BS 7786:2006

BRITISH STANDARD

Specification for unsintered PTFE tapes for general use

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Publishing and copyright information

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Foreword

Publishing information

This British Standard was published by BSI and came into effect on 31 August 2006. It was prepared by Technical Committee PSE/2, *Jointing materials and compounds*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7786:1995, which is withdrawn.

Relationship with other publications

There are two standards covering unsintered PTFE tapes. This British Standard specifies requirements for tapes for general use at a wide range of temperatures. BS EN 751-3 specifies requirements for tapes for use in very specific circumstances at a more limited range of temperatures.

Information about this document

This is a full revision of the standard. The principal change has been to make all unsintered PTFE tapes manufactured in accordance with BS 7786 suitable for use with an oxygen-enriched environment.

Hazard warnings

WARNING. When heated to temperatures above 260 °C, PTFE will begin to degrade and the rate of degradation will increase with increasing temperature. The gases produced during degradation will vary according to the temperature and other conditions but will invariably contain toxic components. Where accidental or unavoidable exposure of PTFE to heat and/or flame occurs, good ventilation is therefore essential.

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to the technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractural and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for unsintered polytetrafluoroethylene (PTFE) tapes with a mass per unit area within the range 25 g/m^2 to 300 g/m^2 and with a thickness in the range 0.05 mm to 0.25 mm.

It specifies requirements for three grades of unsintered PTFE tape, for general or special engineering applications at temperatures between –270 °C and +260 °C. All grades of this tape are suitable for use with most common liquids and gases and in an oxygen-enriched environment.

In addition to the definitive requirements, this standard also requires the items detailed in Clause **3** to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

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.

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)*

BS 572:1985, *Specification for interchangeable conical ground glass joints*

BS 1752, *Specification for laboratory sintered or fritted filters including porosity grading*

BS 2071:1989, *Specification for Soxhlet extractors*

BS 6920-1, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 1: Specification*

BS EN ISO 4797:2004, *Laboratory glassware – Boiling flasks with conical ground joints*

BS EN ISO 12086-1:2006, *Plastics – Fluoropolymer dispersions and moulding and extrusion materials – Part 1: Designation system and basis for specifications*

ASTM D4591, *Standard test method for determining temperatures and heats of transitions of fluoropolymers by differential scanning calorimetry*

3 Information and requirements to be agreed and documented

3.1 Information to be supplied by the purchaser

The information to be supplied by the purchaser shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified:

a) the grade and thickness of tape chosen;

b) the intended application for the PTFE tape, including any relevant British, European or international application standards;

NOTE 1 Some specific applications are covered in BS EN 751-3.

c) the maximum intended working pressure;

NOTE 2 The maximum working pressure will depend upon the grade and thickness of the tape, the method of application, the number of wraps, the size and quality of the fittings (threads) and the specific operating environment (flow product and temperature). In specialist applications, PTFE tapes have been satisfactorily used for sealing against pressures exceeding 300 bar [1)] and also for high vacuum applications.

d) the width and length of tape chosen;

e) whether the tape is to be used in contact with, or likely to be used in contact with, potable water.

3.2 Items for agreement

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance can be made:

a) where no specific application standard exists, the grade, thickness and density required to form a leak-free joint for the intended application (see Clause **6**, **7.1** and Clause **8**);

*NOTE 1 For the purposes of product performance comparisons it might be desirable to select one of the preferred thickness values specified in **7.1**.*

b) if the width differs from that normally supplied, the width supplied in this case (see **7.2**);

c) if the length differs from that normally supplied, the length supplied in this case (see **7.3**);

1) 1 bar = 10^5 N/m^2 = 100 kPa.

d) if the application requires test pressures that differ from those normally applied, the test pressure that will apply in this case (see Clause **8**);

NOTE 2 At the request of the user the manufacturer should provide sufficient information on the application and use of the tape together with any special measures or techniques that might be needed when the tape is being used under extremes of pressure, temperature or size.

e) where no specific application standard exists, the representative thread form used in a thread wrapping test (see Clause **9**).

