

**BRITISH STANDARD**

# **Pressed wool felts – Specification**

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## Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 31 and a back cover.

# Foreword

This British Standard has been prepared by Technical Committee TCI/24. It supersedes BS 4060:1989, which is withdrawn.

## Information about this document

In this revision, the following principal changes have been made.

- a) References to current test methods/standards have been updated.
- b) Reference to pentachlorophenol laurate (PCPL) has been removed, as this is no longer recommended as a suitable rot-proofing treatment.
- c) Appendix B and Table 8 have been removed.
- d) The majority of Appendix C, as obsolescent, has been removed. Table 9, containing cross references between BS 4060 and MOD Defence Standard 83-19, has been retained, as Table B.1.

## Contractual and legal considerations

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

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

In particular, attention is drawn to the following statutory regulations.

- The Textile Products (Indications of Fibre Content) Regulations 1986 [1]
- The Textile Products (Indications of Fibre Content) Regulations 1988 [2]
- The Textile Products (Indications of Fibre Content) Regulations 1994 [3].

# 1 Scope

This British Standard specifies requirements for general purpose felts including packaging felts, and decorative felts and precision felts.

Methods of test for chemical and physical properties are given in normative annexes C and D, respectively.

This standard applies to either white felt or grey felt, with a minimum wool content of 75%, 90% or 97%, except for A97/7D felt, which is dyed (see Table 1).

# 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 572, *Specification for interchangeable conical ground glass joints.*

BS 1752:1983, *Specification for laboratory sintered or fritted filters including porosity grading.*

BS 2087-1, *Preservative textile treatments – Part 1: Specification for treatments.*

BS 8459, *Determination of extractable matter in textiles – Method.*

BS 3591, *Specification for industrial methylated spirits.*

BS 4407:1988, *Methods for quantitative analysis of fibre mixtures.*

BS 4475:2000, *Specification for straight mineral lubricating oils.*

BS 4736, *Method for determination of dimensional changes of fabrics induced by cold-water immersion.*

BS 6810-2:2005, *Determination of metals in textiles – Part 2: Analysis by atomic emission spectroscopy.*

BS EN 1413:1998, *Textiles – Determination of pH of aqueous extract.*<sup>1)</sup>

BS EN 20105-C01/ISO 105-C01, *Textiles – Tests for colour fastness – Part C01: Colour fastness to washing – Test 1.*

BS EN ISO 105-B02, *Textiles – Tests for colour fastness – Part B02: Colour fastness to artificial light – Xenon arc fading lamp test.*

BS EN ISO 105-X12, *Textiles – Tests for colour fastness – Part X12: Colour fastness to rubbing.*

BS EN ISO 139:2005, *Textiles – Standard atmospheres for conditioning and testing.*

BS EN ISO 3696, *Water for analytical laboratory use – Specification and test methods.*

<sup>1)</sup> This will be superseded by BS EN ISO 3071, *Determination of pH of the aqueous extract*, upon its being published.



### 3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

- 3.1 felt**  
fabric characterized by the entangled condition of most, or all, of the fibres of which it is composed
- 3.2 general purpose felt**  
felt used for packaging, clothing, decorative and similar purposes
- 3.3 precision felt**  
felt used in engineering applications, where close tolerances are necessary
- 3.4 pressed felt**  
felt formed from a web or batt containing animal hair or wool, consolidated by the application of heat and mechanical action that causes the constituent fibres to mat together
- 3.5 white felt**  
felt that has the colour of natural, unpigmented wool
- NOTE White felts are used where visual appearance is important.*
- 3.6 grey felt**  
felt, the colour of which has been obtained from using mixtures of coloured wools and other fibres

### 4 Material requirements

Felts shall be manufactured from wool, or mixtures of wool with natural or man-made fibres. The minimum wool content shall be as specified in Table 1 and Table 4.

*NOTE The fibres should be blended, carded and felted to form a uniform product substantially free from permanent ridges and creases. The product should be free from all non-fibrous agents, e.g. stiffening, loading or reinforcing agents of any kind.*

### 5 Designation

Felts shall be designated by a condensed technical description (see Table 1 and Table 4) containing the following:

- a) a first letter to indicate whether the felt is general purpose (A) or precision (B);
- b) a number, consisting of two digits, to indicate the minimum percentage wool content;
- c) an oblique stroke;
- d) a single digit number, 1 to 8, to indicate the hardness or density grade;
- e) a letter to indicate the colour white (W), grey (G) or dyed (D).

*NOTE If appropriate, interested parties can agree to include the additional designations in Table 6 and Table 7 in order to indicate that particular chemical and/or physical requirements have been conformed to (see 6.4 and 6.5).*

**EXAMPLE 1:**

The designation, A75/1W, indicates that the felt is general purpose, with 75% wool content, extra hard and white.

**EXAMPLE 2**

The designation, B97/1G6.1–6.6, indicates that the felt is a precision felt with 97% wool content, extra hard, grey, having a minimum breaking strength of 5.5 MPa and having chemical properties conforming to 6.1 to 6.6 of Table 6.

## 6 Performance requirements

### 6.1 General purpose felts

General purpose felts, including packaging felts, shall conform to Table 1 and Table 2.

*NOTE* Commonly manufactured thicknesses are 1 mm, 3 mm, 5 mm, 10 mm, 15 mm, 20 mm and 25 mm but other thicknesses may be specified by the customer.

Table 1 General purpose felts

Designation			Colour	Hardness	Description	Nominal density in accordance with test method D.2
Minimum wool content in accordance with test method C.1 <sup>A)</sup>						
75%	90%	97%				mg/mm
A75/1W	—	A97/1W	White	1	Extra hard	0.60
A75/1G	—	A97/1G	Grey			
A75/2W	—	A97/2W	White	2	Hard	0.46
A75/2G	—	A97/2G	Grey			
A75/3W	—	A97/3W	White	3	Extra firm	0.40
A75/3G	—	A97/3G	Grey			
A75/4W		A97/4W	White	4	Firm	0.34
A75/4G	A90/4G	A97/4G	Grey			
A75/5W	—	A97/5W	White	5	Medium firm	0.27
A75/5G	—	A97/5G	Grey			
A75/6W	—	A97/6W	White	6	Medium	0.23
A75/6G	—	A97/6G	Grey			
		A97/7D	Dyed	7	Medium soft	0.20
A75/8W	A90/8W	A97/8W	White	8	Soft	0.18
A75/8G	A90/8G	A97/8G	Grey			
A75/9W	—	A97/9W	White	9	Extra soft	0.15
A75/9G	—	A97/9G	Grey			

<sup>A)</sup> These values are taken from the Ministry of Defence 83-19 [4].

Table 2 Tolerances on general purpose felts

Nominal thickness according to test method D.1 mm	Tolerance on nominal thickness and density %	Tolerance of individual thickness measurements %
$\leq 3.0$	$\pm 20^A)$	$\pm 25$
3.1 – 10	$\pm 5$	$\pm 20$
$> 10$	$\pm 10$	$\pm 15$

<sup>A)</sup> See note to D.2.3.

## 6.2 Decorative felts

Decorative felts shall conform to 6.1 and shall meet the minimum colour fastness ratings detailed in Table 3.

## 6.3 Precision felts

Precision felts shall conform to Table 4 and Table 5.

## 6.4 Chemical properties

If felts are required to have particular chemical properties, the felts shall conform to the relevant requirements of Table 6.

