC (volume 650 ml), with a manometer mounted according to EN 837-2 (max. absolute error 25 mbar)

2.2 Four steel balls

2.3 **Calcium carbide ampoule**, with a filling weight of approximately 7 g (granulation 0.3 mm - 1.0 mm)

2.4 **Scale**, error limit ± 0.1 g

2.5 **Clock**

2.6 **Mortar bowl** made of metal or the like.

2.7 Two polyethylene **(PE) bags**

3. Execution

a) Take an average sample over the entire cross-section of the screed and place it in a PE bag (2.7).

NOTE In the case of screeds with higher strength classes or larger screed thicknesses, the use of an electric mortising device is recommended.

b) Grind the average sample in the PE bag (2.7) in the bowl (2.6) to the extent that complete grinding is possible in the CM device (2.1) with the steel balls (2.2).

c) Homogenise the sample by filling the entire sample material into a second PE bag (2.7).

d) Weigh out a material sample from the prepared test material:

- Calcium sulphate screed: 100 g
- Magnesia screed: 50 g
- Cement screed: 50 g

e) Carefully place the test material and the steel balls in the CM device.

f) Hold the CM device at an angle and place the glass ampoule containing calcium carbide (2.3) inside.

g) After closing the CM device, shake vigorously until the reading on the manometer increases. Fully grind the test material in the CM device with the aid of the steel balls by means of back and forth and circular movements. Duration: 2 min.

h) 5 min after closing the CM device, shake for 1 minute as described in g).

i) 10 min after closing the CM device, shake briefly (~ 10 s) once more and read off the value. The moisture content can be read off directly from the manometer or taken from the calibration table. Enter the value read in the log (see Appendix A).

NOTE A further increase in pressure is possible with calcium sulphate-bound screeds; this is to be disregarded, since chemically (i.e. firmly) bound water is present.

j) Work through the test log: if the test material is not completely ground, discard the test result and repeat the measurement.

...UNQUOTE

Readiness for covering values according to the BEB data sheet 'CM measurement', edition: 01/2007

Binding agent	heated	unheated
Cement screed	1.8 CM-%[1]	2.0 CM-%
Calcium sulphate screed	0.3 CM-%	0.5 CM-%

[1] **Under stone and ceramic coverings: 2.0 CM-%.**

QUOTE...

Measurement principle
By adding calcium carbide to the ground test material in a gastight container, the free water present in the test material forms acetylene gas in a reaction. This produces a measurable pressure, from which the water content can be calculated.

Devices and aids
- CM pressure bottle (0.66 l) with manometer
- Scales, accuracy 0.1g
- Steel plate or mortar bowl
- Hammer and chisel
- Steel balls, calcium carbide ampoules (approx. 6 g each), stopwatch
- Other accessories

Procedure
- Remove fragments of the concrete or mortar to be tested with hammer and chisel. The method of sampling of the test material must not influence its moisture content.
- Grind the fragments with the hammer on the steel plate or in the mortar.
- Remove and weigh out a representative quantity from the ground material. The amount weighed out depends on the assumed moisture content of the sample material:

  • Moisture content ≥ 3% Sample weight 20 g
  • Moisture content < 3% Sample weight 50 g
  • Moisture content < 1.5% Sample weight 100 g

- First place the steel balls in the dry pressure bottle, then the weighed sample.
- Hold the pressure bottle at an angle and let the ampoule of calcium carbide carefully slide inside.
- Fit the cover with the manometer and seal it gastight.
- These procedures must be carried out quickly in order to avoid changes in moisture. The pressure bottle must be at ambient temperature.
- Shatter the ampoule by vigorously shaking the pressure bottle. Move the pressure bottle vigorously up and down and in a circle for five minutes, then place it in a shady place to rest.
- Read off the pressure on the manometer when the pressure remains constant, but at the latest after 20 minutes.
- After reading, carefully open the bottle (inflammable gas), pour out the contents and clean with a dry bottle brush.

