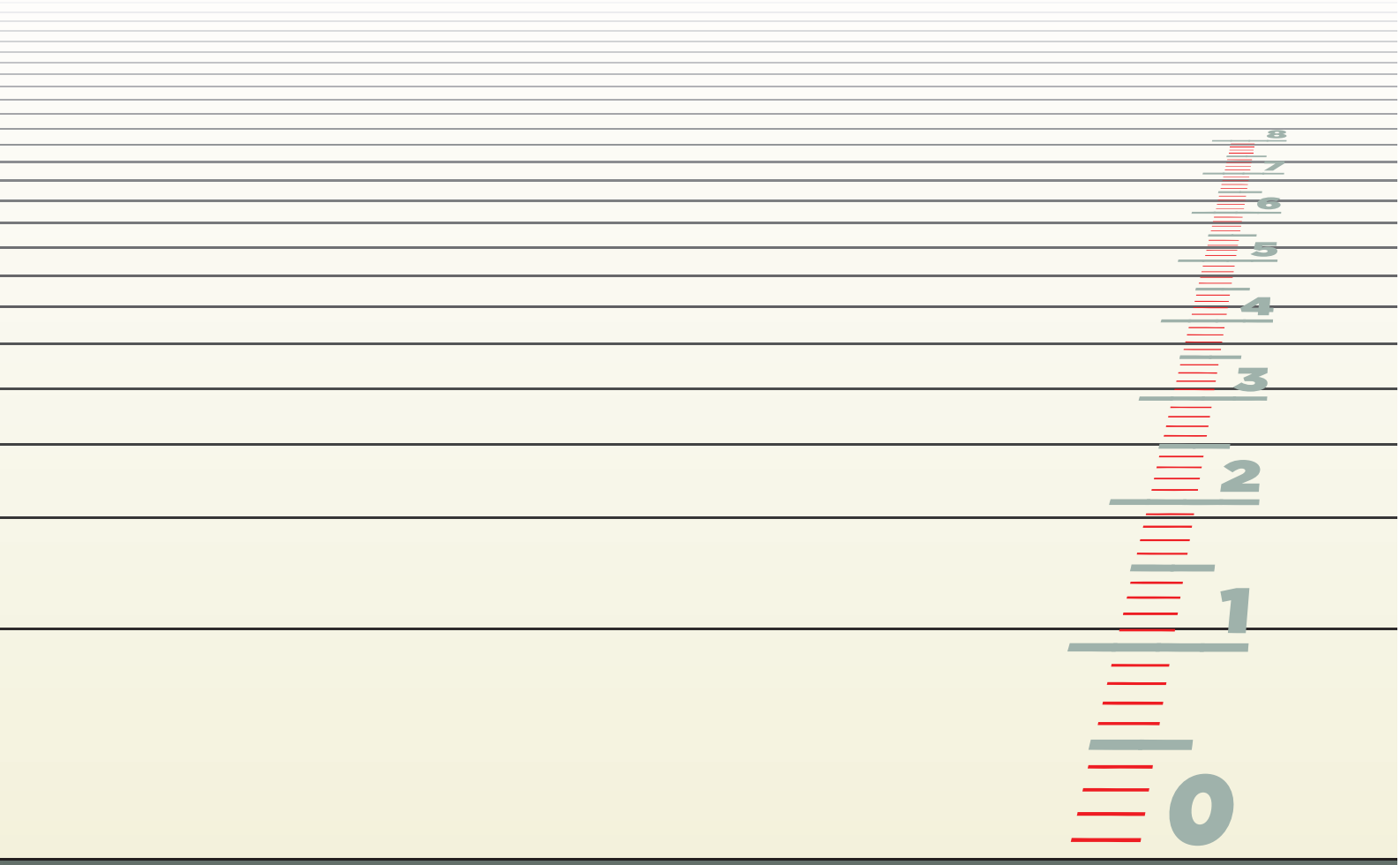
FUNKE GERBER

# LABORATORY CATALOGUE

## for milk analysis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**Dear ladies and gentlemen,**

The name Funke-Gerber stands for innovative chemical milk analysis combined with quality, continuity and reliability. Thousands of instruments installed all over the world, used daily by laboratory specialists, confirm our excellent reputation, a reputation that has been strengthened by longtime trust and cooperation between us and our business partners. Furthermore, Funke-Gerber is considered to be a reliable business partner and supplier of laboratory equipment who offers a very good price-performance ratio. With pride and satisfaction we look back on our more than century-long performance.
In this newly revised catalogue, I would in particular like to point out our new products "LactoFlash" and "LactoStar". Of course, all other equipment is also up-to-date. As you know from previous catalogues, editorial contributions make up a large part of our publications. We are happy that we have been able to expand this important section with additional contributions from highly competent authors.
Our standard product range covers the entire range of chemical milk analysis. Should you have any special requirements that go beyond our product range, please do not hesitate to approach us with your respective inquiries. We will promptly respond by submitting an attractive quote.

*We look forward to working with you!*

*K. Schaefer, CEO*

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# TRADITION
# PROGRESS
# CONTINUITY

**Funke - Dr. N. Gerber Labortechnik GmbH**
*Partners in dairy farming since 1904*

Since 1904, Funke-Gerber has been an important player in dairy farming, both at home and abroad. The production of laboratory equipment for the testing of milk and foodstuffs is among its crowning achievements.

The manufacture of centrifuges together with butyrometers and other appliances for the determination of fat content according to Dr. N. Gerber's method continues to be central to our business activity. Above and beyond this classical field, the company develops and produces modern electronic devices for milk analysis.

The appliances of the **"CyroStar"** line for the determination of freezing points are highly regarded on account of their precision and reliability and have been in use in many dairies and institutes for years.

A new era in routine laboratory analysis has begun with the new **"LactoStar"** and **"LactoFlash"** appliances.

Know how and continuous development make Funke-Gerber an important player in dairy farming.

Decades of cooperation and trust have given our company, in association with our numerous business partners who represent Funke-Gerber in their countries, the necessary global presence to ensure the provision of products to our customers.

Since 1904, the name Funke-Gerber has stood for quality, reliability and continuity.

# PRODUCTS:

**The company develops, manufactures and markets the following equipment and accessories worldwide:**

- All equipment and accessories for the *„Gerber method of determining fat content“*: **centrifuges, water baths, reading lamps, butyrometers**
- **„CryoStar“** freezing point determination units
- **„LactoStar“** and **„LactoFlash“** milk analysis devices
- **pH meters**
- General laboratory equipment

# ACTIVITES:

**Turnkey installation or the design of complete laboratories in the following special fields:**

- The milk-processing industry
- Dairies, milk collection centres
- Cheese dairies, butter works, ice-cream, condensed milk and powdered milk factories

**Company profile:**
*Founded: 1904*
*Managing director:*
*Graduate engineer Konrad Schaefer*
*Authorised signatory:*
*graduate economist Georg Hoernle*

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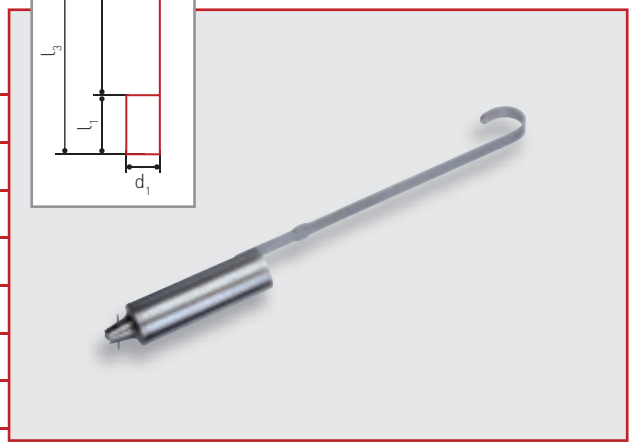
*Fax: (+49-30) 702 006-66*
*E-mail: kontakt@funke-gerber.de*
*Website: www.funke-gerber.de*

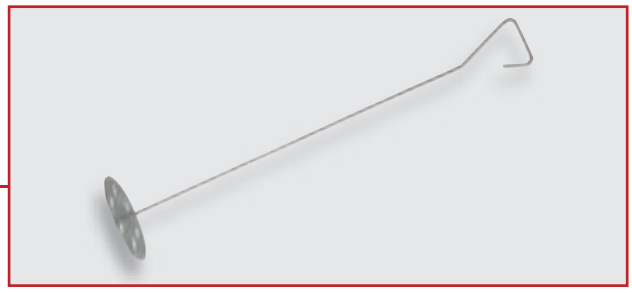
## Milk sampler
stainless steel,
with valve for automatic drainage




| | | |
|---|---|---|
| **3000** | **1 ml** | $l_3$ = 375 mm, $l_2$ = 343 mm, $l_1$ = 32 mm, $b_1$ = 31 mm, $d_1$ = 10 mm |
| **3001** | **2 ml** | $l_3$ = 405 mm, $l_2$ = 355 mm, $l_1$ = 50 mm, $b_1$ = 35 mm, $d_1$ = 10 mm |
| **3003** | **5 ml** | $l_3$ = 290 mm, $l_2$ = 235 mm, $l_1$ = 55 mm, $b_1$ = 31 mm, $d_1$ = 14 mm |
| **3004** | **10 ml** | $l_3$ = 305 mm, $l_2$ = 235 mm, $l_1$ = 70 mm, $b_1$ = 31 mm, $d_1$ = 18 mm |
| **3007** | **20 ml** | $l_3$ = 315 mm, $l_2$ = 240 mm, $l_1$ = 75 mm, $b_1$ = 35 mm, $d_1$ = 30 mm |
| **3008** | **40 ml** | $l_3$ = 335 mm, $l_2$ = 235 mm, $l_1$ = 100 mm, $b_1$ = 32 mm, $d_1$ = 28 mm |
| **3010** | **50 ml** | $l_3$ = 365 mm, $l_2$ = 240 mm, $l_1$ = 125 mm, $b_1$ = 32 mm, $d_1$ = 28 mm |
| **3011** | **100 ml** | $l_3$ = 370 mm, $l_2$ = 235 mm, $l_1$ = 130 mm, $b_1$ = 32 mm, $d_1$ = 38 mm |

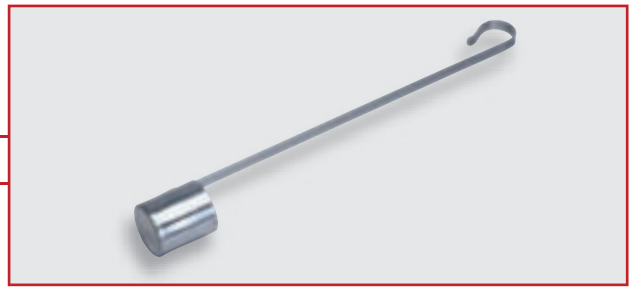
## Milk stirrer
stainless steel, perforated disk,
Ø 160 mm, 770 mm long

**3021**



## Dipper
aluminium with spout, handle aprox. 50 cm long

| | | |
|---|---|---|
| **3030** | **125 ml** | $l_3$ = 625 mm, $l_2$ = 540 mm, $l_1$ = 85 mm, $b_1$ = 53 mm, $d_1$ = 43 mm |
| **3031** | **250 ml** | $l_3$ = 620 mm, $l_2$ = 540 mm, $l_1$ = 80 mm, $b_1$ = 53 mm, $d_1$ = 65 mm |



## Scoop
stainless steel

| | | |
|---|---|---|
| **3033** | **130 ml** | l = 350 mm, inner scoop Ø = 79 mm |
| **3034** | **250 ml** | l = 465 mm, inner scoop Ø = 97 mm |
| **3035** | **450 ml** | l = 480 mm, inner scoop Ø = 118 mm |

## Milk sample bottle
80 ml, PE without metal bottom
(e.g. for art. no. 3510, 3530)
(for cap see art. no. 3043)

**3040**

## Milk sample bottle

| | |
|---|---|
| **3041** | **50 ml,** PP with metal bottom (e.g. for art. no. 3510, 3530) |
| **3042** | **Stopper** with groove (for art. no. 3041) |
| **3043** | **Cap** (for art. no. 3040) |

## Rubber stopper

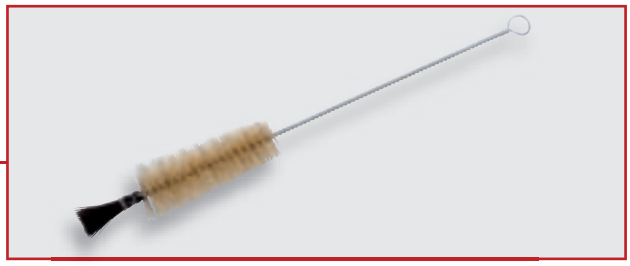
for special solubility index tubes art. no. 3637

| | |
|---|---|
| **3050** | 19 x 24 x 25 mm |

## Cleaning brush

(for art. no. 3040, 3041, 3637)

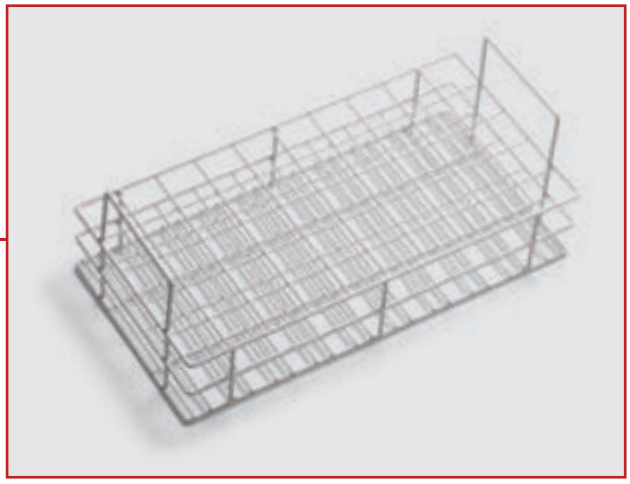
| | |
|---|---|
| **3080** | length: 300 mm |



## Wire cradle

plastic-coated wire, for 50 bottles,

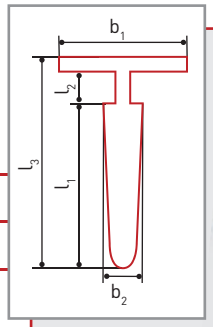
| | |
|---|---|
| **3091** | each 50 ml (for art. no. 3041) |

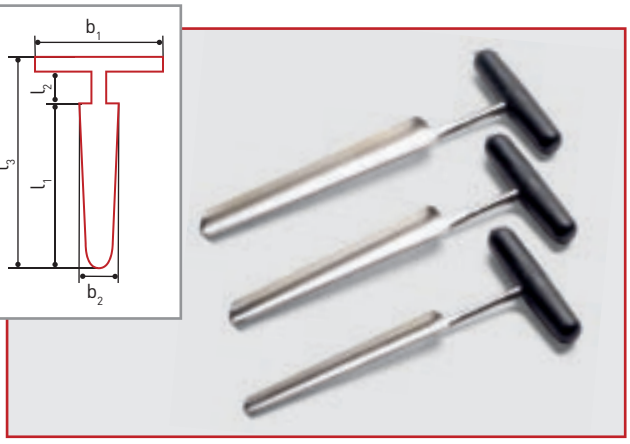


## Cheese trier

chrome-nickel steel, with plastic handle

| | |
|---|---|
| **3120** | $l_1$ = 125 mm, $l_2$ = 60 mm, $l_3$ = 190 mm, $b_1$ = 85 mm, $b_2$ = 13 mm |
| **3121** | $l_1$ = 140 mm, $l_2$ = 48 mm, $l_3$ = 205 mm, $b_1$ = 80 mm, $b_2$ = 19 mm |
| **3122** | $l_1$ = 150 mm, $l_2$ = 75 mm, $l_3$ = 225 mm, $b_1$ = 80 mm, $b_2$ = 21.5 mm |



## Cheese trier
100% stainless steel

**3124** $l_1$ = 125 mm, $l_2$ = 40 mm, $l_3$ = 165 mm, $b_1$ = 65 mm, $b_2$ = 15 mm

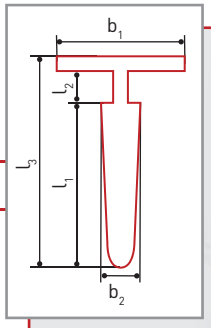
## Milk powder collector
stainless steel for aprox. 230 ml,

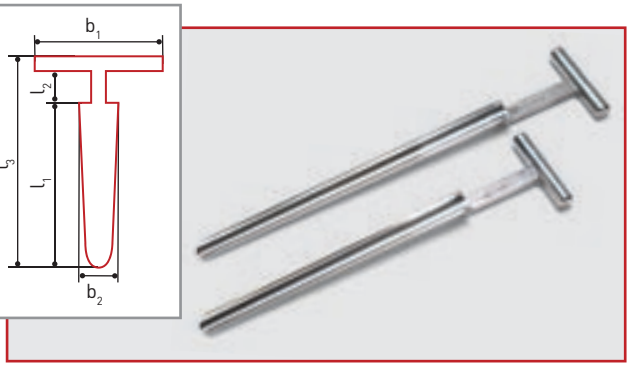
**3125** exterior aprox. Ø = 28 mm, fill length = 375 mm

## Butter trier
chrome-nickel steel, with metal handle

**3130** $l_3$ = 343 mm, $l_2$ = 73 mm, $l_1$ = 255 mm, $b_1$ = 82.5 mm, $b_2$ = 23 mm

**3131** $l_3$ = 410 mm, $l_2$ = 75 mm, $l_1$ = 320 mm, $b_1$ = 80 mm, $b_2$ = 22 mm



## BagMixer 400 with window
capacity: 80 – 400 ml, 230 V/50 Hz

**3139** 17 kg, 400 x 270 x 260 mm

## BagMixer 400 without window
capacity: 80 – 400 ml, 230 V/50 Hz

**3140** 17 kg, 400 x 270 x 260 mm

### Accessories for BagMixer 400

**3141** **Disposable plastic bag** 400 ml, sterile

**3142** **Filter bag,** 400 ml, sterile

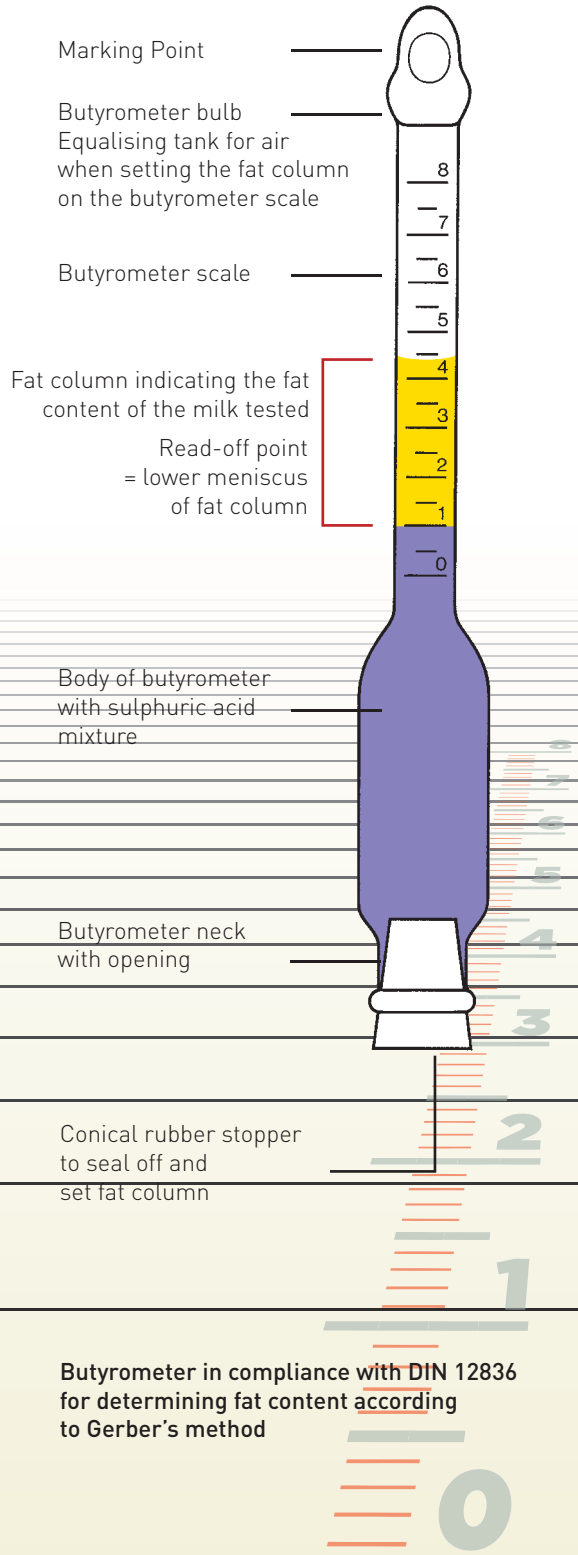
**3143** **Bag clasps**

**3144** **Stand** for 10 bags

# BUTYROMETRIC DETERMINATION OF FAT CONTENT ACCORDING

## TO GERBER'S METHOD

*by graduate chemist Alfred Toepel*




**Butyrometer in compliance with DIN 12836 for determining fat content according to Gerber's method**

Graduate chemist Alfred Toepel started lecturing at the School of Dairy Farming in Halberstadt in 1960. In 1992 he took over the Department of Training in Oranienburg.

He is also author of the textbook The Chemistry and Physics of Milk.

The butyrometric determination of fat content in milk was developed by **Dr. N. Gerber** in 1892 and incorporated into official regulations as a sulphuric acid process in 1935. The rapid testing method appears both in German standards (e.g. DIN 10479) and international standards (e.g. ISO 2446).

Determination of fat content according to Gerber is a rapid testing method and is still used today despite the introduction of automated methods for determining fat content in dairy laboratories. The advantages of the Gerber method over modern rapid testing methods are:

- Omission of the need for time-consuming calibration of the measuring gauge;
- Relatively low investment costs and hence low costs in performing quick tests on individual samples;
- It can be used on all types of milk.

The disadvantage is the use of very corrosive, concentrated sulphuric acid, which necessitates the observation of special precautions and the disposal of the sulphuric acid mixture in an environmentally suitable way.

## PRINCIPLES OF THE METHOD

The determination of fat content according to Gerber involves running off the fat into a special measuring vessel, the butyrometer, and determining its volume as a percentage by mass. The fat is present in the milk in the form of small globules of various diameters, from 0.1 to 10 micrometers. The globules of fat form a consistent emulsion with the milk liquid. All globules of fat are surrounded by a protective coating, a fat globule membrane which is made up of phospholipids, a fat globule coat protein and hydrate water. This protein coating the fat globules prevents them from coalescing and stabilizes the emulsified state.

In order to completely isolate the fat, the protection coating around the fat globules must be destroyed. This is done with concentrated sulphuric acid of 90-91 % by mass. The sulphuric acid oxidizes and hydrolyzes the organic components in the protective coating around the fat globules, the lactoprotein fractions and the lactose. This produces a high heat of reaction in addition to the heat of dissolution. The butyrometer gets quite hot. The oxidation products turn the resulting solution brown. The released fat is then isolated by centrifuging, whereby the addition of amyl alcohol facilitates phase separation and a sharp delineation is produced between the fat and the acid solution. The fat content of the milk can be read off as a mass percent content on the butyrometer scale.

## APPLICATION

This process can be used for untreated and pasteurized milk with a fat content of 0-16 % for milk which contains a suitable preservative as well as for homogenized milk.

# CHEMICALS NEEDED

**Sulphuric acid, $H_2SO_4$**

| Requirements: | Hazard symbol: | Hazard rating: |
|---|---|---|
| Density at 20°C<br>(1,818 ± 0,003) g per $ml^{-1}$<br><br>• *colourless or only slightly discoloured and free from any substances which might influence the outcome* | | C2 R 35<br>S 2 - 26 - 30 |

**Please note:**

*The required density corresponds to 90 to 91 % by mass. Stronger or weaker concentrations are to be avoided. At 65°C, more highly concentrated sulphuric acid attacks the amyl alcohol, producing olefins through dehydration which influence the result. Weaker concentrations reduce the oxidization effect. Destruction of the fat globule coating is incomplete which can lead to the formation of lumps.*

**Amyl alcohol**

For the determination of fat content according to Gerber's method
*An isomer mixture of 2-methylbutane-1-ol and 3-methylbutance-1-ol*

| Requirements: | Hazard symbol: | Hazard rating: |
|---|---|---|
| Density bei 20°C<br>(0,811 ± 0,003) g $ml^{-1}$<br><br>• *Boiling boundary: 98 % (by volume) has to distil at between 128°C and 132°C at 1 bar.*<br>• *The amyl alcohol must not contain any substances which could influence the result.*<br>• *A substitute for amyl alcohol can be used provided that it will bring about the same test results as would be achieved with amyl alcohol.* | | Xn R 10-20<br>S 24/25<br>VbF A II |

**Please note:**

- *The isomers of amyl alcohol have different boiling points: 2-methylbutane-1-ol at 128°C and 3-methylbutane-1-ol at 132°C.*
- *Of the 8 known isomers of amyl alcohol, only this mixture is suitable for the Gerber method.*
- *Contamination with other isomers of amyl alcohol, particularly with the tertiary amyl alcohol 2-methylbutane-2-ol, produces false results. The obtained fat content result is too high.*

## REQUIRED EQUIPMENT

1. **Calibrated butyrometer with suitable stopper in accordance with DIN 12836-A 4, DIN 12836-A 6, DIN 12836-A 8, DIN-12836-A 5**

2. **Pipette** DIN 10283-p **for milk** or **pipette** DIN 12837-A for milk

3. **Pipette** DIN 12837-B or 10 ml **measuring tap** for **sulphuric acid**

4. **Pipette** DIN 12837-C **for 1 ml amyl alcohol**

5. **Centrifuge for determining fat content in milk,** heatable, with rpm counter.
   When used under a full load, this centrifuge must be capable of producing a centrifugal force of (350 ± 50) g on the inside of the butyrometer stopper within 2 minutes at the most. With a rotation radius of e.g. (26 ± 0,5) cm up to the inside of the butyrometer stopper, which is the distance between the point of torque and the butyrometer stopper, this centrifugal acceleration is reached at a rotation speed of (1100 ± 80) min–1.

6. **Tempering devices for butyrometers,** e.g. a (65 ± 2)°C water bath
   With a heated centrifuge, a centrifuge bushing can be used to attach the butyrometer into the water bath. The read-off temperature must be (65 ± 2)°C.

## PREPARATION OF THE TEST SPECIMEN

The milk in the specimen bottle is heated up to 20°C and thoroughly mixed through gentle shaking. This is done to bring about an even distribution of fat and to prevent frothing and the formation of butter.

*Milk fat is lighter than water and creams if it is left standing. A fat-rich layer accumulates on the surface. Stirring and careful shaking restore the original distribution.*

If the layer of cream cannot be evenly distributed in this way, the milk should be slowly heated to 35-40°C and gently swirled around until a homogenous fat distribution is achieved. The milk is then cooled to 20°C before being drawn into the pipette.

*Foam breaks the fat globule coating. The milk may begin to turn into butter when stirred and uniform distribution of fat is no longer possible.*

*The fat liquefies at 35-40° and the distribution process is speeded up.*

After the temperature has been set, the milk can stand for 3 to 4 minutes to allow any pockets of air to disperse.

*The volumeters are calibrated at 20°C. Any variations in temperature will influence the volume. Air pockets reduce the density and hence the mass of milk measured.*

The same milk specimen must be tested twice.

Fig. 1 Protective glasses and rubber gloves must be worn when handling sulphuric acid

1. Place 2 butyrometers into a clamp (butyrometer stand). With the aid of a measuring tap, introduce 10 ml of sulphuric acid into the butyrometer without wetting the neck of the butyrometer (see Fig. 1).

2. Carefully turn the bottle with the milk specimen upside down three or four times. Then immediately pipette 10.75 ml of milk into the butyrometer in such a way that the butyrometer neck does not get wet and the milk does not mix with the sulphuric acid. To do so, lean the tip of the pipette laterally as deeply as possible against the wall of the butyrometer so that the milk forms a layer on top of the sulphuric acid (see Fig. 2).

   *When the Gerber method was first introduced, 11.0 ml of milk were used. By reducing the quantity of milk 10.75 ml, the determined fat content more closely matches the results of the reference method. If the butyrometer neck is wetted with milk, residues may cling to it.*

   *A clear dividing line between the acid and the milk, without a brownish-coloured edge, is the sign of good layering.*

3. 1 ml of amyl alcohol is pipetted onto the milk, or introduced by means of a measuring tap.

   *Due to the low density of amyl alcohol, the two liquids do not mix.*

4. The butyrometer is sealed with a stopper without mixing the liquids.

   *As a rule, the lower end of the stopper comes into contact with the liquid.*

5. The butyrometer is placed in the butyrometer tube with the bulb pointing downwards. Shake the butyrometer vigorously until the two liquids are thoroughly mixed. Keep your thumb firmly pressed down on the butyrometer stopper while doing so. Turn the butyrometer up and down several times in order to enable the sulphuric acid remaining in the bulb to disperse (see Fig. 3).