4 Composition

4.1 The tape shall be manufactured from a suitable grade of coagulated dispersion PTFE powder which conforms to the designation PTFE-E, PDMIN, 7.1.E.H.4.1.2 as specified in BS EN ISO 12086-1:2006. Filler, plasticizer, colour, reprocessed material, or additives other than processing lubricant shall not be added.

4.2 When determined in accordance with Annex A, the residual lubricant content shall not exceed 0.1% by mass.

NOTE 1 This ensures that the tape is suitable for use in an oxygen-enriched environment.

NOTE 2 For applications involving either high concentrations or pressures (or both) of liquid or gaseous oxygen, either detonation or self-ignition tests (or both) might also be required. If in doubt it is essential that the user consult the oxygen supplier for guidance on these potential hazards.

4.3 The conditions during manufacture shall be such that the tape remains in the unsintered state, as evidenced by the absence of a shift or change in peak height of the initial melting peak obtained by differential scanning calorimetry (DSC) when compared with the starting material. The melting endotherm temperature shall be between 340 °C and 350 °C when tested in accordance with ASTM D4591.

4.4 When used under the conditions for which they are designated, PTFE tapes in contact with, or likely to come into contact with, potable water shall conform to the requirements specified in BS 6920-1.

NOTE Non-metallic products for installation and use in the United Kingdom which are verified and listed under the UK Water Regulations Advisory Scheme (WRAS) are deemed to satisfy the requirements of this subclause. Details of the scheme are obtainable from the WRc-NSF Evaluation and Testing Centre, Fern Close, Pen-Y-Fan Industrial Estate, Oakdale, Gwent, NP11 3EH, telephone 01495 248454, fax 01495 249234.

In addition, products introduced in accordance with Regulation 25 of the Water Supply (Water Quality) Regulations 1989 [1] are considered free from adverse health effects for the purposes of conformity to this subclause. A list of substances and products approved under Regulation 25 can be obtained from the WRc-NSF Evaluation and Testing Centre.

5 Appearance and finish

5.1 When viewed in reflected light the tape shall be white in colour.

5.2 The tape shall be free from any edge or surface defects, inclusions, thin patches, tears and holes, when inspected visually.

6 Tape grades

NOTE See Annex B for an explanatory note on tape grades.

6.1 Tape shall be supplied in one of the grades which are designated in terms of the mass per unit area and identified by the indicated grade letter as given in Table 1.

Table 1 **Tape grades**

Grade	**Mass per unit area** g/m^2	**Indicative applications**[A)]
H	300 to 150	1 wrap up to R2 2 wraps R2 – R4[B)] 3 wraps R4 – R6[B)]
M	150 to 75	1 wrap up to R3/4 or antiseize only up to R4 2 wraps R3/4 to R1 1/2 3 wraps R1 1/2 to R2
L	75 to 25	1 wrap up to R1/4 or antiseize only up to R2 2 wraps R1/4 to R1/2 3 wraps R1/2 to R1

A) The indicative applications are not requirements but serve as a guide to the applications most suited to the tape. See also Clause **3** for application limits.

B) For thread sizes larger than R4 the manufacturer should be consulted. For thread sizes larger than R2, if permitted, a non-penetrant lubricant applied to the surface of the wrapped tape is highly beneficial for reduction in tightening torque.

6.2 When determined in accordance with Annex C, the mass per unit area shall not fall outside the range given for the grade.

NOTE The mass per unit area in each category can be achieved by any combination of thickness and density commensurate with the appropriate range of values in each category.