The device manufacturer's instructions must be followed.

Note regarding the method
The water content determined directly with the CM method corresponds to the so-called 'free' water. Oven drying (manufacturer's note: kiln drying at 105 °C) until the weight is constant results in other values, since 'bound' water is also partially released.

Determination of the water content

The water content of the sample is determined from the measured pressure with the aid of Table 1. A bottle volume of 0.66 l and an ampoule of 5 g result in the benchmark figures in accordance with Table 1.

Table 1

Pressure	0,2 bar	0,6 bar	1,0 bar	1,2 bar	1,5 bar
			Water content in % by weight		
Sample 20 g	0,90	3,00	5,00	6,00	7,50
Sample 50 g	0,38	1,18	1,96	2,35	2,94
Sample 100 g	0,19	0,57	0,95	1,14	1,42

Excerpt from chapter 5 'Execution' of the same Swiss standard

5.1 Substrate requirements

5.1.5 The substrate must maintain the following moisture content values during and after the covering of the surface:

- Cement-bound substrates
  - without under-floor heating
    - Linoleum — max. 2.5 %*
    - Textiles — max. 2.5%*
    - Plastic — max. 2.3%*
    - Parquet, derived timber products and laminated material products — max. 2.3%*
    - Rubber — max. 2.0%*
    - Cork — max. 2.0%*
  - with under-floor heating — max. 1.5%*
- Conventional anhydrite mortar (calcium sulphate mortar)
  - without under-floor heating — max. 0.5%*
  - with under-floor heating — max. 0.3%*
- Anhydrite liquid screeds (calcium sulphate liquid mortar)
  - without under-floor heating — max. 0.5%*
  - with under-floor heating — max. 0.3%*

- Timber substrates — 7-12%**
- Chipboards — 6-9%**
- Fibreboards — 4-7%**

* Measurement with CM device

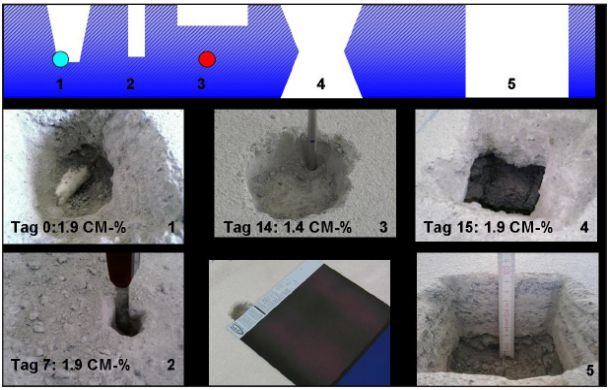
** Measurement with wood moisture measuring device

...UNQUOTE

FAVOURABLE DRYING CONDITIONS

A screed can be regarded as a large flat slab that can give off its water only via the surface during the drying phase, i.e. to the room air. The water is transported out of the building as a gas in the room air. The desorption of the water to the room air depends to a large extent on the climatic conditions in the room and on the intensity of the air movement. **The stronger the ventilation**, the faster the water can be given off to the air. In addition to ventilation, a low relative air humidity assists accelerated water desorption. **A low relative air humidity** is usually achieved on the building site by increasing the temperature of the room air. In addition, **the mobility of the water molecules in the building material can be improved by increasing the temperature in the building material**. Here, however, the suitability of the building material for the selected temperature or its possible reaction to the rise in temperature (possible curling in the case of a cement screed) must be taken into account.
Since the moisture in a screed can be given off only via the surface, **a moisture profile is formed over the cross-section of the screed**. The screed thus exhibits a vertical moisture profile: Dry relatively quickly at the top and increasingly moist in a downward direction.

Furthermore, it may not be assumed that the screed exhibits a homogeneous moisture distribution across the surface. Depending on the room geometry, exposure to the sun, ventilation, under-floor heating and also the installation height, a different moisture distribution can likewise form across the surface.