*NOTE 1 The manufacturer should query the purchaser as to whether there are any particular chemical properties that are required (see Annex A).*

*NOTE 2 For MOD purposes, general purpose felts and felts for aerospace purposes should conform to 6.1, 6.3 and Table 6.*

The tests outlined in Annex C shall be used to determine the wool content of felts.

## 6.5 Physical properties

If felts are required to have particular physical properties, such as breaking strength and oil retention, they shall conform to the relevant requirements of Table 7.

*NOTE The purchaser should specify whether any particular physical properties are required (see Annex A).*

The tests outlined in Annex D shall be used to determine the physical properties of the felts.

## 6.6 Special finishes

Felts shall be manufactured either with or without special finishes imparting, for example, rot, mildew, moth, flame or water resistance, or a combination of these properties.

*NOTE The purchaser should specify whether any special finishes are required (see Annex A).*



Table 3 Decorative felts

Colour fastness (minimum rating) (1.8 mm coloured felt)					Test method	
	To light using Xenon arc		5	BS EN ISO 105-B02		
	To rubbing	Wet	3–4	BS EN ISO 105-X12		
		Dry				
	To water	Change in colour		4	BS EN 20105-C01/ISO 105-C01	
		Staining	on cotton	4		
			on wool	4		
			on polyester	4		
Bursting strength (minimum) (kPa)					Test method	
			for 1.6 mm thick felts	345	BS EN ISO 13938-1 (hydraulic) or BS EN ISO 13938-2 (pneumatic), using 30 mm aperture	
			for 1.8 mm thick felts	760		

Table 4 Precision felts

Designation		Colour	Hardness		Nominal Density according to test method D.2	Maximum swelling in water-alcohol mixture <sup>A)</sup> according to test method D.4	Minimum splitting resistance <sup>B)</sup> according to test method D.6
Minimum wool content according to test method C.1 <sup>C)</sup>			Grade	Description			
90 %	97 %						
B90/1W	B97/1W	White	1	Extra hard	0.60	20	100.0
B90/1G	B97/1G	Grey					
B90/2W	B97/2W	White	2	Hard	0.46	20	87.5
B90/2G	B97/2G	Grey					
B90/3W	B97/3W	White	3	Extra firm	0.40	20	70.0
B90/3G	B97/3G	Grey					
B90/4W	B97/4W	White	4	Firm	0.34	20	50.0
B90/4G	B97/4G	Grey					

A) Requirement for 97% minimum wool content felts only.

B) Requirement for felts of thickness equal to and greater than 5 mm only.

C) These values are taken from the Ministry of Defence 83-19 [4].

Table 5 Tolerances on precision felts

Nominal thickness according to test method D.1 mm	Tolerance on nominal thickness %	Tolerance on individual thickness measurements %	Tolerance on nominal density %
3 to 10	± 7.5	± 12.5	± 10
above 10	± 5	± 10	± 7.5

Table 6 Chemical properties

Designation	Property	Requirement	Test Method
6.1	pH value of aqueous extract	5.0 to 8.0	BS EN ISO 3071 using the hot water extraction method
6.2	Water soluble chloride, as NaCl	0.05(%) (maximum)	Annex E
6.3	Water soluble sulphate, as Na <sub>2</sub> SO <sub>4</sub>	0.05(%) (maximum)	
6.4	Matter soluble in toluene-methanol (other than matter derived from proofing agents)	5.0(%) (maximum)	C.2
6.5	Matter soluble in water after removal of matter soluble in toluene-methanol	3.0(%) (maximum)	C.2
6.6	Ash (other than the ash of proofing agents)	3.5(%) (maximum)	BS 6646
6.7	Rot-proofing	In accordance with BS 2087-1:1992, dichlorophen heavy process or copper 8 normal process	—
6.8	Soluble hexavalent chromium	0.01(%) (expressed as K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> <sup>B)</sup> ) (maximum)	Clause 8.5 of BS 6810-2:2005

A) For determination of water soluble chloride, or water soluble sulphate the following alternative procedures may be used:

a) for water soluble chloride, either:

- 1) automatic microtitration using a chloride ion-selective electrode;
- 2) ion-chromatography;

b) for water soluble sulphate, ion-chromatography.

In cases of dispute, gravimetric methods as specified in BS EN 1413 are used.

B) For finished felt that has been chrome dyed only.

Table 7 Physical properties

Designation	Property	Requirement	Test method
7.1	Breaking strength	mg/mm <sup>3</sup>	(Minimum MPa for nominal densities)
		0.60	5.5
		0.46	4.5
		0.40	3.8
		0.34	3.1
7.2	Oil retention	mg/mm <sup>3</sup>	(Minimum % for nominal densities)
		0.60	80
		0.46	90
		0.40	100
		0.34	120

## 7 Inspection, sampling, conditioning and testing atmosphere

### 7.1 Inspection

Each manufactured piece shall be visually inspected for defects, e.g. permanent ridges and/or creases and holes.

*NOTE 1 Interested parties can agree to the nature and number of defects which may be permitted on the marking of their positions in the roll or sheet and on the appropriate allowance to be made.*

*NOTE 2 Felts for MOD purposes should be substantially free from holes.*

### 7.2 Sampling

**7.2.1** Unless otherwise specified in the relevant test method (test methods are outlined in Annex C and Annex D, as well as referred to in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7), samples of the felt shall be taken from each lot of 200 m<sup>2</sup> or less.

**7.2.2** As a minimum, samples shall be taken either 1 m from either end of a roll or 10 cm from either end of a sheet.

**7.2.3** Each sample shall consist of a strip or strips cut from across the full width of the felt to give a total mass sufficient to perform all tests required and of adequate dimensions appropriate to the tests to be performed.

For chemical tests, the sample shall be cut into cubes having sides no more than 5 mm long. The cubes shall be conditioned for 24 h in accordance with **7.3**. The cubes shall be mixed together and a number of them randomly selected to give a test specimen of mass appropriate to the test method under consideration.

### 7.3 Conditioning and testing atmosphere

Unless otherwise specified in the relevant test method, conditioning and testing shall be carried out in the standard temperate atmosphere specified in BS EN ISO 139:2005, i.e. a relative humidity of  $(65 \pm 4)\%$  and a temperature of  $(20 \pm 2)^\circ\text{C}$ .

Laboratory samples shall be conditioned by exposing them for at least 24 h to the conditioning atmosphere.

## 8 Marking

Pressed felts consisting of wool shall be marked with the following particulars:

- a) the name, trade mark or other means of identification of the manufacturer;
- b) the number and date of this British Standard, i.e. BS 4060:2006<sup>2)</sup>;
- c) the felt type and designation in accordance with Clause 4;
- d) the nominal width, length and thickness of the piece or sheet.

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<sup>2)</sup> Marking BS 4060:2006 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.

## Annex A (informative) **Information to be agreed between the manufacturer and the purchaser**

### A.1 **The following should be detailed in the purchaser's tender or order:**

- a) felt designation (see Clause 5);
- b) thickness in millimetres;
- c) width in millimetres.
- d) length in metres;
- e) whether ridges and/or creases are permitted (see 7.1).

### A.2 **In the case of MOD contracts, the purchaser should supply the following additional information:**

- a) the NATO stock number;
- b) the item name, description and thickness;
- c) the pattern number;
- d) any modification to requirements that might be necessary when special finishing processes are applied.

### A.3 **Where necessary (e.g., during the review of a contract) the following additional information should be added:**

- a) additional chemical or physical requirements, as detailed in Table 6 and Table 7 (see 6.4 and 6.5);
- b) any special finish (see 6.6).