7 Tape dimensions

7.1 Thickness

When determined to an accuracy of 0.002 mm in accordance with Annex D at an applied pressure of 10 kPa to 20 kPa, the mean thickness of the tape, based on a minimum of five readings taken at equal distances apart, shall not differ from the declared value by more than ±10%. Unless otherwise agreed in accordance with **3.2**a), or required by the manufacturer to ensure specified performance levels, tape shall be supplied in the following thicknesses: 0.075 mm; 0.1 mm; 0.2 mm (see Clause **6**).

NOTE It might not be possible within the constraints of the grading system to supply all three preferred thicknesses at each grade. Some of the preferred thicknesses might be mutually exclusive to one or other of the grades.

7.2 Width

When determined to an accuracy of ±0.1 mm in accordance with Annex D, the mean width of the tape, based on a minimum of five measurements taken at equal distances apart along the length of the tape, shall not differ from that marked on the spool by more than ±0.5 mm. Unless otherwise agreed in accordance with **3.2**b), tape shall be supplied in widths of 12 mm, 19 mm or 25 mm.

7.3 Length

When determined in a tension free condition to an accuracy of ±0.1% in accordance with Annex D, the actual length of tape on the spool shall be not less than that marked on the spool. Unless otherwise agreed in accordance with **3.2**c), tape shall be supplied in lengths of 5 m, 10 m, 12 m or 25 m.

8 Sealing

Any sample of tape shall form a leak-free seal when tested in accordance with the relevant British, European or international application standard. In the absence of such a standard, the manufacturer shall supply tape in accordance with **3.2**a), that provides a leak-free seal which provides the agreed performance for the intended application when applied to a joint or joints of representative size and thread form. Unless otherwise agreed in accordance with **3.2**d), the joint(s) shall be tested at a pressure or vacuum as follows:

a) for pressure, 1.5 times the maximum required working pressure; and

b) for vacuum, 1.0 times vacuum, over the expected working temperature range.

NOTE The chosen pressure medium may be the actual flow product, or the joint may be exposed to the flow product, or agreed simulant, prior to pressure testing with compressed air or nitrogen gas.

9 Thread wrapping

When tested in accordance with Annex E, the tape shall not break, or tear or split at the crests of the thread form, and the finishing end of the tape shall remain in position with no tendency to unwind.

10 Sampling

All samples of tape used for the tests specified in Clause **4**, Clause **5**, Clause **8** and Clause **9** shall be taken from a wound spool omitting the first layer or wrapping.

11 Packaging and marking

11.1 Tape shall be wound onto spools that have a close fitting sleeve capable of excluding dust and grit. Spool and sleeve shall be resistant to mechanical damage in normal handling and usage.

11.2 Each spool of tape shall be indelibly and legibly marked with the following information:

a) the manufacturer's or supplier's name or trade mark;

b) the number and year of this British Standard and the grade of tape, e.g. BS 7786:2006[2)]:Grade M;

c) the nominal thickness, width and length of the tape;

d) whether or not the tape is suitable for potable water.

[2)] Marking BS 7786:2006 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex A (normative) Determination of residual lubricant content

A.1 Principle

The residual lubricant content is determined from the loss in mass of a sample after extraction with petroleum spirit and subsequent heating at 300 °C.

A.2 Reagent

A.2.1 *Petroleum spirit* (boiling range 40 °C to 60 °C). The solvent used for this extraction shall be of a general purpose laboratory reagent quality.

> **WARNING.** Petroleum spirit is highly flammable. Take precautions to avoid ignition. Avoid breathing the vapour and contact of the petroleum spirit with skin or eyes. Refer to the supplier's health and safety data for the precautions which are to be taken for the safe use of petroleum spirit.

NOTE Attention is drawn to the Control of Substances Hazardous to Health (COSHH) Regulations 1988 [2].

A.3 Apparatus

A.3.1 *Soxhlet extractor*, conforming to BS 2071 with a nominal capacity of 100 ml. The socket joint shall be of 34/35 size, as specified in BS 572:1985, the cone joint shall be of 24/29 size, as specified in BS 572:1985, and the extraction thimble fitted with a fritted glass plate shall conform to BS 1752 with a maximum pore diameter within the range 100 μm to 160 μm.