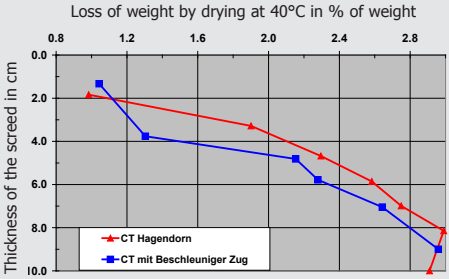


PRACTICAL EXAMPLE: PROBLEMATIC MOISTURE DISTRIBUTION IN THE SCREED

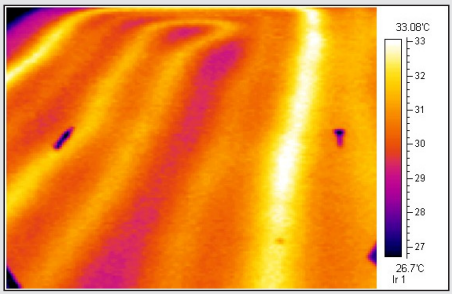
The picture above clearly shows the problem of different moisture distribution when sampling test material for the determination of readiness for covering. In addition to the determined CM values, the schematic also shows the relevant heating pipes. The pictures show the points found on the same building site where samples of test material were taken for the CM measurements. Picture top left, schematic left: With the heating switched off, test material was removed only to the depth of the under-floor heating. The determined residual moisture content of 1.9 CM % led to the under-floor heating being switched on in order to force the drying of the screed.

Picture at bottom left hand with measurer, 2nd schematic from left: One week later a further CM measurement was carried out, this time by another person who, however, also only took the sample of test material from the upper half and between two heating pipes. The same residual moisture of 1.9 CM % determined this time led as expected to uncertainty on the part of the building site management, who were already several weeks behind with their planning.
Pictures in the centre above and below, 3rd schematic from left: The building site management for their part employed an external person a week later to determine the residual moisture. The test material was taken directly above a heating pipe and was taken only to a depth of 3 cm, although the planned installation height was 8 cm. On account of the residual moisture of 1.4 CM % determined on this occasion, the building site management accused the parquet layer of deliberately delaying the work because of his own date problems.
Picture top right and 2nd schematic from right: A fourth person was assigned by the parquet layer on the same day to carry out his own CM measurement. This test material sample, taken for the first time over the entire cross-section, also resulted in a residual moisture content of 1.9 CM %. In taking this sample of test material, a screed installation height of 10 cm was measured. Furthermore, the heating pipe beneath the 3rd sampling position was localised.

With these results it was possible to convince the building site management that there was no intention on the part of the parquet layer to delay construction progress, but rather an inadmissible sampling of test material by all preceding users as well as unawareness of the installation height had led to this disagreement of the parties involved in the construction. All determined measured values were in principle correct, but they were not representative of the screed and thus of no use for the evaluation of the readiness for covering without additional knowledge of the installation height and the layout of the heating pipes.



The table on the left side shows the moisture profil for two different screed systems. The free water was determined by drying at 40°C. This could also have been done by a CM measurement. The moisture profils can be recognized clearly.



The photo on the left side shows the infrared picture of a heated screed surface. The light lines show clearly the placement of the heating tubes. It has to be expected, that due to the higher mobility of the water, these regions are dryer than the region between the tubes.

Sampling of test material directly into the plastic bag

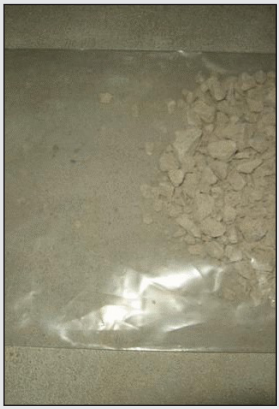
On the basis of our experience in dealing with screed samples, we recommend a brisk approach when sampling the test material. The test material removed should be placed immediately into a prepared **plastic bag** and should be handled **with gloves**. With these two measures, along with the removal of **the sample of material from the entire screed cross-section**, you can be sure of making no error in the first step of the evaluation of readiness for covering, or respectively of giving no cause for doubt about your approach.