## Annex B (informative) **Supplementary Information for MOD contracts**

This annex gives cross reference information on the fabric designations used in BS 4060 and MOD names and descriptions, together with pattern numbers and NATO stock numbers (see Table B.1).

*NOTE The applicable MOD standard, 83-19 [4], is no longer publicly available but is still referred to in this standard, as it is still commonly referred to within the MOD supply chain.*



Table B.1 Cross-references between felt designations used in BS 4060 and MOD names and descriptions, pattern numbers and stock numbers

Designation	Name and description	Pattern number	Nominal thickness mm	NATO stock number: 8305-99-
General purpose felts: unproofed <sup>A)</sup>				
A97/9W	Cloth, compressed felt, wool, white	T1406A(8)	8	843-8774
A97/8G	Cloth, compressed felt, wool, grey	T1121A(3)	3	942-2022
		T1121A(5)	5	942-2023
		T11121A(10)	10	942-2024
		T1121A(12)	12	942-2025
		T1121A(15)	15	193-9493
		T1121A(20)	20	942-2026
		T1121A(25)	25	942-2027
A97/5W	Cloth, compressed felt, wool, white	T1114A(1)	1	942-2010
		T1114A(3)	3	942-2012
		T1114A(5)	5	942-2013
		T1114A(10)	10	942-2014
		T1114A(12)	12	942-2015
A75/9G	Cloth, compressed felt, blended wool, grey	T1120A(3)	3	—
		T1120A(5)	5	942-2051
		T1120A(10)	10	139-9492
		T1120A(12)	12	942-2052
		T1120A(20)	20	942-2053
		T1120A(25)	25	942-2054
A90/8G	Cloth, compressed felt, blended wool, grey	T1119A(3)	3	942-2039
		T1119A(5)	5	942-2040
		T1119A(10)	10	942-2041
		T1119A(12)	12	942-2042
		T1119A(20)	20	942-2043
		T1119A(25)	25	942-2044
A90/4G	Cloth, compressed felt, blended wool, grey	T1117A(5)	5	942-2031
		T1117A(12)	12	942-2032
		T1117A(20)	20	942-2033
		T1117A(25)	25	942-2034

<sup>A)</sup> This information corresponds to Table 1 in Part 1 of Defence Standard 83-19.

Table B.1 Cross references between felt designations used in BS 4060 and MOD names and descriptions, pattern numbers and stock numbers (*continued*)

Designation	Name and description	Pattern number	Nominal Thickness mm	NATO stock number: 8305-W
General purpose felts: rot-proofed <sup>C)</sup>				
A97/9W	Cloth, compressed felt, wool, white, R R <sup>D)</sup>	T1406B(8)	8	122-9121
A97/8G	Cloth, compressed felt, wool, grey, R R <sup>D)</sup>	T1121B(3)	3	139-9499
		T1121B(5)	5	122-9110
		T1121B(10)	10	122-9109
		T1121B(12)	12	122-9108
		T1121B(15)	15	139-9500
		T1121B(20)	20	122-9107
		T1121B(25)	25	122-9106
A97/5W	Cloth, compressed felt, wool, white, R R <sup>D)</sup>	T1114B(1)	1	122-9097
		T1114B(3)	3	122-9095
		T1114B(5)	5	122-9094
		T1114B(10)	10	122-9093
		T1114B(12)	12	122-9092
A75/9G	Cloth, compressed felt, blended wool, grey, R R <sup>D)</sup>	T 1120B(3)	3	—
		T 1120B(5)	5	139-9495
		T1120B(10)	10	139-9496
		T1120B(12)	12	139-9497
		T 1120B(20)	20	122-9122
		T 1120B(25)	25	139-9498
A90/8G	Cloth, compressed felt, blended wool, grey, R R <sup>D)</sup>	T1119B(3)	3	802-2205
		T1119B(5)	5	802-2206
		T1119B(10)	10	122-9120
		T1119B(12)	12	139-9501
		T1119B(20)	20	122-9119
		T1119B(25)	25	139-9503
A90/4G	Cloth, compressed felt, blended wool, grey, R R <sup>D)</sup>	T1117B(5)	5	802-2201
		T1117B(12)	12	802-2202
		T1117B(20)	20	802-2203
		T1117B(25)	25	802-2204

<sup>C)</sup> This information corresponds with Table 1 in Part 1 of Defence Standard 83-19.

<sup>D)</sup> RR indicates rot-proofed (see 6.7 of Table 6).

Table B.1 Cross references between felt designations used in BS 4060 and MOD names and descriptions, pattern numbers and stock numbers (*continued*)

Designation	Name and description	Pattern number	Nominal thickness mm	NATO stock number: 8305-99-
Decorative felts*				
A97/9W	Cloth, compressed felt, wool, white natural unstoved	8056A(1.6)	1.6	942-7158
A97/7D	Cloth, compressed felt, wool, green, No. 13	8018B(1.8)	1.8	122-5036
A97/7D	Cloth, compressed felt, wool, rifle green, No. 6	8018C(1.8)	1.8	122-5037
A97/7D	Cloth, compressed felt, wool, scarlet, No. 7	8018D(1.8)	1.8	122-5038
A97/7D	Cloth, compressed felt, wool, maize	8018E(1.8)	1.8	122-5039
A97/7D	Cloth, compressed felt, wool, dark blue	8018F(1.8)	1.8	122-5040
A97/7D	Cloth, compressed felt, wool, beech brown	8018G(1.8)	1.8	122-5041
A97/7D	Cloth, compressed felt, wool, scarlet, No. 4	8018H(1.8)	1.8	122-5042
A97/7D	Cloth, compressed felt, wool, khaki	8018J(1.8)	1.8	122-5043
A97/7D	Cloth, compressed felt, wool, blue, No. 1	8018K(1.8)	1.8	122-5044
A97/7D	Cloth, compressed felt, wool, black	8018L(1.8)	1.8	122-5045
A97/7D	Cloth, compressed felt, wool, navy blue	8018M(1.8)	1.8	135-4732
Felts for aerospace purposes†				
A97/2G	Cloth, compressed felt, wool, brown‡, RR <sup>E)</sup>	RS1(3)	3	125-0448
		RS1(10)	10	125-0454
A97/18W	Cloth, compressed felt, wool, white, RR <sup>E)</sup>	RS4(3)	3	125-0450
		RS4(5)	5	125-0453
		RS4(10)	10	125-0455
A97/6W	Cloth, compressed felt, wool, off white, RR <sup>E)</sup>	RS7(1.6)	1.6	915-5263

\* This information corresponds with Table 1 in Part 2 of Defence Standard 83-19.

† This information corresponds with Annex A in Part 3 of Defence Standard 83-19.

‡ The exact colour is not important. The colour fastness requirements detailed in Table 3 are not applicable.

<sup>E)</sup> RR indicates rot-proofed (see designation 6.7 of Table 6).

## Annex C (normative) Chemical tests of felts

### C.1 Determination of wool content

#### C.1.1 Introduction

The test method outlined in C.1.4 shall apply to blends of wool and non-protein fibres. The test method outlined in C.1.5 shall apply to blends of wool and regenerated protein fibres.

If the composition of the felt is unknown, a preliminary examination using a microscope and selected stains shall be performed.

In the event of a legal dispute over felt blends, Method 2 of BS 4407:1988 shall be used.

