

INTERNATIONAL
STANDARD

ISO
488

IDF
105

Second edition
2008-09-01

Milk — Determination of fat content — Gerber butyrometers

*Lait — Détermination de la teneur en matière grasse — Butyromètres
Gerber*



Reference numbers
ISO 488:2008(E)
IDF 105:2008(E)

© ISO and IDF 2008

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. Neither the ISO Central Secretariat nor the IDF accepts any liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies and IDF national committees. In the unlikely event that a problem relating to it is found, please inform the ISO Central Secretariat at the address given below.



COPYRIGHT PROTECTED DOCUMENT

© ISO and IDF 2008

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO or IDF at the respective address below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

International Dairy Federation
Diamant Building • Boulevard Auguste Reyers 80 • B-1030 Brussels
Tel. + 32 2 733 98 88
Fax + 32 2 733 04 13
E-mail info@fil-idf.org
Web www.fil-idf.org

Published in Switzerland

Contents

Page

Foreword.....	iv
Foreword.....	v
1 Scope	1
2 Normative references	1
3 Types of butyrometer	1
4 Construction.....	2
4.1 Material	2
4.2 Shape and dimensions.....	2
4.3 Neck	2
4.4 Large bulb (see also Clause 6)	2
4.5 Graduated tube	2
4.6 Small bulb (see also Clause 6)	3
5 Scale and graduations	3
5.1 Length of scale.....	3
5.2 Position of scale	3
5.3 Basis of scale (see also Clause 6)	3
5.4 Graduation lines.....	3
5.5 Graduation scheme	4
5.6 Graduation numbers and percentage symbol	4
5.7 Scale error tolerances (see also Clause 6)	4
6 Reference temperature.....	4
7 Inscriptions.....	4
Annex A (informative) Recommended stoppers	8
Annex B (informative) Recommended method for the determination of scale errors of butyrometers	10
Bibliography	14

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 488|IDF 105 was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 5, *Milk and milk products*, and the International Dairy Federation (IDF). It is being published jointly by ISO and IDF.

This second edition cancels and replaces the first edition (ISO 488:1983), of which it constitutes a minor revision.

.....

Foreword

IDF (the International Dairy Federation) is a non-profit organization representing the dairy sector worldwide. IDF membership comprises National Committees in every member country as well as regional dairy associations having signed a formal agreement on cooperation with IDF. All members of IDF have the right to be represented on the IDF Standing Committees carrying out the technical work. IDF collaborates with ISO in the development of standard methods of analysis and sampling for milk and milk products.

Draft International Standards adopted by the Action Teams and Standing Committees are circulated to the National Committees for voting. Publication as an International Standard requires approval by at least 50 % of the IDF National Committees casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. IDF shall not be held responsible for identifying any or all such patent rights.

ISO 488|IDF 105 was prepared by the International Dairy Federation (IDF) and Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 5, *Milk and milk products*. It is being published jointly by IDF and ISO.

All work was carried out by the former Joint ISO/IDF/AOAC Group of Experts E40-E301 which is now part of the Joint ISO-IDF Action Team on *Fat* of the Standing Committee on *Main components in milk*.

ISO 488|IDF 105:2008 cancels and replaces IDF 105:1981, of which it constitutes a minor revision.

www.iso.org

Milk — Determination of fat content — Gerber butyrometers

1 Scope

This International Standard specifies the characteristics of seven types of butyrometer for use in the determination of the fat content of whole milk, partly skimmed milk and skimmed milk by the Gerber method specified in ISO 2446.

Recommended stoppers for the butyrometers are described in Annex A and a recommended method of determining the scale errors of the butyrometers is described in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2446, *Milk — Determination of fat content (Routine method)*

3 Types of butyrometer

Seven types of butyrometer are specified, as follows:

- a) a butyrometer with a scale range of 0 % to 0,5 % fat, the smallest scale division of which is 0,02 %; this is a “double-quantity” butyrometer suitable for skimmed milk;
- b) a butyrometer with a scale range of 0 % to 4 % fat, the smallest scale division of which is 0,05 %; this is a “precision” butyrometer suitable for whole milk of standardized fat content and partly skimmed milk;
- c) butyrometers with scale ranges of 0 % to 5 %, 0 % to 6 %, 0 % to 7 % and 0 % to 8 % fat, respectively, the smallest scale divisions of which are 0,1 %; these are “general-purpose” butyrometers suitable for whole milk;
- d) a butyrometer with a scale range of 0 % to 10 % fat, the smallest scale division of which is 0,2 %; this is suitable for whole milk of high fat content, for example sheep's milk.

NOTE 1 The 0 % to 0,5 % and 0 % to 4 % butyrometers are also suitable for whey and buttermilk, but this usage is not yet described in ISO 2446.

NOTE 2 For the meaning of “% fat” in relation to scale range, see ISO 2446.