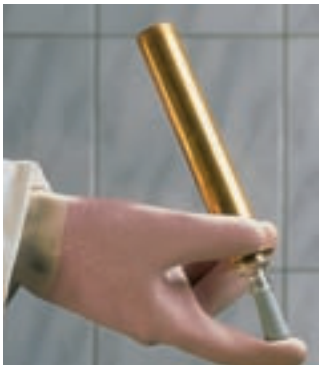


Fig. 3

The butyrometer is shaken in the tube (protective goggles and rubber gloves must be worn)

*When the liquids are mixed, a considerable amount of heat is given off. The gas built up in this way can cause the stopper to shoot out, or the butyrometer to break.*

*The butyrometer tube is used as a safety precaution. Instead of using a butyrometer tube, the butyrometer can be wrapped in a cloth.*

*Too lax shaking of the butyrometer or holding it unnecessarily in a slanted position inhibits quick mixing and therefore the rapid oxidation of the entire specimen, thus ruining the careful work done layering the liquid.*

Fig. 4 Filling the centrifuge

Fig. 5 The butyrometers are brought to the exact reading temperature in a water bath

6. Immediately after the mixture has been shaken and turned upside down a few times, the butyrometers, still hot and with the stoppers pointing downwards, are placed in buckets inside the heated Gerber centrifuge (see Fig. 4), whereby the butyrometers must be placed exactly opposite each other.

   Beforehand, the column of fat should be set at the height of the expected level of fat content by turning the stopper.

   After setting the time on the centrifuge, the centrifuge is started. After reaching a centrifugal force of (350 ± 50) g, which is reached as a rule after 1 minute, the corresponding speed of (1100 ± 50) rpm should be maintained for 4 minutes.

   The centrifuge must be fitted with an interlocking lid. After the time set for the centrifuge has been reached, the rotor brake is automatically applied.

7. The butyrometers are now removed from the centrifuge, taking care not to tilt them, and are placed with the stoppers facing downwards for 5 minutes in a water bath heated to 65°C (see Fig. 5).

   *It is important to maintain an exact temperature so as to obtain accurate results. Only a read-off at 65°C will ensure an exact result. If the temperature is too low, the volume of the column is reduced and a fat content reading that is too low will be indicated.*

Fig. 6 Measured values can be reliably and accurately read off with the aid of a safety reading lamp

## RESULT AND DEGREE OF ACCURACY

8. After removing the butyrometer from the water bath, it should be held vertically at a height where the meniscus of the column of fat is at eye level. With the help of the stopper, mark the demarcation line between the residual mixture and fat on a whole subdivision of the butyrometer scale and read off the height of the fat column at the lowest point of the meniscus. If the reading takes too long, the butyrometer must be placed back into the water bath (see Figs. 6 and 7).

   If the meniscus of the fat column is not at eye level, a parallax error results.

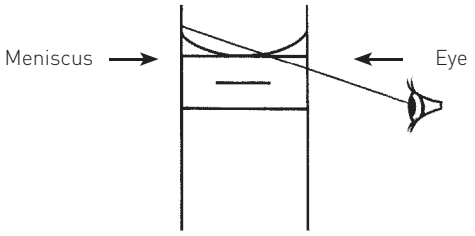



Fig. 7

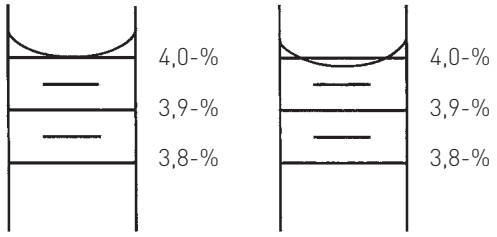



Fig. 7a: 4,0-% reading Fig. 7b: 3,95-% reading

The result should be read off to half a scale point, i.e. to 0.05 %. It is not possible to obtain a more accurate result with whole milk butyrometers. If the meniscus touches the graduation mark, then the result is to be recorded as such (Fig. 7a).

If the meniscus intersects the graduation mark, then the lower value is taken (Fig. 7b).

The difference between the readings from the two butyrometers must not be greater than 0.10 %, i.e. the reproducibility amounts to 0.10 %.

When recording the result, you must add the note "fat content according to the Gerber method".
If the two specimens differ by 0.1 %, the mean value of both readings is taken.

Specimen 1: 4.20 % | Specimen 2: 4.30 % | Result: 4.25 % fat content

However, if the two readings are 4.20 % and 4.25 % fat content, the lower value of 4.20 % is recorded – on the principle that it is better to err on the side of caution.

## Determination of the fat content in homogenized milk according to Gerber's method

Treated milk is homogenized to avoid creaming. This involves reducing the different-sized fat globules to a nearly equal diameter of 1 to 2 micrometers. This considerably decreases the separating effect of the centrifuging process. In order to completely separate off the released fat, the specimen must be centrifuged for a longer period of time.

Process steps 1 to 8 for the testing of non-homogenized milk are carried out and the result is recorded.

Then, the butyrometer is once again heated to 65°C in a water bath for at least 5 minutes and subsequently centrifuged again for 5 minutes. The result is read off in the same way as before.

If the value obtained after the second centrifuging is more than 0.05 % higher than the value after the first centrifuging, then the reheating and centrifuging is to be repeated a maximum of two times.

However, if this value has increased by only 0.05 % or less with respect to the first value, the highest test value applies.

**Example:**

- *After the first centrifuging, the two values were read off at 3.55 % and 3.60 %.*
- *After the second centrifuging, the two values were 3.60 % and 3.65 %. The homogenised milk fat content is stated to be 3.65 %.*
- *Should the difference still be greater than 0.05 % after the two last repetitions, i.e. after the 3rd and 4th centrifuging, the results of this test are to be discarded.*

# BUTYROMETRIC DETERMINATION OF THE FAT CONTENT OF VARIOUS DAIRY PRODUCTS

**FOREWORD:** *The butyrometric determination of the fat content in milk has been and is being replaced at a progressive rate by other routine tests (with appliances such as LactoStar, for instance). However, milk products such as cheese, ice cream, etc. either cannot be tested with such appliances or can only be tested after elaborate specimen preparation. For these products, butyrometric methods are a good alternative for routine analysis.*

## 1.0 FIELD OF APPLICATION

Determination of fat content in milk and various dairy products.

## 2.0 VOLUMES

Unless stated otherwise, the following quantities of chemicals and test specimens are used:

| | |
|---|---|
| Sulphuric acid: | 10.0 ml (20°C + 2°C) |
| Amyl alcohol: | 1.0 ml (20°C + 2°C) |
| Milk or dairy product: | 10.75 ml (20°C + 2°C) |

## 3.0 BRIEF DESCRIPTION OF THE BUTYROMETRIC DETERMINATION OF FAT CONTENT:

### 3.1 ... IN MILK (ACCORDING TO GERBER'S METHOD):

Perfectly cleaned milk butyrometers, most importantly free of fat residues, are filled in the following order: 10 ml of sulphuric acid (density: 1.818 +/- 0.003 g/ml), 10.75 ml of milk, and 1 ml of amyl alcohol. The milk and amyl alcohol are to be filled in layers so that they do not mix before shaking. After sealing the butyrometer, the contents are thoroughly mixed by shaking and turning the butyrometer upside down several times. Through careful adjustment of the sealing stopper, the contents of the butyrometer are regulated in such a way that the scale is full but no liquid enters the bulb. The butyrometer is centrifuged in the heated centrifuge, and then tempered in a 65°C water bath for 5 minutes. The dividing line between the sulphuric acid mixture and the fat column is set at a full scale line and the upper end of the fat column is read off at the lower meniscus.

### 3.2 ... IN HOMOGENISED MILK

*As above, except that the specimens are centrifuged three times, for 5 minutes each time. In between centrifugings, the butyrometers are heated in a 65°C water bath for 5 minutes (for more detail, see page 19).*

### 3.3 ... IN SKIM MILK AND WHEY

*Use of skim milk butyrometers with narrowed scales according to Sichler's method.*

Butyrometers are centrifuged twice and placed in a 65°C water bath for 5 minutes in between centrifugings.

### 3.4 ... IN CONDENSED MILK (UNSWEETENED)

The condensed milk is heated to 50°C and allowed to cool again. Then it is mixed with water in a 1:1 ratio. This dilution is then tested like milk according to Gerber's method. Fat content = read-off value x 2.

## 3.5 ... IN BUTTERMILK (MOHR AND BAUR'S MODIFICATION)

The butyrometer is filled with 10 ml of sulphuric acid (density: 1.830 +/- 0.003 g/ml). Instead of 10.75 ml, 10 ml of buttermilk and 2.0 ml of amyl alcohol are pipetted in. After sealing, the butyrometer is shaken and immediately centrifuged for 10 minutes. This prevents annoying blockages. The reading is taken after tempering the specimen at 65°C +/- 2°C. Fat content = read-off value x 1.075.

## 3.6 ... IN POWDERED MILK ACCORDING TO TEICHERT'S METHOD

*Use of powdered milk butyrometer according to Teichert's method.*

The butyrometer is filled with 10 ml of sulphuric acid (density: 1.818 +/- 0.003 g/ml). 7.5 ml of water and 1 ml of amyl alcohol are layered onto it. 2.5 g of powdered milk are weighed in a weighing boat and transferred into the butyrometer through a funnel, using a hair brush. After sealing, the butyrometer is thoroughly shaken, and intermittently placed in a 65°C water bath several times. It is centrifuged twice, 5 minutes each time, in the heated centrifuge and the value is read off after the butyrometer is placed in the water bath for 5 minutes.

## 3.7 ... IN CREAM ACC. TO ROEDER'S METH. (WEIGHING METH.)

*Use of cream butyrometer according to Roeder's method.*

5 g of cream are weighed out into the glass beaker situated in the stopper and transferred into the butyrometer. Sulphuric acid (density: 1.522 +/- 0.005 g/ml) is poured through the upper opening of the butyrometer until it reaches just over the upper edge of the glass beaker. After sealing, the butyrometer is placed in a 70°C water bath and shaken repeatedly until the protein is completely dissolved. Sulphuric acid is poured in until it reaches the beginning of the scale, 1 ml of amyl alcohol is added and the butyrometer is sealed, shaken, and placed in the 70°C water bath for another 5 minutes. Then, it is centrifuged for 5 minutes and tempered in a 65°C water bath. The reading is taken at 65°C, the fat column adjusted to the zero point, the value read off at the lower meniscus.

## 3.8 ... IN CREAM ACC. TO SCHULZ-KLEY'S METH. (WEIGHING METH.)

*Use of cream butyrometer according to Schulz-Kley's method.*

10 ml of sulphuric acid (density: 1.818 +/- 0.003 g/ml), 5 ml of water, ca. 5 g of cream measured by differential weighing using a syringe or weighing pipette attached to the scale, and 1 ml of amyl alcohol are successively introduced into the butyrometer. After sealing, the contents are mixed by shaking and turning the butyrometer upside down and centrifuged for 5 minutes in the heated centrifuge. The value is read off after 5 minutes of tempering in a 65°C water bath. Note: do not allow more than 15 minutes to pass between adding the water and shaking the specimen due to the possibility of a decrease in the heat of reaction as a result of the addition of water. The dissolution process must be completed within 60 seconds.
Fat content = read-off value x 5 / cream net weight.

## 3.9 ... IN CREAM ACC. TO KOEHLER'S METH. (MEASURING METH.)

*Use of cream butyrometer according to Koehler's method.*

10 ml of sulphuric acid (density: 1.818 +/- 0.003 g/ml), 5.05 ml of cream, 5 ml of water, and 1 ml of amyl alcohol are poured in turn into the cream butyrometer. When using a cream syringe, it must be rinsed several times with water before the 5 ml of water are introduced. The butyrometer is sealed, shaken, centrifuged for 5 minutes, and then the value is read off after tempering the specimen in a 65°C water bath. The value is read off from the zero point.

## 3.10 ... IN CHEESE ACC. TO VAN GULIK'S METH. (WEIGHING METH.)

*(see ISO 3433) Use of the cheese butyrometer according to Van Gulik's method.*

After pouring 15 ml of sulphuric acid (density: 1.522 +/- 0.005 g/ml) into the Van Gulik butyrometer, closed at the scale end, 3 g (+/- 0.2 g) of cheese are added by means of a weighing boat and hair brush, and then the filler opening is sealed. Pasty cheese samples must be weighed out into the perforated glass beaker which accompanies the Van Gulik butyrometer and introduced into the butyrometer. The sealed butyrometer is placed in a 70°C - 80°C water bath with the scale pointing upwards and shaken repeatedly until the cheese is dissolved. Afterwards, 1 ml of amyl alcohol is added, followed by sulphuric acid until it approximately reaches the 15 % mark of the scale. Then close the butyrometer, mix the contents, temper for 5 minutes in a 65°C water bath, adjust the fat column to the zero point and read off the absolute fat content. The reading is taken from the lower end of the meniscus.

## 3.11 ... IN ICE CREAM ACC. TO KOEHLER'S METH. (MEASURING METH.)

*Use of the ice cream butyrometer according to Koehler's method.*

Any icing or rough particles (e.g. fruit, etc.) must be removed. The ice cream is thoroughly mixed after it has reached room temperature; possible air pockets can be almost completely removed by evacuation.

10 m of sulphuric acid (density: .818 +/- 0.003 g/ml), 5 ml of ice cream, 5 ml of water, and 1 ml of amyl alcohol are introduced in turn into the ice cream butyrometer. When using a syringe, it must be rinsed several times with water before the 5 ml of water are introduced. Should the butyrometer prove to not be sufficiently full, up to 2 ml of water can be added. The butyrometer is sealed, shaken, centrifuged for 5 minutes, and, after tempering in a 65°C water bath for 5 minutes, the value is taken.

## 3.12 ... IN ICE CREAM ACC. TO ROEDER'S METH. (WEIGHING METH.)

*Use of ice cream butyrometer according to Roeder's method.*

5 g of well-mixed ice cream are weighed out into the glass beaker situated in the stopper and transferred into the butyrometer. Sulphuric acid (density: 1.522 +/- 0.005 g/ml) is poured through the upper opening of the butyrometer until it reaches just over the upper edge of the glass beaker. After sealing, the butyrometer is placed in a 70°C water bath and shaken repeatedly until the protein is completely dissolved. 1 ml of amyl alcohol is added, and then sulphuric acid is poured in until it reaches the 10 % mark on the scale. The butyrometer is sealed, shaken, and placed in the 70°C water bath for an additional 10 minutes. During this time, the butyrometer is shaken at regular intervals. This process is followed by 7 minutes of centrifuging and tempering in a 65°C water bath. The value is taken at 65°C, the fat column adjusted to the zero point. The value is read off at the lower meniscus.

## 3.13 ... IN BUTTER ACC. TO ROEDER'S METH. (WEIGHING METH.)

*Use of butter butyrometer according to Roeder's method.*

5 g of butter are weighed out into the glass beaker situated in the stopper and transferred into the butyrometer. Sulphuric acid (density: 1.522 +/- 0.005 g/ml) is poured through the upper opening of the butyrometer until it reaches just over the upper edge of the glass beaker. After sealing, the butyrometer is placed in a 70°C water bath and shaken repeatedly until the protein is completely dissolved. Sulphuric acid is poured in until it reaches the beginning of the scale, followed by 1 ml of amyl alcohol. The butyrometer is sealed, shaken, and placed in the 70°C water bath for an additional 10 minutes. This process is followed by 5 minutes of centrifuging and approximately 5 minutes of tempering in a 65°C water bath. The value is read off at 65°C at the lower mensicus.

## 3.14 ... IN MAYONNAISE ACC. TO ROEDER'S METH. (WEIGHING METH.)

*Use of butter butyrometer according to Roeder's method.*

1 g of mayonnaise is weighed out into glass beaker situated in the stopper and transferred into the butyrometer. Sulphuric acid (density: 1.522 +/- 0.005 g/ml) is poured through the upper opening of the butyrometer until it reaches just over the upper edge of the glass beaker. After sealing, the butyrometer is placed in a 70°C water bath for 30 minutes and shaken repeatedly until the protein is completely dissolved. Sulphuric acid is poured in until it reaches the beginning of the scale, followed by 1 ml of amyl alcohol. The butyrometer is sealed, shaken, and placed in the 70°C water bath for an additional 5 minutes. This process is followed by 10 minutes of centrifuging and approximately 5 minutes of tempering in a 65°C water bath. The value is read off at 65°C at the lower meniscus. The read-off value is multiplied by 5 to obtain the correct fat content.

## 3.15 BUTYROMETRIC DETERMINATION OF THE FAT CONTENT OF MEAT AND SAUSAGE ACC. TO GERBER'S METHOD (VAN GULIK)

*According to the recommended methodology of "Pohja and Associates".*

**Instruments:**

1. **Butyrometer**

   Cheese butyrometer according to Van Gulik's method
2. **Centrifuge**

   Milk centrifuge with an RCF (relative centrifugal force) of 350 g +/- 50 g
   (e.g. SuperVario-N or Nova Safety)
3. **Water bath**

   Shaking water bath with a temperature of 65°C +/- 2°C
4. **Precision scale**
5. **Appliances for sampling preparation**

   A mixer or the like is recommended for reducing or homogenising the sample.

**Chemicals:**

1. **Sulphuric acid**

   Density of (1,818 +/- 0,003) g ml-1 at 20°C, colourless or only slightly discoloured and free from any substances which might influence the outcome
2. **Amyl alcohol**

   Density of (0,811 +/- 0,003) g $ml^{-1}$ at 20°C

**Procedure:**

Firstly, the perforated glass cylinder (cheese beaker) of the cheese butyrometer is fitted into the butyrometer stopper (this stopper is fashioned with a hole). Then, exactly 2,500 g of the homogenised sample is weighed and introduced into the glass cylinder ("cheese beaker"). The cheese beaker and stopper are attached to the body of the butyrometer. 10 ml of sulphuric acid, diluted with water in a volume ratio of 1:1, is poured into the small opening on the upper end of the butyrometer. The small opening is sealed with the small compatible stopper and placed in a shaking water bath, where it is left at 65°C for approximately 30 to 40 minutes, until all proteins are dissolved. Then, 1 ml of amyl alcohol is pipetted into the butyrometer and, after renewed sealing, is shaken powerfully. Afterwards, sulphuric acid is added until the overall fluid level is at about 30% on the scale. Then the butyrometer is centrifuged for 5 minutes at 350 g. Note: the centrifuge must be loaded evenly. I.e. one butyrometer cannot be centrifuged alone – this leads to an unbalance and the risk of glass breaking. The butyrometers are then placed in the water bath to be tempered, i.e. the shaking mechanism is turned off. The reading should be taken immediately after the specimens are taken out of the water bath as the fat column diminishes significantly at very small temperature decreases, resulting in too low fat content read-off values. The butyrometers are dimensioned for samples of 3,000 g, meaning that the determined values are to be assessed at this substance amount (increase by 16.666 %).

## BUTYROMETER

The foundation of the Gerber method is the butyrometer. The original butyrometer with the rounded neck, invented by Dr. N. Gerber, was developed into the well-known flat butyrometer under the management of Paul Funke, accompanied by his glassblowers. While the original Gerber butyrometer is hardly employed anymore, the **original FUNKE-GERBER** butyrometers with the flattened scale neck are used almost exclusively. The flattened scale neck increases comfort when reading off values and improves precision.

These flat butyrometers are manufactured to standards of unmatched quality and the highest production control. Each individual butyrometer is individually gauged and correspondingly scaled. The high level of precision in setting the scale divisions and volumes guarantees exact test results.

**FUNKE-GERBER butyrometers** are precision instruments with a flattened scale section, manufactured from acid-proof glass (borosilicate) in compliance with national (DIN) and international (ISO/IDF etc.) standards. Our over 100 years of production experience and high assembly numbers enable us to offer the highest quality at low prices. You will find a multitude of different butyrometers for various tasks in the following pages of this catalogue.

In Germany and some other countries, butyrometers must be officially calibrated. These butyrometers are labelled with an engraved mark (see adjacent figure). Although all other butyrometers are not officially calibrated, they are manufactured in the same way and meet the same high quality standards.

All butyrometers come in standard packs of 10.
Please place your order in units of 10.

## Precision butyrometer

for drinking milk and vat milk, frosted rear scale wall, fault tolerance 0.025%

| | |
|---|---|
| **3150** | 0 – 4 %: 0.05 (accessory: 3280) |

## Milk butyrometer

| | |
|---|---|
| **3151** | 0 – 5 %: 0.1 (accessory: 3280) |
| **3152** | 0 – 6 %: 0.1 (accessory: 3280) |
| **3153** | 0 – 7 %: 0.1 (accessory: 3280) |
| **3154** | 0 – 8 %: 0.1 (accessory: 3280) |
| **3155** | 0 – 9 %: 0.1 (accessory: 3280) |
| **3156** | 0 – 10 %: 0.1 (accessory: 3280) |
| **3157** | 0 – 12 %: 0.1 (accessory: 3280) |
| **3158** | 0 – 16 %: 0.2 (accessory: 3280) |

## Skim milk butyrometer

according to Sichler's method, with rounded scale

| | |
|---|---|
| **3160** | 0 – 1 %: 0.01, with open bulb (accessories: 3280, 3290) |
| **3160-G** | 0 – 1 %: 0.01, with closed bulb (accessory: 3280) |

## Skim milk butyrometer

according to Kehe's method

| | |
|---|---|
| **3161** | 0 – 4 %: 0.05 (accessory: 3280) |
| **3162** | 0 – 5 %: 0.05 (accessory: 3280) |

## Skim milk butyrometer
according to Siegfeld's method

| | |
|---|---|
| **3164** | 0 – 0.5 %: 0.02 (accessory: 3280) |

## Powdered milk butyrometer
according toTeichert's method

| | |
|---|---|
| **3170** | 0 – 35 %: 0.5, (accessory: 3310) |
| **3171** | 0 – 70 %: 1.0, (accessory: 3310) |

## Ice cream and condensed milk butyrometer
according to Roeder's weighing method

| | |
|---|---|
| **3180** | 0 – 6 – 12 %: 0.1, (accessories: 3290, 3300, 3320) |
| **3181** | 0 – 15 %: 0.2, (accessories: 3290, 3300, 3320) |

## Cream butyrometer
measuring method, for ice cream

| | |
|---|---|
| **3189** | 0 – 15 %: 0.2 (accessory: 3280) |
| **3190** | 0 – 20 %: 0.2 (accessory: 3280) |

## Cream butyrometer
according to Roeder's weighing method

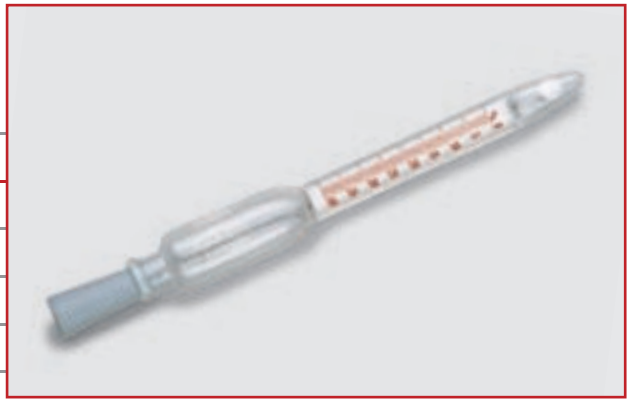
| | |
|---|---|
| **3200** | 0 – 5 – 40 %: 0.5 (accessories: 3290, 3300, 3320) |
| **3201** | 0 – 30 – 55 %: 0.5 (accessories: 3290, 3300, 3320) |
| **3202** | 0 – 50 – 75 %: 0.5 (accessories: 3290, 3300, 3320) |
| **3203** | 0 – 5 – 70 %: 1.0 (accessories: 3290, 3300, 3320) |

## Cream butyrometer
according to Schulz-Kley's weighing method
with closed bulb

| | |
|---|---|
| **3208** | 0 – 5 – 40 %: 0.5 (accessory: 3280) |

## Cream butyrometer
according to Koehler's measuring method

| | |
|---|---|
| **3209** | 0 – 30 %: 0.5 (accessory: 3280) |
| **3210** | 0 – 40 %: 0.5 (accessory: 3280) |
| **3211** | 0 – 50 %: 1.0 (accessory: 3280) |
| **3212** | 0 – 60 %: 1.0 (accessory: 3280) |
| **3213** | 0 – 70 %: 1.0 (accessory: 3280) |
| **3214** | 0 – 80 %: 1.0 (accessory: 3280) |



**Butter butyrometer**
according to Roeder's weighing method

**3220** 0 – 70 – 90 %: 0.5 (accessories: 3290, 3300, 3323)

**Cheese butyrometer**
according to Van Gulik's weighing method

**3230** 0 – 40 %: 0.5 (accessories: 3290, 3300, 3321)

**Curd butyrometer**
weighing method

**3240** 0 – 20 %: 0.2 (accessories: 3290, 3300, 3321)

**Food butyrometer**
according to Roeder's weighing method

**3250** 0 – 100 %: 1.0 (accessories: 3290, 3300, 3320)

**Free fat butyrometer**
for determining free fat content in milk and cream,

**3252** complete with screw cap, scale 0.002 g

**Babcock bottle**
without stopper

**3254** 0 – 8 % for milk, stopper on request

**Babcock bottle**
without stopper

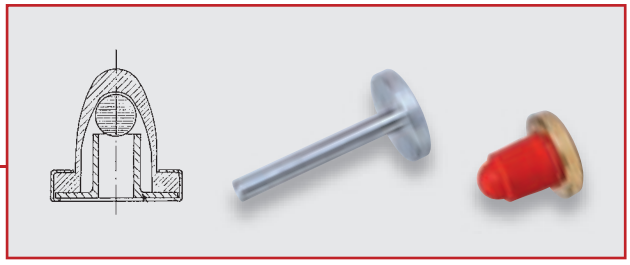
**3256** 0 – 20 % for cream (accessory: 3290)

**Babcock bottle**
without stoppper

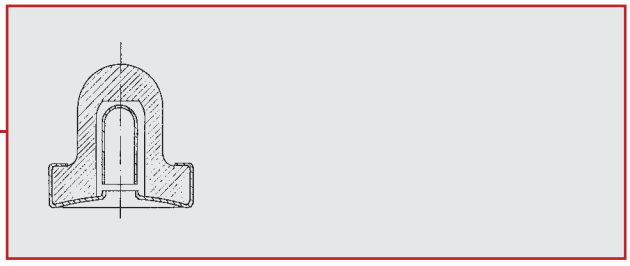
**3258** 0 – 60 % for cream and cheese (accessory: 3290)

**Patent closure FIBU**
for all measuring method butyrometers

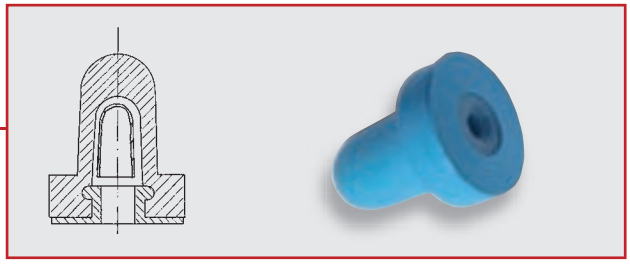
**3260** FIBU without adjustment key
(Fig. with adjustment key art. no. 3270)



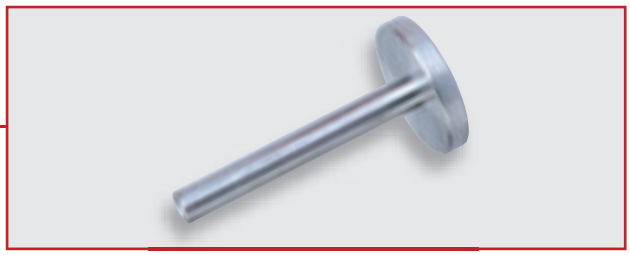
**3261** **Patent closure GERBAL**
for all measuring method butyrometers



**3262** **Patent closure NOVO**
for all measuring method butyrometers



**3270** **Adjustment key**
for patent closure FIBU



**3271** **Adjustment key**
for patent closure GERBAL

**3272** **Adjustment key**
for patent closure NOVO

**Rubber stopper, conical**
for all measuring method butyrometers

**3280** 11 x 16 x 43 mm

**Rubber stopper** for sealing the bulbs
of all weighing method butyrometers

**3290** 9 x 13 x 20 mm

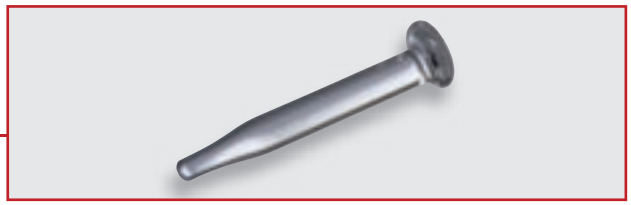
**Rubber stopper with hole**
for all weighing method butyrometers

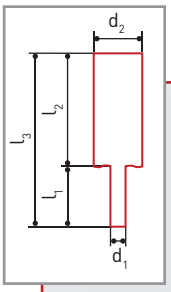
**3300** 17 x 22 x 30 mm

**Rubber stopper without hole**
for powdered milk butyrometer
(also suitable for the extraction tube acc. to Mojonnier
art. no. 3870, 3871)

**3310** 17 x 22 x 30 mm

**Glass nail**
for powdered milk butyrometer
**3315** length: 41.5 mm





**3320**

### Cream beaker, unperforated

for ice cream and condensed milk butyrometers and cream butyrometers according to Roeder's method