#### C.1.2 Sample preparation

A representative sample of the felt shall be cut into cubes having sides of no more than 5 mm long. The sample shall be pre-treated by extracting in a soxhlet apparatus with toluene and methanol, as described in C.2.1. The solvent shall be removed by heating in an oven at  $(105 \pm 3)^\circ\text{C}$  and the sample conditioned for 24 h in the standard atmosphere, as specified in 7.3.

#### C.1.3 Wool content of mixtures of wool and non-protein fibre

##### C.1.3.1 Principle

Wool is removed from the mixture using boiling sodium hydroxide solution and the wool content calculated from the mass of the residue.

*NOTE This method is not applicable if regenerated protein fibres are present since all protein fibres are removed by the sodium hydroxide solution (see C.1.3.2.2).*

##### C.1.3.2 Reagents

**C.1.3.2.1 General.** Unless otherwise stated, only reagents of recognized and analytical grade and water conforming to grade 3 of BS EN ISO 3696:1995 shall be used.

**C.1.3.2.2 Sodium hydroxide,** 50 gl solution.

**C.1.3.2.3 Dilute acetic acid solution.** Dilute 50 ml concentrated acetic acid (relative density 1.048) to 1 l with water.

**C.1.3.2.4 Dilute ammonia solution.** Dilute 100 ml concentrated ammonia (relative density 0.880) to 1 l with water.

##### C.1.3.3 Apparatus

**C.1.3.3.1 Balance,** capable of weighing to an accuracy of 0.1 mg.

**C.1.3.3.2 Conical flasks,** 500 ml, with reflux condensers.

**C.1.3.3.3 Sintered glass crucibles,** conforming to grade P160, BS 1752:1983.

**C.1.3.3.4 Vacuum pump.**

**C.1.3.3.5 Oven,** capable of maintaining a temperature of  $(105 \pm 3)^\circ\text{C}$ .

**C.1.3.3.6 Glass weighing bottle.**



**C.1.3.4 Procedure**

Take about 5 g of the sample, prepared as described in **C.1.2**, and weigh to the nearest 0.1 mg. Bring 150 ml of sodium hydroxide solution to the boil in a 500 ml conical flask fitted with a reflux condenser. Transfer the specimen to the flask and boil gently for 20 min. Remove from the heat and add 150 ml of cold water.

Filter through the sintered glass crucible, washing well with water. Wash the residue consecutively with dilute acetic acid, dilute ammonia and, finally, water.

Dry under suction and then in an oven at  $(105 \pm 3) ^\circ\text{C}$ . Transfer the fibrous residue from the filter to a weighing bottle. Allow to condition in the standard atmosphere as specified in **7.3** for 4 h and determine the mass.

**C.1.3.5 Calculation of results**

The wool fibre content,  $W$ , expressed as a percentage of the clean, conditioned sample, is given by the equation:

$$W = 100 \times \frac{(100m_2 \times 1.05)}{m_1}$$

where

$m_1$  is the conditioned mass of the specimen (g);

$m_2$  is the conditioned mass of the residue (g);

1.05 is the correction factor for loss in mass of the insoluble components.

**C.1.3.6 Test report**

The test report shall include the following:

- all information necessary for identification of the sample tested;
- reference to this British Standard, i.e. BS 4060:2006;
- the method used;
- any deviations from the procedure specified;
- the observations/measurements made;
- any unusual features (anomalies) observed during the test;
- the date of the test.

**C.1.4 Wool content of mixtures of wool and regenerated protein fibre****C.1.4.1 Principle**

The phosphorus content is determined colorimetrically following wet ashing, and from this the percentage of regenerated protein content is calculated.

For blends of wool and regenerated protein only, the wool content is then directly derived. For blends containing both protein and non-protein fibres, additional analysis as described in **C.1.4** or BS 4407 is necessary.



**C.1.4.2 Reagents**

**C.1.4.2.1 General.** Unless otherwise stated, use only reagents of recognized analytical grade and water conforming to grade 3 of BS EN ISO 3696:1995.

**C.1.4.2.2 Nitric acid,** concentrated, relative density of 1.42.

**C.1.4.2.3 Sulfuric acid,** concentrated, relative density of 1.84.

**C.1.4.2.4 Dilute ammonia solution.** Dilute 250 ml of concentrated ammonia (relative density of 0.880) to 1 l with water.

**C.1.4.2.5 Ammonium molybdate solution.** Carefully add, while cooling, 150 ml of concentrated sulfuric acid to 150 ml of water. When cool, carefully add 100 ml of 100 g/l aqueous ammonium molybdate solution, cool and store in a brown glass or polyethylene bottle.

**C.1.4.2.6 L-ascorbic acid.**

**C.1.4.2.7 Potassium dihydrogen phosphate stock solution.** Dissolve 0.478 g of potassium dihydrogen phosphate, previously dried for 3 h at  $(105 \pm 3)^\circ\text{C}$ , in water and dilute to 1 l.

**C.1.4.2.8 Potassium dihydrogen phosphate reference solution.** Dilute 10 ml of the stock solution to 500 ml to give a reference solution containing 2.1 mg/l phosphorus.

**C.1.4.3 Apparatus**

**C.1.4.3.1 Kjeldahl flasks,** 200 ml (in accordance with BS 6711-1:1986).

**C.1.4.3.2 Means for heating Kjeldahl flasks.**

**C.1.4.3.3 Fume cupboard.**

**C.1.4.3.4 Balance,** capable of weighing to an accuracy of 0.1 mg.

**C.1.4.3.5 Spectrophotometer.**

**C.1.4.4 Procedure****C.1.4.4.1 Calibration procedure**

Transfer by pipette 0 ml, 1.0 ml, 2.0 ml, 3.0 ml, 4.0 ml, 5.0 ml and 6.0 ml, respectively, of the potassium dihydrogen phosphate reference solution (C.1.4.2.8) to seven 100 ml beakers and dilute each to 40 ml. Add, to each beaker, 4 ml of the ammonium molybdate solution (C.1.4.2.5) followed by 0.1 g L-ascorbic acid (C.1.4.2.6) and boil for 1 min.

Cool and transfer the contents of each of the seven beakers to 50 ml volumetric flasks. Dilute to volume.

Determine the absorbance of each of the seven solutions at 820 nm using appropriate cells and plot the phosphorus content in micrograms against absorbance to give a calibration curve.

**C.1.4.4.2 Determination of phosphorus content**

Accurately weigh about 0.5 g of the sample, prepared as described in C.1.2 and transfer to a Kjeldahl flask. Add 5 ml of concentrated sulfuric acid and 10 ml of concentrated nitric acid.

Apply heat gradually and digest with further addition of nitric acid as necessary until the solution is clear and colourless. Remove excess nitric acid by evaporating down to fuming, cool and carefully add 25 ml of water. Boil vigorously for 5 min to ensure quantitative conversion of phosphoric acids to orthophosphoric acid, cool and dilute to 250 ml in a volumetric flask to give solution A.

Transfer a suitable aliquot (usually 5 ml or 10 ml) of solution A to a 100 ml beaker. Neutralize with dilute ammonia, and dilute to 40 ml. Add 4 ml of the ammonium molybdate solution, mix well and then add 0.1 g of L-ascorbic acid.

Boil for 1 min, cool, transfer to a 50 ml volumetric flask and dilute to volume.

Prepare a reagent blank in a similar manner and read the absorbance of the solution against the reagent blank on the spectrophotometer at a wavelength of 820 nm, using an appropriate cell.

Determine the phosphorus content, in micrograms, by reference to the calibration curve outlined in **C.1.4.4.1**.