4 Construction

4.1 Material

The butyrometers shall be made of clear glass which is as free as possible from visible defects. The stress in the glass shall be reduced by annealing to minimize the possibility of fracture by thermal or mechanical shock. The glass shall be resistant to the reagents used in the Gerber method (see ISO 2446).

4.2 Shape and dimensions

The shape and dimensions of the butyrometers shall be as shown in Figures 1, 2, 3 and 4; the 0 % to 5 %, 0 % to 7 % and 0 % to 8 % butyrometers shall have the same shape and dimensions as the 0 % to 6 % butyrometer shown in Figure 3.

The internal surface of the butyrometers shall be smooth and free from any defects so that, in use, none of the fat is prevented from entering the graduated tube.

The outer surface of the butyrometers shall be symmetrical about the axis and changes in cross-section shall be smooth, particularly the transition from the large bulb to the graduated tube.

The minimum wall thickness at any point shall be 0,9 mm in order to ensure that the butyrometers are sufficiently robust for the usage to which they are normally subjected.

4.3 Neck

Two types of neck are permitted:

- a) Plain-neck, strengthened at the outer end by an outside rim not exceeding 2,5 mm in thickness (see Figures 1 and 3);
- b) Corrugated neck, with the corrugations at right angles to the axis of the butyrometer and not in the form of a spiral producing a screw thread (see Figures 2 and 4). The number of corrugations is not specified. The internal diameter of a corrugated neck shall be measured at the crests of the corrugations.

4.4 Large bulb (see also Clause 6)

The capacity of the large bulb, measured between the end of the neck and the 0 % graduation line (i.e. between levels A and B in Figures 1, 2, 3 and 4), shall be in accordance with Table 1 for the different types of butyrometer.

Table 1 — Capacity of large bulb according to type of butyrometer

Scale range % fat	Capacity of large bulb ml
0 to 0,5	43,5 ± 0,5
0 to 4	21,7 ± 0,3
0 to 5, 6, 7 or 8	21,5 ± 0,4
0 to 10	21,0 ± 0,4

4.5 Graduated tube

The graduated tube shall be of the flat-bore type shown in cross-section in Figures 1, 2, 3 and 4.

4.6 Small bulb (see also Clause 6)

The capacity of the small bulb, measured between the top graduation line and the inside of the end of the bulb (i.e. between levels C and D in Figures 1, 2, 3 and 4), shall be at least 1,5 ml for all the butyrometers.

The small bulb shall be slightly tapered as shown in Figures 1, 2, 3 and 4, and the inside of the bulb shall be so shaped that liquid can flow freely between the bulb and the graduated tube.

A small patch of matt surface, on which a temporary identification mark can be written, shall be provided on the small bulb.

5 Scale and graduations

5.1 Length of scale

The length of the scale between the extreme graduation lines (i.e. between levels B and C in Figures 1, 2, 3 and 4) shall be as follows:

- a) 0 % to 0,5 % butyrometer: not less than 17,5 mm;
- b) all other butyrometers: not less than 65 mm.

It is recommended that scale lengths are as large as possible, consistent with the other constructional requirements, for ease of reading the scales.

5.2 Position of scale

The position of the scale on the flat-bore tube shall be such that the scale is approximately central with respect to the length of the tube and that the tube is internally uniform in cross-section for at least 3 mm beyond each end of the scale.

5.3 Basis of scale (see also Clause 6)

The basis of the scale shall be as follows:

- a) for the 0 % to 0,5 % butyrometer, the capacity of the flat-bore tube between the 0 % and 0,5 % graduation lines shall be 0,125 ml;
- b) for all other butyrometers, the capacity of the flat-bore tube between any two graduation lines covering a range of 1 % shall be 0,125 ml.

5.4 Graduation lines

The graduation lines shall be fine, clean and permanent, and of a uniform thickness which is not less than 0,1 mm and not more than 0,2 mm. The lines shall lie in planes perpendicular to the longitudinal axis of the flat-bore tube, with no evident irregularity in their spacing. The mid-points of the lines shall be coincident with the longitudinal axis.

Short graduation lines shall be at least 2 mm in length for the 0 % to 0,5 % and 0 % to 4 % butyrometers, and at least 3 mm in length for all other butyrometers. Graduation lines of intermediate length shall project equally to the left and right for a distance of at least 1 mm beyond the short graduation lines. Full-length graduation lines shall extend completely across the flat portion of the front of the flat-bore tube.

5.5 Graduation scheme

The graduation scheme shall be as follows:

- a) for the 0 % to 0,5 % butyrometer: the graduation lines shall indicate 0,02 % intervals, those indicating 0,1 % intervals being full length and numbered and the remainder being short (see Figure 1);
- b) for the 0 % to 4 % butyrometer: the graduation lines shall indicate 0,05 % intervals, those indicating 1 % intervals being full length and numbered, those indicating 0,5 % intervals being full length, those indicating 0,1 % intervals being of intermediate length and the remainder being short (see Figure 2);
- c) for the 0 % to 5 %, 0 % to 6 %, 0 % to 7 % and 0 % to 8 % butyrometers: the graduation lines shall indicate 0,1 % intervals, those indicating 1 % intervals being full length and numbered, those indicating 0,5 % intervals being of intermediate length and the remainder being short (see Figure 3);
- d) for the 0 % to 10 % butyrometer: the graduation lines shall indicate 0,2 % intervals, those indicating 1 % intervals being full length and numbered and the remainder being short (see Figure 4).

