

Coal — Methods for evaluating flocculants for use in coal preparation —

Part 2: Flocculants as filter aids in rotary vacuum filtration systems

ICS 73.040

National foreword

This British Standard reproduces verbatim ISO 10086-2:2004 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee PTI/16, Solid mineral fuels, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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 does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii to iv, pages 1 to 12, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 20 January 2004

© BSI 20 January 2004

ISBN 0 580 43297 1

INTERNATIONAL
STANDARD

ISO
10086-2

First edition
2004-01-15

**Coal — Methods for evaluating
flocclulants for use in coal preparation —**

Part 2:

**Flocclulants as filter aids in rotary
vacuum filtration systems**

*Charbon — Méthodes d'évaluation des flocclulants utilisés dans
la préparation des charbons —*

*Partie 2: Flocclulants comme aides à la filtration dans des systèmes
rotatoires de filtration sous vide*



Reference number
ISO 10086-2:2004(E)

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Principle	1
4 Apparatus	1
5 Materials	2
5.1 Slurry	2
5.2 Water	2
6 Sampling	2
7 Preparation of flocculant solutions	3
8 Test procedure	3
8.1 Preliminary	3
8.2 Procedure	4
8.3 Calculation of flocculant dosage rate	5
8.4 Filtration test	6
8.5 Analysis of cake sample	7
9 Clarity of the filtrate	7
10 Recording of results	8
11 Repeatability	8
12 Test report	8
Annex A (informative) Worked example	9
Annex B (informative) Data recording sheet	11
Bibliography	12

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 10086-2 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 1, *Coal preparation: Terminology and performance*.

ISO 10086 consists of the following parts, under the general title *Coal — Methods for evaluating flocculants for use in coal preparation*:

- *Part 1: Basic parameters*
- *Part 2: Flocculants as filter aids in rotary vacuum filtration systems*

Coal — Methods for evaluating flocculants for use in coal preparation —

Part 2: Flocculants as filter aids in rotary vacuum filtration systems

1 Scope

This part of ISO 10086 specifies a method for the comparative evaluation of the performance of flocculants used as filter aids for rotary vacuum filtration applications on a given slurry.

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 10086-1:2000, *Coal — Methods for evaluating flocculants for use in coal preparation — Part 1: Basic parameters*

3 Principle

The performance of different flocculants on a given slurry is determined by measuring the cake yield and moisture content.

A flocculant solution is added to an aliquot of slurry in a beaker. A filter leaf is then applied to the flocculated sample and the cake thus produced on the apparatus is weighed wet, dried and reweighed. A measure of the efficiency of the flocculant is obtained from the cake yield and moisture content.

4 Apparatus

Ordinary laboratory apparatus and the following.

NOTE The apparatus is generally arranged as shown in Figure 1.

4.1 Laboratory vacuum pump or piped vacuum system, capable of producing a vacuum better than that proposed for the plant equipment.

4.2 Vacuum gauge

4.3 Two-way valves, of at least 2 mm to 3 mm bore, manufactured in glass or plastics.

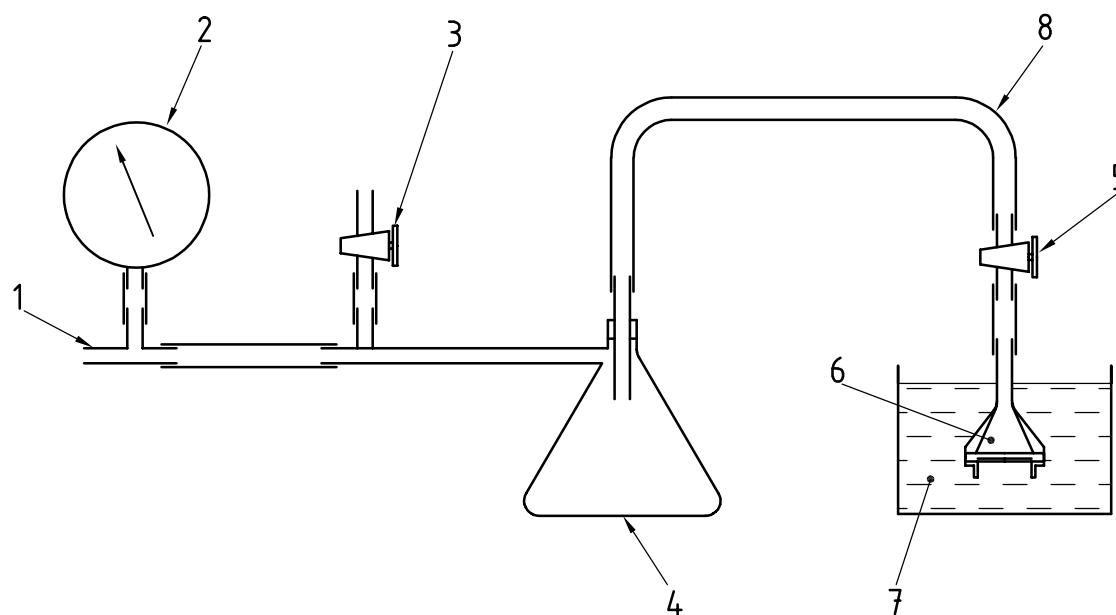
4.4 Buchner flask, with a minimum volume of 1 L.