$l_3$ = 75 mm, $l_2$ = 49 mm, $l_1$ = 26 mm, $d_2$ = 15 mm, $d_1$ = 5 mm

**3321**

### Cheese beaker, perforated

for butyrometers according to Van Gulik's method

$l_3$ = 75 mm, $l_2$ = 49 mm, $l_1$ = 26 mm, $d_2$ = 15 mm, $d_1$ = 5 mm

**3321-001**

### Cheese beaker, perforated, short design

for butyrometers according to Van Gulik's method

$l_3$ = 66 mm, $l_2$ = 38 mm, $l_1$ = 27.8 mm, $d_2$ = 15 mm, $d_1$ = 5 mm

**3322**

### Weighing boat for butter

for butyrometers according to Roeder's method

$l_3$ = 75 mm, $l_2$ = 45 mm, $l_1$ = 30 mm, $d_2$ = 15 mm, $d_1$ = 5 mm

**3323**

### Butter beaker with 2 holes

$l_3$ = 75 mm, $l_2$ = 48 mm, $l_1$ = 27 mm, $d_2$ = 15 mm, $d_1$ = 5 mm

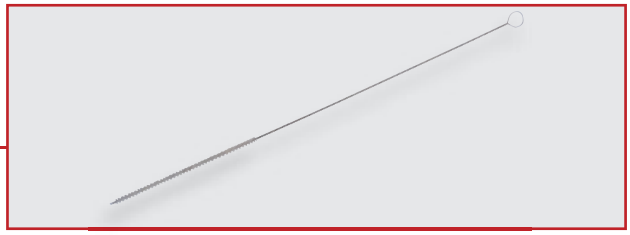
FUNKE GERBER

**Cleaning brush**
for butyrometer body

**3324** length: 270 mm

**Cleaning brush**
for butyrometer neck

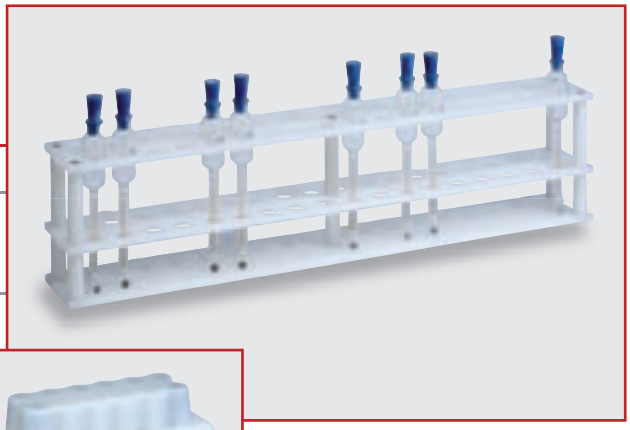
**3325** length: 278 mm



**Butyrometer stand**
(also suitable for special solubility index tubes, art. no. 3637)

**3330** for 36 samples (PP plastic)

**3331** for 12 samples (PP plastic)



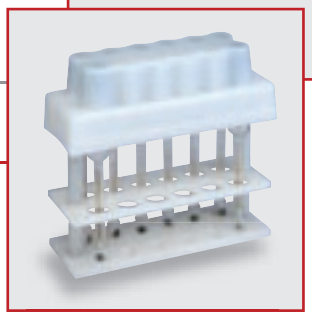
**Shaking stand**

**3332** for 12 samples (PP plastic)

**Protective shaking hood**

**3340** for 36 samples (PP plastic), compatible with art. no. 3330

**3341** for 12 samples (PP plastic) compatible with art. no. 3331



**Permanent automatic dispenser**
with ground-in measuring chamber and stopper, one spout in accordance with DIN 10282

**3390** 10 ml sulphuric acid

**3391** 1 ml amyl alcohol

**Stand for permanent automatic dispenser**
consists of stand panel, stem and retaining ring with socket

**3400** 10 ml for 1 permanent automatic dispenser

**3401** 1 ml for 1 permanent automatic dispenser

**3402** 10 ml / 1 ml for 2 permanent automatic dispensers

## Automatic tilt measure Superior
with rubber stopper and storage bottle 500 ml / 250 ml

| | |
|---|---|
| **3420** | 10 ml sulphuric acid |
| **3421** | 1 ml amyl alcohol |

## Weighing pipettes
curved

| | |
|---|---|
| **3425** | **1 ml,** d = 6 mm |
| **3426** | **2 ml,** d = 8 mm |
| **3427** | **3 ml,** d = 9 mm |
| **3428** | **5 ml,** d = 6 mm |
| **3429** | **10 ml,** d = 7 mm |

## Volumetric pipettes
with one ring mark

| | |
|---|---|
| **3430** | 10 ml sulphuric acid |
| **3431** | 10.75 ml milk |
| **3432** | 11 ml milk |
| **3433** | 1 ml amyl alcohol |
| **3434** | 5.05 ml cream |
| **3435** | 5 ml water |
| **3436** | 5 ml cream |
| **3437** | 50 ml, short design |
| **3438** | 25 ml, short design |

## Syringes
nickel-plated brass

| | |
|---|---|
| **3440** | 10.75 ml milk |
| **3441** | 10.75 ml milk, rep. exch. |
| **3442** | 5.05 ml cream |
| **3443** | 5.05 ml cream, rep. exch. |
| **3450** | 11 ml milk |
| **3452** | 5 ml cream |

## Pipette stand
**3460** PVC, for pipettes of various sizes

## Cleaning brush
for pipettes

**3470** length: 470 mm

**3480** **Safety goggles**

# LactoStar

(article no. 3510)

## Chemical milk analysis device with fully automatic cleaning and rinsing system and zero point calibration for the fast and accurate testing of milk

Countless installations in institutes and laboratories all over the world attest to the outstanding quality, reliability and accuracy of this chemical analysis device.

The following parameters can be determined quickly and reliably with just one measurement:

| Contents | Measuring range | Reproducibility (r) |
|---|---|---|
| Fat: | 0.00 % to 40.00 % | ± 0.02 %* |
| Protein: | 0.00 % to 10.00 % | ± 0.03 % |
| Lactose: | 0.00 % to 10.00 % | ± 0.03 % |
| SNF:(fat free dry matter) | 0.00 % to 15.00 % | ± 0.04 % |
| Minerals/conductance | 0.01 % to 5.00 % | ± 0.02 % |

* *The reproducibility equals +0.02 % in the 0% to 8 % fat range.*
*In the higher ranges of 8 % to 40 % fat, the reproducibility equals 0.2 %*

The measurement resolution is 0.01 %.
The accuracy depends on the respective calibration.

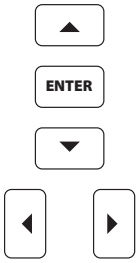
Further parameters are determined based on calculational algorithms:

- Density (calculated value)
- Freezing point (calculated value)

The software is continually improved with the aim of obtaining additional interesting parameters. The updates are quickly and easily transmitted over the interfaces. In this way, the instrument is kept up-to-date over a long period of time.

### High matrix tolerance

The device is characterised by a high matrix tolerance which it owes to the multi-sensor measurements systems used. This means different kinds of milk can be measured with the same calibration (product profile).




### Operation

The operation is clear and simple.
5-key menu-driven handling: 4 arrow keys and one "enter" key.
By pressing the "enter" key, the function or action, which has been selected with the help of the arrow keys, is started.

# LactoStar

## Language selection

You can select your preferred language from a number of menu languages. Currently, German, English, French, Spanish, among others, are available. The number of languages is continuously being expanded with help from our partners in different countries. The language is selected in the same way as with the previous settings.

## Calibration

For customer-specific calibration, the already existing basic calibrations are merely adjusted. This is done with a simple two point calibration (A calibration and B calibration). Each parameter is calibrated in only one step. A clear calibration menu simplifies the entry of reference values. Up to 20 different calibration data sets can be saved. Therefore, you can switch from one product to another (e.g. from milk to cream) without having to re-calibrate.

## Automatic maintenance

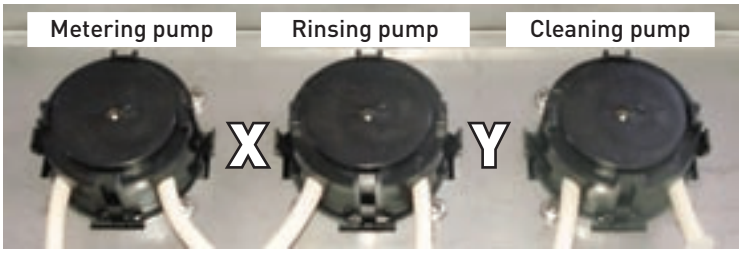
The instrument has three pumps, namely the measuring pump, the rinsing pump, and the cleaning pump, all of which are connected to the corresponding canisters.

Up to five different times can be entered for various maintenance activities: rinsing, cleaning, and zero point calibration. Thus routine tasks are completed automatically.

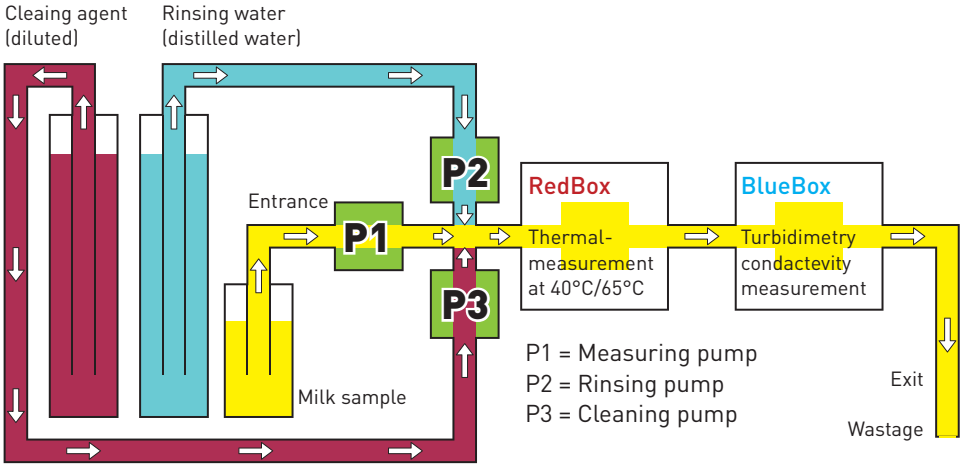
## Replacing the pump heads

The pumps are located under the stainless steel cover sheet on the left side of the instrument. The pump heads can be replaced easily without the use of tools.

The old pump heads can be pulled off by pushing in on both tabs (see Fig, "X" and "Y") simultaneously. The new pump heads are set on the motor axis and pressed down on until both tabs snap into place.



## Principle design




### Technical specifications:

| | |
|---|---|
| Sample capacity: | up to 90/h |
| Sample volume: | from 12 ml to 20 ml |
| Interfaces: | 1 x parallel, 1 x serial (RS 232 / 9.600 baud), USB<br>6 volt electrical power supply for thermal printer (order no. 7151) |
| Connection values: | 230V / 115V AC (50...60 Hz) 180 W |
| Dimensions: | 43 x 20 x 43 cm (B x H x T) |
| Weight: | approx. 15.7 kg (net) |

### Ordering data

| Article no. | Description |
|---|---|
| **3510** | LactoStar |
| **7151 *** | Thermal printer, incl. 1 thermal paper roll |
| **3511 *** | Each canister 5 L, for rinsing water and cleaning agent |
| **3516 *** | Hardware standardisation, 250 ml |
| **3563 *** | Cleaning agent, 500 ml |

*(articles marked with * are included in the 3510 scope of delivery)*

### Accessories (optional)

| | |
|---|---|
| **3040** | Milk sample bottle without metal bottom, 80 ml / PE |
| **3041** | Milk sample bottle with metal bottom, 50 ml / PP |
| **7157** | Thermal paper roll for thermal printer |

### Spare and wear parts

| | |
|---|---|
| **3510-023** | Hose pump, complete |
| **3510-023 A** | Pump head (attachment for hose pump) |

# LactoFlash

(article no. 3530)

## Inexpensive chemical analysis device for the fast and accurate determination of fat and SNF content

Countless installations in institutes and laboratories all over the world attest to the outstanding quality, reliability and accuracy of this chemical analysis device.

The following parameters can be determined quickly and reliably with just one measurement:

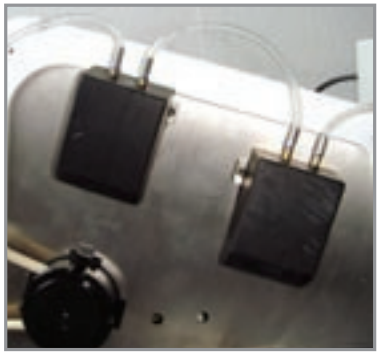
| Parameter | Resolution | Reproducibility (r) | Measuring range |
|---|---|---|---|
| Fat: | 0.01 % | 0.02 % in 0 ... 5 % range<br>0.2 % in 5 ... 30 % range | 0 ... 30 % |
| SNF: | 0.01 % | 0.04 % | 0 ...15 % |

Further parameters are determined based on calculational algorithms:

| Parameter | Resolution | Reproducibility (r) | Measuring range |
|---|---|---|---|
| Density: | 0.0001 | 0.001 | no limit |
| Protein: | 0.01 % | 0.03 % | no limit / calculated value |
| Lactose: | 0.01 % | 0.02 % | no limit / calculated value |
| Gpp: | 0.001°C | 0.002°C | no limit / calculated value |

**Quick and easy replacement of pump heads and measuring cells.**

The pump head (wear part) can be replaced easily without the use of tools. This is done by removing the blue side cover sheet and pulling off the old pump head by pushing in on both side tabs simultaneously. The new pump head is set on and pressed down on until both tabs snap into place.



If one of the two measuring cells has to be replaced, it can simply be pulled out of the plug connection. The new measuring cell is plugged in.

# LactoFlash

## Operation

The instrument has 4 arrow keys and an "enter" key. With the "enter" key, the function or action, which has been selected with the help of the arrow keys, is started.

## Language selection

Two menu languages are available: German and English.

## Calibration

For customer-specific calibration, the already existing basic calibrations are merely adjusted. This is done with a simple two point calibration (A calibration and B calibration). Each parameter is calibrated in only one step. A clear calibration menu simplifies the entry of reference values.

## Technical specifications:

| | |
|---|---|
| Sample capacity: | up to 120/h |
| Sample volume: | from 12 ml to 20 ml |
| Interfaces: | 1 x parallel, 1 x serial (RS 232 / 9.600 baud) |
| | 6 volt electrical power supply for thermal printer (order no. 7151) |
| Connection values: | 230V / 115V AC (50..60 Hz) 60 W |
| Dimensions: | 30 x 24 x 33 cm (w x h x d) |
| Weight: | 5 kg (net) |

## Ordering data

| Article no. | Description |
|---|---|
| **3530** | LactoFlash |
| **7151** | Thermal printer, incl. 1 thermal paper roll |
| **3516** | Hardware standardisation |
| **3563** | Cleaning agent, 500 ml |

## Accessories (optional)

| | |
|---|---|
| **3040** | Milk sample bottle without metal bottom, 80 ml / PE |
| **3041** | Milk sample bottle with metal bottom, 50 ml / PP |
| **7157** | Thermal paper roll for thermal printer |

## Spare and wear parts

| | |
|---|---|
| **3530-023** | Hose pump, complete |
| **3530-023 A** | Pump head (attachment for hose pump) |

## LactoStar

newly developed instrument
for the routine testing of milk
fat, protein, lactose, SNF, freezing point

see p. 36 for a more detailed description

**3510** accessories included

**Accessories:**

| | |
|---|---|
| Thermal printer | art. no. 7151 |
| Canister | art. no. 3511 |
| Hardware standardisation | art. no. 3516 |
| Cleaning agent | art. no. 3563 |

**Replacement parts:**

3510-023 Hose pump, complete
3510-023A Attachment for hose pump

## Canister

space saving design, 5 L

**3511** 334 x 64 x 334 mm (w x d x h)

## Hardware standardisation,

for art. no. 3510, 3530

**3516** 250 ml

## REFERENCE MATERIAL

**3517** **Reference milk, 1.5 % fat class**
*The exact values depend on the batch.*
*They are included in the delivery.*

**3518** **Reference milk, 3.5 % fat class**
*The exact values depend on the batch.*
*They are included in the delivery.*

**3519** **Reference cream, 30 % fat class**
*The exact values depend on the batch.*
*They are included in the delivery.*

**3521** **Reference milk, 0.1 % fat class**
*The exact values depend on the batch.*
*They are included in the delivery.*

**3530** **LactoFlash**
Chemical analysis device for the fast
and accurate determination of fat and SNF content.
accessories included

**Accessories:**

| | |
|---|---|
| Thermal printer: | art. no. 7151 |
| Hardware standarisation | art. no. 3516 |
| Cleaning agent | art. no. 3563 |

**Replacement parts:**

| | |
|---|---|
| 3530-023 | Hose pump, complete |
| 3530-023A | Attachment for hose pump |

**3550** **Shaking water bath**
stainless steel with cover,
shaking stand and 18 tubes

**Technical specifications:**
PID controller with PT-100 temperature sensor

| | |
|---|---|
| Setting: | in 0.1°C increments |
| Accuracy: | +/– 0.1°C |
| Connection values: | 230 V / 8.7 A, 2000 W |
| Volume: | 22 L |
| Internal dimesions: | 350 x 290 x 220 mm |
| External dimensions: | 578 x 436 x 296 mm |
| Weight: | approx. 17 kg net |

## Butyrometer bucket

pressure cast light metal
accessory for SuperVario-N centrifuge
(art. no. 3680 p. 48)

| | |
|---|---|
| **3631** | 1 bucket |
| **3631-12** | set with 12 buckets |
| **3631-24** | set with 24 buckets |
| **3631-36** | set with 36 buckets |

## Babcock bucket

accessory for SuperVario-N centrifuge
**3632** (art. no. 3680)

## Bucket for ADPI tubes

**3633** accessory for SuperVario-N centrifuge (art. no. 3680)

## Solubility index tube

ADPI, 50 ml, graduated from 0 – 20 ml,
mark at 50 ml
**3634** see SuperVario-N (art. no. 3680)

## Stand

**3636** for 6 tubes (art. no. 3634)

## Special solubility index tubes

for determining the solubility of powdered milk
fit in butyrometer tube (art. no. 3641)
for use in the Nova Safety bench centrifuge
(art. no. 3670)

for compatible rubber stoppers, see art. no. 3050
**3637** for compatible stand, see art. no. 3331

## Centrifuge tube

**3638** with 2 stoppers according to Friese's method

## Homogenisation pipette

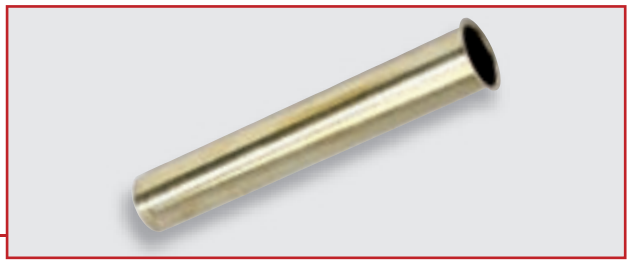
with a mark at 5 ml and 25 ml, incl. stopper

external diameter: 24 mm
**3639** length without stopper: 152 mm

## Replacement butyrometer tube

for Nova Safety art. no. 3670

brass, with flanged edge
external diameter: 27 mm
internal diameter: 25.8 mm
**3641** length: 170 mm



## Nova Safety centrifuge

Thousands of these centrifuges have been installed in laboratories all over the world. They are characterized by extreme robustness and reliability. This table centrifuge with the angular rotor can be used for the determination of fat content according to Dr. N. Gerber's method as well as for the determination of the solubility of powdered milk.

**Properties:**
Automatic interlocking lid
Automatic brake (braking time < 8 s)
Centrifugation timer (digital)
Heater, thermostatic set point at 65°C
Capacity: max. 8 butyrometer

**Technical specifications:**
RCF: 350 g +/- 50 g
rpm: 350 U/min
Effective radius: 160 mm
Weight: 13 kg
**3670** Dimensions (l x w x h): 470 x 380 x 230 mm

# SuperVario-N

## MULTIPURPOSE CENTRIFUGE FOR THE DAIRY LABORATORY

This centrifuge stands out due to its exceptional engine smoothness. That it is largely free of vibration and has swing out butyrometer buckets positively effects the lifetime of your butyrometers. Correspondingly, good results (reproducibility and comparability) are assured. For these reasons, the SuperVario-N is often used as a reference centrifuge for calibration purposes. Due to its versatility, the SuperVario-N is widely accepted in dairy laboratories. High versatility means free programmability of rpm, temperature and time ("free mode") as well as 4 set programs for the following tests:

Dr. N. Gerber's method (determination of fat content)
Roese-Gottlieb's method (determination of fat content, reference method)*
Babcock's method (determination of fat content)
Solubility (determination of the solubility of powdered milk)

* Operation only possible under observation of respective safety regulations

**Properties:**

- Stainless steel housing
- Programmable rotor speed from 600 to 1130 rpm
  in increments of 10 rpm
  (corresponds to a g-value of 77 to 372 g)
- Programmable heater up to 68°C in 1°C increments
- Programmable centrifugation time from 1 to 99 minutes
- Automatic interlocking safety lid
- Automatic shut down in case of unbalance
- Automatic brake

**Technical specifications:**

| | |
|---|---|
| Connection values: | 230 V/50 ... 60 Hz/1200 VA |
| Weight, empty: | 26 kg |
| Total height with lid: | 460 mm |
| Filling height: | 370 mm |
| Rotor speed range: | 600 to1130 rpm** |
| Temperature range: | room temperature up to 68°C |

** For the determination of fat content due to Gerber's method, a g-value of 350 g ± 50 g is required. With a **r**elative **c**entrifugal **f**orce **(RCF)** of 365 g in its unloaded state (idle running) and 340 g in its fully loaded state, the SuperVario-N fulfils the standard specifications in an exemplary manner.

# MILK LABORATORY CENTRIFUGES

**Centrifuges for butyrometric determination of fat content according to Dr. N. Gerber**

*K. Schaefer, graduate engineer, reports*

## QUIET OPERATION

In order to avoid glass breakage and to increase butyrometer lifetime, it is very important that the centrifuge operates with the lowest level of vibration possible. The different types of centrifuges are:

### TYPE 1: Centrifuge with flat-lying butyrometers

This way of loading butyrometers guarantees that they will be gently treated during centrifugation. However, this type of centrifuge tends to lead to a renewed intermixing of the separated phases after the centrifugal process.

### TYPE 2: Centrifuge with angular rotor

The butyrometers are held in the angular rotor at a fixed angle. Unfortunately, this causes the long, thin butyrometer necks considerable stress. This design is predominately found in small, inexpensive centrifuges.

### TYPE 3: Centrifuge with swing-out butyrometer holders

The butyrometers swing out horizontally in mounted movable holders. The butyrometers are only stressed along their vertical axis. For this reason, this type of centrifuge is preferable.

These special centrifuges differ from other laboratory centrifuges in several ways. The following points should be taken into consideration when purchasing and using centrifuges for the determination of fat content according to Dr. N. Gerber's method:

## UNBALANCE

The centrifuge should be equipped with an unbalance shut-down mechanism. In case of glass breakage (butyrometer breakage) or other types of unbalance, the centrifuge shuts itself off automatically.

## INTERLOCKING LID

For safety purposes, more and more centrifuges are being equipped with an interlocking lid.

## HEATING

Heating a centrifuge reduces butyrometer cooling. This means that the subsequent tempering time in the water bath can be kept to a minimum and leads to a more reliable realization of the analysis. The temperature in the centrifuge tank should be at least 50°C.

## SET-UP

The centrifuge must be set up on a flat, secure surface (e.g. a stable tabletop or platform). The lowest possible humidity and a room temperature of less than 30°C are preferable.

## ROUTINE OPERATION/MAINTENANCE

The centrifuge should be loaded in such a way that it is as balanced as possible, i.e. the butyrometers must always be evenly positioned. In case of glass breakage, the centrifuge should be cleaned immediately after standstill is reached. This prevents unnecessary corrosion and guarantees a long lifetime.

## RPM

The determination of fat content according to Gerber's method specifies a **"RCF"** (**r**elative **c**entrifugal **f**orce) or 350 g with a maximum variation of ± 50 g. The RCF does not only depend on the rpm but also on the effective radius. The effective radius is defined as the distance between the rotor and the outer end of the butyrometer. For this reason, the rpm of different centrifuge types varies as a function of their respective radii. What is important is that the rpm is constant or only changes negligibly (within the range of tolerance, see above), depending on whether the centrifuge is fully or only partially loaded.

The **RCF** is calculated in the following way:

$$RCF = 1{,}12 \times 10^{-6} \times R \times N^2$$

$$N = \sqrt{\frac{RCF}{1{,}12 \times 10^{-6} \times R}}$$

*whereby:*
*R = effective horizontal radius in mm;*
*N = revolutions per minute [min$^{-1}$].*

### SYNOPTICAL TABLE OF THE DEPENDENCE OF G-FORCE AND RPM

| rpm (min $^{-1}$) | Head A (ø=52 cm) g force | Head B (ø=38 cm) g force | Head C (ø=38 cm) g force |
|---|---|---|---|
| 600 | 104.8 g | 76.6 g | 76.6 g |
| 610 | 108.4 g | 79.2 g | 79.2 g |
| 620 | 111.9 g | 81.8 g | 81.8 g |
| 630 | 115.6 g | 84.5 g | 84.5 g |
| 640 | 119.3 g | 87.2 g | 87.2 g |
| 650 | 123.0 g | 89.9 g | 89.9 g |
| 660 | 126.8 g | 92.7 g | 92.7 g |
| 670 | 130.7 g | 95.5 g | 95.5 g |
| 680 | 134.7 g | 98.4 g | 98.4 g |
| 690 | 138.6 g | 101.3 g | 101.3 g |
| 700 | 142.7 g | 104.3 g | 104.3 g |
| 710 | 146.8 g | 107.3 g | 107.3 g |
| 720 | 151.0 g | 110.3 g | 110.3 g |
| 730 | 155.2 g | 113.4 g | 113.4 g |
| 740 | 159.5 g | 116.5 g | 116.5 g |
| 750 | 163.8 g | 119.7 g | 119.7 g |
| 760 | 168.2 g | 122.9 g | 122.9 g |
| 770 | 172.7 g | 126.2 g | 126.2 g |
| 780 | 177.2 g | 129.5 g | 129.5 g |
| 790 | 181.7 g | 132.8 g | 132.8 g |
| 800 | 186.4 g | 136.2 g | 136.2 g |
| 810 | 191.1 g | 139.6 g | 139.6 g |
| 820 | 195.8 g | 143.1 g | 143.1 g |
| 830 | 200.6 g | 146.6 g | 146.6 g |
| 840 | 205.5 g | 150.2 g | 150.2 g |
| 850 | 210.4 g | 153.7 g | 153.7 g |
| 860 | 215.4 g | 157.4 g | 157.4 g |
| 870 | 220.4 g | 161.1 g | 161.1 g |
| 880 | 225.5 g | 164.8 g | 164.8 g |
| 890 | 230.7 g | 168.6 g | 168.6 g |
| 900 | 235.9 g | 172.4 g | 172.4 g |

| Drehzahl (min $^{-1}$) | Head A (ø=52 cm) g force | Head B (ø=38 cm) g force | Head C (ø=38 cm) g force |
|---|---|---|---|
| 910 | 241.1 g | 176.2 g | 176.2 g |
| 920 | 246.5 g | 180.1 g | 180.1 g |
| 930 | 251.9 g | 184.1 g | 184.1 g |
| 940 | 257.3 g | 188.0 g | 188.0 g |
| 950 | 262.8 g | 192.1 g | 192.1 g |
| 960 | 268.4 g | 196.1 g | 196.1 g |
| 970 | 274.0 g | 200.2 g | 200.2 g |
| 980 | 279.7 g | 204.4 g | 204.4 g |
| 990 | 285.4 g | 208.6 g | 208.6 g |
| 1000 | 291.2 g | 212.8 g | 212.8 g |
| 1010 | 297.1 g | 217.1 g | 217.1 g |
| 1020 | 303.0 g | 221.4 g | 221.4 g |
| 1030 | 308.9 g | 225.8 g | 225.8 g |
| 1040 | 315.0 g | 230.2 g | 230.2 g |
| 1050 | 321.0 g | 234.6 g | 234.6 g |
| 1060 | 327.2 g | 239.1 g | 239.1 g |
| 1070 | 333.4 g | 243.6 g | 243.6 g |
| 1080 | 339.7 g | 248.2 g | 248.2 g |
| 1090 | 346.0 g | 252.8 g | 252.8 g |
| 1100 | 352.4 g | 257.5 g | 257.5 g |
| 1110 | 358.8 g | 262.2 g | 262.2 g |
| 1120 | 365.3 g | 266.9 g | 266.9 g |
| 1130 | 371.8 g | 271.7 g | 271.7 g |
| 1140 | 378.4 g | 276.6 g | 276.6 g |
| 1150 | 385.1 g | 281.4 g | 281.4 g |
| 1160 | 391.8 g | 286.3 g | 286.3 g |
| 1170 | 398.6 g | 291.3 g | 291.3 g |
| 1180 | 405.5 g | 296.3 g | 296.3 g |
| 1190 | 412.4 g | 301.3 g | 301.3 g |
| 1200 | 419.3 g | 306.4 g | 306.4 g |
| | | | |

**Example:**
A centrifuge with an effective radius of 260 mm necessitates an rpm of 1100 in order to reach the required RCF of 350 g.