5.6 Graduation numbers and percentage symbol

The graduation numbers shall be permanent and clearly legible, and each shall be located immediately above the graduation line to which it refers, to the right of the longitudinal axis of the scale and upright when the butyrometer is placed vertically with the small bulb uppermost (see Figures 1, 2, 3 and 4).

The percentage symbol (%) shall be permanent, clearly legible and located to the left of the uppermost graduation number (see Figures 1, 2, 3, and 4).

5.7 Scale error tolerances (see also Clause 6)

The scale error tolerances shall be as follows:

- a) for the 0 % to 0,5 % butyrometer: the error in a single portion of the scale covering at least four-fifths of the total scale shall not exceed a value equivalent to plus or minus half the smallest scale division;
- b) for all other butyrometers: the error in each of at least three approximately equal and consecutive portions of the scale which in total cover most of the scale, and the algebraic sum of these errors, shall not exceed a value equivalent to plus or minus half the smallest scale division.

NOTE For certain special purposes, described in ISO 2446, butyrometers having scale errors, as defined above, of less than $\pm 0,01$ % are required.

6 Reference temperature

The reference temperature in relation to the requirements for capacity specified in 4.4, 4.6 and 5.3, and in relation to the requirements specified in 5.7, is 20 °C.

7 Inscriptions

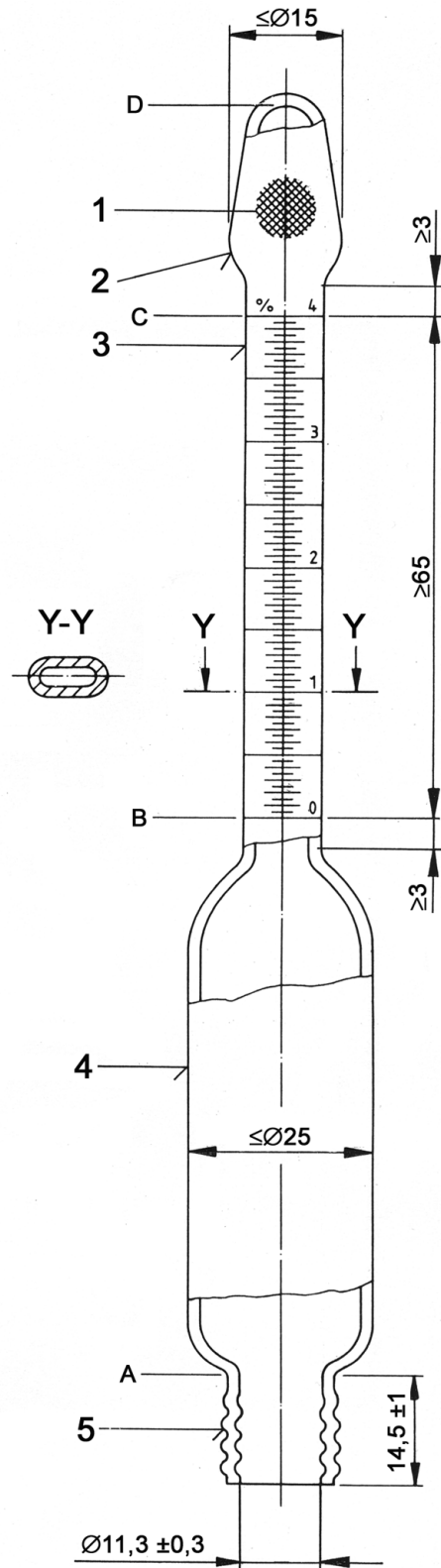
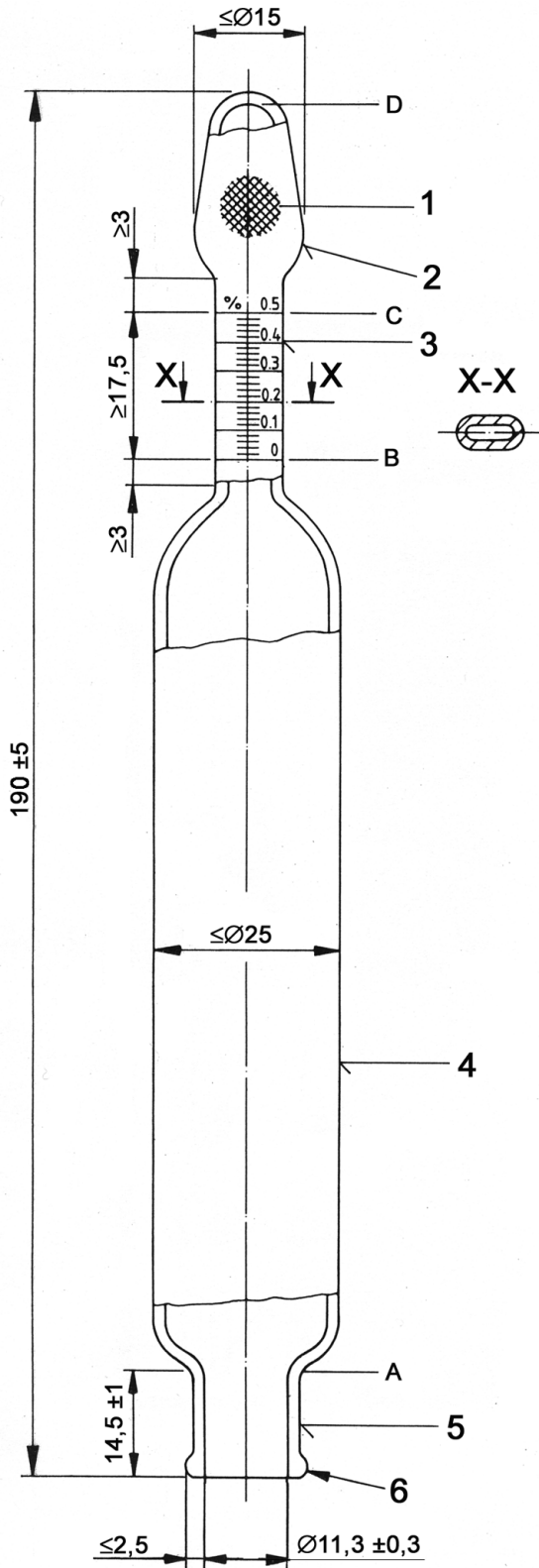
The following inscriptions shall be permanently and legibly inscribed on the large bulb of the butyrometer:

- a) for the 0 % to 0,5 % butyrometer:
 - 1) "Skimmed milk",
 - 2) "Double-quantity",

- 3) the reference number of this International Standard, i.e. ISO 488,
 - 4) the maker's or vendor's name or mark;
- b) for all other butyrometers:
- 1) "Milk",
 - 2) the reference number of this International Standard, i.e. ISO 488,
 - 3) the maker's or vendor's name or mark.

In both cases, an identification number may be inscribed, if required.

Dimensions in millimetres



Key

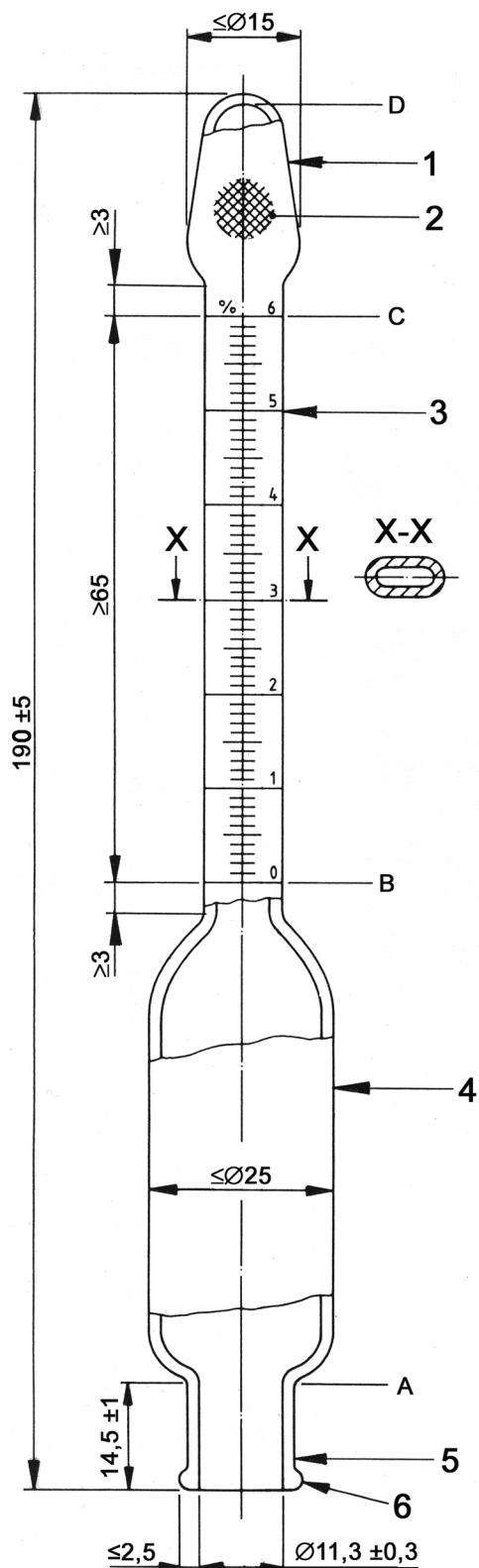
- | | |
|----------------|------------------|
| 1 matt surface | 3 graduated tube |
| 2 small bulb | 4 large bulb |