NOTE Suitable sizes of extraction thimble and condenser are given in BS 2071:1989, Annex A.

A.3.2 *Condenser.*

A.3.3 *Boiling flask*, with conical ground glass joint of size 29/32, conforming to BS EN ISO 4797:2004.

A.3.4 *Air circulation oven*, capable of being maintained at a temperature of (100 ± 5) °C and (300 ± 5) °C.

A.3.5 *Metal crucible.*

A.3.6 *Balance*, of sufficient capacity to weigh the metal crucible and its contents to an accuracy of 0.1 mg.

A.3.7 *Desiccator.*

A.4 Procedure

A.4.1 Extraction

A.4.1.1 Clean, dry and weigh the extraction thimble fitted with the fritted glass plate (**A.3.1**) to the nearest 0.1 mg using the balance (**A.3.6**).

A.4.1.2 Cut approximately 15 g of the tape sample (see Clause **10**). Place the tape into the extraction thimble fitted with the fritted glass plate and weigh to the nearest 0.1 mg.

A.4.1.3 Insert the extraction thimble fitted with the fritted glass plate and tape, into the Soxhlet extractor (**A.3.1**). Pour 300 ml to 400 ml of petroleum spirit (**A.2.1**) into the boiling flask (**A.3.3**).

A.4.1.4 Assemble the boiling flask, Soxhlet extractor and condenser (**A.3.2**) and subject the tape to at least 60 extractions during a continuous period of not less than 4 h. After the extraction is completed, remove the thimble from the apparatus and dry in an air circulation oven (**A.3.4**) maintained at (100 ± 5) °C.

A.4.2 Heating

Clean, dry and weigh the metal crucible (**A.3.5**) using the balance (**A.3.6**). Transfer the extracted tape from the thimble to the metal crucible and place them in the air circulation oven (**A.3.4**) at (300 ± 5) °C for 6 h. At the end of this period remove the metal crucible from the oven and cool in the desiccator (**A.3.7**). Remove the metal crucible from the desiccator and using the balance weigh the crucible and tape.

A.5 Expression of results

The residual lubricant content c, as a percentage by mass (%), is given by the equation:

$$c = (m_1 - m_2) \times \frac{100}{m_1}$$

where:

m_1 is the original mass of the tape;

m_2 is the mass of the tape after the extraction and heating treatments.

Calculate and report the residual lubricant content, to the nearest 0.01%.

Annex B (informative) Explanatory note on tape grades

Since the publication of BS 4375:1968, technical advances have been made in PTFE tape manufacture such that tapes can now be produced with varying micro-void contents by hot stretching techniques. The stretching process allows the production of tapes with densities commonly in the range 0.3 g/ml to 1.6 g/ml (full density). Lower density tapes generally exhibit improved conformability, drapeability, joint cohesion, and the ability to seal fine threads.

However, sealing performance depends primarily upon the mass per unit area which gives a measure of the fully compressed thickness available at the sealing interface. Low density tapes will require more wraps than higher density products to effect a given seal.

Specifying only a preferred thickness does not in itself fully characterize the properties of the tape except in the special case where no stretching has been performed, i.e. full density tape, 1.5 g/ml to 1.7 g/ml.

In order to fully characterize the properties of the tape, it is necessary that at least two of the following parameters are known:

a) thickness;

b) density; or

c) mass per unit area.