**3680-L**

## Safety centrifuge for fat content determination

according to Roese-Gottlieb's method

**3680**

## SuperVario-N

multi-purpose centrifuge for all butyrometers
see p. 48 for more details

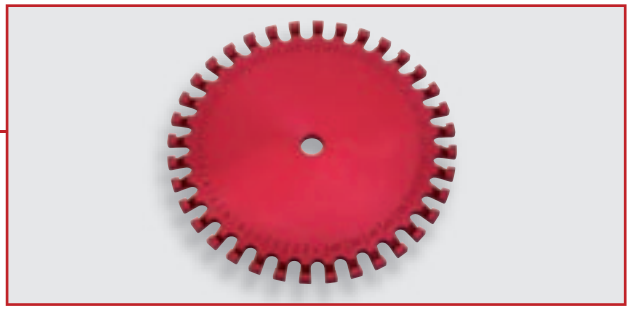
**Accessories for SuperVario-N**

**3685**

## Head A

centrifuge head for a maximum
of 36 butyrometer buckets or 18 Babcock buckets
Radius of head A: 260 mm

**Accessories:**
Butyrometer bucket: art. no. 3631, p. 46
Babcock bucket: art. no. 3632, p. 46



**3686**

## Head B

centrifuge head (protective tank)
for a maximum of 8 Mojonnier tubes
Radius of head B: 190 mm

**Accessory:**
Mojonnier tubes: art. no. 3870, 3871, p. 55

**3687**

## Head C

centrifuge head
for a maximum of 6 buckets for solubility index tubes
Radius of head C: 190 mm

**Accessories:**
Bucket for solubility index tubes: art. no. 3633, p. 46
Solubility index tube (ADPI glass): art. no. 3634, p. 46

## **WB-436 D universal water bath** (digital)

digital temperature display (actual value)
digital set-point temperature control
PT 100 sensor (platinum sensor)
stop watch (1 to 99 min. with acoustic signal)

stainless steel inner and outer casing
*external heating: heating elements are located separately in the casing*
*protection against overheating (even when tank is empty)*
*use with distilled water preferable*

**Technical specifications:**

| | |
|---|---|
| Temperature range: | up to 100°C |
| Connection values: | 230 V / 50 Hz ... 60 Hz / 1000 W |
| Dimensions (l x w x h): | 396 mm x 331 mm x 265 mm |
| Volume: | 16 l |
| Weight: | 10 kg |

**3707** without butyrometer stand (art. no. 3717)

## **WB 436-A universal water bath** (analogue)

Like art. no. 3707 but with analogue temperature control (adjusting knob), temperature display with thermometer (included in the scope of delivery), thermostatic heat controller

Stainless steel inner and outer casing
*External heating: heating elements are located separately in the casing*
*Protection against overheating (even when tank is empty)*
*Use with distilled water preferable*

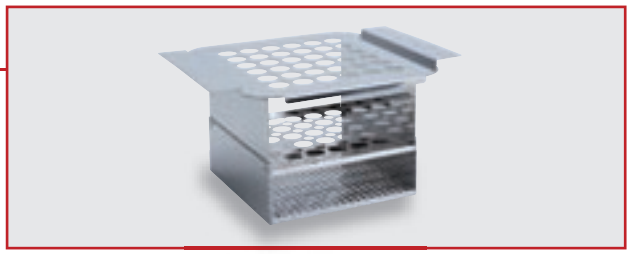
**Technical specifications:**

| | |
|---|---|
| Temperature range: | up to 100°C |
| Connection values: | 230 V / 50 Hz ... 60 Hz / 1000 W |
| Dimensions (l x w x h): | 396 mm x 331 mm x 265 mm |
| Volume: | aprox. 16 l |
| Weight: | 10 kg |

**3708** without butyrometer stand (art. no. 3717)

## Accessories for water baths WB 436 (art. no. 3707, 3708)

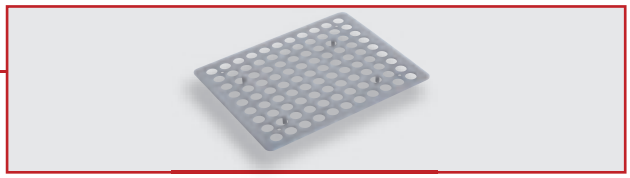
**3717** Butyrometer stand for WB-436
stainless steel, for 36 butyrometers



**3718** Mojonnier stand
stainless steel

for 10 Mojonnier tubes

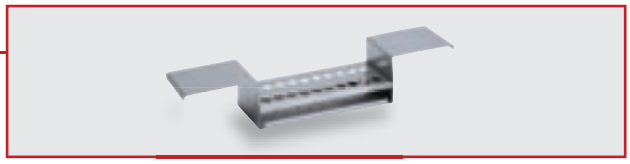
**3727** Universal shelf
stainless steel



**3737** Reductase insert
for 99 samples

**3747** Lid for Reductase test

**3754** "Delvo-Test" insert



**3766-G** **Butyrometer tubes,** closed
brass, for butyrometer stand (art. no. 3717)

**3766-O** **Butyrometer tubes,** open (for art. no. 3707, 3708)
brass, for butyrometer stand (art. no. 3717)

FUNKE GERBER

**Safety reading lamp**
for safely and precisely
reading of butyrometers

anti-glare illumination, lens with protective Plexiglass cover,
adjustable height and lens distance, cord-operated switch

**3800** 230 V / 50 ... 60 Hz

**Shaking machine**
for extraction tubes according to Mojonnier's method

for forceful, uniform and reproducible mixing,
230 V / 50 ... 60 Hz

**3850** for 4 Mojonnier tubes

**3851** for 6 Mojonnier tubes

**Shaking machine**
for 36 butyrometers with stand

**3852** 230 V / 15 Watt, 915 x 270 x 300 mm (l x w x h)

**3870** **Extraction tube** with rounded bulb
acc. to Mojonnier's meth. with cork stopper (art. no. 3872)
suitable rubber stopper (art. no. 3310)

**3871** **Extraction tube** flattened bulb
acc. to Mojonnier's meth., with cork stopper (art. no. 3872)
suitable rubber stopper (art. no. 3310)

**3872** **Cork stopper for extraction tube**
according to Mojonnier's method (art. no. 3870, 3871)

**3875** **Wooden stand**
for 12 extractions tubes according to Mojonnier's method

# KJELDAHL'S NITROGEN DETERMINATION METHOD

*Anna Politis, graduate engineer of nutrition technology and of biotechnology, reports*

For more than 120 years, Kjeldahl's nitrogen determination method has been an internationally accepted standard. In 1883, chemist Johan Kjeldahl developed this method for the quantitative determination of nitrogen. In the dairy industry, Kjeldahl's nitrogen determination method is used to determine protein content. The process is applied in accordance with ISO, DIN 8968-2/8968-3. To calculate the protein content, the nitrogen value obtained is multiplied by the product-specific factor for milk and dairy products, **6.38**. Nowadays, the entire determination can be automatised, even with multiple samples.

## KJELDAHL'S NITROGEN DETERMINATION METHOD

### 1. Principle

The sample is solubilised with concentrated sulphuric acid and potassium sulphate in the presence of the catalyst copper sulphate. This causes the nitrogen bonded in the organic compounds to convert into the inorganic compound ammonium sulphate. Boiling the solution with sodium hydroxid releases ammonia from the ammonium sulphate. This is then led together with water vapour through a distillation apparatus. An ammonia-water solution results, which is introduced into a exactly defined amount of boric acid solution. By acidimetric titration, the amount of bonded boric acid and the nitrogen content is determined. Then protein content of the sample can be calculated with the help of the protein specific conversion factor.

### 2. Chemicals needed

2.1 Potassium sulphate ($K_2SO_4$) with a low nitrogen content.

2.2 Copper sulphate solution ($CuSO_4.5H_2O$): 5.0 g copper sulphate pentahydrate are dissolved and stirred into 100 ml of water.

2.3 Sulphuric acid: with 98 % by weight, nitrogen free, $\rho 20(H_2SO_4)$~1,84 g/ml

2.4 Sodium hydroxid: with a low nitrogen content and a percent by weight of 30 g of sodium hydroxide per 100 g.

2.5 Indicator solution: 0.1 g of methyl red is dissolved into 95 % ethanol and diluted to 50 ml with ethanol. 0.5 g of bromcresol green are dissolved into 95 % ethanol. One part methyl red solution is mixed with five parts bromcresol green.

2.6 Boric acid solution ($H_3BO_3$): 40.0 g of boric acid are dissolved in one litre of hot water. The solution is cooled and the volume is adjusted to one litre. 3 ml of indicator solution (2.5) are added and the solution is stirred and stored in a borosilicate glass bottle (the solution is light yellow). The solution must be kept away from light and ammonia vapour during storage.

2.7 Hydrochloric acid: the concentration must be 0.1±0.0005 mol/L.

2.8 Ammonium sulphate [ $(NH_4)_2SO_4$)]. Before use, the ammonium sulphate must be dried for at least two hours at 102 ±2°C and cooled in a dehydrator to room temperature. The purity of the dried substance must equal 99.9 %.

2.9 Water: distilled or fully desalinized water or water of equivalent purity.

2.10 Sucrose: with a nitrogen content of less than 0.002 %.

2.11 Tryptophan or lysine hydrochloride with a purity of at least 99 %.

## 3. Equipment and appliances

3.1 Laboratory scale: suited for weighing increments of 0.1 mg.
3.2 Boiling stones: grain size 10; (boiling stones not for reuse).
3.3 Water bath, adjustable to (38±1)°C, suited for tempering milk and dairy products.
3.4 Digestion apparatus (art. no. 4200) consisting of a metal block, equipped with a heater and temperature regulator, and an emissions collector (supply voltage 230 V, temperature range up to 450°C).
3.5 Extraction apparatus with suction system (Behrosog 3, art. no. 4203): this neutralises dangerous vapours.
3.6 Distillation apparatus suitable for connecting to the 250 $cm^3$ digestion flask (art. no. 4210).
3.7 Titrator: an automatic titrator or a burette with a nominal volume of 50 ml and a scale division calibre of at least 0.1 ml in accordance with ISO 385, class A (art. no. 4220).
3.8 Digestion flask with a nominal volume of 250 $cm^3$
3.9 Pipette: suited for dispensing 1 ml of copper sulphate solution (2.2).
3.10 Erlenmeyer flask, nominal volume of 500 ml.

## 4. Preparation

The milk sample is heated to 38±1°C in a water bath, stirred gently, and then cooled to room temperature. (5± 0,1) g are weighed out to exactly 0.1 g into a digestion flask.

## 5. Procedure

**1** **Digestion**
Total solubilization time: 1.75-2.5 hours. **Note: must be executed under a flue.**

$$\text{Proteins} + H_2SO_4 + K_2SO_4 + CuSO_4 \rightarrow (NH_4)_2SO_4$$

12 g of potassium sulphate, 1 ml of copper sulphate solution (2.2), about (5± 0,1 g) of the heated and mixed milk sample and 20 ml of sulphuric acid are introduced into a digestion flask (the exact amount of milk must be determined to ± 0.1 mg and recorded because it will later be the basis for the nitrogen calculation. See "calculation"). The digestion flask is mixed carefully.

A suitable temperature program is selected on the digestion device, and then the digestion flask is set on the heating block. A glass emissions collector is carefully fixed onto every digestion flask. The entire apparatus is connected to a second apparatus (Behrosog 3, art. no. 4203) by a hose which can neutralise dangerous vapours. Selecting the following temperature program is recommended:

1) Preheat the heating block at 200°C for 10 min.
2) Heat the sample to 200°C for approx. 30 min.
3) Continue at 420°C for approx. 90 min for digestion (at a capacity of 10°C/min).

The digestion time is to be adjusted so that the maximum nitrogen contents are obtained. Too short or too long digestion times can lead to low values.

After digestion, the samples are removed from the heating block and cooled at room temperature for 25 minutes. Afterwards, they are put into the distillation apparatus.

- *The addition of potassium sulphate serves to increase the boiling temperature of the sulphuric acid and the addition of copper sulphate serves as an oxidation catalyst. They are also available as Kjeldahl tabs (art. no. 4230/4231). If the process is executed with tabs, then 5± 0.1 g of milk are mixed with 20 ml of sulphuric acid and 2 Kjeldahl tabs and left to sit for 5 min. Then the temperature program can be carried out.*
- *During the heating of the sample, foam is not allowed to climb higher then 4 - 5 cm below the flask opening.*
- *The sulphuric acid is added in such a way that any copper sulphate solution, potassium sulphate or milk which may have adhered to the flask neck is flushed down. If the flask is sealed airtight, it can also be stored for later digestion.*
- *To determine the specific digestion time, it is advisable to execute preliminary tests with samples high in protein and fat.*
- *Substantial crystallisation is a sign of too little sulphuric acid and can lead to low protein values. It is therefore advisable to reduce the loss of sulphuric acid by minimising the amount sucked.*
- *Before the hot digestion flasks can be taken from the digestion block, it must be ensured that no condensed fluid has collected in the extraction apparatus. If it has, the suction volume must be increased and the condensed liquid removed.*
- *The undiluted digestion should not be stored in the flask for a long period of time (overnight) for any reason. There is a risk that the sample will solidify and it is difficult to bring it into solution form again. After the sample is cooled down and diluted with 70 ml of water, there is no problem to keep it overnight.*

**2**

**Distillation**
Total distillation time: 5-7 min

Ammonia release $(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2\ NH_4OH$
Ammonia absorption $NH_4OH + H_3BO_3 \rightarrow H_2O + NH_4H_2BO_3$

Do not touch any parts of the distillation apparatus either during a distillation or for a while after.

They could be hot.

The amount of water and sodium hydroxid, the reaction time, the distillation time, the heat output of the vapour generator and the suction time for the remains distilled out of sample are programmable. With the push of a button, the desired menu is found and by pushing the button again it is selected. Another push changes the value and a final push saves it.

The distillation apparatus must be degassed if it has not been used for a long time or if it is being used for the first time. To do this, "options", and then "direct input" are selected. Then, "$H_2O$ in sample" is selected and the knob is held down until water runs into the digestion apparatus. Next, "NaOH" is chosen and the button is pushed down until soda lye runs into the digestion vessel. Finally, the menu "extractionPro" is selected by pushing "next" and the operating knob is pushed down until the chemicals are sucked from the digestion vessel. The aeration process is now finished.

A trial run without a sample must be executed daily before beginning the distillation process. To do this, a discharge hose is introduced into an empty digestion vessel, the main menu "options" and then "direct input" are selected. Then, "vapour" is chosen. By quickly pushing the operating button again, the vapour discharge is begun. Renewed pushing of the button ends the process. The process should not be ended until there is 1 cm of distillate in the Erlenmeyer flask. Finally, "extractionPro" is selected and the operating button is pushed down until the water is extracted from the digestion vessel.

After degasing and the test run, the distillation of the sample is carried out. A 500 ml Erlenmeyer flask for the boric acid solution is placed under the distillation apparatus outlet pipe. With the "start" menu option, the distillation process is begun. It is recommendable to run the following distillation program:

Bidest water: 70 ml (5 sec)
NaOH: 70 ml of a 30 % solutin (7 sec)
Distillation time: 5 min
Vapour capacity: 90 %
Sample suction: 30 sec.
Boric acid addition: 50 ml (4 sec)

The vapour distillation is begun and the ammonia, released through the addition of sodium hydroxid, is distilled with vapour. The distillate is absorbed in the boric acid solution (2.6). After the distillation program terminates, the digestion flask is removed from the apparatus, the distillation hose is flushed with distilled water and the Erlenmeyer flask containing the sample is also removed from the apparatus.

- *The water distiller must be set up on a stable laboratory bench with an even, horizontal support which is located near a cold water supply and a drain. The water pressure must be at least 0.5 bar.*
- *Before starting the operation, all hoses must be connected and the coolant engaged. The storage tank must be correctly positioned and the fluid level checked. The water vapour discharge hose must be introduced into the digestion flask. The water distiller is equipped with a safety gate.*
- *During the first distillation, the water vapour comes into contact with cold pipes and glass parts. This leads to increased build-up of condensation which can in turn lead to excessive sample dilution and liquid volume in the digestion vessel. A trial run is therefore essential. The discharge of water vapour with a temperature of approx. 106°C creates loud noises. This is no cause for alarm.*
- *The distillation is conducted until a distillation volume of 150 ml is obtained.*
- *About 2 minutes before the end of the distillation, the Erlenmeyer flask is lowered in such a way that the end of the discharge pipe is no longer submerged in the acid solution. The pipe must be flushed with water. This water is collected in the Erlenmeyer flask.*

## 3 Titration 1 min

$NH_4H_2BO_3 + HCl \rightarrow NH_4Cl + H_3BO_3$

The boric acid absorption solution (which contains the indicator) is titrated with 0.1 M standard hydrochloric acid. The hydrochloric acid is added until the first trace of pink coloration arises. The volume of the hydrochloric acid consumed is read off on the burette at 0.05 ml. An illuminated disc can serve as a neutral background and enables the user to determine the colour change accurately at the end of the titration.

- *The mixture of methyl red and bromcresol green (see 2.5, 2.6) serves as the indicator. The indicator is responsible for the colour change and signals the end of the titration.*
- *The neutral background improves the accuracy and reproducibility of the results. This means that the titrations are always carried out under optical conditions that are as similar to each other as possible.*

### Blind trial

The blind trial is carried out in the same way as above. The sample is replaced with 5 ml of water and 0.85 g of sucrose. The volume of hydrochloric acid consumed during titration is recorded.

- *The blind trial is important for the calculation of the nitrogen content of the sample.*

### Calculation and analysis

The nitrogen content, given in g of nitrogen per 100 g of the product, is calculated using the following numerical equation:

$$Wn = \frac{1{,}4007\ (V - Vo)\ Cs}{Wt}$$

**Wn:** the nitrogen content of the sample

**V:** the volume of hydrochloric acid consumed during titration of the sample

**Vo:** the volume of the hydrochloric acid consumed during titration of the blind trial (see blind trial)

**Cs:** the exact molarity of the hydrochloric acid, given to four decimal places

**Wt:** the mass of the test sample in grams, given within 0.1 gram

To calculate the protein content of the sample, the Wn value must be multiplied by 6.38.

**Model calculation**
If the Kjeldahl determination yields a nitrogen content of 55 %, a protein content of 3.5% results (55% x 6.38).

- *Kjeldahl's digestion method is not specific to amino acids and proteins and includes all organically bonded nitrogen. Other non-protein compounds are also are digested and collected (NPN: non-protein nitrogen). However, the proportion of these compounds is very small and is disregarded in the calculation.*
- *If the non-protein containing nitrogen should also be established, then method must be executed in accordance with DIN EN ISO 8968-4. If only the protein nitrogen should be determined, then the milk proteins must first be separated. 5±0.1 ml of milk diluted with 5±0.1 ml of water is washed in stages with in total 60 ml of 15 % (w/v) trichloroacetic acid in accordance with DIN EN ISO 8968-5, the proteins are precipitated and finally filtered out into a hard paper filter. The filtrate contains the components of the non-protein nitrogen and the filtered-out precipitate contains the protein nitrogen. The filter with the precipitate is put into a digestion vessel and Kjeldahl's nitrogen determination method is carried out as described above. The protein content is calculated by multiplying by a factor of 6.38.*
- *The value 6.38 is specific to milk and dairy products and was established because milk proteins have a nitrogen content of 15.65 % (100:15.65 = 6.38).*

## Alternatives, rapid methods

There is a faster way to execute Kjeldahl's method than the standard process. In accordance with ISO 8968-3, smaller milk samples are used (2 g, exactly weighed within 1 mg). 2 g of the sample, a catalyst tablet (consisting of 5 g $K_2SO_4$, 0.105 g $CuSO_45H_2O$ and 0.105 g $TiO_2$), 10 ml of 98% sulphuric acid, and a few drops of antifoam agent (30% silicon compound) are introduced into a 250 ml digestion flask. The contents are mixed carefully, 5 minutes are allowed to pass and then 5 ml of 30 % hydrogen peroxide are added at the side of the flask. The sample is left to sit for 10-15 minutes before digestion. The heating block is preheated to 400°C for 10 minutes and the sample is heated at 400°C for 60 minutes. Afterwards, the sample is cooled to room temperature and diluted with 50 ml of water. 55 ml of 30 % NaOH and 50 ml of 4 % boric acid are used to absorb the distillate. HCL 0.05 M is used for titration. 0.2 ml of a mixture of 0.03 % methyl red and 0.17 % bromcresol green in 95 % ethanol serves as the indicator.

- *Caution! The addition of hydrogen peroxide causes an intense reaction.*
- *The blind trial is executed with 2 ml of water and 0.25 g of sucrose. The effectiveness of the decomposition is tested with 0.08 g of tryptophan or 0.06 g of lysine hydrochloride.*

## Monitoring the process

The accuracy of the process should be reviewed regularly. A loss of nitrogen should be tested for. As a sample, 0.12 g of ammonium sulphate [ $(NH_4)_2SO_4$ ] and 0.85 g of sucrose are used here. Kjeldahl's method is carried out under the same conditions as with normal samples and the percentage of nitrogen content must be between 99.0 % and 100 %. The determination with ammonium sulphate is of use in detecting nitrogen losses during decomposition or distillation and differences in concentrations in the titration agent.

- *In order to monitor the effectiveness of the decomposition, 0.18 g of tryptophan or 0.16 g or lysine hydrochloride and 0.67 g of sucrose are used. 98 % of the nitrogen content must be recovered. If that is not the case, either the decomposition temperature or time is insufficient or the sample is charred.*

## Determining the nitrogen content of dairy products

The reference standard process can also be adapted for other milk products. The only difference in the method is the sample amount. The sample must show a protein amount of 0.15-0.30 %. It is therefore advisable to use the following sample amounts:

| | |
|---|---|
| Condensed milk: | 3 g |
| Powdered skim milk: | 1 g |
| Whey: | 10 g |
| Cream cheese: | 3 g |

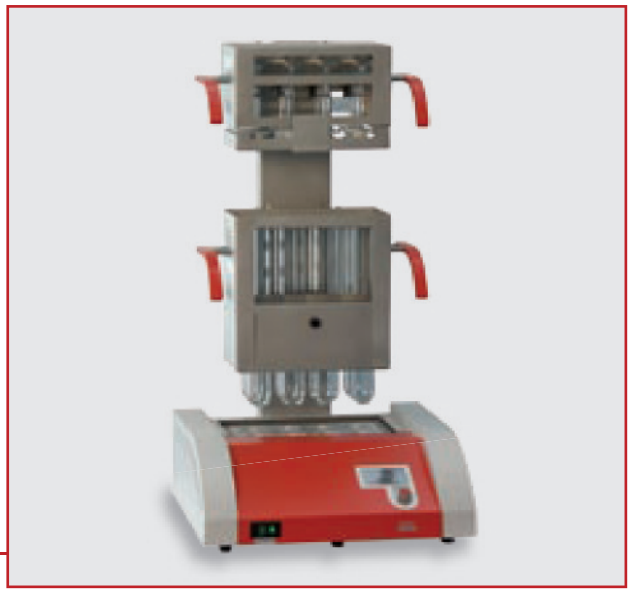
The method is carried out in the same way as the standard process.

## Kjeldahl digestion apparatus K8

Heating block and glass extraction system for 8 samples, for connecting to the Behrosog suction station. Suitable for 250 ml digestion flasks.
The front side of the sample rack is covered. Stable and robust construction. The block casing as well as the extraction hood is made of acid-proof, rust-free stainless steel.

Programmable for up to
10 different temperature steps.
Maximum temperature 450°C,
time adjustment range 0-999 min
230V, 50 Hz, weight: 28 kg

**4200** 480 x 510 x 765 mm (w x d x h)



## Digestion flask

**4201** 250 ml

## Suction station Behrosog 3 with cooler

Extracts aggressive acid vapours during digestion.
In the process, an upstream two-staged pre-filter edulcorates and precipitates the toxic substances.

230 V, 50 /60 Hz,
weight: 18 kg
cuction pump: 40 l/h

**4203** 80 x 340 x 400 mm (w x d x h)

## Kjeldahl distillation apparatus S-3

behind a safety screen,
automatic water vapour production,
manual or automatic addition of $H_2O$, NaOH.
programmable distillation time and reaction time,
automatic suction of sample remains,
automatic fluid level surveillance of the storage tank.

230 V, cooling water usage: 3 L/min,
weight: 35 kg

**4210** 410 x 675 x 410 mm (w x d x h)

## Automatic titrator STI

The titration station consists of a burette with a digital display and a magnetic stirrer with a custom-fit holder for an Erlenmeyer flask. Result accuracy and reproducibility are enhanced due to a viewing shield which serves as a neutral background.

230 V, 50 / 60 Hz, weight: 3.5 kg

**4220** 330 x 200 x 600 mm (w x d x h)

## Kjeldahl Tabs KT1

**4230** consisting of 5 g of potassium sulphate, 0.5 g of copper sulphate

## Kjeldahl Tabs KT2

**4231** consisting of 5 g of potassium sulphate, 0.105 g of copper sulphate, 0.105 g of titanium dioxide

# pH VALUE MEASUREMENT

*Anna Politis, graduate engineer of nutrition technology and of biotechnology, reports*

The pH value is a measurement of the $H^+$ activity. Simply put, it is a measurement of the concentration of acid (pH ‹7) or base (pH ›7). The formal definition was formulated by chemist Soerenson:

$$pH = -\log a_{H^+}$$

The pH value is the negative decadal logarithm of the activity of protons $a_{H^+}$ in mol/l. This value is measured by means of a pH meter with a suitable electrode in accordance with DIN 38404-C5. pH meters measure the potential difference between measuring electrodes and reference electrodes. According to the Nernst equation, the potential difference changes by 59 mV per pH unit. The pH meter must be calibrated regularly from time to time. The calibration is carried out by means of standard buffer solutions with defined pH values.
During a 2 point calibration, the zero point is set by an additive correction with the buffer solution (pH=7). Subsequently, the end value (e.g. pH=4.01) is set over a multiplicative correction (transconductance). How often the meter should be calibrated depends on how exact the measurements should be and varies from meter to meter. If the pH meter is not in constant use, it should be calibrated before every measurement. If the electrode is continuously in the storage liquid, it doesn't have to be calibrated as frequently. For each calibration, 20 ml of buffer solution are needed. Solutions should not be used more than once. The bottles containing the buffer solution must be sealed immediately after use. Alkaline calibration solutions are more sensitive. Their pH values change because they absorb $CO_2$ from the air. A sealed bottle of buffer solution keeps for several months to two years. Between calibrations or measurements, the sensor must be rinsed with distilled water but not wiped off. Excess drops can be dabbed away with a soft cloth.

The pH value is temperature-dependent; therefore the temperature must always be recorded along with the entry of the pH value. Nowadays most pH meters are equipped with a temperature measuring unit. This allows the temperature influence to be compensated during the measurement.

A pH meter requires regular maintenance to measure optimally.

With electrodes with refillable electrolyte, the fluid level of the electrolyte solution must be checked. The level of the reference electrolyte must always be a few cm above the fluid level of the measurement solution. If necessary, the KCl solution 3M must be refilled after removing the seal over the filler hole. During use, the refill hole for KCl should always be open, otherwise the solution cannot be diffused out. If the electrode is no longer needed, it should be quickly rinsed, the refill hole for KCl should be sealed and the electrode should be stored in the 3M KCl solution so that it doesn't dry out.

During transport and storage, KCl solution can leak out of the protective cap, out of which crystallised white potassium chloride is formed. This salt deposit has no effect on measuring accuracy and can be easily washed off with water. If the electrode is dried out, then it must be soaked in 1ML HCl and subsequently reactivated for several hours in 3M KCl.

Should constant deviations be determined during measurements, the electrode must be checked for possible contamination. Depending on the type of contamination, different cleaning measures are recommended.