- | |
|---------------------|
| 5 neck |
| 6 strengthening rim |

Figure 1 — 0 % to 0,5 % butyrometer with plain neck

Figure 2 — 0 % to 4 % butyrometer with corrugated neck

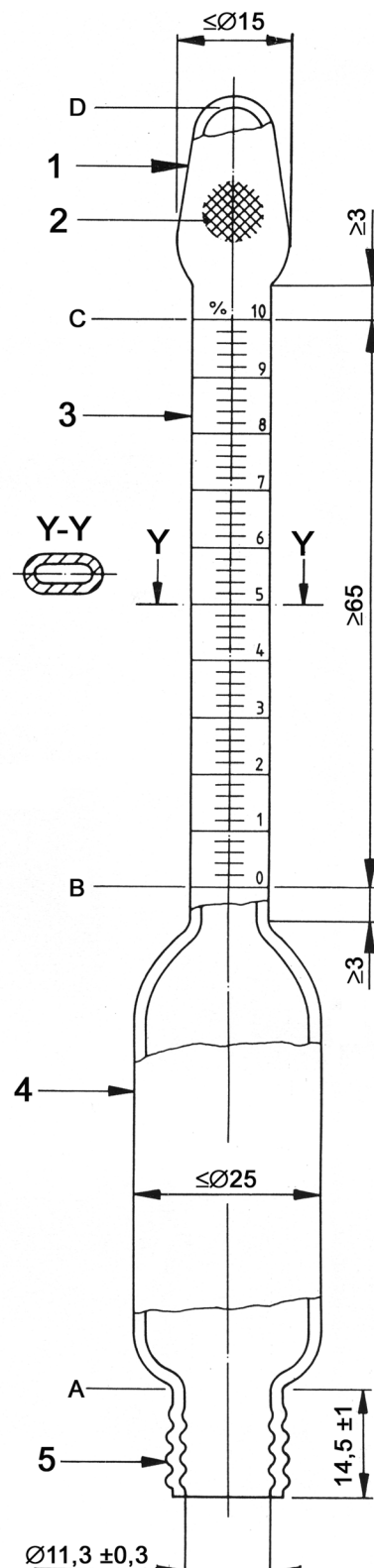
Dimensions in millimetres



Key

- | | |
|----------------|------------------|
| 1 small bulb | 3 graduated tube |
| 2 matt surface | 4 large bulb |

Figure 3 — 0 % to 6 % butyrometer with plain neck



- | |
|---------------------|
| 5 neck |
| 6 strengthening rim |

Figure 4 — 0 % to 10 % butyrometer with corrugated neck

Annex A (informative)

Recommended stoppers

A.1 General

Various types of stopper can be used with the butyrometers specified in this International Standard. Those recommended in this annex are the types most commonly used. The shapes and dimensions given are for the general guidance of manufacturers, but should be adhered to as closely as practicable.

A.2 Types of stopper

The recommended types of stopper are shown in Figure A.1. The following points should be noted:

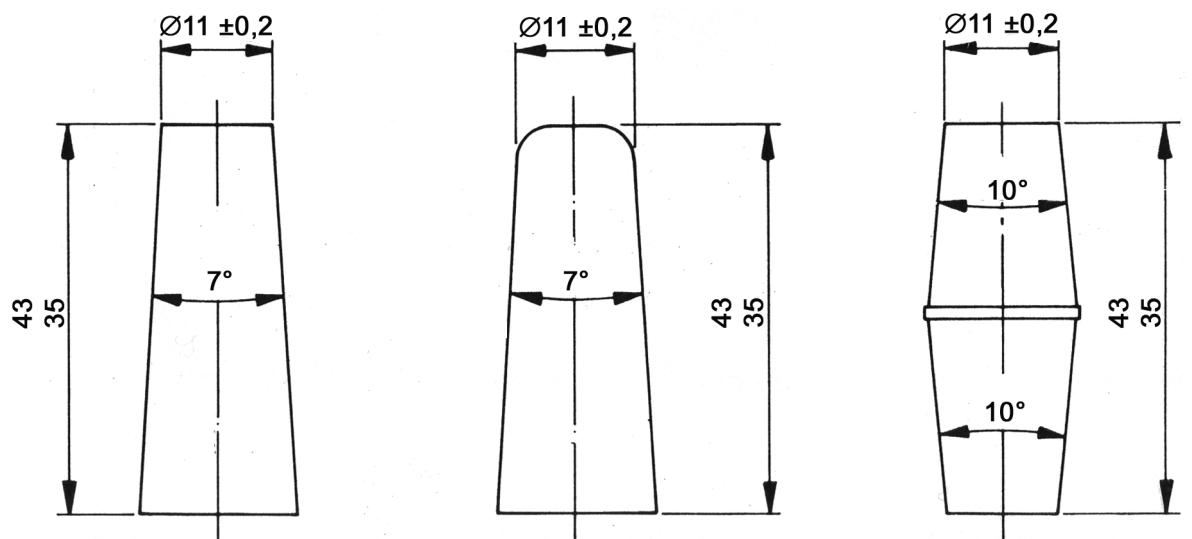
- a) single-ended and double-ended stoppers should be made from a suitable grade of rubber or plastics material having a hardness of 38 ± 5 IRHD (International Rubber Hardness Degrees);
- b) the construction of the double-ended stopper should be such that it can be screwed into the butyrometer until the widest part is at least level with the rim of the neck;
- c) lock stoppers and keys should be such that, in use, the position of a fat column in the graduated tube of a butyrometer can be easily adjusted for readings to be taken.