Grinding of the test material in the plastic bag

The test material removed contains fragments of screed in different sizes and with different water contents. In the following step the **entire collected test material is ground step-by-step in the bag with the lump hammer** on the screed slab and immediately afterwards placed in a new bag. As a result of this procedure the screed fragments are ground and mixed due to being poured into new bags. An increasingly homogeneous material sample is created.

Homogenisation of the test material

Repeat the above two steps **(grinding and re-bagging) 2 to 3 times** until you have only fragments of screed that are **smaller than approx. 10 mm**. Once again – the re-bagging is important so that the differently moist sample material is well mixed.
PREPARATION



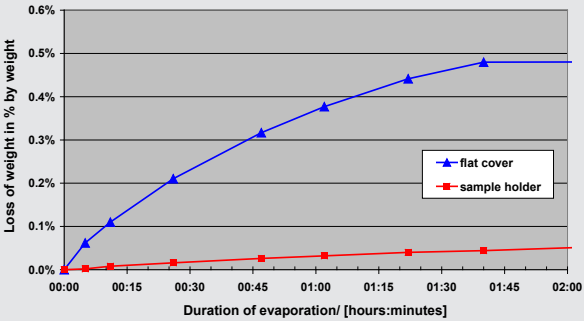
Temporary storage of test material

Working with the plastic bags has the advantage that no significant quantity of moisture can be lost from the test material. Hence, the removed and homogenised sample can be used for repetition measurements.

Representative sampling of test material

The material sample ultimately prepared in this way may be called homogeneous in the sense of DIN 18121, and a sample of the material may now be weighed out and processed further for the determination of the capillary (free) water (picture center).

Problem of sample taking: Sample ventilation



Problem when leaving a sample unprotected

When material sample is not protected from ventilation a loss of water by evaporation imediately begins. Its extent strongly depends on ambient conditions, the contact surfaces and the moisture content of the sample. The grafic above shows this effect, when two sam prélèvement ple of 50g each are left in different places (see picture below).

CALIBRATED PRESSURE BOTTLE

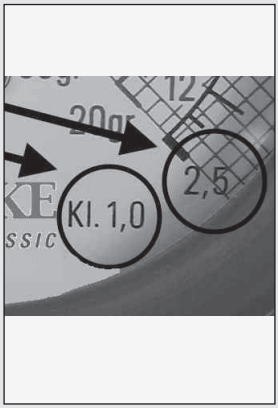
Regulations	Conforms to the Pressure Equipment Directive 97/23/EC
Accuracy	± 1% of the nominal volume for the conversion of 1 g water to 1 bar.
	(Version «longbo»: 0.55 bar)
Material	Stainless steel
Diameter	90 mm
Height	ca. 164 mm
Wallthickness	grösser 2 mm
Weight	ca. 1000 g
Type of closure	Swing top
Special feature	Surface thermometer 7–32 ° C

DIGITAL SAMPLE SCALES

Capacity	200 g
Division	0.05 g
Colour	black
Accuracy	+/- 15mg in accordance with calibration weight
Tare range	100% of capacity
Weighing bowl	Stainless stell
automatic power-off	after 120 secunds
User calibration	with 100 g calibration weight M2
Power supply	2 alkaline batteries Typ AAA
Special features	Scales are sensitive to electro-magnetic radiation
Further data can be found in the separate manual.	