- *To clean off fat or oil deposits, the membrane must be degreased with cotton which has been soaked in acetone or soap solution.*
- *If protein has settled on the diaphragm, the electrode is soaked in HCl/Pepsin solution for approx. 1-2 hours.*
- *In case of a silver sulphide contamination, the electrode is to be set in a thiocarbamide solution and left to soak.*
- *To remove inorganic films, the electrode is dipped into 0.1 M HCl or 0.1 M NaOH. With 40-50°C solutions, cleaning is more effective.*
- *After every cleaning procedure, the electrode is to be set in a 3M KCl solution about a quarter of an hour a new conditioning and subsequently calibrated once again.*

Battery/pocket pH meter

Laboratory pH meter

## pH meters

### Laboratory pH meter

electrode not included, with DIN electrode connection, for compatible single rod electrodes, see art. no. 4336

**4310** **Knick 766** easy to use measurement device for pH, mV and °C: electrode adjustment and monitoring self-test, automatic temperature compensation recorder output, calibration data memory

**4311** **Knick 765** plus RS 232 interface for computer and printer (GLP documentation)

### Battery/pocket pH meter

electrode not included in the scope of delivery (see art. no. 4370, 4380)

**4315** **Knick 911** highly developed measuring device for pH, mV and °C with support for use on a table, protected from dust, water, as well as impact: automatic calibration, buffer recognition, temperature compensation, self-test, DIN electrode connection

**4317** **Knick 913** similar to 911, but with additional measurement value storage and interface for computer and printer (GLP documentation), with DIN electrode connection

**Pt 1000 temperature sensor**
for Knick 911, 913 (art. no. 4315, 4317),
**4319** with DIN plug

**Single rod electrode SE 100**
with integrated temperature sensor Pt 1000
compatible with Knick 766, 765 (art. no. 4310, 4311),
**4336** with DIN plug

**Single rod electrode Inlab Basics**
suitable for milk und other fluids
**4350** fixed cable with DIN plug

**Insertion electrode Inlab Solids**
insertion head electrode
**4360** with cable and DIN plug

**Insertion electrode Inlab Solids**
**4361** without cable

**Single rod electrode SE 104**
for insertion measurements in cheese, meat, and sausage,
compatible with Knick 911, 913 (art. no. 4315, 4317)
**4370** fixed cable with DIN plug

**Single rod electrode SE 102**
integrated with temperature sensor Pt 1000
design compatible with Knick 911/913 (art. no. 4315, 4317)
**4380** fixed cable with DIN plug

**Buffer solutions**
in 250 ml PE bottles

**4390** pH 4.01
**4391** pH 7.00
**4392** pH 9.21

**KCl solution**
in 250 ml PE bottles
**4400** 3 mol/L

**4420** **Cleaning agent for single rod electrode**
in 250 ml PE bottles
thiocarbamide solution for Ag-Cl diaphragms

**4421** **Pepsin hydrochloric acid solution**
protein solvent

**4422** **Reactivation solution**
hydrofluoric acid
in 25 ml PE bottles

**4450** **pH Meter "pH 49"**
in accordance with guideline 89/336/EWG
Battery type: 9 V
Operation temperature: 0-50°C
Electrode connection: pH / mV: BNC connector
°C: DIN connector

**4451** **Temperature sensor Pt 100**
for pH meter "pH 49"

**4452** **pH single rod electrode EGA 184**
for pH meter "pH 49"

**4453** **pH single rod electrode with integrated Pt 100**

**4455** **Platinum redox single rod electrode**

**4460** **Buffer solution pH 4.01 / 250 ml**
**4461** **Buffer solution pH 7.0 / 250 ml**
**4462** **Buffer solution pH 9.18 / 250 ml**

# TITRATION APPARATUS

**determination of acid content**
**to ascertain the degree of freshness**

### Titration apparatus STANDARD

complete with storage bottle, rubber stopper, burette with automatic zero point adjustment, sodalime with ascending tube, rubber pressure bulb, burette tip with pinchcock, one 1 ml and one 25 ml pipette, one 200 ml Erlenmeyer flask

| | |
|---|---|
| **4500** | for milk: 0 - 25° SH |
| **4501** | for cream: 0 - 40 °SH |
| **4510** | for curd: 0 - 250 °SH<br>with porcelain mortar and pestle, 2 ml pipette<br>(without 1 ml and 25 ml pipette and Erlenmeyer flask) |

### Titration apparatus SIMPLEX

for milk and cream, complete with polyethylene bottle on a plastic base, burette with automatic zero point adjustment, precision titration by button control, one 1 ml and one 25 ml pipette, one 200 ml Erlenmeyer flask

| | |
|---|---|
| **4520** | for milk: 0 - 25° SH |
| **4521** | for cream: 0 - 40° SH |

### Titration apparatus SIMPLEX

for general titration purposes, as above, but without accessories

| | |
|---|---|
| **4530** | with burette 0 - 10 ml: 0.05 |
| **4540** | with burette 0 - 25 ml: 0.1 |
| **4550** | with burette 0 - 50 ml: 0.1 |

## Titration apparatus
with bottle and holder
without accessories

| | |
|---|---|
| **4654** | 0 - 100° Dornic |
| **4655** | 0 - 40° Dornic |

## Protein titration apparatus
with storage bottle,
for use with 25 ml of milk,
special burette with automatic
zero point adjustment,
sodalime with ascending tube, rubber bulb,
outlet tip, pinchcock,
one 1 ml, one 5 ml and one 25 ml volumetric pipette,
two 250 ml short beakers,
two 1 ml: 0.01 measuring pipettes

| | |
|---|---|
| **4660** | 0 - 6 ET: 0.02 |

## Acidity tester
for determining the degree of freshness
**4705** of unpasteurised milk

## Salt test
for butter and cheese
see art. no. 4530, 4540,
but with brown storage bottle

| | |
|---|---|
| **4760** | for butter 10 ml: 0.05 |
| **4770** | for cheese 25 ml: 0.1 |

**SEDILAB sediment tester**
easy-to-use manual sediment tester,
with clamp for attaching to tables, stainless steel

**4800** for 500 ml of milk

**SEDILAB-E sediment tester**
for serial testing of liquids for particle contamination,
particularly for sediment testing of milk,

splash-proof design, approx. 800 samples per hour,
sharply defined sediment images,
220 V / 50 Hz

**4810** for 500 ml of milk

**ASPILAC sediment tester**
pump design for direct suction from a can,
Plexiglass casing for original filter papers

**4905** for 500 ml of milk

**4910** **Filter papers**
with area for records, 1000 pieces, Ø 28 mm, 80 x 45 mm

**4911** **Filters, round**
32 mm, 1000 pieces

**4920** **Reference table**
with 3 purity grades, German standard

**Pipetting syringes**
for determining out nutrient and dye solutions,
self-priming, can be sterilised

**5110** adjustable to 1 ml

**5111** adjustable to 2 ml

**5112** adjustable to 5 ml

**Methylene blue tablets**
for bacteria count estimation
**5140** 50 pieces

**Resazurine tablets**
**5150** for LOVIBOND comparator (art. no. 5160), 100 pieces

**LOVIBOND comparator 2000**
for resazurine tests,
housing for 2 test tubes
for colour comparisons,
with milk observation stand,
**5160** without colour disc (see art. no. 5161)

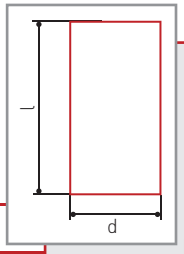
**Colour disc**
**5161** for resazurine 4/9 with 7 standard reference colours

**Test tube**
**5162** set of 4 tubes

**Dry matter calculator**
**5360** according to Ackermann's method, for milk

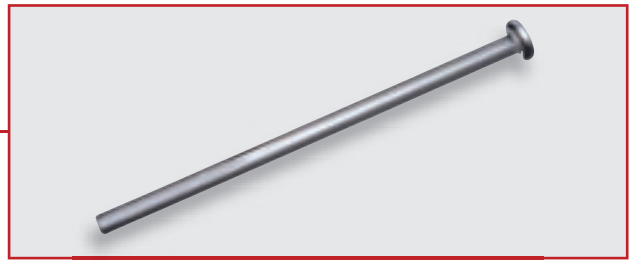
**Butter melting beaker**
for the determination of water content in butter

**5400** Aluminium, 30 g; l = 51 mm, d = 60 mm
**5401** Aluminium, 50 g; l = 66 mm, d = 64 mm




**5420 Tongs**

**Glass stirrer**
**5430** pestle type, 140/6 mm



**Double-ended spatula**
**5440** pure nickel, 150 mm

**Butter testing spoon**
**5450** Plexiglass

## Crystalline quartz sand
0.6-1.2 mm grain size, calcined quality

| | |
|---|---|
| **5460** | washed, 1 kg, transport costs available on request |
| **5461** | washed, 3 kg, transport costs available on request |
| **5462** | washed, 5 kg transport costs available on request |
| **5463** | washed, 25 kg transport costs available on request |
| **5464** | washed, 10 kg transport costs available on request |

## Aluminium foil

| | |
|---|---|
| **5470** | 150 x 190 mm, 1000 pieces |

## Weighing dish
aluminium, with lid, (numbered on request)

| | |
|---|---|
| **5490** | 75 x 30 mm |

## Bunsen burner
for propane gas
(other gas types available on request)

| | |
|---|---|
| **5550** | |

## Infrared burner, up to 750°C
suitable for fast, contact-free heating

| | |
|---|---|
| **5571** | 0.9 kg, 100 x 100 x 100 mm |
| **5572** | Output regulator |

**Wator paper**
Indicator paper for determining moisture distribution in butter

**5600** 40 x 78 mm, 50 pieces

**Test tube according to Beckel's method**
for determining the acid value in butter

**5601** 5 ml / 11 ml, PE stand

**Butter cutter**
**5605** wire gauge 0.5 mm

**Separating funnel**
for extraction

**5606** 250 ml

**Thin layer chromatography chamber**

**5607** 200 x 200 mm

**Thin layer chromatography plates**
25 silicon dioxide gel plates
with aluminum liner
can be cut with scissors

**5608** 200 x 200 mm

## Pocket refractometer

for measuring the degree of evaporation in milk and determining the concentration in various fields of application, inc. case
the internationally approved Brix scale enables the weight percentage of dry matter to be determined directly.

| | |
|---|---|
| **5610** | 0 – 32 % Brix: 0.2 % for milk, fruit juices, soft drinks |
| **5612** | 28 – 62 % Brix: 0.2 % for concentrated fruit juice |
| **5613** | 45 – 82 % Brix: 0.5 % for honey |

## Digital hand refractometer

can be switched from 1.330 – 1.5318 $n_D$:
resolution 0.1 % Brix, 0.0001 $n_D$
automatic temperature compensation from 10 - 40°C

| | |
|---|---|
| **5614** | 0 - 95 % : 0.1 % Brix |

## Digital Abbe refractometer

LED display 590 nm, serial interfaces RS-232
and RS 422, 115/230 V, 50/60 Hz
1.3000 – 1.7200 $n_D$ : 0.0001 $n_D$
5 kg - 140 x 275 x 300 mm

| | |
|---|---|
| **5620** | 0 - 95 %: 0.1 % Brix, 0 - 99°C: 0.1°C |

**Humidiy measuring device MLB 50-3**
for the fully automatic determination of moisture content or dry substance content
data interface RS 232

**5670** 5.5 kg - 217 x 283 x 165 mm

**Accessories for humidity measuring device MLB 50-3**

**5671** Aluminium specimen dish
92 mm diameter, packs of 80 pieces

**5672** Circular glass fibre filter
for splashing or caking specimens

**5673** Matrix needle printer

**5674** Specimen dish
aluminium
100 x 7 mm, pack: 100 pieces

## Reference drier RD-8

for determining the moisture content of powdered milk in accordance with ISO/DIN 5537, IDF 26

8 samples can be dried simultaneously under precisely defined conditions (87°C / 33 ml/Min airflow).

| | | |
|---|---|---|
| | Connections: | a) 230 V / 115 V, 520 W<br>b) 2.5 bar ... 7.5 bar |
| | Temperature range: | adjustable, up to 110.0°C |
| **5700** | Stability: | +/- 0.3°C |

### Accessories for reference drier RD-8

**5701** specimen container
PP, 20 pieces

**5702** Lid for specimen container
PP plastic, 20 pieces

**5703** Cap
PP plastic, 20 pieces

**5704** Filter
100 pieces

**5705** **Loading arm**
for easy and exact positioning of the filter
in the specimen receptacle, acrylic

**5706** **Weighing stand**

**5707** **Stand for lids and caps**

**5708** **Flowmeter**
for measuring the air flow
in the reference drier RD-8
ADM 1000

**5712** **Round aluminium foil**
130 x 0.03 mm, 1000 pieces

## Analytical scale

with modern all-glass wind protection,
automatic internal adjustment every 3 hours
or with a temperature change of >0.8°C
display change from piece to weight,
GLP/ISO logging possible,
percentage determination, RS 232 data interface,
under-floor weighing possible,
gauge or calibration certificate for additional charge

weighing plate diameter: 85 mm

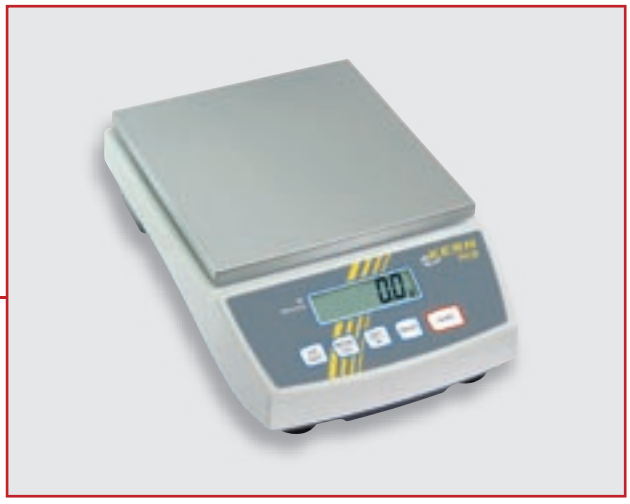
| | |
|---|---|
| **5810** | 160 g: 0.1 mg |
| **5811** | 220 g: 0.1 mg |

## Precision scale

with formulation memory, unit counter,
GLP/ISO logging possible,
percentage determination, RS 232 data interface,
under-floor weighing possible

weighing plate: 130 x130 mm

| | |
|---|---|
| **5820** | 1600 g: 0.01g |



**Further scales available on request**

## HEATING CABINETS UNB

with natural air circulation for standard tempering tasks from 30-220°C

| Order no. | Model | Volume (litres) | ext. dimensions w/h/d (mm) | int. dimensions w/h/d (mm) | supporting ribs/ slide-in plates | Watts/ volts | Kg net | Equipment type/fixtures |
|---|---|---|---|---|---|---|---|---|
| 6000 | UNB 100 | 14 | 470/520/325 | 320/240/175 | 2/1 | 600/230 | 20 | Digital (switch-off) clock 99 hours 59 min. |
| 6001 | UNB 200 | 32 | 550/600/400 | 400/320/250 | 3/1 | 1100/230 | 28 | |
| 6002 | UNB 300 | 39 | 630/600/400 | 480/320/250 | 3/1 | 1200/230 | 30 | |

## HEATING CABINETS UFB

with forced air circulation for standard tempering tasks from 30-220°C

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6008 | UFB 400 | 53 | 550/680/480 | 400/400/330 | 4/2 | 1400/230 | 35 | Digital (switch off) clock 99 hours 59 min. |
| 6009 | UFB 500 | 108 | 710/760/550 | 560/480/400 | 5/2 | 2000/230 | 50 | |

## INCUBATORS INE

with natural air circulation for tempering tasks from 30-70°C

| Order no. | Model | Volume (litres) | ext. dimensions w/h/d (mm) | int. dimensions w/h/d (mm) | supporting ribs/ slide-in plates | Watts/ volts | Kg net | Equipment type/fixtures |
|---|---|---|---|---|---|---|---|---|
| 6035 | INE 200 | 32 | 550/600/400 | 400/320/250 | 3/1 | 1100/230 | 28 | Excellent Fuzzy PID controller with two integrated clocks (running time 1 min. to 999 hours and weekly program timer) and triple thermal safety fuse, air turbine speed controller |
| 6036 | INE 300 | 39 | 630/600/400 | 480/320/250 | 3/1 | 1200/230 | 30 | |
| 6037 | INE 400 | 53 | 550/680/480 | 400/400/330 | 4/2 | 1400/230 | 35 | |
| 6038 | INE 500 | 108 | 710/760/550 | 560/480/400 | 5/2 | 2000/230 | 50 | |

## STERILISING OVENS SNB

with natural air circulation for tempering tasks from 30-220°C

| Order no. | Model | Volume (litres) | ext. dimensions w/h/d (mm) | int. dimensions w/h/d (mm) | supporting ribs/ slide-in plates | Watts/ volts | Kg net | Equipment type/fixtures |
|---|---|---|---|---|---|---|---|---|
| 6047 | SNB 100 | 14 | 470/520/325 | 320/240/175 | 2/1 | 600/230 | 20 | Digital (switch-off) clock 99 hours 59 min. |
| 6048 | SNB 200 | 32 | 550/600/400 | 400/320/250 | 3/1 | 1100/230 | 28 | |
| 6049 | SNB 300 | 39 | 630/600/400 | 480/320/250 | 3/1 | 1200/230 | 30 | |

## REFRIDGERATED INCUBATORS WITH COMPRESSION COOLING ICP

for tempering tasks from 0-60°C

| Order no. | Model | Volume (litres) | ext. dimensions w/h/d (mm) | int. dimensions w/h/d (mm) | supporting ribs/ slide-in plates | Watts/ volts | Kg net | Equipment type/fixtures |
|---|---|---|---|---|---|---|---|---|
| 6070 | ICP 400 | 53 | 558/967/486 | 400/400/330 | 4/2 | 500/230 | 68 | PID process controller, serial and parallel interfaces, motorised inner air circulation |
| 6071 | ICP 500 | 108 | 718/1047/556 | 560/480/400 | 5/2 | 500/230 | 87 | |
| 6072 | ICP 600 | 256 | 958/1335/656 | 800/640/500 | 7/2 | 700/230 | 144 | |

**further instruments available on request**

**Laboratory furnaces**
heating and incineration at up to 1100°C,
rust-free stainless steel furnace casing,
high-grade isolation, short heating-up time
230 V/50 Hz, 1.2 kW, Volume: 3L

**6220** Internal dimensions: 160 x 140 x 100 mm,
External dimensions: 380 x 370 x 420 mm, 20 kg

**Discharge viscometer**
Easy-to-use viscometer for in-house measurement of the viscosity of yogurt, curdled milk, kefir and other products.

The stop time of the discharge of the measured material serves as a measure of the viscosity.

**6520** with stand and two different discharge nozzles

**6521** **Glass plate**

**6522** **Stop watch**

**Visco tester VT6R Haake**
rotation viscometer for measurements in accordance with ISO 2555 and ASTM (the Brookfield method)

- measuring range 20 ... 13,000,000 mPas (cP)
- acoustic warning for measuring range
- RS 232C interface
- set of 6 spindles

**6530** stand and case included in the scope of delivery

## INHIBITOR DETECTION

**6570** **Delvotest SP-NT** for 100 samples

**Delvotest plate test SP-NT**
**6571** each for 96 samples

# LACTODENSIMETER

*Lactodensimeters are frequently used with an official calibration, or are officially calibrated with a certificate. Please refer to our price list or contact us for more information.*

## Lactodensimeter

for milk according to GERBER's method, large model,
negative scale, with thermometer in stem,
1.020 – 1.040: 0.0005 g/ml,
T = 20°C, 10 - 40°C, ca. 300 x 28 mm

| | |
|---|---|
| **6600** | standard model |
| **6602-E** | officially calibrated, the calibrated range of the thermometer goes from 10°C to 30°C |
| **6603-ES** | officially calibrated, with certificate, the calibrated range of the thermometer goes from 10°C to 30°C |

## Lactodensimeter

for milk acc. to GERBER's meth., small model,
with thermometer in body,
1.020 – 1.035: 0.0005 g/ml,
T = 20°C, 0 - 40°C, ca. 210 x 17 mm

| | |
|---|---|
| **6610** | standard model |
| **6612-E** | officially calibrated, the calibrated range of the thermometer goes from 10°C to 30°C |
| **6613-ES** | officially calibrated, with certificate, the calibrated range of the thermometer goes from 10°C to 30°C |

## Hydrometer

for milk in accordance with DIN 10290
without thermometer,
1.020 -1.045: 0.0005 g/ml,
T = 20°C, ca. 350 x 25 mm

| | |
|---|---|
| **6620** | standard model |
| **6621-E** | officially calibrated |
| **6622-ES** | officially calibrated, with certificate |

## Lactodensimeter

for milk according to Quevenne's method,
with coloured triple scale

| | |
|---|---|
| **6630** | 1.015 – 1.040: 0.001 g/ml, T = 20°C<br>with thermometer 0 - 40°C, approx. 290 x 22 mm |
| **6630-15** | 1.015 – 1.040: 0.001 g/ml, T = 15°C<br>with thermometer 0 - 40°C, approx. 290 x 22 mm |
| **6631** | 1.015 – 1.040: 0.001 g/ml, T = 20°C<br>without thermometer, approx. 210 x 22 mm |
| **6631-15** | 1.015 – 1.040: 0.001 g/ml, T = 15°C<br>without thermometer, approx. 210 x 22 mm |

## Hydrometer for buttermilk serum

DIN 10293, without thermometer, T = 20°C,
1.014 – 1.030: 0.0002 g/ml, approx. 240 x 21 mm

| | |
|---|---|
| **6640** | standard model |
| **6641-E** | officially calibrated |
| **6641-ES** | officially calibrated, with certificate |

## Buttermilk tester

according to Dr. Roeder's method
with thermometer in stem,
approx. 210 x 25 mm

| | |
|---|---|
| **6650** | 1.010 – 1.030: 0.001 g/ml, T = 20°C |

## Hydrometer for condensed milk

without thermometer, reading at top

| | |
|---|---|
| **6660** | 1.000 – 1.240: 0.002 g/ml, T = 20°C, approx. 310 x 19 mm |
| **6661** | 1.040 – 1.080: 0.001 g/ml, T = 20°C, approx. 230 x 21 mm |

## Hydrometer for yogurt and chocolate milk

with thermometer incorporated in body,
reading at top
approx. 220 x 16 mm

| | |
|---|---|
| **6670** | 1.030 – 1.060: 0,001 g/ml, T = 20°C |

### Hydrometer for brine / Beaumé
0 - 30 / 0.5 Bé, T = 15°C
approx. 240 x 17 mm

| | |
|---|---|
| **6680** | without thermometer |
| **6681** | with thermometer, 0 - 40°C |

### Hydrometer for boiler water
DIN 12791, M 100
without thermometer,
approx. 250 x 20 mm

| | |
|---|---|
| **6690** | 1.000 – 1.100: 0.002 g/ml, T = 20°C |

### Alcoholometer
0 - 100 Vol. %: 1.0, T = 20°C,
approx. 290 x 16 mm

| | |
|---|---|
| **6710** | with thermometer |
| **6711** | without thermometer |

### Hydrometer for amyl alcohol
DIN 12791, M 50
without thermometer
260 x 24 mm

| | |
|---|---|
| **6720** | 0.800 – 0.85: 0.001 g/m, T = 20°C |

### Hydrometer for sulphuric acid
DIN 12791, M 50
without thermometer
270 x 24 mm

| | |
|---|---|
| **6730** | 1.800 – 1.850: 0.001 g/ml, T = 20°C |
| **6731** | 1.500 – 1.550: 0.001 g/ml, T = 20°C |

### Hydrometer
DIN 12791,M 50
for various liquids,
without thermometer, T = 20°C,
270 x 24 mm

| | |
|---|---|
| **6740** | 1.000 - 1.050: 0.001 g/ml |
| **6741** | 1.050 - 1.100: 0.001 g/ml |
| **6742** | 1.100 - 1.150: 0.001 g/ml |
| **6743** | 1.150 - 1.200: 0.001 g/ml |

FUNKE GERBER

**Level gauge for lactodensimeters**
internal diameter: 39 mm
**6800** length: 265 mm

**Stand**
tripod with cardanic suspension
and hanging cylinder
for lactodensimeters art. no. 6610 - 6613

**6810** 265 x 60 mm

**Replacement hanging cylinder**
for art. no. 6810

**6820** 210 x 22 mm

**Stand**
with cardanic suspension,
overflow hanging cylinder,
compatible with all lactodensimeters
and hydrometers, incl. drip tray,
**6830** hoses and pinchcock

## THERMOMETER/ACCESSORIES

### Dairy thermometer
with loop
special red filling
0 -100°C: 1°C

**7001** approx. 250 x 17 mm

### Dairy thermometer
in plastic case with loop,
boil- and impact-proof, floatable,
special red filling
0 - 100°C: 1°C

**7031** approx. 280 x 28 mm

### Dairy thermometer
special red filling
replacement for art. no. 7031,

**7041** approx. 250 x 17 mm

| | |
|---|---|
| | **Universal thermometer**<br>special red filling |
| **7046** | -10 to 100°C: 1.0, approx. 260 x 8 mm |

| | |
|---|---|
| | **Cooling chamber thermometer**<br>special blue filling<br>in plastic holder with loop and hook |
| **7060** | -40 to +40°C: 1.0, approx. 200 x 20 mm |

| | |
|---|---|
| | **Control thermometer**<br>special red filling<br>-10 to +100°C: 1.0, approx. 305 x 9 mm |
| **7070-ES** | officially calibrated, with certifiicate |
| **7071** | uncalibrated |

| | |
|---|---|
| | **Low temperature laboratory thermometer**<br>special red filling |
| **7081** | -38 to +50°C: 1.0, approx. 280 x 8 x 9 mm |

| | |
|---|---|
| | **Maximum-minimum rod thermometer**<br>white coating, creosote filling |
| **7095** | -35 bis + 50°C: 1.0, approx. 220 x 10 mm |
| **7096** | -10 bis + 100°C: 1.0, approx. 220 x 10 mm |

The **psychrometer**
*Measurement of relative humidity*

*A hair hygrometer is typically used to measure relative humidity. A strand of hair elongates when it absorbs moisture. The psychrometer functions more accurately. The instrument consists of two exactly matching thermometers (with as little deviation as possible). The mercury receptacle (alcohol is not used due to too high inaccuracy) of one thermometer is wrapped in a damp piece of absorbent cotton or the like. The other thermometer is kept dry and gives the temperature of the surrounding air. At a relative humidity of 100 %, both temperatures show the same temperature. If the humidity is lower than 100 %, the water on the "damp" thermometer evaporates. A lower temperature is shown on the damp thermometer as on the dry thermometer due to evaporation chill (the warmth necessary to evaporate is detracted from the thermometer and the piece of cotton). The humidity can be calculated from the temperature difference.*

## PSYCHROMETER

water storage tank,
2 calibratable thermometers with translucent glass scale, with humidity table, lacquered wood plate

**7100** -10 + 60: 0.5°C, approx. 190 x 12-13 mm

**Polymeter** (hair hygrometer)
for measuring relative humidity and temperature,
with scale for water vapour saturation pressure,
thermometer with special filling
Thermometer dimensions: approx. 130 x 12 mm
Hygrometer dimensions: Ø 100 mm

**7110** Measuring range: 0 - 100 %, 0 - 30°C,

**Humidity/temperature measuring device**
with moisture sensor and NTC temperature sensor

Measuring range: -10 - +50°C, 0 - 100 % rH
**7115** Accuracy: ± 0.5°C, ± 2.5 % rH

**Digital thermometer 826-T4**
contact-free measurement and core temperature measurement in foodstuffs with one device

Measuring ranges:
contact-free / IR: -50°C to +300°C, accuracy: ± 2°C
**7119** with NTC sensor: -50°C to +230°C, accuracy: ± 1°C

**Digital second thermometer 926**
for daily temperature measurements in the food industry, for laboratory use
ISO calibration certificate for an additional price

Measuring range: -50 to +400°C: 0.1°C (1°C from 200°C),
**7120** Accuracy: ±0.3°C.

## INSERTION/IMMERSION SENSORS

Robust **precision sensor**

**7122** Ø 4 mm, length 110 mm

**Stainless steel sensor for food**
stainless steel ,

**7123** Ø 4 mm, length 125 mm

**Needle sensor**
for quick measurements
without visible pinhole,

**7124** Ø 1.4 mm, length 150 mm

**Frozen goods sensor**
screws in without pre-drilling

**7125** Ø 8 mm, length 110 mm

**TopSafe**
protective cover against contamination,
**7127** water and impact

# FREEZING POINT DETERMINATION

**One of the main focuses of Funke - Dr. N. Gerber Labortechnik GmbH**

*K. Schaefer, graduate engineer, W. Spindler, graduate physician report*

## HISTORY

*The German chemist Beckmann, known for the thermometer named after him, began using the freezing point of milk in as early as 1895 to detect if it had been adulterated with water. The American Hortvet worked intensively with this method in 1920 and improved some of its essential features. The first thermistor cyroscopes were brought to the market in the 1960s. However, they had to be operated entirely by hand. At the beginning of the 1970s, the first automatic thermistor cyroscopes became available. With this development it was possible to determine the freezing point automatically at the push of a button.*

*A decisive step in the improvement of thermistor cryoscopy was displayed at the "FoodTec" tradeshow in 1984: Funke-Gerber introduced the first device with automatic calibration. This successful and intensive development work reached a new peak at the "FoodTec" in 1988, where Funke-Gerber presented a fully automatic freezing point determination mechanism with a capacity of 220 samples per hour.*

*With the introduction of an indirect freezing point measurement device (e.g. LactoStar) for routine analysis, interest was focused primarily on reference devices which are able to determine freezing points in accordance with the applicable standards and regulations. These devices must satisfy the strictest requirements with regard to measuring accuracy. For this reason Funke-Gerber developed a programmable cryoscope with a resolution of 0.1 m °C. This instrument has proven its accuracy and reliability in countless laboratories all over the world. The product range has been expanded with a multi-sample device (CryoStar$_{automatic}$). Since January 2007, these instruments have been equipped with a graphic colour display. This makes it possible to show the entire freezing curve, in particular the process of the plateau search, with a patented screen presentation.*

## THE FREEZING POINT:

The freezing point of pure water is the temperature at which ice and water are in equilibrium.

If soluble components are added to this liquid, the freezing temperature lowers (becomes colder) because the ability of the water molecules to escape from the surface diminishes. As fat is not water soluble, it has no influence on the freezing point.

## MEASURING PRINCIPLE:

The milk is cooled to -3°C (super-cooled) and crystallisation is induced by mechanical vibration. As a result of this freezing process, the temperature increases due to the released lattice energy and stabilises at a certain plateau which corresponds to the freezing point.

## MEASURING PROCEDURE:

The freezing point of liquids is not just any temperature, but the exact temperature at which one part of the sample is in a solid state and another part is in a frozen state, whereby the parts are in equilibrium.

To measure the freezing point, the sample must therefore be brought into this state. In order to do this, a certain procedure must be followed, which is carried out in the following way:

First the sample must be cooled to under the actual freezing point while being stirred. Stirring is necessary for 3 reasons:

- The sample is kept in motion so that it can not freeze on its own.
- The sample is thoroughly mixed so that all parts of the sample have the same temperature.
- The warmth contained in the sample is transported out where it can be dissipated by the cooling mechanism.