A.3 Usage

The type of stopper to be used is a matter for the personal preference of the user but the following suggestions are made.

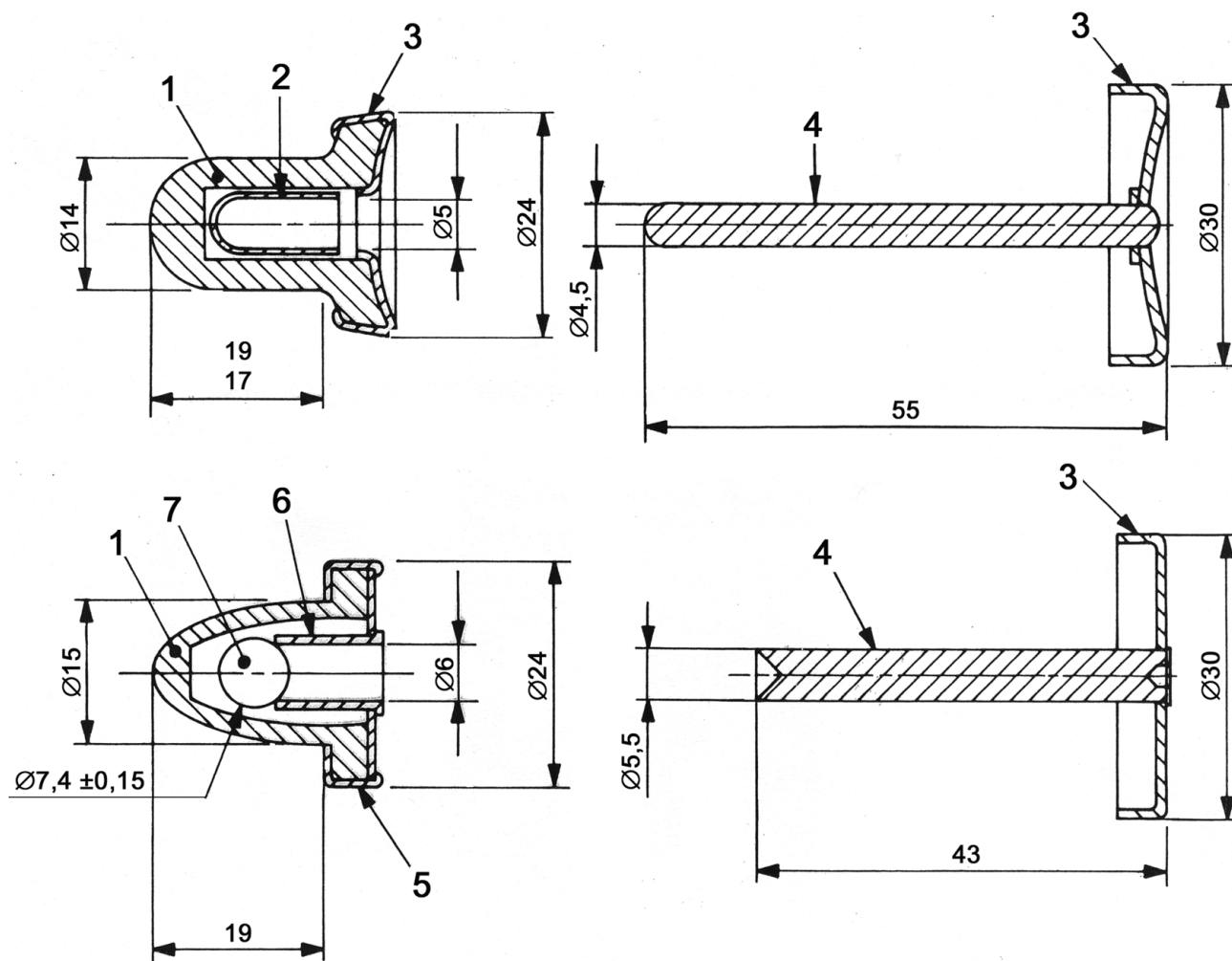
- a) When a small number of butyrometers is to be used, any of the recommended stoppers is suitable.
- b) When a large number of butyrometers is to be used, lock stoppers may be found advantageous. Although lock stoppers can be used with either plain-neck or corrugated-neck butyrometers, it is preferable that these stoppers be used with plain-neck butyrometers.
- c) Although single-ended or double-ended stoppers can be used with either plain-neck or corrugated-neck butyrometers, the double-ended stoppers may be found preferable with corrugated-neck butyrometers.