#### **C.1.4.5 Calculation of results**

**C.1.4.5.1** The phosphorus content,  $P$ , expressed as a percentage of the clean, dry conditioned specimen, is given by the equation:

$$P = \frac{0.025B}{mA}$$

where:

$B$  is the phosphorus content of the test solution ( $\mu\text{g}$ );

$A$  is the volume of solution A used (ml) (see **C. 1.5.4.2**);

$m$  is the mass of specimen taken (g).

**C.1.4.5.2** Using the values of 0.65 for the phosphorus content of regenerated protein and 0.007 for the phosphorus content of wool, the regenerated fibre content,  $R$ , expressed as a percentage of the clean, dry conditioned specimen, is given by the equation:

$$R = \left( \frac{P \div 0.007}{0.65 \div 0.007} \right) \times 100$$

where:

$P$  is the percentage phosphorus content of the clean, dry conditioned specimen.

Where no other fibres are present, the wool content,  $W$ , expressed as a percentage of the clean, dry conditioned specimen, is given by the equation:

$$W = 100 \div R$$

If fibres other than protein fibres are present, perform an additional analysis in accordance with the method described in **C.1.3** or BS 4407, as appropriate.

**C.1.4.6 Test report**

The test report shall include the following:

- a) all information necessary for identification of the sample tested;
- b) reference to this British Standard, i.e. BS 4060:2006;
- c) the method used;
- d) any deviations from the procedure specified;
- e) the observations/measurements made;
- f) any unusual features (anomalies) observed during the test;
- g) the date of the test.

**C.2 Determination of the amount of matter soluble in toluene-methanol mixture and in water****C.2.1 Determination of the amount of matter soluble in toluene-methanol mixture**

**C.2.1.1 General.** Perform the test in accordance with the procedure described in BS 8459, except for the modifications described in **C.2.1.2** and **C.2.1.3**.

**C.2.1.2 Reagents.** In place of dichloromethane, use a solvent comprising a mixture of one part by volume toluene and three parts methanol, both reagents being of at least analytical reagent grade.

**C.2.1.3 Test specimen.** Take a test specimen of approximately 5 g mass prepared and conditioned in accordance with Clause 7.

**C.2.2 Determination of matter soluble in water after removal of matter soluble in toluene-methanol**

After carrying out the test to establish matter soluble in toluene-methanol (see **C.2.1**), remove the solvent from the test specimen by drying in a ventilated oven. Then determine, on the same test specimens, the water-soluble matter using the hot water procedure described in BS EN 1413.

The amount of matter soluble in water, after removal of matter soluble in toluene-methanol, expressed as a percentage of the conditioned mass of the specimen before extraction with toluene-methanol or with water,  $M$ , is given by the equation:

$$M = \frac{100m_2}{m_1}$$

where

$m_1$  is the conditioned mass of the specimen before extraction with either toluene-methanol or water (g);

$m_2$  is the mass of the residue from the water extract (g).

**C.2.3 Report**

The test report shall include the following:

- a) all information necessary for identification of the sample tested;
- b) reference to this British Standard, i.e. BS 4060:2006;
- c) the method used;
- d) any deviations from the procedure specified;
- e) the matter soluble in toluene-methanol mixture and in water, both expressed to the nearest 0.05% of soluble matter;
- f) any unusual features (anomalies) observed during the test;
- g) sample identification and the date of the test.

**Annex D (normative) Physical tests of felts****D.1 Determination of thickness**

Measure the thickness as described in BS EN ISO 5084 but with the following deviations:

- a) the diameter of the presser foot shall be  $(100 \pm 0.5)$  mm;
- b) the dimensions of the reference plate shall be not less than 150 mm  $\times$  150 mm;
- c) the dial shall be graduated to read directly to an accuracy of 0.05 mm;
- d) for felts that have a density of 0.14 mg/mm<sup>3</sup> and above, the pressure shall be  $(2.2 \pm 0.04)$  kPa; for felts with a density below 0.14 mg/mm<sup>3</sup>, the pressure shall be  $(0.9 \pm 0.02)$  kPa;
- e) the test specimen shall be a strip of felt taken in accordance with 7.2 and the thickness shall be measured at five equidistant positions along the strip
- f) the thickness reading shall be taken  $(10 \pm 3)$  s after the load is applied.

**D.2 Determination of density****D.2.1 Principle**

The density of the felt is calculated from the mass and dimensions of a specified test specimen.

**D.2.2 Apparatus**

**D.2.2.1** *A steel rule, graduated in millimetres.*

**D.2.2.2** *Means of cutting out the specimen, e.g. sharp knife or scissors.*

**D.2.2.3** *Balance, weighing to 0.1 g with an accuracy of within 0.05 g.*



**D.2.3 Procedure**

Take a strip of felt of minimum area 0.25 m<sup>2</sup> from across the full width of the sample or take a number of smaller specimens to give an equivalent area.

Condition the specimen or specimens for 24 h under the standard conditions described in 7.3.

Measure the width and length of the specimen or specimens, by means of the steel rule, to the nearest 1 mm and calculate the total area, *A*. Weigh the specimen to the nearest 0.1 g. Determine the thickness as described in D.1.

The density (in mg/mm<sup>3</sup>) is given by the expression:

$$\frac{1\,000m}{Ad}$$

where

*m* is the mass of specimen (g);

*A* is the area of the specimen (mm<sup>2</sup>);

*d* is the thickness of the specimen (mm).

*NOTE* The calculation of density for felts under 3 mm should be based on the nominal thickness and not the actual thickness.

**D.2.4 Test report**

The test report shall include the following:

- a) all information necessary for identification of the sample tested;
- b) reference to this British Standard, i.e. BS 4060:2006;
- c) the method used;
- d) the density expressed to the nearest 0.01 mg/mm<sup>3</sup>;
- e) any deviations from the procedure specified;
- f) any unusual features (anomalies) observed during the test;
- g) sample identification and the date of the test.

**D.3 Determination of breaking strength****D.3.1 General**

Perform the breaking strength test in accordance with BS EN ISO 13934-1 and with the specific procedures described from D.3.2 to D.3.5.

**D.3.2 Specimens**

Cut, from the conditioned samples, five specimens (25 ± 1) mm wide at uniformly spaced intervals across the felt at right angles to the selvedge. Cut the specimens to give a nominal gauge length, i.e. free length between jaws of 200 mm.



**D.3.3 Procedure**

Measure the width of the specimen to the nearest 0.1 mm. Measure the thickness in accordance with **D.1**.

**D.3.4 Calculation**

The breaking strength (in MPa),  $S$ , is given by the formula:

$$S = \frac{F}{bd}$$

where

$F$  is the breaking force (N);

$b$  is the specimen width (mm);

$d$  is the specimen thickness (mm).

Calculate the breaking strength of the sample as the mean of the results for the five test specimens.

**D.3.5 Test report**

The test report shall include the following:

- a) all information necessary for identification of the sample tested;
- b) reference to this British Standard, i.e. BS 4060:2006;
- c) the method used;
- d) breaking strength of the felt expressed to the nearest 0.1 MPa;
- e) any deviations from the procedure specified;
- f) type and capacity of the testing machine used;
- g) any unusual features (anomalies) observed during the test;
- h) sample identification and the date of the test.

**D.4 Determination of dimensional change in water-alcohol mixture****D.4.1 General**

Perform the test in accordance with the procedure described in BS 4736, except for the modifications described in **D.4.2** and **D.4.3**.