MECHANICAL SAMPLE SCALES

Capacity	100 g
Division	1.0 g
Colour	Grün transparent
Accuracy	± 0.3%
Tare range (zeroing)	15 - 20%
S (Scale length)	100 mm
L0 (length unloaded)	225 mm
Lm (maximum lenght)	330 mm
Ø (diameter)	12.2 mm
Components	non-corroding (Clip only protected)
Net weight	20 g
User calibration	no (only by manufacturer)

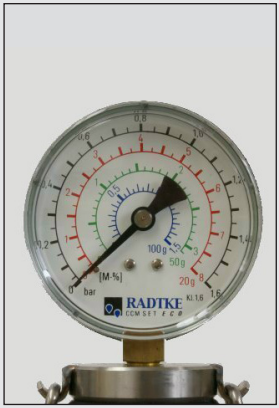


ACCURACY OF A MANOMETER

The typical error of a manometer is calculated as the product of the two parameters **'accuracy class'** and **'full scale reading'**. This is shown (picture on left) taking the CLASSIC manometer as an example: Accuracy class (Kl.) 1.0, full scale reading 2.5 bar. The permissible error for this manometer is:

2.5 bar * 1 % = 25 mbar

This error applies absolutely to the entire pressure range and is relatively higher at a lower pressure (at 0.25 bar: ± 10%) than at a high pressure (2.5 bar: ± 1%). This must be taken into account for each evaluation of a measured value.



MECHANICAL MANOMETER ECO

Measuring range	0 to 1,6 bar
Display (division)	0.05 bar (50 mbar)
Overloadproff to	2,0 bar
Accuracy	± 1.6% typ. ± 25,6 mbar (absolute over the entire pressure range)
Operating temperature	-10 to 80 °C
Manometer housing	Sheet steel, black
Protection class	IP32
Special features	G1/4 cover stainless steel

MECHANICAL MANOMETER CLASSIC

Measuring range	0 to 2,5 bar
Display (division)	0.05 bar (50 mbar)
Overloadproff to	3,0 bar
Accuracy	± 1.0% typ. ± 25,0 mbar (absolute over the entire pressure range)
Operating temperature	-10 to 80 °C
Manometer housing	Sheet steel, black
Protection class	IP32
Special features	Installation according to EN 837-2 protective cap with rubber

DIGITAL MANOMETER BUSINESS

Measuring range	-1 bis 3,0 bar
Display (division)	0.01 bar (10 mbar)
Overload-proof to	3,5 bar
Accuracy	± 0.1% typ. ± 4 mbar (absolute over the entire pressure range)
Operating temperature	0 bis 50 °C
Manometer housing	robust plastic
Protection class	IP 64
Special feature	Installation according to EN 837-2
Data output	RS232/TTL printing log printer RS485 recording with PC
Power supply	Button cell type 2032 3V

BATTERY REPLACEMENT – BUSINESS MANOMETER

If the battery power is low, this is indicated on the left-hand side of the display by a crossed-out battery symbol. We recommend that you replace the battery at the earliest convenience.

To do this, the interface cover must be unscrewed and the rubber cap removed.

The front side of the display can be removed from the top side (ideally with the help of a coin).

Remove the old battery by lifting it out of the holder with the fingernails of both index fingers. When doing this the thumbs touch the black clip points on the opposite sides of the red circle. **Insert the new battery such that the two contacts on one side lead around the battery (red circle).**

Assemble the device again in the reverse order, ensuring that the rubber sealing ring lies on the top edge of the front part so that the part lies tight against the manometer housing when closed.

In principle the battery can be used for several hundred measurements. Power consumption during the measurement is very small. Most power is consumed when sending the data packets to the log printer.

CARBIDE AMPOULE ACCORDING TO DIN 18560-4

Regulations	Safety data sheet in accordance with 1907/2006/EC article 31 (see: www.cpm-radtke.com)
Possible dangers	Reacts with water to form highly flammable gases
First aid measures	see safety data sheets
Ampoule diameter	14 mm
Ampoule height	approx. 75 mm
Contents	Calcium carbide techn. (80.0 % typ.)
Qunatity	**7.0 g (± 0.5 g)**
Granulation	**0.3/1 mm**
Self life	unlimited if sealed tight