Dimensions in millimetres



a) Single-ended stoppers

b) Double-ended stopper



c) Examples of lock stoppers and keys

Key

- | | | | |
|--------------|--------------|----------------|-----------------------------------|
| 1 rubber | 3 metal disc | 5 metal ring | 7 ball of metal, glass or plastic |
| 2 metal tube | 4 metal rod | 6 metal collar | |

Figure A.1 — Recommended stoppers

Annex B (informative)

Recommended method for the determination of scale errors of butyrometers

B.1 General

Various methods can be used to check whether the scale errors of a butyrometer comply with the requirements specified in 5.7. In one method, known volumes of mercury are added to the butyrometer by means of a special automatic pipette (Reference [1]) and the scale errors are the differences between the expected and the observed changes in the scale readings. However, the method recommended in this annex has the advantage that the error in as many scale portions as desired can be determined without special apparatus.

B.2 Apparatus and materials

B.2.1 Thermometer, maximum error 1 °C.

B.2.2 Clamp and stand, for holding a butyrometer in a vertical position with the neck uppermost.

B.2.3 Magnifying device, for taking butyrometer scale readings without errors caused by parallax.

B.2.4 Mercury, of recognized analytical grade.

B.3 Procedure

B.3.1 Safety precautions

Since the test method involves the use of mercury, which is a toxic substance, it is essential that adequate precautions are taken to avoid contact with the skin, to contain any spillage and, in particular, to prevent inhalation of mercury vapour.

B.3.2 General test requirements

B.3.2.1 The procedure shall be carried out under conditions such that the ambient temperature is in the range 10 °C to 35 °C and does not change by more than ± 2 °C.

B.3.2.2 The mercury and the butyrometer to be tested shall be at ambient temperature before starting the test.

B.3.2.3 The mercury, the empty butyrometer and the butyrometer when containing mercury shall be handled in such a way as to prevent changes in the temperature of the mercury and the butyrometer.

B.3.2.4 Scale readings coincident with the top of the mercury meniscus shall be taken to the nearest 0,01 % with all the butyrometers except the 0 % to 10 % butyrometer, in which case the scale readings shall be taken to the nearest 0,1 %.

B.3.2.5 For the 0 % to 0,5 % butyrometer, it is necessary only to determine the error in a single portion of the scale covering at least four-fifths of the total scale (see 5.7), but with all other butyrometers it is necessary

to determine the error in each of at least three approximately equal and consecutive portions of the scale which in total cover most of the scale (see 5.7).

B.3.2.6 The reference temperature in relation to scale errors is 20 °C (see Clause 6).

B.3.3 Procedure for 0 % to 0,5 % butyrometers

B.3.3.1 Measure the temperature of the mercury (B.2.4) to the nearest 1 °C.

B.3.3.2 Carefully add some of the mercury to the clean and dry butyrometer, without trapping air, until the mercury meniscus is slightly above the graduation line nearest the small bulb (C in Figure 1).

B.3.3.3 Tap the butyrometer to dislodge any small amount of air that may have been trapped and to obtain a well-formed meniscus, clamp the butyrometer in a vertical position, and take the scale reading coincident with the top of the mercury meniscus to the nearest 0,01 % using the magnifying device (B.2.3).

B.3.3.4 Weigh the butyrometer plus mercury to the nearest 0,1 mg.

B.3.3.5 Proceeding as described in B.3.3.2 to B.3.3.4 inclusive, add more of the mercury to the butyrometer until the mercury meniscus is slightly below the top graduation line (B in Figure 1), tap and clamp the butyrometer, take the scale reading, and weigh the butyrometer plus mercury. The second portion of mercury added shall cover at least four-fifths of the total scale.

B.3.3.6 Measure the temperature of the mercury (B.2.4) to the nearest 1 °C and calculate the mean of this temperature and the first (see B.3.3.1), rounding to the nearest even whole number when 0,5 occurs in the first decimal place.

B.3.3.7 Calculate the scale error as shown in the following example.