**D.4.2 Reagent**

*Immersion liquid*, comprising equal parts, by volume, of water conforming to grade 3 of BS EN ISO 3696 and industrial methylated spirits conforming to BS 3591.

**D.4.3 Test specimens**

**D.4.3.1 Preparation.** From a sample of felt prepared and conditioned in accordance with Clause 7, cut out test specimens, each being a right parallelepiped with  $200 \pm 1$  mm square faces and thickness that of the felt under consideration. Space the test specimens equidistantly along the sample strip.

**D.4.3.2 Marking.** Specimens are not marked.

**D.4.3.3 Measuring.** Measure and record the length of each of the four major sides to the nearest 0.5 mm and calculate the area from the mean value of each pair of parallel sides. Measure the thickness of the test specimen in accordance with **D.1**.

**D.4.3.4 Test procedure.** Allow the specimen to remain immersed for  $60 \pm 5$  min. Remove it and allow it to drain for 10 min before remeasuring the lengths of each of the four major sides.

## **D.5 Determination of oil retention**

### **D.5.1 Principle**

Specimens of given dimensions are suspended in a specified grade of mineral oil for a given time. They are then removed. After allowing to drain for a specified time, the specimens are weighed again and the change in mass, expressed as a percentage of the original mass, is calculated.

### **D.5.2 Reagent**

**D.5.2.1 Mineral oil**, conforming to BS 4475:2000.

### **D.5.3 Apparatus**

**D.5.3.1 Glass cylinders**, with capacity and dimensions appropriate to the thickness of the test specimen.

**D.5.3.2 Balance**, accurate to 1 mg.

**D.5.3.3 Suitable equipment**, capable of maintaining the reagent at  $(20 \pm 2) ^\circ\text{C}$ .

### **D.5.4 Procedure**

Cut four specimens, each 100 mm long by 10 mm wide, from a sample of felt prepared and conditioned in accordance with Clause 7. Weigh to the nearest 0.01 g ( $m_1$ ). For felts over 10 mm thick, reduce the thickness to 10 mm.

Suspend each of the specimens in a separate glass cylinder, containing approximately 100 ml of mineral oil, so that they are totally immersed with the upper edge 25 mm below the oil surface. After 6 h, raise the specimens out of the liquid, allow them to drain for 1 h, and re-weigh ( $m_2$ ).

### **D.5.5 Calculation**

The oil retention, expressed as a mean percentage,  $O$ , is calculated from the equation:

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

where

$m_1$  is the sum of the total conditioned mass of all the specimens (g);

$m_2$  is the sum of the total mass of all the specimens after draining (g).

### **D.5.6 Report**

The test report shall include the following:

- a) all information necessary for identification of the sample tested;
- b) reference to this British Standard, i.e. BS 4060:2006;
- c) the method used;
- d) the oil retention, expressed to the nearest 1% of oil absorbed;
- e) any deviations from the procedure specified;
- f) any unusual features (anomalies) observed during the test;
- g) sample identification and the date of the test.

## **D.6 Determination of splitting resistance**

### **D.6.1 General**

Perform the test in accordance with BS EN ISO 2411:2000, except for the following modifications described from **D.6.2** to **D.6.4**.

*NOTE The tests are only applicable to felts where the thickness is 5 mm or above. For felts of less than 5 mm thickness, the tensile breaking strength only is recommended as an indicative test (see **D.3**).*

### **D.6.2 Preparation of test specimens**

Cut four specimens, each 150 mm long × 50 mm wide, from a sample of felt, prepared and conditioned in accordance with Clause 6. Cut two in the longitudinal and two in the transverse direction. Split the specimens in a plane parallel to the outer surface of the felt by cutting with a knife within the middle third of the thickness for a distance of 50 mm from one end only. Mount a specimen centrally in the jaws of the test machine with one half of the split portion in each grip.

### **D.6.3 Procedure**

Separate the grips at a constant rate of extension of  $(300 \pm 10)$  mm/min and make an autographic record of the force required to further separate the specimen into two portions.

### **D.6.4 Calculation and expression of results**

The first peak shall be ignored and the splitting resistance calculated, in N per 50 mm width, as the average of the maxima on the graph.

The test shall be repeated on the remaining three specimens.

The splitting resistance of the sample shall be calculated as the mean of the values determined for each of the four specimens.

## Annex E (normative)

# Method for the determination of water soluble chloride and water soluble sulfate in aqueous extracts of textile materials

## E.1 Principle

An aqueous extract is prepared, using distilled water. Separate portions of the extract are used for determinations of chloride (gravimetrically or volumetrically) and sulfate (gravimetrically).

## E.2 Reagents

**E.2.1** *Potassium chloride solution*, of concentration 0.000 1 mol/l, which has a conductivity of 12.780 mS/m at 20 °C.

**E.2.2** *Distilled or deionized water*, in accordance with BS EN ISO 3696. It should have a maximum conductivity of 1 mS/m.

**E.2.3** *Silver oxalate suspension*, made by dissolving 14 g of sodium oxalate and 10 g of potassium nitrate in 1 litre of water (**E.2.2**) adding, with constant stirring, 100 ml of silver nitrate (**E.2.8**). The stock suspension shall be kept in a dark glass bottle.

**E.2.4** *Low conductivity water*, for determination of conductivity, the conductivity of the water shall not exceed 0.2 m/Sm<sup>3</sup>).

**E.2.5** *Nitric acid solution*, concentrated.

**E.2.6** *Nitric acid solution*, approximately 0.5% V/V.

**E.2.7** *Nitric acid solution*, approximately 10% V/V.

**E.2.8** *Silver nitrate solution*, 0.1 mol/l.

**E.2.9** *Silver nitrate solution*, 0.01 mol/l.

**E.2.10** *Sodium chloride solution*, approximately 100 g/l.

**E.2.11** *Hydrochloric acid solution*, concentrated.

**E.2.12** *Barium chloride solution*, 20 g/l.

<sup>3)</sup> Water of the required quality may be obtained by passing water through mixed ion-exchange resins. Suitable proprietary apparatus is available.



## E.3 Apparatus

### E.3.1 Introduction

The following apparatus is required. All glassware shall be of chemically resistant glass, and each item shall be fitted with the same size of ground glass joints, e.g., B24/29 size, in accordance with BS 572. British Standard apparatus shall be used where appropriate.

### E.3.2 General

**E.3.2.1** *Round bottomed flasks*, of capacity approximately twice the volume of extract to be prepared with either of the following.

- a) A glass stopper incorporating a stopcock for hot water extractions, and with a PTFE cone liner to prevent sticking of the glass cone in the neck of the flask and to ensure an airtight joint. Grease shall not be used for this purpose.
- b) A plain glass stopper for cold water extractions.

The flasks that are to be used for the preparation of extracts shall not be used for any other purpose.

**E.3.2.2** *Beakers*, capacity 150 ml.

**E.3.2.3** *Efficient water-cooled condensers*.

**E.3.2.4** *Mechanical shaker*, providing rotational or reciprocating movement sufficient to provide a ready exchange of liquid between the interior of the material and the water used in preparing the extra. A to-and-fro movement at a rate of 60 min<sup>-1</sup> have been found satisfactory.

**E.3.2.5** *Balance*, accurate to 0.05 g.

**E.3.2.6** *Balance*, accurate to 0.000 2 g.

### E.3.3 Chloride determinations

**E.3.3.1** *Sintered glass crucible*, porosity 4 in accordance with BS 1752 for chloride determinations by gravimetric method.