The mass per unit area, m/a, in grams per square metre (g/m^2), is given by the equation:

$$\frac{m}{a} = 1\,000 \times \frac{m}{wL}$$

where:

L is the length, in metres (m);

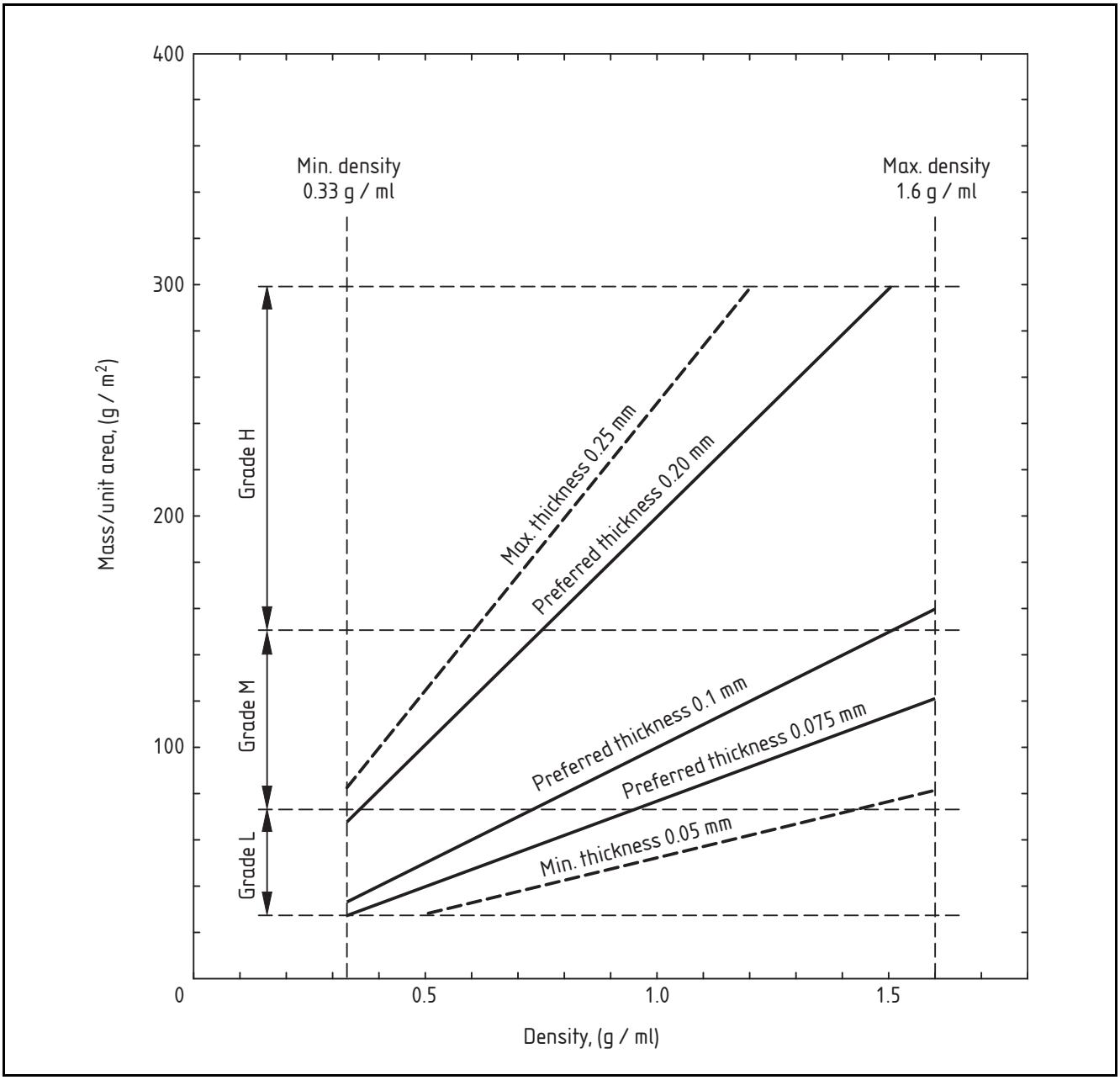
m is the mass of PTFE on the spool, in grams (g);

w is the average width, in millimetres (mm).