When a liquid is colder than its actual freezing point, this state is instable. This state is called "metastable". Even the smallest influences, such as the impact of a hard object on the glass wall, cause freezing to set in. This continues like an avalanche until the released fusion heat increases the temperature of the sample so much that the freezing point is reached and the frozen parts of the sample are in equilibrium with the not yet frozen parts of the sample.

A cryoscope must therefore trigger freezing when the sample is sufficiently colder than its actual freezing point. But what is "sufficiently colder"? The aim here is that so much ice builds up during freezing that there are normal-sized ice crystals all throughout the sample but that the sample is not completely frozen. With milk, it has been proved optimal to trigger the freezing at about -2°C to -3°C.

After triggering freezing, the temperature of the sample climbs because the fusion heat created during freezing is released. It stabilises at a certain value, which is called the plateau. The cooling bath continues to pull warmth out of the sample, and to the same degree that this happens, more parts in the sample freeze and release their fusion heat. Therefore the temperature remains the same – at least as long as there are still liquids parts in the sample. This plateau lasts for a few minutes. The cryoscope determines the freezing point from the temperature measurement values of the plateau. There are rules regulating this.

## POSSIBLE SOURCES OF ERROR IN THE MEASUREMENT PROCESS

When determining the freezing point, a certain procedure must be adhered to during measurement, whereby errors can occur at every stage of the procedure.

### Errors during cooling:

If the heat withdrawn from the sample is too little, the cooling takes too long.

The reason for this is either the cooling bath or the stirring rod. The cooling bath must be at least 6°C and circulate well in order to be able to transfer the heat out of the sample. The stirring rod must stir uniformly with an amplitude of 3.4 mm. When cooling errors occur, the cooling bath temperature must therefore be measured with a thermometer, then the cooling bath circulation is checked with an empty sample tube. Then, it is determined whether the stirring rod can move freely and that it does not strike or grind against anything. Finally, the stirring rod amplitude is tested. There is a special menu in the device for this purpose. The valid reference value is not simply some number on the display; this is only meant to be an indication. The tip of the oscillating stirring rob is observed and adjusted so that the points of regression are only about 3-4 mm apart. Then 2.5 ml of water is poured into a sample tube which is held under the thermistor so that the stirring rod stirs the water. It is determined whether the stirring rod oscillates well in the water.

When everything has been tested and adjusted, a sample measurement with water is carried out and the temperature value in display is observed. The time that the device takes to cool one sample from room temperature (20 °C to 25°C) to -2°C should be almost exactly one minute. If this is the case, it means that the cooling bath and the stirring rob are adjusted correctly. If cooling takes less than 45 seconds, then the cooling bath is too cold or the stirring rod setting is too high. If cooling takes longer than 75 seconds, the cooling bath is too warm or is circulating poorly or the stirring intensity is too low.

If an "error during cooling" occurs after the cooling bath and stirring rod have been tested and determined to be functioning correctly, then the thermistor and the calibration of the instrument must be tested. If the instrument has been incorrectly calibrated, it will not find its temperature scale and therefore cannot measure the temperature correctly.

### Frozen too early

The state of the sample is instable when it is below its freezing point. It can therefore happen that the sample freezes due to an unintentional influence or on its own before the device triggers freezing. There are many possible reasons for this. If stirring is too strong or if the stirring rod is grinding against something, jolting can occur and trigger freezing. The longer cooling takes the more time the sample has to freeze on its own. Therefore the cooling should be carried out as quickly as possible. If the sample is contaminated, freezing may be triggered.

### Not frozen:

If the temperature set for supercooling (the "trigger temperature") is reached, the device beats against the glass wall of the sample tube to trigger freezing. The temperature should then start to rise. A criterion for this is a rise in temperature of at least 0.1° C. This is always the case with water or calibration solutions if the stirring rod is set in such a way that it beats hard against the glass wall. This is not always the case with milk. Some milks freeze slowly. Should this error occur rarely with individual milk samples, the milk in question should be heated to approx. 40°C, cooled and measured again. However, if this error occurs often in a certain region, then it is better to lower the trigger temperature so that the samples are supercooled more aggressively, causing them to freeze easier. If this error occurs with calibration solutions, then the calibration of the device is incorrect or cooling bath liquid has leaked into the sample.

### Plateau not found:

This error can only occur when the "Plateau Search Method" in accordance IDF is used to determine the freezing point. With this method, the temperature value must be within the defined range for a certain time during the plateau. It can so happen that a certain milk sample does not fulfil this criterion. Then a second sample of this milk must be measured. If this error occurs frequently even though the device is otherwise functioning correctly, the error is either with the thermistor or the result of external disturbances.

### Uncalibrated or defective thermistor:

The instrument tests the current thermistor value when starting a measurement or calibration. Its electrical resistance is known to be a function of the temperature. This electrical resistance is translated with an ADC (analogue digital converter) into a number which is then used by the instrument. If the thermistor has a short circuit or a disruption, its resistance is zero or infinite, both of which conditions are impossible for a properly functioning thermistor. In this case, the thermistor will not start the measurement.

If the temperature which is given from the current thermistor value together with the calibration constant stored in the device is lower than +1°C (which is not possible with a thermistor which is located in a new, i.e. still warm sample), the device will also fail to start the measurement.

## IDENTIFYING TECHNICAL DEFECTS

**Switching on:** the device must show the starting message *„CryoStar I (or. CryoStar automatic), Funke Gerber"* on the display when it is switched on.

**Possible errors:**

- Locking devices on the network connection block
- Locking device on the main conductor board
- Main rectifier. Verify that the voltage of the main condenser is at least 11 V.
- Power transformer
- Error with the main conductor board
- Display or a cable leading to the display is defective

**Cooling phase:** the device should reach a cooling bath temperature of at least -6°C in a reasonable amount of time. This time depends on the surrounding temperature, but should not be longer than 20 minutes.

**Possible errors:**

- Air supply is not functioning properly: ventilation slots on the sides of the device are clogged, the inside of the device is contaminated.
- A ventilator has failed.
- Ventilator control system is defective. Verify that the voltage is approx. 24-26 V.
- Cooling block has suffered heating damage and is now defective.
- Cooling block control system is defective. Verify that the Peltier connectors are approx. 6-10 V at full cooling capacity.
- No or poor circulation: when an empty sample tube is immersed (with lid removed) into the measuring site and taken back out, the cooling bath liquid should flow back in within approx. 1 to 2 seconds. **Possible errors:**
  - Cooling bath liquid has become too thick. Change the liquid.
  - Too little cooling liquid, therefore air in the lead: add liquid.
  - Pump is blocked. Switch off device, open lid, carefully turn the pump motor rotor by hand: it should spin without resistance. If this is not the case (contaminants in the pump): rinse pump and lead.
  - Pump control system is defective. Verify that the voltage on the pump motor connectors is approx. 24-26 V.
  - Pump motor is defective: replace motor.
    - Axle between pump motor and pump is defective: remove pump motor, check axle.
    - Device reports the signal "lift error" when starting a measurement. **Possible errors are:**
    - Final position switch on the lift is defective.
    - Cable from measuring head to main conductor board is defective.
    - Conductor board in measuring head is defective.
- Device indicates a much too cold value on the display immediately after staring a measurement, beats the sample tube and reports "not frozen". This only occurs with old firmware versions. **Causes:**
  - Thermisor is defective. Change thermistor, install newer firmware version.
  - Stirring rod cannot be properly adjusted. **Possible causes:**
    - Stirring rod has been bent during a thermistor change and is touching the thermistor shaft. Bend the stirring rod back into shape and adjust the thermistor so that the stirring rod can oscillate freely.
    - Upper part of the stirring rod has a fatigue fracture: replace stirring rod.
    - Stirring rod was assembled backwards. The magnet in the stirring rod must be orientated in such a way that it is pulled by the current-carrying reel and is not pushed away. Assemble the stirring rod in the correct position.
- Device measures and can be calibrated, but measurement values are scattered. **Possible causes:**
  - Thermistor is defective. Somewhere on the thermistor, microscopic cracks have formed which moisture can now seep through. This causes the electrical properties of the thermistor to become compromised, meaning that the thermistor must be replaced.
  - Impure specimen dishes.
  - Cooling bath liquid has reached the thermistor shaft. A measurement was started without a sample tube. This means that the thermistor was dipped into the cooling bath liquid and the remains of it stuck to the thermistor shaft and have slowly got into the sample.

## IDENTIFYING OPERATIONAL ERRORS

Most errors that are made during operation of the device are incorrect calibrations. The calibration of a cryoscope is a precondition for each and every use. For measuring reasons it is necessary to use a thermistor to measure the temperature of a sample. Thermistors have a very strong temperature effect which is necessary for resolutions of more than 1 m°C. Unfortunately, the production-oriented fluctuation range of the resistance values of these components is so large that the temperature zero point (0°C) must usually be determined by a pre-calibration before the device can be calibrated with a new thermistor.

It has to be assumed that the A calibration cannot be successfully executed after a thermistor replacement. The reason for this is that the device first has to reach the set "trigger temperature" and then must recognize a rise in temperature after the glass wall has been hit (as a sign that the freezing has started). This does not happen because the values of the new thermistor result in false temperatures being given when calculated with the calibration constant of the old thermistor. Therefore a so-called pre-calibration is necessary, in which the device ignores the temperatures and follows a purely time-controlled measuring procedure. The calibration constants are subsequently adapted to the characteristics of the new thermistor so that both the A and the B calibration can be successfully carried out.

Unfortunately, it often happens that during the calibration sample tubes filled with calibration solution are taken for something else or that the incorrect menu item is selected.

### MIX UP: A CALIBRATION INSTEAD OF B CALIBRATION

The entire temperature scale of the device is displaced. When re-measuring the calibration solutions, reversed values and a reversed sign are given.

**Example:** A cal. with 0.000
A cal. with 0.000
B cal. with –0.557
A cal. with –0.557 (faulty operation)
Re-measuring solution B: results in 0.000
Re-measuring solution A: results in 0.557

### MIX UP: TAKING THE A SOLUTION INSTEAD OF THE B SOLUTION

At first the A calibration goes as expected. However, when it comes to the B calibration, the devices reports the error "uncalibrated" or "thermistor defective" and remains uncalibrated.

### Defective thermistor

This is a frequently occurring error. There are two possibilities:

1. The thermistor is (was) broken. This can be identified because display constantly shows a negative value that doesn't change.
2. The thermistor bonding is permeable. This is can be identified by extremely instable measurement behaviour. The reproducibility is very poor, e.g. there are variations of approx. ±0.1°C. In both cases the thermistor must be replaced.

## Stirring rod errors

- **The stirring rod does not oscillate freely:** it must be able to move freely in the slot provided. It cannot be allowed to touch the thermistor at any place. This must be kept in mind when replacing the thermistor.
- **The stirring rod amplitude is not high enough:**
  The cooling of the sample is not carried out uniformly and takes much longer than 1 minute. With a correctly adjusted stirring rod, the cooling time is almost exactly 1 minute. The stirring rod amplitude must be approx. 3-4 mm. If necessary, the stirring rob must be adjusted accordingly.
- **The stirring rod amplitude is too high:**
  Premature freezing of the sample occurs frequently.

## SPECIAL APPLICATIONS/MEASUREMENT OF CREAM

Since the liquid relevant for the freezing point only exhibits 60 % sample volume with a cream of approx. 40 %, it is recommended to increase the sample volume to 3 ml. In addition, the trigger temperature should be set to -3°C, or -3.2°C if the sample repeatedly fails to freeze. It is also possible to marginally increase the impact force of the stirring rod.

**Suggested set points**

| Description | Set points |
|---|---|
| A calibration | 0.000°C or -0.408°C |
| B calibration | -0.557°C or -0.600°C |
| Base value | -0.520°C (EU boundary value) Serves solely for calculation of the infiltration water content percentage. |
| Trigger temperature | -2.00°C ( -3.00°C minimum) |
| Mode | Celsius |
| Plateau | Plateau search: 0.4 m°C / 22s |
| Fixed time: | 50 s |
| Maximum: | 0.2m°C |
| Language | free choice |
| Stirring rod / amplitude | 3 - 4 mm |
| Stirring rod / frequency | **Note:** Do not change the set value!<br>The values lie between 95 Hz and 104 Hz, depending on the device.<br>Stirring rod/impact force. The impact force should be set to be so powerful that a relatively loud noise is heard when the trigger temperature (e.g. -2°C) is reached. However, it should be seen to that the impact force is not too strong, as this could lead to breakage of the sample tube. The set points lie between approx. 40 % and 50 %. |

**If the set points are changed, the device must be re-calibrated.**

# CryoStar automatic CryoStar I

**Important:**
The freezing curve is illustrated on the graphic colour display during the measurement. This enables the plateau search in accordance with the prescribed standard (DIN/ISO/IDF/5764) to be ideally tested and reproduced (patent-registered).

**Quick and reliable measurement of the freezing point in milk with the CryoStar**
Reference measurement in accordance with DIN / ISO / IDF 5764

## THE MOST IMPORTANT FEATURES AT A GLANCE:

- **Forward-looking and flexible:** fixed-time measurement, plateau search and maximum search features are available. All parameters relevant to these features can be programmed freely, and, of course, recorded as well. This means that the device can be adjusted to all national and international standards.

- **Easy-to-use:** operation is menu-assisted in the language of your choice. Currently, German, English, French, Greek, Italian, Polish, Portuguese, Spanish, Turkish and Hungarian are available.

- **Efficient:** a new cooling system provides for quick operational readiness even at high surrounding temperatures (up to approx. 32°C).

- **Fast:** up to 40 samples can be measured per hour, depending on the setting.

- **Multifunctional:** the device has a parallel connection (for standard printers) and can be hooked up to a PC with a serial interface. This makes it possible to map the freezing curve on the screen during a measurement and, when necessary, to save it. An efficient zoom function tops off the image. The software needed for this is included in the scope of delivery.

- **User-friendly:** the operation of this device is uncomplicated. The percentage of infiltration water is immediately indicated and printed out. The calibration is executed automatically. All settings and calibrations are permanently saved to non-volatile storage.

**Technical specifications:**

| | |
|---|---|
| Connection: | 230V/115 V AC (50...60 Hz), 180 VA |
| Measurement resolution: | 0.0001°C (0.1 m°C) |
| Reproducibility: | ± 0.002°C (± 2.0 m°C) |
| Measuring range: | 0.0000°C to -1.5000°C |
| Sample volume: | 2.0 ml to 2.5 ml<br>*(recommended value: 2.2 ml)* |
| Sample turnover: | up to 40/h, typically 30/h |
| Interfaces: | 1 x parallel, 1 x serial (RS232) |
| Cooling time: | approx. 15 min. |
| Display: | graphic colour display, freezing curve, measurement result [°C], [% infiltration water], date, time, measurement conditions |
| Protocol printing: | measurement result [°C], [% infiltration water], date, time, measurement conditions |

**CryoStar I** (single sample device)
Automatic cryroscope

Reference method in accordance with ISO/IDF/DIN 5764
This device differs from the "CyroStar$_{automatic}$" only in the sample feed system.

Weight: 12.0 kg (net)
Dimensions: 290 x 380 x 190 mm (w x d x h)
With measuring head: 240 mm (h)

**7150**

**CryoStar$_{automatic}$** (multi-sample device)

The measurement procedure of this device is identical to that of the single sample device "CyroStar 1".
It differs from the "CyroStar 1" only in the sample feed system. In addition, this device is equipped with a round magazine for 12 samples. This makes fully automatic measurement of 12 samples possible with the push of a button.

Weight: 14.6 kg (net)
Dimensions: 440 x 440 x 200 mm (w x d x h)
With measurement head: 240 mm (h)

**7160**

## Accessories/Expendable items

**7151** **Thermal printer** protocol printer (6 V DC)
for direct connection to the devices
CryoStar (art. no. 7150, 7160) and
LactoStar (art.no. 3510, 3530). Please see art. no. 7157
for compatible thermal paper rolls.

**7152** **Replacement thermistor,**
for CryoStar I and CryoStar$_{automatic}$ (art. no. 7150, 7160)
in accordance with ISO/DIN 5764, PVC, white

**7156** **Software**
for CryoStar (included in the scope of delivery)

**7157** **Thermal paper roll**
for thermal printer art. no. 7151

**7159** **Connecting cable** (12 V DC)
for CryoStar 12 Volt connection

**7165** Calibration standard "A"
0.000°C, in 250 ml PE bottle

**7166** Calibration standard "B"
-0.557°C, in 250 ml PE bottle

**7167** Sample tube
mit Marke with marking at 2.0 ml, 50 pieces

**7168** Sample stand
PPH, for 27 sample tubes (art. no. 7167)

**7169** Cooling bath liquid
in 500 ml PE bottle

**7174** Sampling pipette
adjustable from 1.0 to 5.0 ml

**7175** Pipette tips
for art. no. 7174

**7186** Calibration standard A
-0.408°C, in 250 ml PE bottle

**7187** Calibration standard B
-0.600°C, in 250 ml PE bottle

**7188** Confirmation standard C
-0.512°C, in 250 ml PE bottle

## Lactometer

**7500** easy-to-use hand refractometer for the in-house determination of SNF.

## Solubility index mixer

for determining the solubility of milk, cream, whey powder, among others

in accordance with ADPI and DLG regulations, with special motor, glass mixing bowl, stainless steel stirrer, timer and continuous operation switch.
See also art. no. 3634

**7610** **Solubility index mixer**

**7620** **Replacement glass mixing bowl**

**7621** **Replacement stirrer**

**7622** **Replacement drive belt**

## Reference table

**7650** ADPI "Scorched Particle Standards of Dry Milks", 4 stages

## Jolting volumeter

Type STAV II for determining the jolting volume of powdered milk.

White plastic casing, high gloss with single-phase AC motor 220 V/50 Hz, jolting mechanism with tension lock for measuring cylinder, five digit electrical pre-selection counter, on/off switch with control lamp, red semi matte control panel. The 250 ml measuring cylinders are standardised by weight and graduation in accordance with DIN 53194

**7660**

## Replacement measuring cylinder

**7661** for art. no. 7660

## SHORT TIME HEATING DETECTION
determination of alkaline phosphatase

**Lactognost original pack**
with reference table for 100 samples,
**7820** 1 spoon

**Lactognost refill pack**
with reagents I, II and III
**7821** for 100 samples

**Testing strips Phosphatesmo MI,**
**7822** pack of 50 strips

**Peroxtesmo MI**
high temperature heating detection/UHT test
detemination of peroxidase

**7825** pack of 100 strips

**Mastitis detection**
LactoStar is used to diagnose a mastitis infection (see art. no. 3510). In addition, determination by means of the California Mastitis Test can be done.

**California Mastitis Test (CMT)** (shalm test)
for quick determination of increased cell content in milk from which a possible mastitis infection can be diagnosed

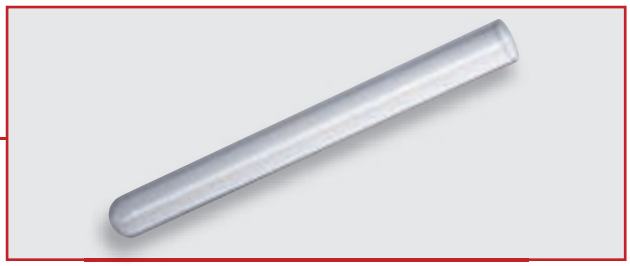
2 test trays with 4 dishes
**7920** 1 injection flask 250 ml

**California Mastitis Test (CMT)**
(test liquid)

**7930** 1 litre
**7931** 5 litres

**Test tube**
thick-walled, 100 pieces,

**8100** 160 x 15 x 16 mm



**Coli tube**
**8120** 20 x 10 mm, 100 pieces

**Durham tube**
**8130** 40 x 8 mm, 100 pieces

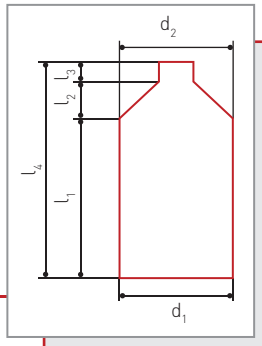
**Coli tube stand**
for 54 samples
stainless steel, sterilisable

**8140** 150 mm x 100 mm x 205 mm (w x h x d), 600 g

**Sterilizing box for pipettes**
stainless steel

**8190** 300 x 65 mm (length x thickness)
**8191** 420 x 65 mm (length x thickness)

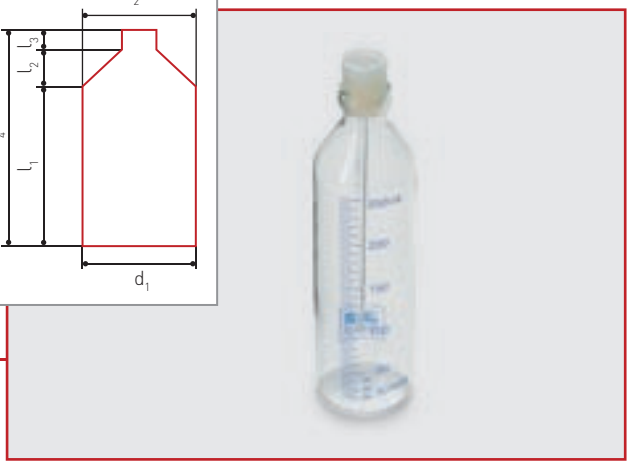
**8201** **Kapsenberg cap**
various colours




**Dilution flask**
borosilicate glass 3.3

**8290** **250 ml,** with glass rod and silicon stopper, sterilisable

**8291** without accessories
$l_4$ = 190 mm, $l_3$ = 20 mm, $l_2$ = 27 mm, $l_1$ = 143 mm, $d_2$ = 20.5 mm, d = 52 mm



**Dilution pipettes**

**8300** **1.1: 0.1 ml**
l = 250 mm, Ø = 5.9 mm

**8301** **1.0 + 1.1 ml,**
according to Demeter's method, with 2 markings
l = 225 mm, Ø = 6.9 mm

**8302** **1.0 + 2.0 + 2.1 + 2.2 ml,**
according to Demeter's method, with 4 markings
l = 260 mm, Ø = 6.3 mm

**8303** **1.0 + 1.1 + 1.2 ml,**
according to Demeter's method, with 3 markings
l = 225 mm, Ø = 7 mm

**Petri dish**
glass

**8310** 100 x 20 mm

## Petri dishes
plastic (disposable),
sterile packaging

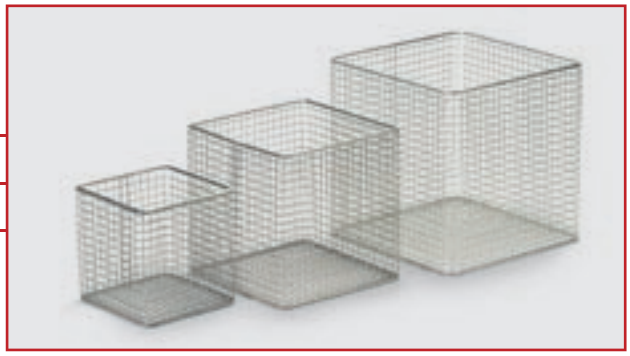
| | |
|---|---|
| **8312** | 1620 pieces, without vent cam, Ø 55 x 15 mm |
| **8313** | 480 pieces, with vent cam, Ø 94 x 16 mm |
| **8314** | 480 pieces, without vent cam, Ø 94 x 16 mm |

## Sterilizing box
with insert,
stainless steel, for Petri dishes

| | |
|---|---|
| **8320** | 250 x Ø 120 mm |

## Wire cages
for sterilisation

| | |
|---|---|
| **8330** | 100 x 100 x 100 mm |
| **8331** | 140 x 140 x 140 mm |
| **8332** | 200 x 200 x 200 mm |

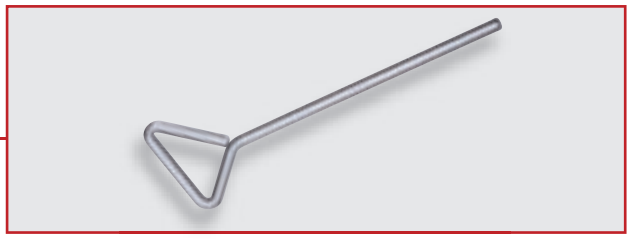


## Smear needle
rectangular bend

| | |
|---|---|
| **8340** | 0.59 mm thick |

**Drigalski spatula**
glass

**8350** l = 150 mm, triangle height = 30 mm



**Inoculation wire**
stainless steel

**8370** 1 m, Ø = 0.46 mm

**Burri loop**
platinum, calibrated

**8380** 0.001 ml

**8381** 0.01 ml

**Needle holder**
**8382** for inoculation wire loop

**Slide**
for microscope (art. no. 8761, 8762)
half white, cut edges,
50 pieces

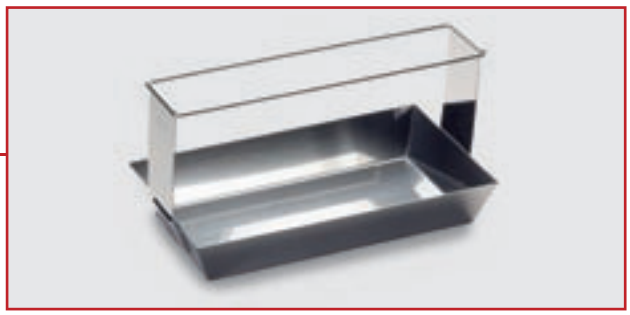
**8400** 76 x 26 mm

**Cover glass**
for microscope (art. no. 8761, 8762)

**8401** 18 x 18 mm

**8410** **Tweezers for slides**

| | |
|---|---|
| **8420** | **Staining stand**<br>according to Bongert's method |



| | |
|---|---|
| **8430** | **Staining cuvette**<br>rectangular |

| | |
|---|---|
| | **Wire mesh** |
| **8440** | with ceramic centre |
| **8441** | without ceramic centre |
| **8450** | **Tripod** for Bunsen burner |

## ColonyStar bacteria counter

easy-to-clean plastic casing, height adjustable illuminated area of 145 mm Ø with direct or indirect glare free lighting, frosted glass and clear glass plate with $cm^2$ und 1/9 $cm^2$ graduation, electrical contact pin with felt tip pen for marking Petri dishes of up to 145 mm Ø can be used. The supplied reducing insert can be used for dishes with smaller diameters.

220 V/50 Hz, 250 x 230 x 75 mm, 1.7 kg

| | |
|---|---|
| **8500** | **ColonyStar**<br>with accessories (art. no. 8501, 8503, 8504, 8505) |
| **8501** | **Magnifying lens** with sturdy base a. flexible arm |
| **8502** | **ColonyStar** without accessories |
| **8502-001** | Replacement **frosted glass plate** |
| **8503** | Automatic **contact pin** |
| **8504** | **Felt pen refill** replacement part for art. no. 8503 |
| **8505** | **Clear glass plate** with dark field |

## Portable bench autoclaves

with screwed-on control thermometer for rapid and efficient vapour sterilisation at 140°C/2.7 bar or 125°C/1.4 bar. Also suitable for autoclaving small amounts of culture media. Special valves can be supplied on request for 115°C/0.7 bar and 121°C/1.1 bar.

A stainless steel instrument board (Ø 215 mm) and a stainless steel tripod are included in the shipment.