4.5 **Filter-leaf apparatus**, consisting of a drainage plate and filter cloth in an assembly, as shown in Figure 4.

4.6 **Vacuum tubing and glass/plastics tubing**

4.7 **Stirrers**, motorized variable-speed stirrers, capable of speeds up to 1 000 r/min, one for flocculant preparation and one for sample homogenization.

4.8 **Syringes**, having capacities of 1 ml, 2 ml, 5 ml, 10 ml and 50 ml.



Key

- | | |
|----------------------|---------------------------|
| 1 vacuum pump/source | 5 two-way valve |
| 2 vacuum gauge | 6 filter leaf |
| 3 two-way valve | 7 slurry in 800 mL beaker |
| 4 buchner flask | 8 vacuum tubing |

Figure 1 — Laboratory vacuum filter-leaf apparatus

5 Materials

5.1 Slurry

The slurry for evaluation shall be collected and divided by the method described in ISO 10086-1. The contents of each test cylinder shall then be poured into an 800 ml beaker for evaluation.

5.2 Water

The water used for the preparation of flocculant solutions shall be collected by the method described in ISO 10086-1.

6 Sampling

The flocculant samples should be collected according to the recommendations described in ISO 10086-1.

7 Preparation of flocculant solutions

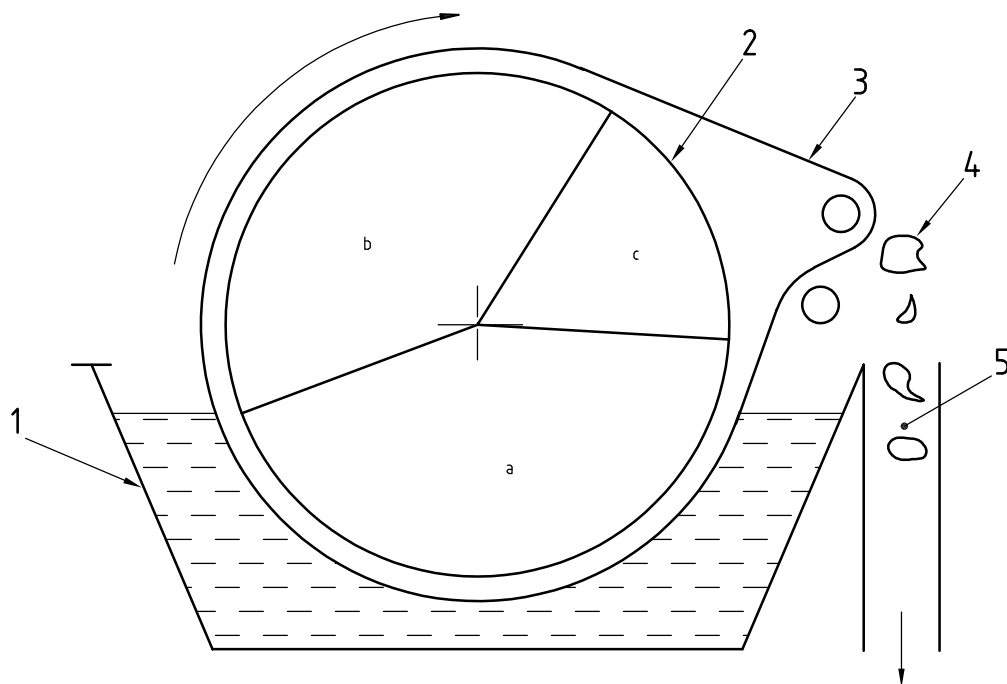
The flocculant, both powder and liquid grades, shall be prepared in accordance with the methods specified in ISO 10086-1.

8 Test procedure

8.1 Preliminary

The test procedure shall simulate the operating conditions of a rotary vacuum filter on a plant (see Figures 2 and 3). Where the slurry is taken from a plant using such equipment, the immersion and drying times in the test procedure shall be the same as on the plant equipment. Where these times are not known, or where no vacuum filtration system exists, the following times shall apply:

- immersion time: 1 min 10 s;
- drying time: 2 min.