This standard allows three grades of tape to be designated according to their range of mass per unit area. The lowest bound of 25 g/m^2 is set to exclude lightweight tapes, which are unlikely to seal even the finest threads unless used in multiple wraps. The highest bound is set either by the maximum attainable density for unsintered tapes of 1.5 g/ml to 1.7 g/ml or by the mass per unit area of 300 g/m^2, a value which is seldom exceeded in thread sealing applications.

Figure B.1 shows the theoretical relation between mass per unit area and density and the bounds allowed by this specification (see bounded area). Within any given grade the mass per unit area can be attained by various combinations of thickness and density. This allows the manufacturer and purchaser to specify the optimum thickness and density best suited for the particular application. The full lines show the mass per unit area/density relationships for the preferred thickness values.

Figure B.1 **Mass per unit area/density/thickness relationships**



Annex C (normative) Determination of mass per unit area

C.1 Apparatus

C.1.1 *Balance*, capable of measuring to ±5 mg.

C.2 Procedure

After the measurement of thickness, width and length (see Clause **7**), weigh the full length of tape removed from the spool to the nearest 5 mg.

C.3 Expression of result

Calculate the mass per unit area, m/a, in grams per square metre (g/m^2), from the following equation:

$$\frac{m}{a} = 1\,000 \times \frac{m}{wL}$$

where:

L is the length, in metres (m);

m is the mass of PTFE on the spool, in grams (g);

w is the average width, in millimetres (mm).

Annex D (normative) Measurement of tape dimensions

D.1 Apparatus

D.1.1 *Micrometer gauge*, capable of reading to an accuracy of 0.002 5 mm and having a foot of not less than 6.3 mm in diameter. The micrometer shall apply a pressure at the foot of between 10 kPa and 20 kPa when used for measuring the thickness of the tape.

D.1.2 *Graticule*, for measuring lengths of 10 mm to 25 mm to an accuracy of ±0.1 mm.

D.1.3 *Metre rule*, for measuring lengths of 1 m to an accuracy of ±0.5 mm.

D.2 Procedure

D.2.1 Take readings of the thickness of the tape, in millimetres (mm), using the micrometer gauge (**D.1.1**) at points approximately 50 mm from each end of the tape and at a minimum of three other points at equal distances between the first two readings. Take the mean value of the readings as the thickness of the tape.

D.2.2 Determine the width of the tape, in millimetres (mm), using the graticule (**D.1.2**), to an accuracy of ±0.1 mm at points approximately 50 mm from each end of the tape and at a minimum of three other points at equal distances between the first two readings. Take the mean value of the readings as the width of the tape.

D.2.3 Lay the tape out free from tension in close contact along its length with a flat surface. Measure the length of tape on the spool, in metres, to an accuracy of ±0.5 mm, using the metre rule (**D.1.3**).

D.3 Test report

Record the following in the test report:

a) the thickness of the tape sample, in millimetres (mm);

b) the width of the tape, in millimetres (mm); and

c) the length of the tape on the spool, in metres (m).