**E.3.3.2** *Titration vessel and reference half-cell*, with suitable pH meter as used with glass electrodes, set to read in mV<sup>4)</sup> for chloride determinations by volumetric method. A convenient arrangement is shown in Figure E.1. The half-cell is filled with silver oxalate suspension (**E.2.3**).

### E.3.4 Sulfate determinations

*Sintered porcelain or silica gooch filter crucibles*, porosity 4 in accordance with BS 1752. These should be checked for, and discarded when there is no significant damage or blockage.

<sup>4)</sup> Other suitable means may be used such as a digital voltmeter, multimeter or galvanometer and tapping key.



## **E.4 Atmosphere for conditioning**

The atmosphere for conditioning the samples shall be the standard atmosphere for testing textiles, as defined in BS EN ISO 139, i.e., a relative humidity of  $(65 \pm 4) \%$  and a temperature of  $(20 \pm 2) ^\circ\text{C}$ . The determinations need not be carried out in the standard atmosphere for testing.

## **E.5 Sampling**

Take a sample that is representative of the bulk and sufficient to provide all the test specimens that are required. Cut the samples under test into pieces of such size that all parts readily wet out. Handle the material as little as possible using clean stainless steel forceps. Do not handle the sample or specimen with the hand.

## **E.6 Test procedure**

### **E.6.1 Preparation of extract**

#### **E.6.1.1 General**

Two methods of preparing an extract are given which may differ in the amount of water-soluble impurity extracted. In quoting the results, clearly state the method used.

*NOTE It is recommended that for wool, determination of water-soluble matter should only be made on extracts prepared as described in E.6.1.3.*

Where only water-soluble matter, chlorides and sulfates are to be determined, distilled water (E.2.2) may be used.

Condition the sample in the standard atmosphere for conditioning and testing for at least 24 h. Take from the conditioned sample a specimen of convenient size, weigh it to an accuracy of  $\pm 0.05 \text{ g}$ , and transfer it to the flask. For all materials in yarn or fabric form other than wool, add to the flask  $(20 \pm 0.1) \text{ ml}$  of water per gram of specimen. For wool in any textile form and for felts and loose fibre masses add  $(50 \pm 0.2) \text{ ml}$  of water per gram of specimen.

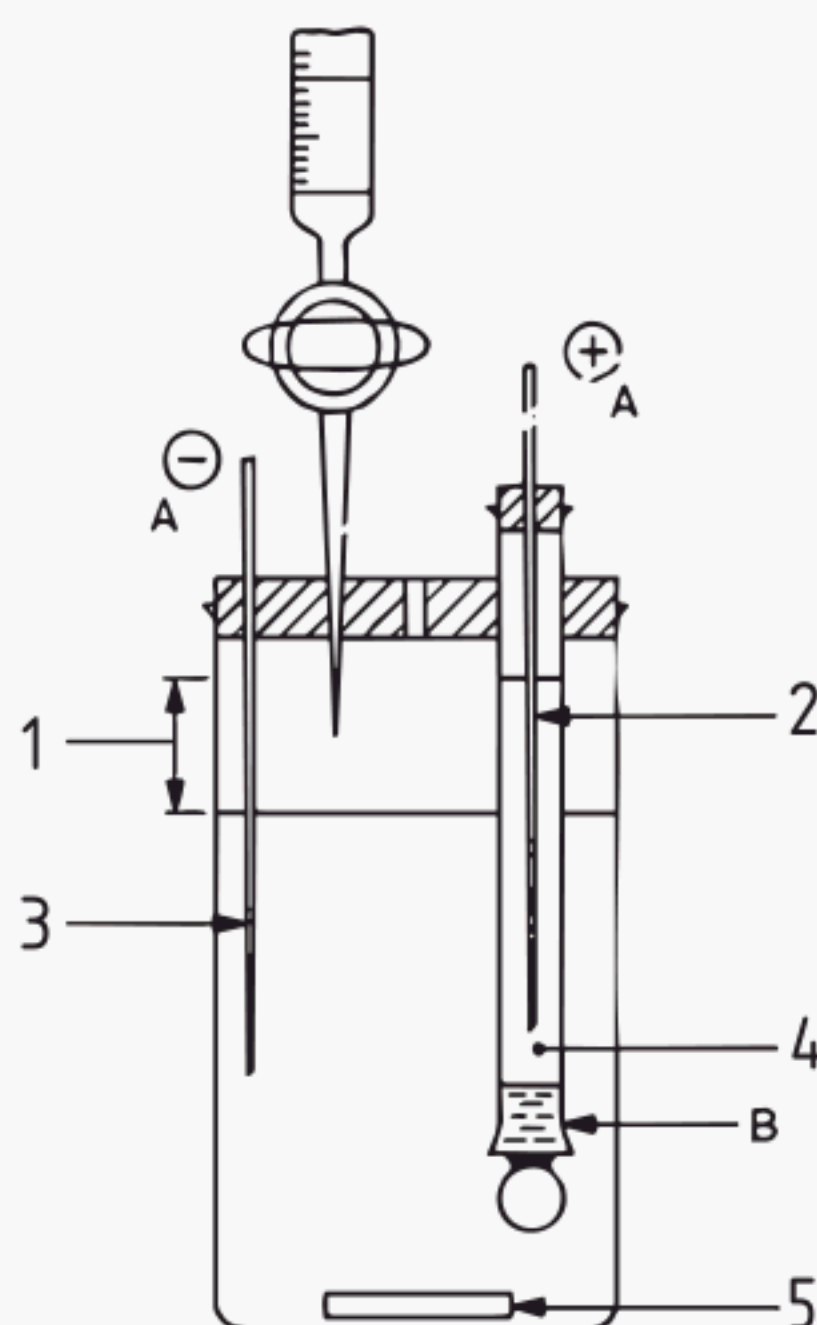
#### **E.6.1.2 Hot water extraction**

Connect the flask (E.3.2.1) to a condenser (E.3.2.3), bring the contents rapidly to the boil and continue to boil the liquor gently for 60 min. Disconnect and remove the flask while the liquor is still boiling and close it immediately with the glass stopper with a stopcock. Do not filter or make up to volume, but cool rapidly to  $(20 \pm 2) ^\circ\text{C}$ . Reject any extract unless there is a partial vacuum inside the flask immediately before it is opened.

#### **E.6.1.3 Cold water extraction**

Agitate the flask for a short period by hand to ensure that the textile is properly wetted out then shake it with the mechanical shaker (E.3.2.4) for 1 h.

Figure E.1 Apparatus for electrometric titration of chloride

**Key**

- |   |  |
|---|--|
| 1 | Reference solution level to be higher than test solution level |
| 2 | Silver electrode   |
| 3 | Silver electrode   |
| 4 | Reference half cell  |
| 5 | Magnetic stirrer   |

*NOTE (A) leads to pH meter and (B) is the ground glass join (not greased) or porous ceramic or glass joint, in accordance with BS 572.*

**E.6.2 Determination of water-soluble matter**

Prepare an extract as described in **E.6.1.1**. Filter the extract through a suitable filter paper<sup>5)</sup> and evaporate a measured portion of the extract to dryness in a tared vessel<sup>6)</sup>. Dry the residue at 105 °C to 110 °C until it achieves a constant mass<sup>7)</sup>.

Calculate the water-soluble matter as described in **E.7.3**.