CALIBRATION AMPOULE

Regulations	none available
Ampoule diameter	10 mm
Ampoule height	approx. 35 mm
Contents	distilled water
Quantity	1.00 g (typ. better than ± 1%)
Self life	unlimited if sealed tight

STOPWATCH/TIMER

Measuring range	99:59 minutes as stopwatch 99:59 minutes as timer
Display (division)	Minutes and seconds
Accuracy	typically +/- 1 second
Operating temperature	-10 to 80 °C.
Manometer housing	PE
Protection class	IP32
Special feature	Beeps for one minute, thereafter displays the timer time. Clamp and magnetic holder.
Power supply	Battery type AAA

CM MEASUREMENT LOG

COMPANY: _____ NAME OF TESTER:

_____ _____

RADTKE MESSTECHNIK

Building/ property						
Building section/ part						
Floor/ apartment						
Type of screed	**CT**		**CA**		**CAF**	
	OTHER:					
Additive						
Under-floor heating	**YES**		NO			

DOCUMENTATION OF ROOM AIR

Temperature	**[°C]**	**[°C]**	**[°C]**
Humidity	**[%rF]**	**[%rF]**	**[%rF]**

DOCUMENTATION OF FLOOR

Measurement No.:	**1**	**2**	**3**
Screed thickness	**[mm]**	**[mm]**	**[mm]**
Temperature	**[°C]**	**[°C]**	**[°C]**

PRELIMINARY TEST

Test device used			
Measured value digits			

RESULT OF MATERIAL CLIMATE CCM HYGRO COMBI

Equilibrium moisture	**[%rF]**	**[%rF]**	**[%rF]**
Equilibrium temperature	**[°C]**	**[°C]**	**[°C]**

RESULT OF MEASUREMENT

Sample weight	**[g]**		**[g]**		**[g]**	
Pressure	**[bar]**		**[bar]**		**[bar]**	
Water content	**[M-%]**		**[M-%]**		**[M-%]**	
Temperature	**[°C]**		**[°C]**		**[°C]**	
Readiness for covering reached?						
	YES	**NO**	**YES**	**NO**	**YES**	**NO**
Date/signature Client						
Remarks: relevant Standard: DIN 18560-4: 2011-03 **Remarks: relevant Norm: SIA 253/2002 incl. C1 2011**						

CONCLUSION

The data in the operating instructions correspond to our present level of knowledge and are intended to inform about our products as well as their application possibilities. They are not intended to assure certain characteristics of the products or their suitability for a specific purpose of use. Any existing industrial property rights are to be taken into account.
We constantly strive to improve our products. Therefore we reserve the right to make changes and improvements to the products described in these operating instructions without prior notice.

DECLARATION OF CONFORMITY

European Union directives applied:
We confirm that our products were manufactured in accordance with the following directives.

- 2002/95/EC of the European Parliament and of the Council of 27/01/2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
- 2002/96/EC of the European Parliament and of the Council of 27/01/2003 on waste electrical and electronic equipment.
- Directive (EC) No. 1907/2006 (REACh regulation) of the European Parliament and of the Council of 18/12/2006.
- Manufacturing of the pressure bottle according to the Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the member states concerning pressure equipment.
- Assembly of the digital manometer (for equipment version CCM Set ECO dig dig) according to DIN EN 837-2 Pressure gauges, selection and installation recommendations for pressure gauges.
- **Carbide ampoules conform to the specifications according to the latest edition of DIN 18560-4 'Screeds in the construction industry' Part 4 'Screeds on separating layers', item 5.3, suitable for evaluation of readiness for covering.**

RADTKE MESSTECHNIK

LOG BOOK: ON-SITE-CALIBRATION OF CM MOISTURE METER			
Company:			
Street:			
Postal code/ Place:			
Bottle-Nr.			
Gauge-Nr.			
The resulting pressure must be between 0.95 and 1.05 bar (black scale).			
Date of cal.	**Pressure [bar]**	**Temperature [°C]**	**Signature**