

Temperature measurement —

Part 2: Expansion thermometers —

Section 2.2 Guide to selection and use of dial-type expansion thermometers

UDC 536.5.51:67.192.53:531.717.51 – 620.113.004.14

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Industrial-process Measurement and Control Standards Policy Committee (PCL/-) to Technical Committee PCL/1, upon which the following bodies were represented:

- British Coal Corporation
- British Gas plc
- British Pressure Gauge Manufacturers' Association
- Department of Energy (Gas and Oil Measurement Branch)
- Department of Trade and Industry (National Weights and Measures Laboratory)
- Energy Industries Council
- Engineering Equipment and Materials Users' Association
- GAMBICA (BEAMA Ltd.)
- Health and Safety Executive
- Institution of Gas Engineers
- Coopted members

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1990

© BSI 01-2000

First published January 1943
First revision January 1990

The following BSI references relate to the work on this standard:
Committee reference PCL/1
Draft for comment 86/27223 DC

ISBN 0 580 17396 8

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
0 Introduction	1
1 Scope	1
2 Liquid expansion dial-type thermometers	1
3 Gas expansion dial-type thermometers	2
4 Vapour pressure dial-type thermometers	3
5 Bi-metal strip actuated dial-type thermometers	6
6 Installation and use of dial-type expansion thermometers	6
Figure 1 — Typical arrangements of dial-type expansion thermometers	4
Figure 2 — Typical types of bulbs and installations	8
Table 1 — Examples of filling liquids used in vapour pressure dial-type thermometers	6
Publications referred to	Inside back cover

Foreword

This Section of BS 1041 has been prepared under the direction of the Industrial-process Measurement and Control Standards Policy Committee. It is a revision of clauses **34** and **44** to **71** of BS 1041:1943 which was withdrawn as obsolete in March 1985, and it also includes bi-metal strip actuated dial-type thermometers.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

Dial-type expansion thermometers consist of a metal sensing bulb, which contains a suitable gas, liquid, or bi-metallic coil, connected to an indicating gauge. They may be direct mounting with rigid stem, or distant reading with a length of capillary between bulb and indicator. Thermometers of this type are inherently safe for use in hazardous atmospheres.

BS 5235:1975 specifies requirements for liquid-filled, gas-filled and vapour pressure dial-type expansion thermometers.

The information to be supplied by the purchaser to the manufacturer when ordering dial-type expansion thermometers is given in Appendix A of BS 5235:1975.

1 Scope

This Section of BS 1041 provides guidance on the principles of operation, installation and use of dial-type expansion thermometers. It covers liquid-filled, gas-filled, vapour pressure and bi-metallic types of instrument, as used in the range $-200\text{ }^{\circ}\text{C}$ to $+700\text{ }^{\circ}\text{C}$.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Liquid expansion dial-type thermometers

2.1 General

Liquid expansion dial-type thermometers consist of a metallic bulb connected to a bourdon tube type gauge with the whole system completely filled with liquid. Change of volume of the liquid in the bulb due to change of temperature causes movement of the bourdon tube and the temperature is indicated by a pointer on the dial.

In the liquid expansion dial-type thermometer the gauge or indicator acts essentially as a volume change indicator and not a pressure gauge as in the vapour pressure and gas expansion thermometers.

2.2 Characteristics

Inherent advantages of the liquid expansion dial-type thermometer are as follows.

- a) The scales are evenly divided throughout the range.
- b) a wide variation of range is possible with a single filling liquid.
- c) Ample energy is available for operating the bourdon tube which can therefore be robust and can be arranged to give good pointer control.

d) The filling liquid can be under high pressure. This improves linearity and elevates the boiling temperature to allow measurement of higher temperatures.

e) Accuracy achievable is $\pm 1\%$ of range. (See BS 5235.)

Typical liquid expansion dial-type thermometers are shown in Figure 1(a).

2.3 Filling liquid

Organic based fluids can be used as the filling liquid in liquid expansion dial-type thermometers but in the majority of practical applications mercury in a steel system is used for the following reasons.

- a) The expansion is essentially linear with temperature. This is not true for organic liquids.
- b) Although the coefficient of expansion of mercury is small compared to those of organic liquids and requires mercury-filled systems to have a larger volume bulb for the same sensitivity, mercury will operate readily in smaller bore capillaries (typically 0.15 mm bore) giving a small volume in the capillary. These two characteristics together mean that in capillary type distant reading thermometers, the ratio between the volume of mercury in the bulb and that in the capillary can be kept very large so that the expansion of the small amount of mercury in the capillary is small. This ensures that the expansion due to temperature change of the bulb is two or three orders of magnitude greater than the expansion of mercury in the capillary due to likely ambient temperature changes.
- c) Mercury is liquid over a wide temperature range and this allows instruments to be used in the range $-39\text{ }^{\circ}\text{C}$ to $+650\text{ }^{\circ}\text{C}$. Continuous use above $500\text{ }^{\circ}\text{C}$ is not recommended.

Mercury filling requires the use of steel or stainless steel bulbs, capillaries and bourdon tubes, with welded joints. This construction tends to make mercury-in-steel thermometers more costly than other types of dial thermometers in which copper based materials are used. Organic filling liquids such as xylene and alcohol may be used when capillary length (if any) is small and either the possible contamination from mercury has to be avoided at all costs or a very small bulb is required.

2.4 Sources of error

Errors in use of liquid expansion dial-type thermometers arise mainly from variations in ambient temperature and from the effects of pressure head differences between the bulb and the gauge.