**E.6.3 Determination of water-soluble chlorides****E.6.3.1 Gravimetric method**

Prepare an extract as described in **E.6.1**. If the textile contains chlorinated compounds, e.g. PCPL, carry out a preliminary extraction with a suitable solvent before preparing the extract as described in **E.6.1**. Take a suitable measured portion, add 5 ml of concentrated nitric acid (**E.2.6**) per 100 ml of extract, boil for 5 min and leave overnight. Filter through a filter-paper pulp pad, wash with distilled water, and add

<sup>5)</sup> Whatman 42 is suitable.

<sup>6)</sup> Any suitable vessel can be used, e.g. a 100 ml glass evaporating basin.

<sup>7)</sup> That is until the residue suffers no more than 0.0005 g loss of mass on drying for a further 30 min.

a slight excess of silver nitrate solution (**E.2.8**) to the combined filtrate and washings. Heat the solution, protected from direct light, in a water bath until the precipitate is coagulated and the supernatant liquor is clear. Verify completeness of precipitation by adding a drop of silver nitrate solution (**E.2.8**) to the supernatant liquor. Allow to cool in the dark, and then filter through a tared crucible (**E.3.4**). Wash the crucible with dilute nitric acid (**E.2.6**) until the washings give no opalescence when tested with sodium chloride solution (**E.2.10**). Then dry the crucible initially at about 100 °C and finally to constant mass<sup>7)</sup> at 130 °C to 150 °C. Carry out a blank determination and subtract the mass thus obtained from the mass obtained in the test. Calculate the water-soluble chlorides as described in **E.7.4**.

#### **E.6.3.2 Volumetric method<sup>8)</sup>**

Before each test, verify that all parts of the apparatus are clean. Clean the silver wire electrodes with very fine abrasive or use a suitable chemical method. Discard and replace the silver oxalate suspension (**E.2.3**) at the first sign of darkening; to delay darkening, shield the half-cell from light when not in use. Shake the suspension bottle thoroughly before replenishing the half-cell.

Take particular care that electrolytes do not come into contact with the junctions between the silver wire electrodes and their leads to the pH meter. Flush the electrolyte junction after each determination by easing the stopper at the bottom of the half-cell to allow fresh oxalate suspension (**E.2.3**) to flow into the junction.

Prepare an extract as described in **E.6**.

Take a suitable measure portion<sup>9)</sup>, add 1 ml of nitric acid (**E.2.7**) per 100 ml of extract, boil for 5 min, cool rapidly to room temperature and transfer to the titration vessel. Start the stirrer, connect the electrodes to the pH meter, set to read in mV, and titrate with silver nitrate solution (**E.2.9**) until a reading of 0 mV is first indicated. Carry out a blank determination and calculate the water soluble chlorides as described in **E. 7.4**.

#### **E.6.4 Determination of water-soluble sulfates by gravimetric analysis**

Prepare an extract as described in **E.6.1.1**. Take a measured portion, filter through a suitable filter paper<sup>10)</sup> and wash with distilled water. Add concentrated hydrochloric acid (**E.2.11**) drop by drop until the solution is just acid to litmus, then add 1 ml of acid per 100 ml solution. Boil for 5 min and leave to cool overnight. Filter off any precipitate on a filter-paper pulp pad, wash with distilled water and heat the combined filtrate and washings to boiling. While still boiling add, drop by drop, 10 ml of hot barium chloride solution (**E.2.12**).

<sup>8)</sup> This method is similar to that described in BS 6068-2.37.

<sup>9)</sup> A suitable test portion should contain a minimum of 0.2 mg of chloride ion.

<sup>10)</sup> Whatman 42 is suitable.



Continue boiling for 30 min, then leave to cool overnight. Transfer the precipitate quantitatively to a crucible and wash with cold water (E.2.2) until the washings are free from chloride. Heat the crucible and its contents, gently at first, and finally to constant mass at 800 °C to 900 °C.

Carry out a blank determination and calculate the water-soluble sulfates as described in E.7.4.

## E.7 Calculation and expression of results

### E.7.1 General

State which method of extraction and what ratio of water to textile have been used.

*NOTE For the calculation of the amount of water-soluble matter, chloride, and sulfate, it should be noted that 100 ml of extract are equivalent to 5.0 g of conditioned specimen, except for wool in any textile form and for felts and loose fibre masses of any composition, where 100 ml of extract are equivalent to 2.0 g of conditioned specimen.*

In the equations given below, masses are expressed in grams and volumes in millilitres.

### E.7.2 Water-soluble matter

The water-soluble matter ( $P_w$ ), as a percentage by mass of the conditioned mass of the specimen, is given by the following equations.

a) For yarns or fabrics other than wool:

$$(E.1) \quad P_w = \frac{2 \times 10^3 \times m}{V}$$

b) For felts, loose fibres and wool in any textile form:

$$(E.2) \quad P_w = \frac{5 \times 10^3 \times m}{V}$$

Where

$M$  is the mass of residue (g)

$V$  is the volume of extract taken (ml)

### E.7.3 Water-soluble chlorides

The mass of chloride ion ( $P_c$ ), as a percentage by mass of the conditioned mass of the specimen, is given by the equations in E.7.4.

#### E.7.3.1 Gravimetric

a) For yarns or fabrics other than wool:

$$(E.3) \quad P_c = \frac{495 \times m}{V}$$

- b) For felts, loose fibres and wool in any textile form:

$$(E.4) \quad P_c = \frac{1 \ 237 \times m}{V}$$

Where

$M$  is the mass of residue, corrected for blank (g);

$V$  is the volume of extract taken (ml).

- c) The percentage of water soluble chlorides, expressed as sodium chloride is  $P_c \times 1.65$ .

#### E.7.3.2 Volumetric

- a) For yarns or fabrics other than wool:

$$(E.5) \quad P_c = \frac{0.71 \times v}{V}$$

- b) For felts, loose fibres and wool in any textile form:

$$(E.6) \quad P_c = \frac{1.77 \times v}{V}$$

Where

$v$  is the volume of  $\text{AgNO}_3$  used (E.2.9) corrected for blank (ml);

$V$  is the volume of extract taken (ml).

- c) The percentage of water-soluble chlorides, expressed as sodium chloride is  $P_c \times 1.65$ .

#### E.7.4 Water-soluble sulfates

The mass of sulfate ion ( $P_s$ ), as a percentage by mass of the conditioned mass of the specimen, is given by the following equations.

- a) Yarns or fabrics other than wool:

$$(E.7) \quad P_s = \frac{823 \times m}{V}$$

- b) Felts, loose fibres and wool in any textile form:

$$(E.8) \quad P_s = \frac{2 \ 058 \times m}{V}$$

Where

$m$  is the mass of precipitate connected for blank (g);

$V$  is the volume of extract taken (ml).

- c) The percentage of water-soluble sulfates, expressed as anhydrous sodium sulfate is  $P_s \times 1.48$ .



## **E.8 Test report**

The report shall state that the test was performed in accordance with this standard and shall contain the following information.

- a) The nature and origin of the sample.
- b) Which of the alternative methods of extraction was used and the ratio of water to textile used.
- c) As required:
  - 1) The conductivity of the aqueous extract, in  $\mu\text{S/m}$ .
  - 2) The content of water-soluble matter as a percentage of the conditioned mass of the specimen.
  - 3) The content of water-soluble chlorides as a percentage of the conditioned mass of the specimen, or expressed as sodium chloride.
  - 4) The content of water-soluble sulfates as a percentage of the conditioned mass of the specimen, or expressed as anhydrous sodium sulfate.
  - 5) Details of any deviation from the test method.

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<sup>11)</sup> This document was withdrawn in 1994.

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