Annex E (normative) Thread wrapping test

E.1 Apparatus

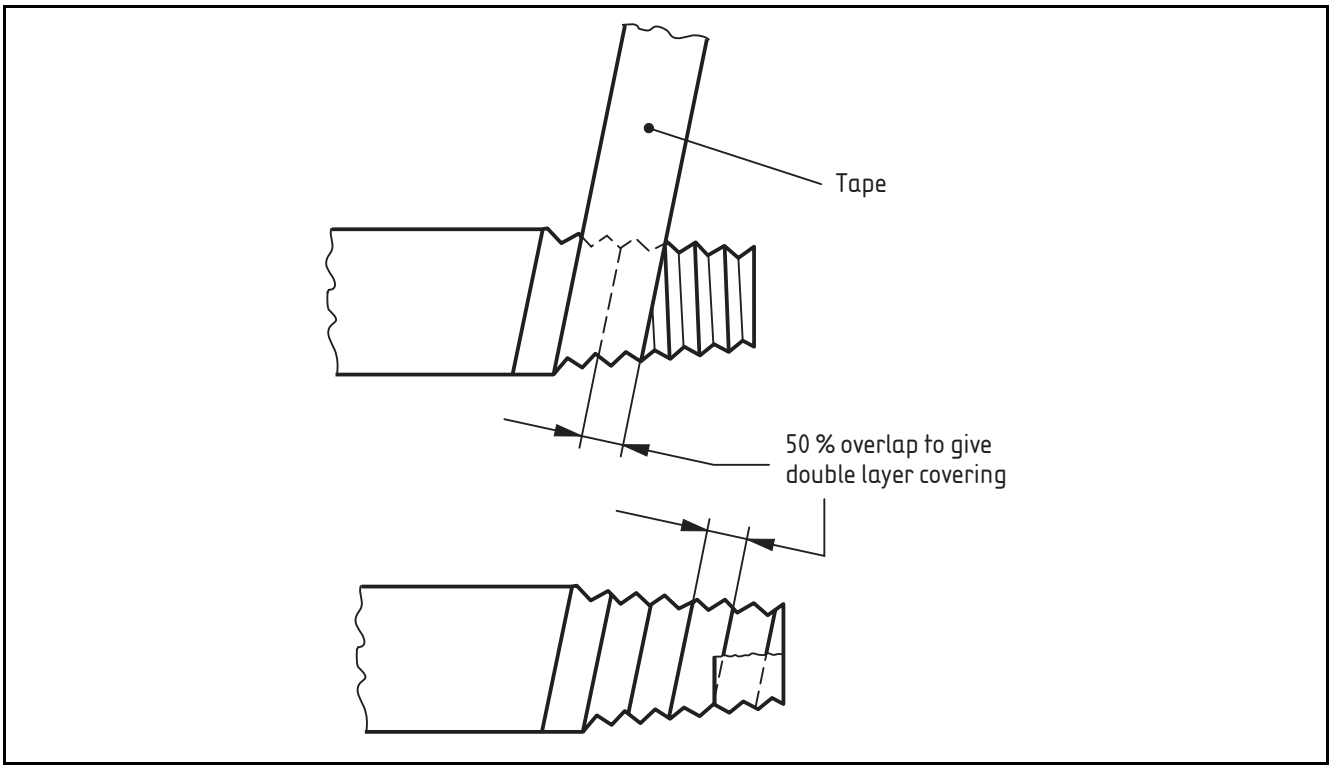
E.1.1 *Pipe*, of approximately 150 mm length, with a wall thickness that exceeds 2 mm, machine-cut at one end with a taper thread conforming to BS 21, of size and material as specified in the appropriate application standard. Where no application standard exists, the size and material of the thread shall be as agreed between the purchaser and the manufacturer in accordance with **3.2**e).

E.2 Procedure

E.2.1 Wind a length of the tape sample round the thread by hand, in a clockwise direction when viewed from the open end of the pipe, to give a double layer covering, using a constant, minimal tension sufficient for the tape to take up the form of the thread. The tape width shall not exceed the length of the thread form.

E.2.2 Where the length of the thread form exceeds the tape width apply the tape in helical fashion, in the same clockwise direction, but with a 50% overlap as shown in Figure E.1.

Figure E.1 **Thread wrapping test**



E.3 Test report

Record the following in the test report:

a) whether or not the tape has taken up the form of the thread;

b) whether or not the finishing end of the tape remains in position;

c) whether or not the tape has broken, or torn or split at the crests of the thread form.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 751-3, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water – Part 3: Unsintered PTFE tapes*

Other publications

[1] GREAT BRITAIN. Water Supply (Water Quality) Regulations 1989. London: HMSO.

[2] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations 1988. London: HMSO.

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