220 - 230 Volt, 50 - 60 Hz, 1.6 KW to 1.75 KW, aluminium, polished silk gloss exterior, thermostatic temperature controller, tested safety (GS)

### CV-EL 12 L

**8541** Volume 12 L, weight 6.1 kg, diameter 24 cm, interior height 24 cm, maximum usable diagonal 32 cm

### CV-EL 18 L

**8542** Volume 18 L, weight 7.7 kg, diameter 24 cm, internal height 38 cm, usable diagonal 43 cm

**8543** **Wire basket**

## Culture cultivating appliance

for cultivation of individual dairy cultures. Stainless steel culture vessels, 5 L with lid and stirrer, PP plastic casing, microprocessor controller, 8 different sizes from 1 x 5 L to 4 x 20 L

| | |
|---|---|
| **8610** | 1 x 5 L - vessel, 2 x 0.5 L starter culture flask |
| **8611** | 2 x 5 L - vessel, 2 x 0.5 L starter culture flask |
| **8612** | 4 x 5 L - vessel, 4 x 0.5 L starter culture flask |
| **8613** | 1 x 10 L - vessel, 2 x 0.5 L starter culture flask |
| **8614** | 2 x 10 L - vessel, 2 x 0.5 L starter culture flask |
| **8615** | 4 x 10 L - vessel, 4 x 0.5 L starter culture flask |
| **8616** | 2 x 20 L - vessel, 2 x 0.5 L starter culture flask |
| **8617** | 4 x 20 L - vessel, 4 x 0.5 L starter culture flask |

## Test tube shaking device

The shaking function is started by pressing down on the test tube support plate.
Shaded pole motor, 45 Watt, 230V
rpm infinitely variable from 0-2800

**8650** 110 x 100 x 90 mm (w x d x h)

## Magnetic stirrer L-71

without heater,
rpm range 50 - 1250
up to 5000 ml capacity
compact aluminium casing

**8690** plate diameter: 155 mm

## Magnetic stirrer L-81

with heater, heating plate temperature 50-325°C
rpm range 50 - 1250
up to 5000 ml capacity
compact aluminium casing

**8691** plate diameter: 145 mm

## Stirring rod

| | |
|---|---|
| **8696** | 25 x 7 mm |
| **8697** | 30 x 7 mm |
| **8698** | 80 x 9 mm |

## Photometer Spekol 1300

Single jet instrument for spectrum and kinetic measurements in the range of 190 - 1100 nm

with numerical display, equipped with printer interface. Easy handling with pre-programmed methods
230 V, 50-60 Hz, 11.5 kg, temperature range: 15 - 35°C

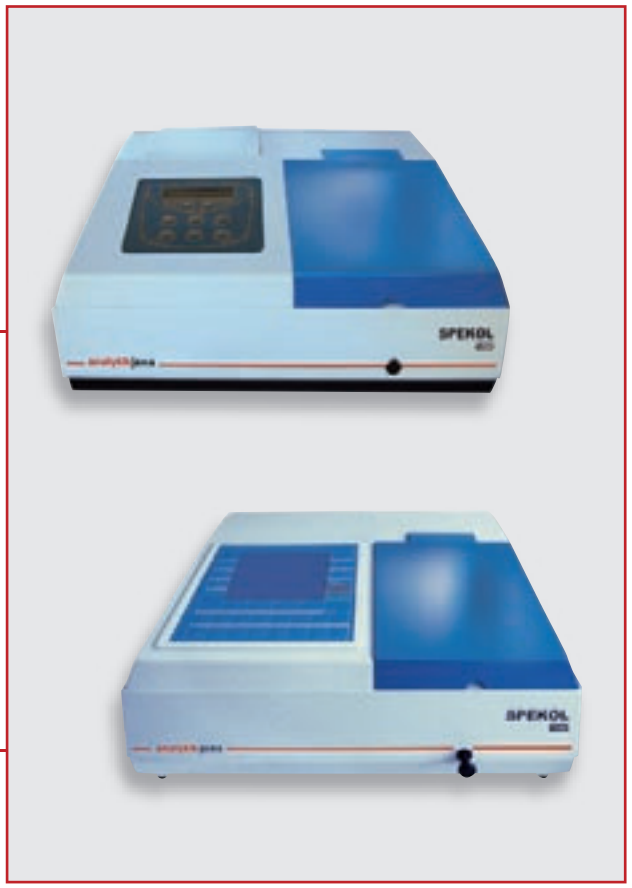
**8700** 465 x 365 x 175 mm (w x h x d)

## Photometer Spekol 1500

Single jet instrument for spectrum and kinetic measurements in the range of 190 - 1100 nm

with high-resolution LDC-VGA screen,
equipped with printer interface.
Easy handling with pre-programmed methods
230 V, 50-60 Hz, 11.5 kg, temperature range: 15 - 35°C

**8701** 465 x 365 x 175 mm (w x h x d)




## Manual 4x cuvette changer

**8702** for 1 cm or for 5 cm, 10 cm cuvettes

**8705** **Cuvettes**

## Binocular microscope
with 45° slanted viewer

stable metal casing with coaxial fine and coarse focus with adjustable end stop. Built-in cross table movement L-R 74, V-H 30 mm.
Built-in illumination 6V/20W, power supply 230 V, 50 Hz.
Doppel lens Abbe condenser N.A 1.25 with iris diaghragm, pivotable filter holder, height adjustment,
glass filters: blue, green.
(Accessories: art. no: 8400, 8401, 8410)

Eyepiece: 0x planar eyepiece
Objectives: achromatic 4x/0.10; 10x/0.25; 40x0.65, 100 x 1.25 oil immersion

**8761**

## Trinocular microscope
in addition to the binocular model with trinocular sliding tube
(accessories: art. no. 8400, 8401, 8410)

**8762**

## Automatic water distillation apparatus
For generating distilled water with a conductivity of under 2.3 µS/cm at + 20°C.
Apparatus is fabricated completely from stainless steel 1.401. Wall holder and water supply and discharge hoses are included in the scope of the delivery.

Efficient energy consumption due to use of cooling water heated to 80°C.

| | |
|---|---|
| Destillatmenge: | 4 L / h |
| Storage tank: | 4 L |
| Cooling water consumption: | 50 L / h |
| Power supply: | 220 V / 50 Hz; 3.2 kW |
| Dimensions: | 510 x 460 x 230 mm |
| Weight: | 13 kg |

**8771**

| | |
|---|---|
| Distillate amount: | 7 L / h |
| Storage tank: | 7 L |
| Cooling water consumption: | 70 l / h |
| Power supply: | 220 V / 380 V / 50 Hz; 4.8 kW |
| Dimensions: | 670 x 500 x 340 mm |
| Weight: | 19 kg |

**8772**

## Water bath

with digital clock up to 999 hours
and temperature rise safety

| | |
|---|---|
| **8786** | 7 L with gable cover<br>approx. 11 kg, 240 x 20 x 140 mm |
| **8788** | 22 l with gable cover<br>approx. 16 kg, 350 x 290 x 220 mm |

# THE USE OF REFERENCE MATERIAL IN THE LABORATORY

Dr. Ulrich Leist, DRRR GmbH, reports

***Dr. Ulrich Leist*** *studied chemistry and marine life science in Marburg, Stuttgart and Oldenburg, where he got his doctorate in the field of surface science. Afterwards, he was employed as a postdoctoral researcher for a year at Harvard University, Cambridge USA. He gathered additional experience in the field of interlaboratory tests/reference material during his four year employment at Muva Kempten. Since 2007 he has been the executive director of the Deutsches Referenzbüro für Lebensmittelringversuche und Referenzmaterialien GmbH (DRRR GmbH) (German Reference Office for Foodstuff Interlaboratory Tests and Reference Material, Ltd.).*

**Fundamentals for evaluating laboratory results of the main parameters in dairy farming**

The use of reference material in the laboratory serves to assure quality. On the one hand, laboratory personnel can be trained, methods can be developed, checked and optimized, and measuring devices can be tested for their operational capability, accuracy and precision. Of particular importance when doing this is the calibration of indirect measurement equipment, e.g. IR spectrometers, with which the measurement signal is first related to the reference parameter, for example to a measurement parameter such as fat.

To ensure the optimal use of reference material, the fundamental terms should be briefly defined:

- **Accuracy:** degree of the total error of an analysis and thereby an umbrella term for correctness and precision.
  A result is accurate when it is free of incidental and systematic mistakes.
- **Correctness:** degree of deviation from the measurement value (or, the mean of many measurement values) to the correct (actual) value due to a systematic mistake *(also: bias for the amplitude of a systematic mistake)*.
- **Precision:** precision indicates how widely the analysed values are scattered due to incidental mistakes. Precision is statistically described by the standard deviation or the confidence interval.
- **Reproducibility (repeatability limit) r:**
  The absolute difference between two single measurement values that can be expected from the same material, the same methods, the same person, the same instrument, the same laboratory and the same time frame with a probability of 95 %.
- **Comparability (comparability limit) R:**
  The absolute difference between two single measurement values that can be expected from the same material, the same methods, different people, different instruments, different laboratories and a larger time frame with a probability of 95 %.

Precision data for the methods is of particular importance as this makes it possible for laboratories to evaluate whether they are proficient in a method and whether measurement results of different laboratories are comparable. This is crucial in the case of reference methods because they are the accepted foundation on which products like foodstuffs can be judged. Precision data is documented in various standards and official regulations.

**Precision data r and R from:**

- DIN/EN/ISO
- IDF
- § 64 LFGB (previously: § 35 LMBG)
- VDLUFA

## Precision data for milk

| Parameter | Method | r | R | $s_R$ | CRD | Range of application |
|---|---|---|---|---|---|---|
| Fat | Roese Gottlieb | 0.02 %<br>0.02 %<br>0.01 % | 0.04 %<br>0.03 %<br>0.025 % | 0.014 %<br>0.011%<br>0.009 % | 0.026 %<br>0.019 %<br>0.017 % | 3.5 % fat<br>1.5 % fat (0.5 to 2 %)<br>skim milk <0.5 % fat |
| Dry matter | 102°C, sea sand | 0.10 % | 0.20 % | 0.071 % | 0.132 % | |
| Protein | Kjeldahl | 0.04 % | 0.10 % | 0.035 % | 0.068 % | |
| Lactose | enzymatic determination | Value x 0.05 | Value x 0.06 | $\frac{R}{2.83}$ | | |
| Freezing point | cryoscopy | 0.004°C | 0.006°C | 0.002°C | 0.004°C | |

## Precision data for powdered milk

| Parameter | Method | r | R | $s_R$ | CRD | Range of application |
|---|---|---|---|---|---|---|
| Fat | Roese Gottlieb | 0.2 %<br>0.15 %<br>0.1 % | 0.3 %<br>0.25 %<br>0.2 % | 0.106 %<br>0.088 %<br>0.071 % | 0.187 %<br>0.160 %<br>0.132 % | VMP, powdered cream<br>Partially removed powder<br>Skim milk powder |
| Dry matter | 102°C, sea sand | 0.2 % | 0.4 % | 0.141 % | 0.265 % | |
| Protein | Kjeldahl | 0.3 % | 0.8 % | 0.283 % | 0.545 % | |
| Lactose | enzymatic determination | Value x 0.05 | Value x 0.06 | $\frac{R}{2.83}$ | | |

## Precision data for processed cheese

| Parameter | Method | r | R | $s_R$ | CRD | Range of application |
|---|---|---|---|---|---|---|
| Fat | SBR | 0.1 %<br>0.2 % | 0.4 %<br>0.6 % | 0.141 %<br>0.212 % | 0.278 %<br>0.412 % | 10 % abs. fat<br>25 % abs. fat |
| Dry matter | 102°C, sea sand | 0.3 % | 0.5 % | 0.177 % | 0.320 % | |
| Protein | Kjeldahl | 0.19 % | 0.38 % | 0.134 % | 0.251 % | |
| Lactose | enzymatic determination | Value x 0.05 | Value x 0.06 | $\frac{R}{2.83}$ | | |

# QUALITY FROM THE VERY BEGINNING

The use of modern analytical reference systems for the processing of milk is characterized by challenging analytical and statistical demands.

Milk processing is accompanied by a series of measures which assure quality. These measures of course include the analysis of milk beginning at the moment the milk is delivered to the milk processing company, namely dairies. For the analysis of chemical quality parameters of milk such as protein, fat, lactose, dry matter and freezing point, infrared spectroscopy methods as well as thermo-analytical methods (LactoStar) are used extensively in the processing of milk. When doing so, the use of modern IR spectrometers makes it possible to provide test results for the above-mentioned testing parameters within just a few seconds. The speed advantage over the reference testing methods such as Roese Gottlieb's method for determining fat content (test duration approx. 8 hours) or Kjeldahl's method for determining protein content (test duration approx. 8 hours) is enormous. This speed advantage enables rapid response to changes in the constitution of milk as well as with milk supply and the intermediate and end products and makes it possible to adjust the production accordingly. This means that e.g. the fat or protein content for the respective product can be held constant throughout the production time. The IR and thermal analysis not only lend themselves to the control of raw milk but also to all intermediate and end products.

The only disadvantage of the IR spectroscopic methods and thermo-analytical methods is the fact that these are indirect methods. That means that the analytical instruments have to be calibrated.

## Calibration

For calibration, a concentration value must be related to the measurement signal of the analytical instrument.

This fundamental calibration is usually included in the scope of delivery of the instrument or is configured with the help of the instrument manufacturer.

The basic calibration is ultimately a relation of the physical measurement scope to a substance. The regular calibration related to a concrete product is usually carried out by the user himself. Here, the change in concentration of a substance is ultimately correlated to the change in the strength of the signal. Conventionally, to do this a sample is measured with the analytic instrument whose substance is determined at the same time through tests with rapid methods or reference methods. The test results obtained are then allocated to the analytical instrument during calibration. At the same time, this means that the uncertainty of measurement of the test results must be factored in to the instrument. The precision reached with the calibration can hence only lie within the boundaries of the method comparability. This means that the theoretically possible precision is entered into the analytical instrument. In addition, the measurement speed advantage is partially quantified by the increase in measurement certainty. In order to cancel out this disadvantage, the number of calibration sample tests with rapid or reference methods can be increased, which is however very costly. Since it is necessary to regularly calibrate the analytical instrument, each and every increase in the sample number for tests in the context of calibration value assignment leads to an increase in test complexity and expense.

However, consideration of measurement uncertainty can not be foregone. When fulfilling official regulations regarding foodstuffs, e.g. pasteurized milk, these uncertainties during calibration must be considered. If the target values for a product are not fulfilled, it can lead to penalties from the customer or to violation of food labelling regulations.

Modern analytical instruments boast precise measuring technology, but reliable and accurate calibration is essential to complement it.

The means of selecting accurate and precise calibration lies in the use of verified reference systems.

A reference system is ultimately dependent on the reference material which has been confirmed by interlaboratory tests. Particularly high demands are placed on quality assurance with a reference system like that of the DRRR corporation, which has earned the status of a leading proficiency level.

**The reference values are determined by an interlaboratory test.**

- Only reference methods are used to test reference methods
- The reference laboratories fulfil the demands of standards DIN EN ISO/IEC 17025
- The reference laboratories are under constant supervision, through with they regularly demonstrate their above-average competence by successful participation in respective interlaboratory tests
- The determination of reference values is carried out using extensive modern statistical methods in accordance with the current status of science and technology
- Materials are manufactured without preservatives, using actual shock frost procedures.

**The use of reference materials yields the following advantages:**

- The materials are related to the reference methods. Thus, the calibration also refers to reference methods. Being that the laboratories are supervised, the return to the reference method is largely assured.
- The material uncertainty corresponds to the comparability of the reference method.
- The use of reference materials makes the simultaneous testing of self-produced calibration samples superfluous. This means lower costs.
- The use of calibration materials assures high linearity, precision and accuracy.
- The materials can be used at any time. Thus, flexibility is increased. In connection with the rapid analysis time with an IR device, a considerable speed advantage is won over classic calibration procedures in dairy laboratories.

## CALIBRATION PROCEDURE

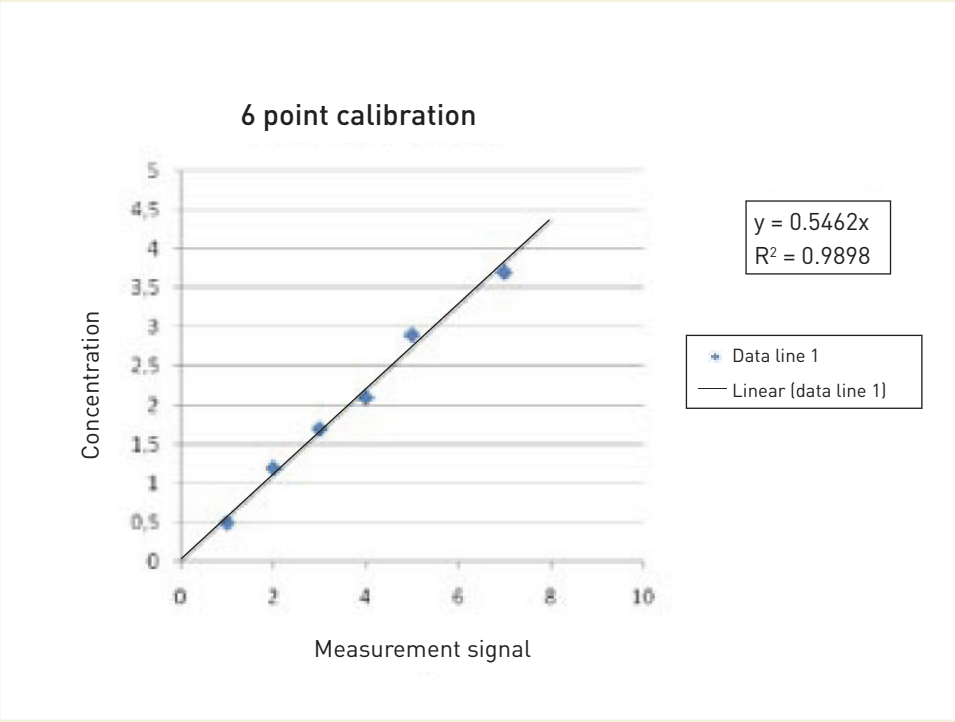
There are in essence two calibration procedures. First, the multiple point calibration procedure and second, the one point calibration procedure. A fundamental calibration is required for both procedures.

### One point calibration

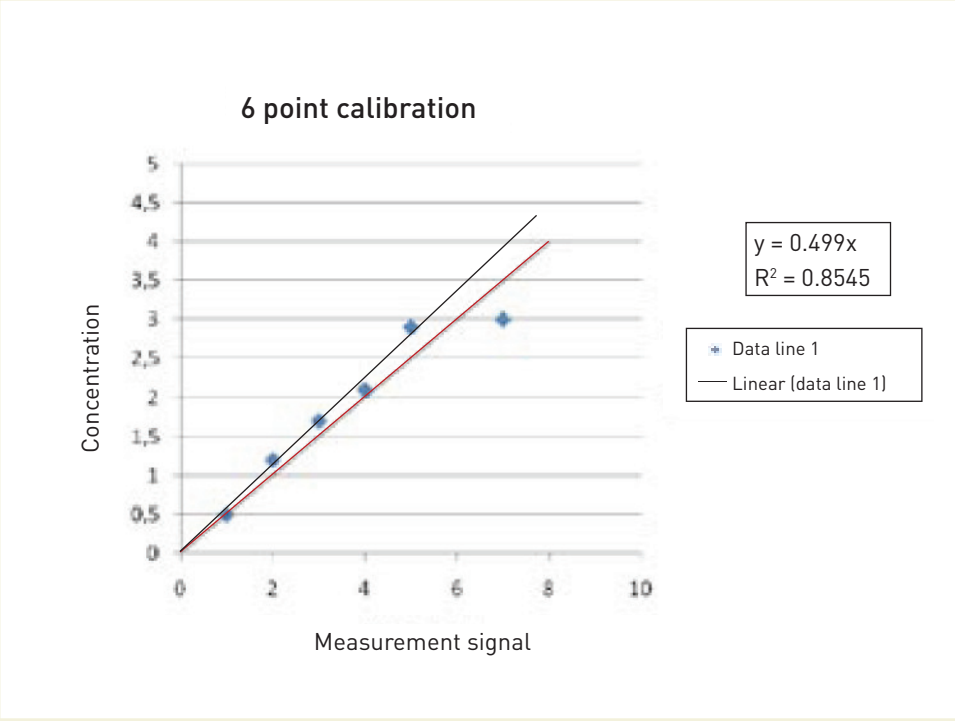
In this context, the calibration usually only has to do with a bias adjustment. This is by all means acceptable if the calibration itself can be assumed to be stable. If this is not the case, a deviation in the measurement value to the expected reference value can only indicate a general deviation. An adjustment to the instrument setting in the direction of the reference value can even in an extreme lead to a degradation of the calibration state.

### Multiple point calibration

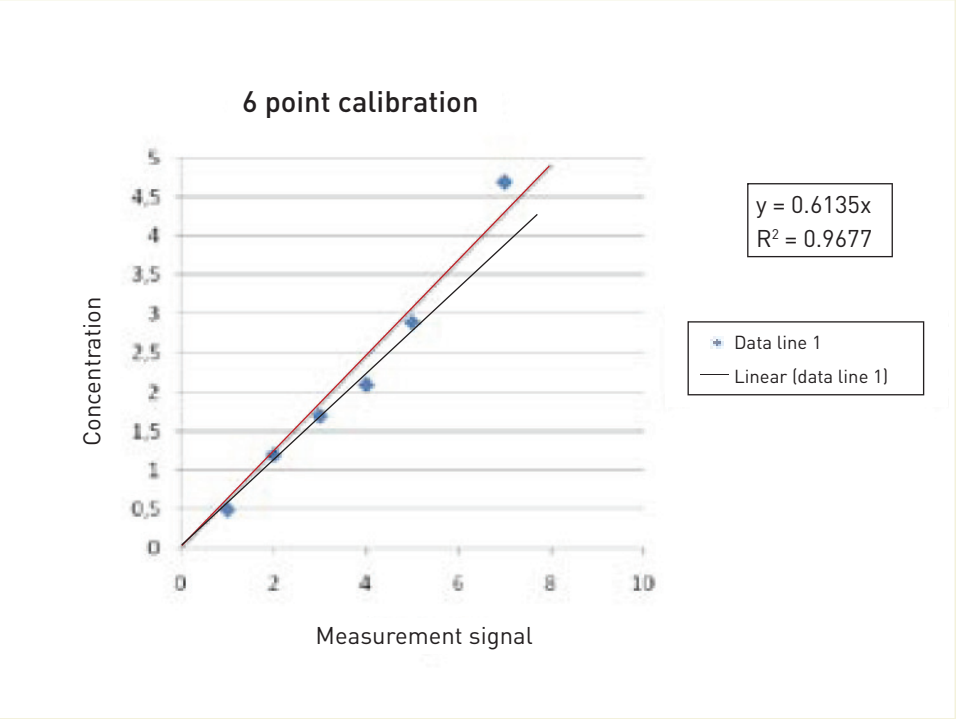
Various calibration samples with different concentrations of the target parameters are measured. The various concentrations of the respective substance (parameter) are set in relation to different measurement signal strengths. In doing so, for each calibration sample measured the reference value of the target parameter is related to the measurement signal. Within the area of concentration of the various calibration samples, a mathematical interrelation regarding the calibration slope between the sample concentration and measuring value is produced on the analytical instrument.
Of particular importance with the multiple point calibration is the "rear values", meaning the values with higher concentration. As can be seen in the following figure, the "rear" value has considerable influence on the calibration slope. If the calibration slope should be steepened, it is advisable to set additional calibration points in the high (rear) area of concentration. The goods of the calibration can be read off on the correlations coefficient, among other things. This should by all means be higher than 0.9. The correlation coefficient indicates how probable it is that the calibration points actually match the calibration slope. The maximum correlations coefficient that can be reached is 1 (=100 %).



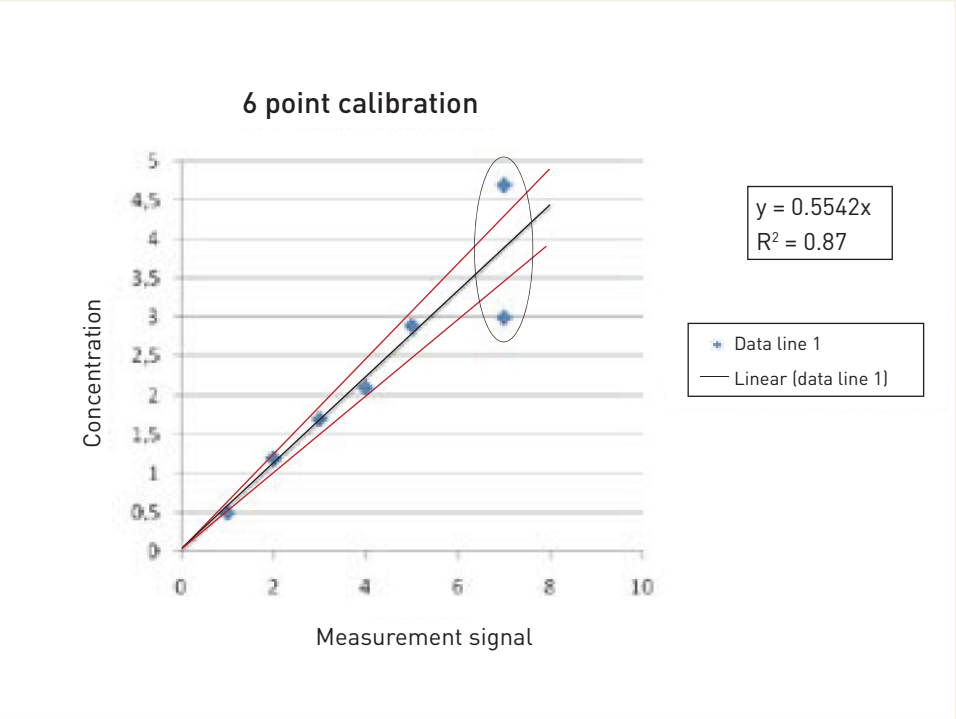

Normal 6 point calibration, with a correlation coefficient near 1.




The 6th measurement value (rear value) is low. The correlation coefficient is near 0.9.



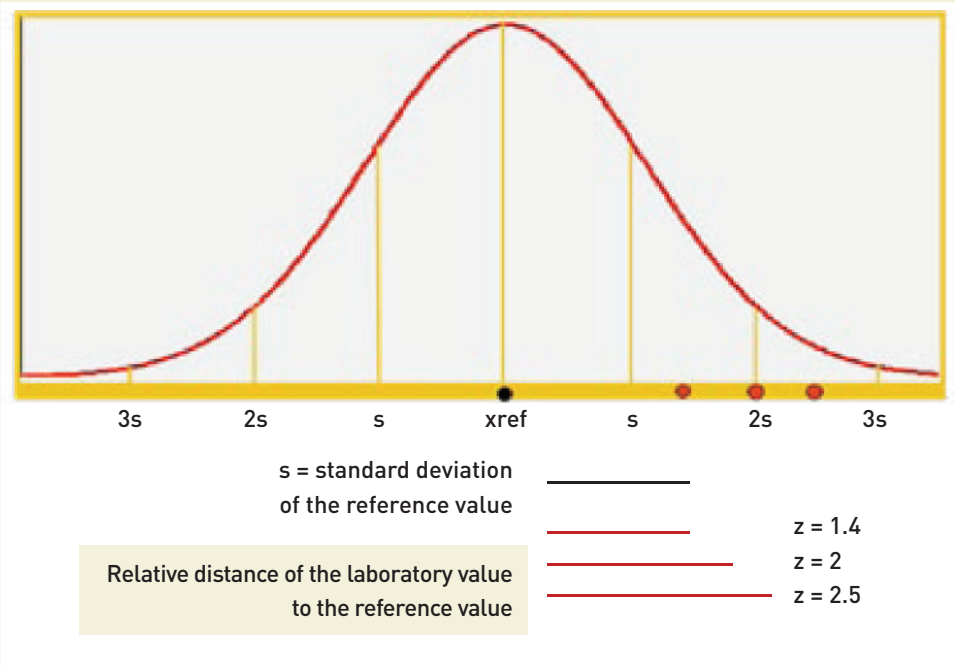

**6 point calibration, the 6th measurement value is high, correlation coefficient near 1.**




**Range of calibration slope, with uncertainties in "rear" value area.**

In addition to the use of reference material, interlaboratory tests are applied to assure quality. However, the focus of these is often set exclusively on the z-score. For this reason, it will be briefly explained in the following section.

## THE Z-SCORE




With the midpoint and the standard deviation the z-score can be calculated for any laboratory using the following equation [2].

$$z - score = \frac{x_i - m}{s}$$

The respective laboratory measurement value (usually the midpoint of the repeat determination) $\mathbf{x_i}$ is set in the equation above. Then the midpoint **m** and the standard deviation **s** of the entire data set are entered into the equation. Thus, the distance of the laboratory value to the midpoint is calculated in units of standard deviation. A laboratory which has a z-score of exactly 2 has a distance to the midpoint of exactly 2 standard deviations. That means that the laboratory is just barely part of the 95.45 % of the values that are expected around the midpoint. In the area between 2 and 3 standard deviations lies the remaining 5 % of the values. A z-score of 3 or larger means that there is only a probability of 0.027 % of belonging to the data sat observed. The z-score is assessed accordingly:

| | |
|---|---|
| z < 2 | data credible |
| 2 < z < 3 | 3 data questionable |
| z > 3 | data not credible |

In any case it can be wise for the interlaboratory test participant to select the data sets of a interlaboratory test with which he wants to use for comparison, for example because it uses the same methods, or features the competitor or his customer. He can calculate his own z-score according to his test question with equation 3, which has the necessary informative value according to the test question.