Experimental data

First scale reading (B.3.3.3):	0,48 %	(a)
Mass of butyrometer plus mercury at first weighing (B.3.3.4):	52,376 6 g	(b)
Second scale reading (B.3.3.5):	0,01 %	(c)
Mass of butyrometer plus mercury at second weighing (B.3.3.5):	53,968 4 g	(d)
Mean temperature of mercury (B.3.3.6):	23 °C	
Conversion factor for 23 °C (see Table B.1):	0,073 857	

Derived data

Observed scale difference:	0,47 %	(a-c)
Corresponding mass of mercury at 23 °C:	1,591 8 g	(d-b)
Capacity of scale portion at 20 °C (reference temperature):	$1,591 8 \times 0,073 857$ ml = 0,117 6 ml	

As the basis of the scale (see 5.3) is that the capacity of the flat-bore tube between the 0 % and 0,5 % graduation lines shall be 0,125 ml at 20 °C, then 0,117 6 ml should correspond to a scale difference of $0,5 \times 0,117 6 / 0,125$ %, i.e. the calculated scale difference is 0,47 %. Since the observed scale difference is the same as the calculated scale difference, the scale error is 0,00 % and the butyrometer complies with the requirement specified in 5.7 that the scale error shall not exceed a value equivalent to plus or minus half the smallest scale division, i.e. $\pm 0,01$ %.

If the observed scale difference had been 0,46 % or 0,48 % the scale error would have been – 0,01 % and + 0,01 %, respectively, and in each case the butyrometer would still have complied with the requirement in 5.7. However, if the observed scale difference had been less than 0,46 % or greater than 0,48 %, the scale error would have exceeded $\pm 0,01$ % and the butyrometer would not have met the requirement specified in 5.7.

B.3.4 Procedure for all other butyrometers

B.3.4.1 Follow the same procedure as described in B.3.3 except that, after the first mercury addition, scale reading and weighing, add, in turn, at least three approximately equal portions of mercury so that most of the scale is covered, determining the scale reading and the mass of the butyrometer plus mercury after each addition of mercury, and then taking the final temperature of the mercury.

B.3.4.2 Calculate the scale errors as shown in the following example for a 0 % to 6 % butyrometer, three scale portions of which have been tested.

Experimental data

First scale reading:	5,91 %	(a)
Mass of butyrometer plus mercury at first weighing:	45,185 2 g	(b)
Second scale reading:	4,10 %	(c)
Mass of butyrometer plus mercury at second weighing:	48,147 9 g	(d)
Third scale reading:	1,95 %	
Mass of butyrometer plus mercury at third weighing:	51,789 3 g	
Fourth scale reading:	0,03 %	
Mass of butyrometer plus mercury at fourth weighing:	55,142 2 g	
Mean temperature of mercury:	19 °C	
Conversion factor for 19 °C (see Table B.1):	0,073 806	

Derived data (for first scale portion, i.e. 5,91 % to 4,10 %)

Observed scale difference:	1,81 %	(a–c)
Corresponding mass of mercury at 19 °C:	2,962 7 g	(d–b)
Capacity of scale portion at 20 °C (reference temperature):	$2,962 7 \times 0,073 806$ ml = 0,218 7 ml	

As the basis of the scale (see 5.3) is that the capacity of the flat-bore tube between any two graduation lines covering a range of 1 % shall be 0,125 ml at 20 °C, then 0,218 7 ml should correspond to a scale difference of $1 \times 0,218 7/0,125$ %, i.e. the calculated scale difference is 1,75 %. However, the observed scale difference is 1,81 % and thus the error in the first scale portion (5,91 % to 4,10 %) is 1,81 % minus 1,75 %, i.e. + 0,06 %.

In the same manner, the error in the second scale portion (4,10 % to 1,95 %) and in the third scale portion (1,95 % to 0,03 %) can be calculated to be 0,00 % and – 0,06 % respectively. The algebraic sum of the errors in the three scale portion is 0,00 %.

Therefore, since the requirement specified in 5.7 for a 0 % to 6 % butyrometer is that the error in each of the three scale portions tested, and the algebraic sum of these errors, shall not exceed $\pm 0,05$ % (i.e. plus or minus half the smallest scale division), the butyrometer does not comply with the requirement.

Table B.1 — Factor (ml/g) to convert mass (g) of mercury at t °C to corresponding capacity (ml) of scale portion of butyrometer at 20 °C

Temperature t °C	Factor ml/g	Temperature t °C	Factor ml/g
10	0,073 692	23	0,073 857
11	0,073 705	24	0,073 869
12	0,073 718	25	0,073 882
13	0,073 730	26	0,073 894
14	0,073 743	27	0,073 907
15	0,073 755	28	0,073 920
16	0,073 768	29	0,073 932
17	0,073 781	30	0,073 945
18	0,073 793	31	0,073 958
19	0,073 806	32	0,073 970
20	0,073 819	33	0,073 983
21	0,073 831	34	0,073 995
22	0,073 844	35	0,074 008

NOTE The values given in this table are valid for glass (borosilicate) butyrometers with a coefficient of cubic expansion α of $10 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$.

Bibliography

- [1] BIGG, P.H. An accurate automatic mercury pipette. *J. Sci. Instrum.*, 1936, **13**, p. 156-157.

© 2011 International Organization for Standardization

ISO 488:2008(E)
IDF 105:2008(E)

ICS 67.260

Price based on 14 pages