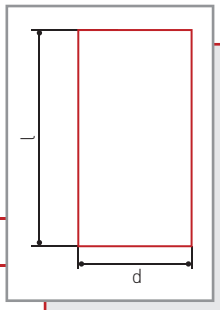
**Reference material**

You will find the most important reference material for chemical milk analysis eith article numbers 3517, 3518, 3519, 3521 (page 45)

# LABORATORY GLASSWARE

## Beaker

short design, borosilicate glass,
with graduation and spout



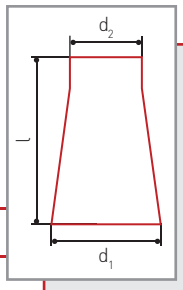
| | | |
|---|---|---|
| **8800** | **50 ml** | d = 38.7 mm, l = 60 mm |
| **8801** | **100 ml** | d = 47 mm, l = 70 mm |
| **8802** | **250 ml** | d = 67 mm, l = 95 mm |
| **8803** | **400 ml** | d = 76.2 mm, l = 110 mm |
| **8804** | **600 ml** | d = 86.6 mm, l = 125 mm |
| **8805** | **800 ml** | d = 94 mm, l = 135 mm |
| **8806** | **1000 ml** | d = 102 mm, l = 145 mm |

tall design, borosilicate glass,
with graduation and spout

| | | |
|---|---|---|
| **8808** | **50 ml** | d = 34.6 mm, l = 71 mm |
| **8809** | **100 ml** | d = 44.5 mm, l = 80 mm |
| **8810** | **250 ml** | d = 57 mm, l = 122 mm |
| **8811** | **400 ml** | d = 67 mm, l = 129 mm |
| **8812** | **600 ml** | d = 77.9 mm, l = 148 mm |
| **8813** | **800 ml** | d = 84 mm, l = 175 mm |
| **8814** | **1000 ml** | d = 92.8 mm, l = 180 mm |
| **8815** | **2000 ml** | d = 114 mm, l = 240 mm |

## Erlenmeyer flasks

narrow necked, borosilicate glass
with graduation, DIN 12380



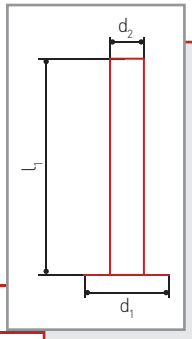

| | | |
|---|---|---|
| **8817** | **50 ml** | $d_2$ = 19.4 mm, l = 87 mm, $d_1$ = 51 mm |
| **8818** | **100 ml** | $d_2$ = 17.9 mm, l = 108 mm, $d_1$ = 63.5 mm |
| **8819** | **200 ml** | $d_2$ = 31.1 mm, l = 135 mm, $d_1$ = 78.7 mm |
| **8820** | **250 ml** | $d_2$ = 32 mm, l = 146 mm, $d_1$ = 83 mm |
| **8821** | **300 ml** | $d_2$ = 31.5 mm, l = 165 mm, $d_1$ = 86 mm |
| **8822** | **500 ml** | $d_2$ = 32.3 mm, l = 180 mm, $d_1$ = 104.5 mm |
| **8823** | **1000 ml** | $d_2$ = 38.9 mm, l = 225 mm, $d_1$ = 130.3 mm |
| **8824** | **2000 ml** | $d_2$ = 46.6 mm, l = 285 mm, $d_1$ = 165 mm |

wide necked, borosilicate glass
with graduation, DIN 12385

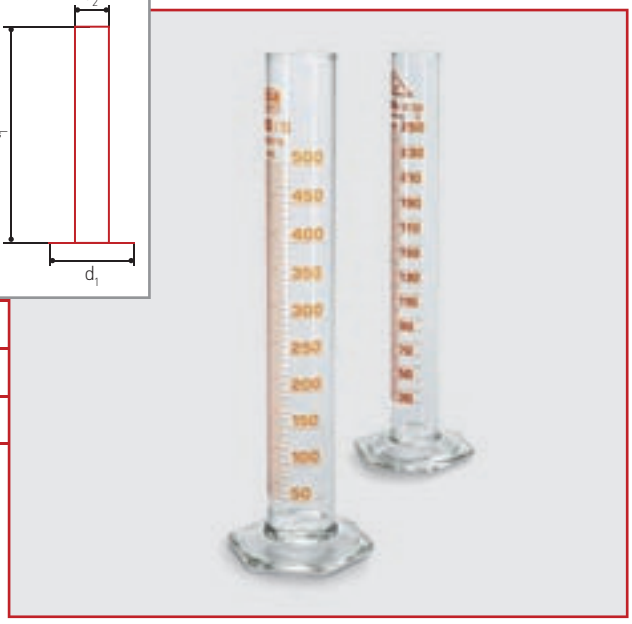
| | | |
|---|---|---|
| **8826** | **50 ml** | $d_2$ = 31.1 mm, l = 86 mm, $d_1$ = 51.4 mm |
| **8827** | **100 ml** | $d_2$ = 31.7 mm, l = 107 mm, $d_1$ = 63.5 mm |
| **8828** | **200 ml** | $d_2$ = 45.7 mm, l = 140 mm, $d_1$ = 78 mm |
| **8829** | **250 ml** | $d_2$ = 47 mm, l = 140 mm, $d_1$ = 84.7 mm |
| **8830** | **300 ml** | $d_2$ = 47.6 mm, l = 154 mm, $d_1$ = 87 mm |
| **8831** | **500 ml** | $d_2$ = 46.8 mm, l = 175 mm, $d_1$ = 105 mm |
| **8832** | **1000 ml** | $d_2$ = 47.8 mm, l = 215 mm, $d_1$ = 132 mm |
| **8833** | **2000 ml** | $d_2$ = 64.8 mm, l = 280 mm, $d_1$ = 150 mm |

## Measuring cylinder

tall design, glass,
with spout




| | | |
|---|---|---|
| **8850** | **50 ml** | 1/1 ml, $d_2$ = 22.4 mm, $d_1$ = 65 mm, $l_1$ = 195 mm |
| **8851** | **100 ml** | 1/1 ml, $d_2$ = 27.5 mm, $d_1$ = 76 mm, $l_1$ = 245 mm |
| **8852** | **250 ml** | 2/1 ml, $d_2$ = 36.5 mm, $d_1$ = 96 mm, $l_1$ = 320 mm |
| **8853** | **500 ml** | 5/1 ml, $d_2$ = 47 mm, $d_1$ = 114 mm, $l_1$ = 380 mm |
| **8854** | **1000 ml** | 10/1 ml, $d_2$ = 61 mm, $d_1$ = 145 mm, $l_1$ = 465 mm |



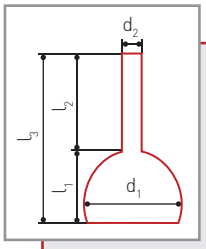
## Measuring cylinder
tall design, polypropylene,
blue graduation

| | | |
|---|---|---|
| **8855** | **50 ml** | 1/1 ml, $d_2$ = 23 mm, $d_1$ = 68 mm, $l_1$ = 200 mm |
| **8856** | **100 ml** | 1/1 ml, $d_2$ = 28 mm, $d_1$ = 88 mm, $l_1$ = 260 mm |
| **8857** | **250 ml** | 2/1 ml, $d_2$ = 42 mm, $d_1$ = 101 mm, $l_1$ = 310 mm |
| **8858** | **500 ml** | 5/1 ml, $d_2$ = 61 mm $d_1$ = 95 mm, $l_1$ = 350 mm |
| **8859** | **1000 ml** | 10/1 ml, $d_2$ = 70.5 mm, $d_1$ = 135 mm, $l_1$ = 415 mm |
| **8860** | **2000 ml** | 20/1 ml, $d_2$ = 81 mm, $d_1$ = 160 mm, $l_1$ = 490 mm |

## Mixing cylinder
AR glass, round base,
with NS PE stopper

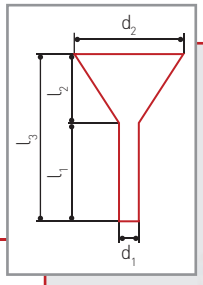
| | | |
|---|---|---|
| **8862** | **100 ml 1/1** | $d_2$ = 22.4 mm, $d_1$ = 58 mm, $l_1$ = 280 mm |
| **8863** | **250 ml 2/1** | $d_2$ = 27.7 mm, $d_1$ = 85 mm, $l_1$ = 340 mm |

## Measuring flask
with stopper,
borosilicate glass, with ring markings
DIN 12664, adjusted to "In"



| | | |
|---|---|---|
| **8870** | **25 ml** | $d_2$ = 6.5 mm, $d_1$ = 37 mm, $l_1$ = 38 mm, $l_2$ = 73 mm, $l_3$ = 111 mm |
| **8871** | **50 ml** | $d_2$ = 12 mm, $d_1$ = 48 mm, $l_1$ = 45 mm, $l_2$ = 92 mm, $l_3$ = 137 mm |
| **8872** | **100 ml** | $d_2$ = 11.09 mm, $d_1$ = 60 mm, $l_1$ = 63 mm, $l_2$ = 111 mm, $l_3$ = 174 mm |
| **8873** | **250 ml** | $d_2$ = 12.9 mm, $d_1$ = 78 mm, $l_1$ = 85 mm, $l_2$ = 130 mm, $l_3$ = 215 mm |
| **8874** | **500 ml** | $d_2$ = 17.3 mm, $d_1$ = 100 mm, $l_1$ = 110 mm, $l_2$ = 150 mm, $l_3$ = 260 mm |
| **8875** | **1000 ml** | $d_2$ = 22 mm, $d_1$ = 126 mm, $l_1$ = 140 mm, $l_2$ = 165 mm, $l_3$ = 305 mm |

## Glass funnel
AR glass, smooth,
slanted end,
with short stem, DIN 12445



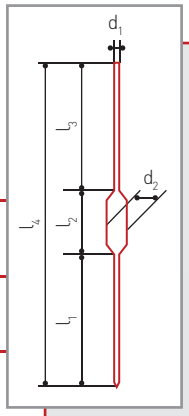
| | |
|---|---|
| **8876** | $d_2$ = 55 mm, $d_1$ = 10 mm, $l_3$ = 90 mm, $l_2$ = 40 mm, $l_1$ = 50 mm |
| **8877** | $d_2$ = 100 mm, $d_1$ = 10.2 mm, $l_3$ = 180 mm, $l_2$ = 80 mm, $l_1$ = 100 mm |
| **8878** | $d_2$ = 150 mm, $d_1$ = 16 mm, $l_3$ = 275 mm, $l_2$ = 130 mm, $l_1$ = 145 mm |
| **8879** | $d_2$ = 200 mm, $d_1$ = 20.3 mm, $l_3$ = 330 mm, $l_2$ = 165 mm, $l_1$ = 165 mm |

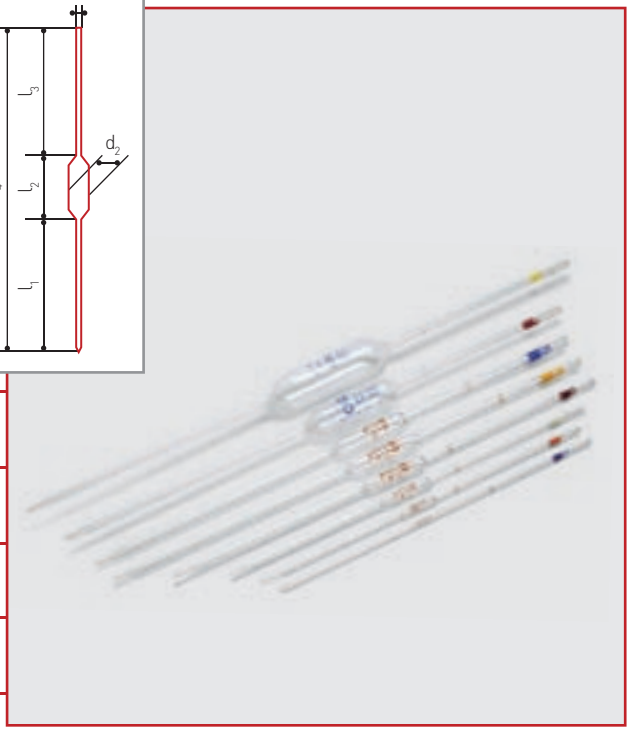
## Measuring pipettes
colour code, AR glass

| | | |
|---|---|---|
| **8882** | **1 ml, 1/100** | $l_4$ = 360 mm, $d_1$ = 5 mm |
| **8883** | **2 ml, 1/50** | $l_4$ = 360 mm, $d_1$ = 5.9 mm |
| **8884** | **5 ml, 1/10** | $l_4$ = 360 mm, $d_1$ = 7.5 mm |
| **8885** | **10 ml, 1/10** | $l_4$ = 360 mm, $d_1$ = 9.9 mm |
| **8886** | **25 ml, 1/10** | $l_4$ = 400 mm, $d_1$ = 14 mm |
| **8887** | **50 ml, 1/5** | $l_4$ = 455 mm, $d_1$ = 16 mm |

## Volumetric pipette
color code, AR glass

| | | |
|---|---|---|
| **8888** | **1 ml** | $l_4$ = 325 mm, $l_3$ = 135 mm, $l_2$ = 35 mm<br>$l_1$ = 155 mm, $d_1$ = 4 mm, $d_2$ = 6 mm |
| **8889** | **2 ml** | $l_4$ = 340 mm, $l_3$ = 145 mm, $l_2$ = 40 mm<br>$l_1$ = 155 mm, $d_1$ = 5 mm, $d_2$ = 7 mm |
| **8890** | **5 ml** | $l_4$ = 380 mm, $l_3$ = 155 mm, $l_2$ = 55 mm<br>$l_1$ = 170 mm, $d_1$ = 6 mm, $d_2$ = 10 mm |
| **8891** | **10 ml** | $l_4$ = 450 mm, $l_3$ = 200 mm, $l_2$ = 70 mm<br>$l_1$ = 180 mm, $d_1$ = 7 mm, $d_2$ = 12 mm |
| **8892** | **20 ml** | $l_4$ = 520 mm, $l_3$ = 250 mm, $l_2$ = 90 mm<br>$l_1$ = 180 mm, $d_1$ = 8 mm, $d_2$ = 16 mm |
| **8893** | **25 ml** | $l_4$ = 530 mm, $l_3$ = 230 mm, $l_2$ = 105 mm<br>$l_1$ = 195 mm, $d_1$ = 10 mm, $d_2$ = 17 mm |
| **8894** | **50 ml** | $l_4$ = 550 mm, $l_3$ = 245 mm, $l_2$ = 120 mm<br>$l_1$ = 185 mm, $d_1$ = 7 mm, $d_2$ = 26 mm |
| **8895** | **100 ml** | $l_4$ = 575 mm, $l_3$ = 240 mm, $l_2$ = 135 mm<br>$l_1$ = 200 mm, $d_1$ = 8 mm, $d_2$ = 36 mm |

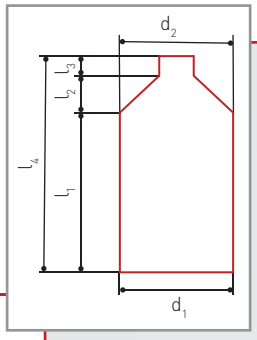


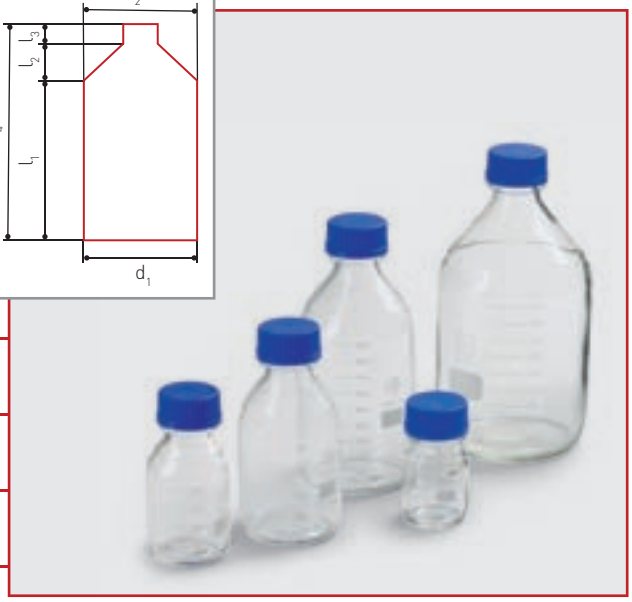



## Pipette helper
**8920** for pipettes up to 25 ml

## Laboratory bottles

borosilicate glass, with ISO thread, graduated, with PPN screw cap and PPN pouring ring (blue)



| | | | | | |
|---|---|---|---|---|---|
| 8970 | 100 ml | $l_4$ = 105 mm, $l_1$ = 65 mm | $l_3$ = 20 mm, $d_1$ = 55 mm | $l_2$ = 20 mm, $d_2$ = 31 mm |
| 8971 | 250 ml | $l_4$ = 140 mm, $l_1$ = 90 mm | $l_3$ = 25 mm, $d_1$ = 70 mm | $l_2$ = 25 mm, $d_2$ = 29.5 mm |
| 8972 | 500 ml | $l_4$ = 180 mm, $l_1$ = 112 mm | $l_3$ = 28 mm, $d_1$ = 84.7 mm | $l_2$ = 40 mm, $d_2$ = 29.5 mm |
| 8973 | 1000 ml | $l_4$ = 230 mm, $l_1$ = 154 mm | $l_3$ = 28 mm, $d_1$ = 100 mm | $l_2$ = 48 mm, $d_2$ = 29.5 mm |
| 8974 | 2000 ml | $l_4$ = 270 mm, $l_1$ = 168 mm | $l_3$ = 27 mm, $d_1$ = 136 mm | $l_2$ = 75 mm, $d_2$ = 29.5 mm |

## Wide necked reagent bottles

AR glass, white with standard polish and stopper

| | | | | | |
|---|---|---|---|---|---|
| 8980 | 50 ml | NS 24/20 | $l_4$ = 87 mm, $l_1$ = 53 mm | $l_3$ = 17 mm, $d_2$ = 14 mm | $l_2$ = 17 mm, $d_1$ = 45 mm |
| 8981 | 100 ml | NS 29/22 | $l_4$ = 96 mm, $l_1$ = 63.1 mm | $l_3$ = 24.5 mm, $d_2$ = 28 mm | $l_2$ = 8.4 mm, $d_1$ = 53 mm |
| 8982 | 250 ml | NS 34/35 | $l_4$ = 142 mm, $l_1$ = 86 mm | $l_3$ = 28 mm, $d_2$ = 34 mm | $l_2$ = 28 mm, $d_1$ = 142 mm |
| 8983 | 500 ml | NS 45/40 | $l_4$ = 167 mm, $l_1$ = 110 mm | $l_3$ = 31 mm, $d_2$ = 43.8 mm | $l_2$ = 26 mm, $d_1$ = 87 mm |
| 8984 | 1000 ml | NS 60/46 | $l_4$ = 200 mm, $l_1$ = 125 mm | $l_3$ = 45 mm, $d_2$ = 58 mm | $l_2$ = 30 mm, $d_1$ = 109 mm |
| 8985 | 2000 ml | NS 60/46 | $l_4$ = 255 mm, $l_1$ = 164 mm | $l_3$ = 50 mm, $d_2$ = 58 mm | $l_2$ = 41 mm, $d_1$ = 134 mm |

## Narrow necked reagent bottles

AR glass, white with standard polish and stopper

| | | | | | |
|---|---|---|---|---|---|
| 8990 | 50 ml | NS 14/15 | $l_4$ = 77 mm, $l_1$ = 50 mm | $l_3$ = 15 mm, $d_2$ = 13 mm | $l_2$ = 12 mm, $d_1$ = 42 mm |
| 8991 | 100 ml | NS 14/15 | $l_4$ = 105 mm, $l_1$ = 60 mm | $l_3$ = 25 mm, $d_2$ = 13 mm | $l_2$ = 7 mm, $d_1$ = 52 mm |
| 8992 | 250 ml | NS 19/26 | $l_4$ = 135 mm, $l_1$ = 80 mm | $l_3$ = 25 mm, $d_2$ = 17.6 mm | $l_2$ = 30 mm, $d_1$ = 71 mm |
| 8993 | 500 ml | NS 24/20 | $l_4$ = 165 mm, $l_1$ = 100 mm | $l_3$ = 47 mm, $d_2$ = 22 mm | $l_2$ = 35 mm, $d_1$ = 87 mm |
| 8994 | 1000 ml | NS 29/22 | $l_4$ = 205 mm, $l_1$ = 128 mm | $l_3$ = 35 mm, $d_2$ = 28 mm | $l_2$ = 42 mm, $d_1$ = 108 mm |
| 8995 | 2000 ml | NS 29/32 | $l_4$ = 265 mm, $l_1$ = 160 mm | $l_3$ = 35 mm, $d_2$ = 29 mm | $l_2$ = 70 mm, $d_1$ = 130 mm |

## Culture tubes
DURAN glass, straight rim

| | |
|---|---|
| **9050** | 16 x 160 mm, 100 pieces |

## Culture tubes
with ISO thread and screw cap
AR glass, sterilisable

| | |
|---|---|
| **9054** | 16 x 100 mm, 100 pieces |
| **9056** | 16 x 160 mm, 100 pieces |

## Test tubes
DURAN glass

| | |
|---|---|
| **9080** | without rim, 16 x 160 mm, 100 pieces |
| **9081** | with rim, 16 x 160 mm, 100 pieces |

## Test tube brush
with wool head

| | |
|---|---|
| **9090** | length: 230 mm |

## Weighing dishes
short design, with knob lid

| | |
|---|---|
| **9120** | 35 x 30 mm |
| **9121** | 50 x 30 mm |

**Digital burette type µ 10**
without bottle
certified conformity up to 100 ml,
smallest adjustment interval 10 µl.

**9190** bottle: see art. no. 8973

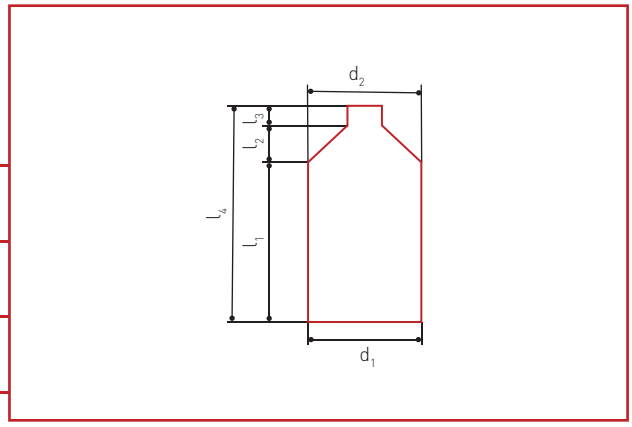
**Desiccator,** glass, type Novus,

**9201** flat flange with knob lid, 250 mm,

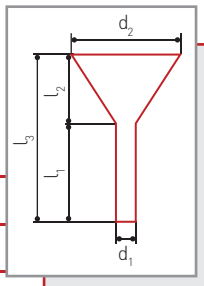
**9211** **Desiccator plate,** porcelain

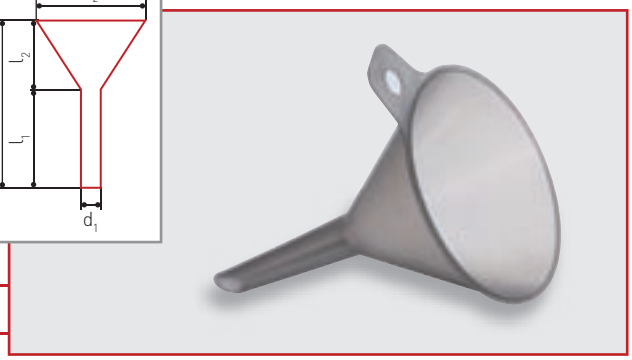
**Wash bottles**
polyethylene

| | | | | | |
|---|---|---|---|---|---|
| **9230** | **100 ml** | $d_1$ = 44.5 mm, | $d_2$ = 12 mm, | $l_4$ = 105 mm | |
| | | $l_3$ = 15 mm, | $l_2$ = 27 mm, | $l_1$ = 63 mm | |
| **9231** | **250 ml** | $d_1$ = 59 mm, | $d_2$ = 19.5 mm, | $l_4$ = 139 mm | |
| | | $l_3$ = 15 mm, | $l_2$ = 39 mm, | $l_1$ = 85 mm | |
| **9232** | **500 ml** | $d_1$ = 74 mm, | $d_2$ = 18 mm, | $l_4$ = 175 mm | |
| | | $l_3$ = 15 mm, | $l_2$ = 45 mm, | $l_1$ = 115 mm | |
| **9233** | **1000 ml** | $d_1$ = 94 mm, | $d_2$ = 21.5 mm, | $l_4$ = 220 mm | |
| | | $l_3$ = 26 mm, | $l_2$ = 49 mm, | $l_1$ = 145 mm | |



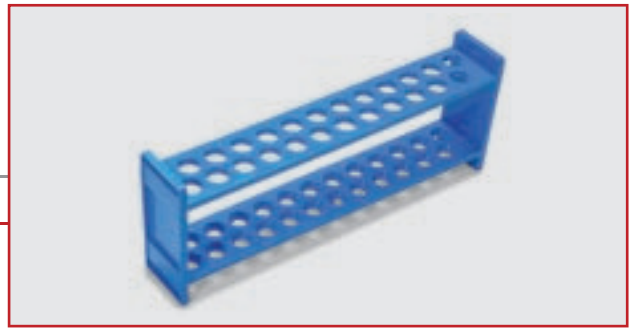
## Funnels
polyethylene



| | |
|---|---|
| **9235** | $d_2$ = 40 mm, $d_1$ = 9.5 mm, $l_3$ = 63 mm, $l_1$ = 33 mm, $l_2$ = 30 mm |
| **9236** | $d_2$ = 70 mm, $d_1$ = 11.7 mm, $l_3$ = 109 mm, $l_1$ = 55 mm, $l_2$ = 54 mm |
| **9237** | $d_2$ = 100 mm, $d_1$ = 13.8 mm, $l_3$ = 155 mm, $l_1$ = 80 mm, $l_2$ = 75 mm |
| **9238** | $d_2$ = 120 mm, $d_1$ = 15.3 mm, $l_3$ = 175 mm, $l_1$ = 85 mm, $l_2$ = 90 mm |
| **9239** | $d_2$ = 140 mm, $d_1$ = 16.7 mm, $l_3$ = 170 mm, $l_1$ = 65 mm, $l_2$ = 105 mm |

## Test tube racks
PP plastic, for glass 160 x 16 mm,
sterilisable up to 121°C



| | |
|---|---|
| **9255** | 12 samples |
| **9256** | 24 samples |

## Test tube rack
**9257** 36 samples, wire, plastic coated

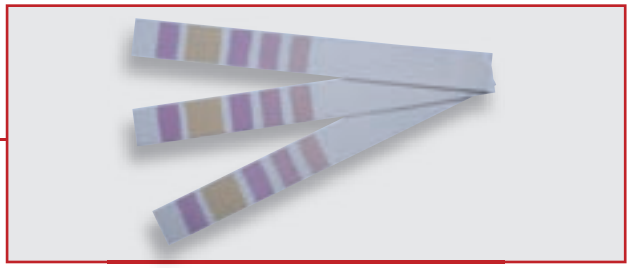
**9300** **Laboratory lift**

## Lyphan strips
in plastic screw jar

| | |
|---|---|
| **9360** | pH 1 – 11 |
| **9361** | pH 3.9 – 6.9 |
| **9362** | pH 4.9 – 7.9 |
| **9363** | pH 6.9 – 9.9 |
| **9364** | pH 0 – 14 |

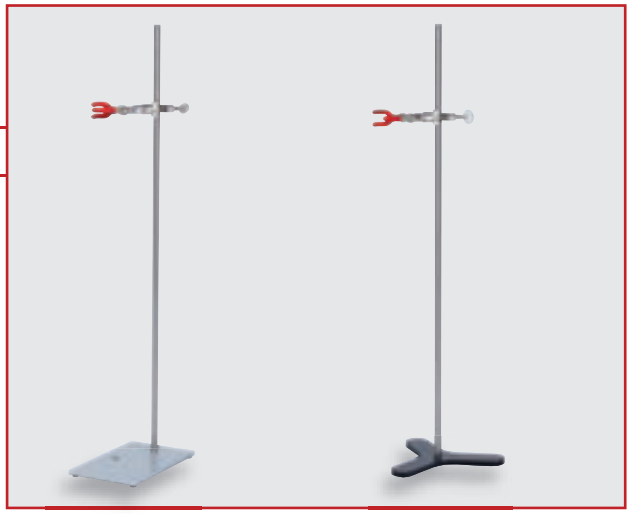
## Indicator paper
for degree of freshness of milk, Duplex

| | |
|---|---|
| **9365** | pH 7.9 – 11, 100 pieces |



## Burette stand

| | |
|---|---|
| **9400** | Plate stand, 210 x 130 x 750 mm |
| **9401** | Tripod stand, 210 x 130 x 750 mm |



| | |
|---|---|
| **9405** | **Double socket** |
| **9406** | **Double socket**<br>rotatable |
| | **Stand clamp**<br>without socket |
| **9407** | 25 mm |
| **9408** | 60 mm |

| | |
|---|---|
| **9409** | **Stand ring**<br>with socket, 160 mm |
| | **Burette clamp**<br>with socket |
| **9410** | single |
| **9411** | double |
| **9440** | **Laboratory clock**<br>0 - 60 min. |
| **9470** | **Laboratory vacuum pump/compressor**<br>electrical, can be used as a vacuum or pressure pump<br>max. output 16 L/min.,<br>max. operating pressure 3.5 bar |

## Proportioning devices (digital)

for aggressive acids and bases,
without bottle

| | |
|---|---|
| **9484** | 1 – 10 ml: 0.05 ml,<br>with thread adapter: A25, A28, A32, A38, A40 |
| **9485** | 2.5 – 25 ml: 0.1 ml,<br>with thread adapter: A32, A38, A40 |

## Variable proportioning devices

for aggressive acids and bases,
without bottle

| | |
|---|---|
| **9487** | 1 – 10 ml: 0.2 ml,<br>with thread adapter: A25, A28, A32, A38, A40 |
| **9488** | 2.5 – 25 ml: 0.5 ml,<br>with thread adapter: A32, A38, A40 |

**Replacement parts for proportioning devices**

## Adapter external thread

| | |
|---|---|
| | 32 mm for bottle thread A 25 mm |
| | 32 mm for bottle thread A 28 mm |
| | 45 mm for bottle thread A 32 mm |
| | 45 mm for bottle thread A 38 mm |
| | 32 mm for bottle thread S 40 mm |
| **9489** | 45 mm for bottle thread S 40 mm |

## Microlitre pipettes

variable volume adjustment, with disposable tips

| | |
|---|---|
| **9495** | 10 – 100 µl |
| **9498** | 100 – 1000 µl |

## Pipette tips

| | |
|---|---|
| **9510** | 1 – 200 µl (yellow), 1000 pieces |
| **9511** | 50 – 1000 µl (blue), 1000 pieces |

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