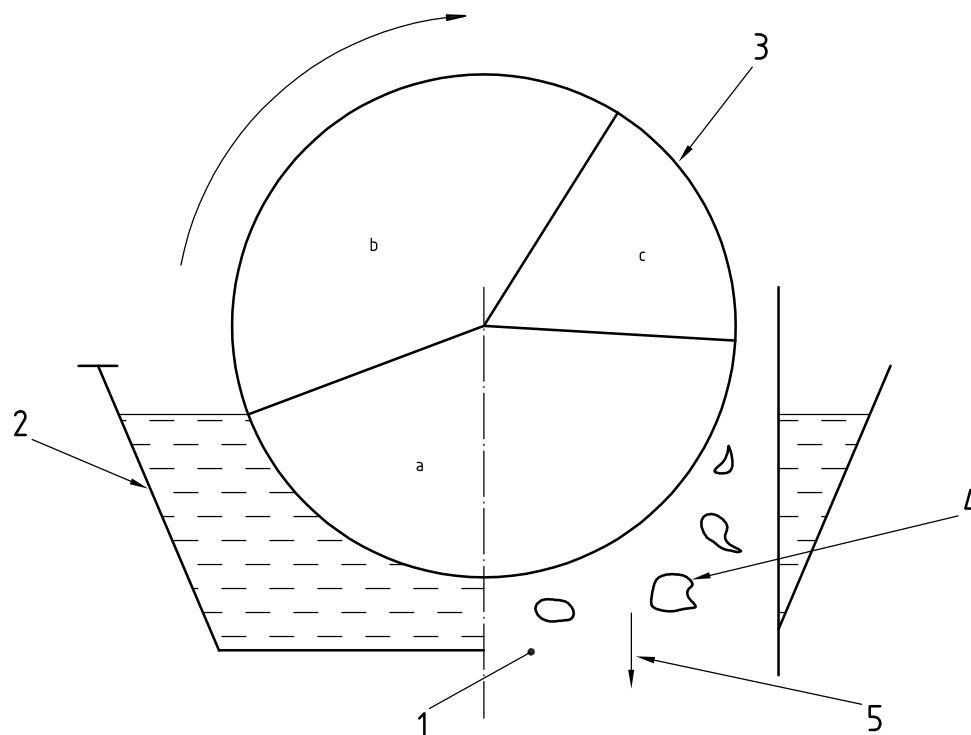


Key

- 1 filter bowl
- 2 filter drum
- 3 filter cloth
- 4 filter cake
- 5 filter cake

- a Filter leaf.
- b Slurry in 800 mL beaker.
- c Vacuum tubing.

Figure 2 — Diagram to show the immersion, drying and discharge sequences of a rotary vacuum drum filter



Key

- 1 filter cake discharge chute
- 2 filter bowl
- 3 disk filter
- 4 filter cake
- 5 cake discharge

- a Immersion.
- b Drying.
- c Discharge.

Figure 3 — Diagram to show the immersion, drying and discharge sequences of a rotary vacuum disc filter

8.2 Procedure

Prepare a 500 ml subsample of the slurry as described in ISO 10086-1. Place one subsample in an 800 ml beaker and homogenize the slurry for 1 min using the laboratory stirrer at a speed sufficient to create a vortex.

Using a syringe, add the desired quantity of flocculant solution (see 8.3) to the surface of the slurry in the beaker and mix well by stirring until completely conditioned.

Record the conditioning time.

Excessive mixing should be avoided, to prevent degradation of the flocculant.

8.3 Calculation of flocculant dosage rate

8.3.1 Calculation of content of the flocculant solution

Mass of water in the beaker = m_W

Mass of flocculant dissolved in the water = m_F

Therefore, the content of the flocculant solution w_F is given by:

$$w_F = \frac{m_F}{m_W}, \text{ in grams of flocculant per gram of water}$$

For the purpose of this calculation, it is assumed that a volume of 1 ml of flocculant solution weighs 1 g.

8.3.2 Calculation of the quantity of solids in the test cylinder

Volume of slurry suspension used in the test cylinder (V_S) = 500 ml (= 0,5 L)

Solids concentration in the slurry, in $\text{g} \cdot \text{L}^{-1}$ (c_S) = c_S ($\text{g} \cdot \text{L}^{-1}$)

Therefore, the mass of the solids in 500 ml of slurry = $0,5 \times c_S$ (g)

= $0,5 \times 10^{-3} c_S$ kg of dry solids

8.3.3 Calculation of flocculant dosage rate

Volume of flocculant solution used to dose a slurry suspension in the cylinder = V_F ml

= V_F g

The mass of the flocculant used in the test cylinder = $\frac{m_F}{m_W} \times V_F$ g

NOTE It is approximated that 1 ml of flocculant weighs 1 g.

The flocculant dosage rate is given by:

Mass of flocculant used : Mass of solids in the cylinder

$$= \frac{m_F}{m_W} \times V_F : 0,5 \times 10^{-3} c_S$$

$$= 2\,000 \times \frac{m_F \times V_F}{m_W \times c_S} \text{ g of flocculant per kg of dry solids}$$

The units of the dosage rate may also be expressed as “kg of flocculant per tonne of dry solids”.

8.3.4 Worked example

Mass of water (m_W) = 201,2 g

Mass of flocculant (m_F) = 0,23 g

Solids concentration in the slurry (c_S) = 50,6 g per litre

Volume of slurry used in the test = 500 ml

Volume of flocculant solution used (V_F) = 3,0 ml

Therefore, the flocculant dosage rate = $2\,000 \times \frac{m_F \times V_F}{m_W \times c_S}$

$$= \frac{2\,000 \times 0,23 \times 3,0}{201,2 \times 50,6}$$

= 0,136 g of flocculant per kg of dry solids

(or 0,136 kg of flocculant per tonne of dry solids, or 136 g of flocculant per tonne of dry solids)

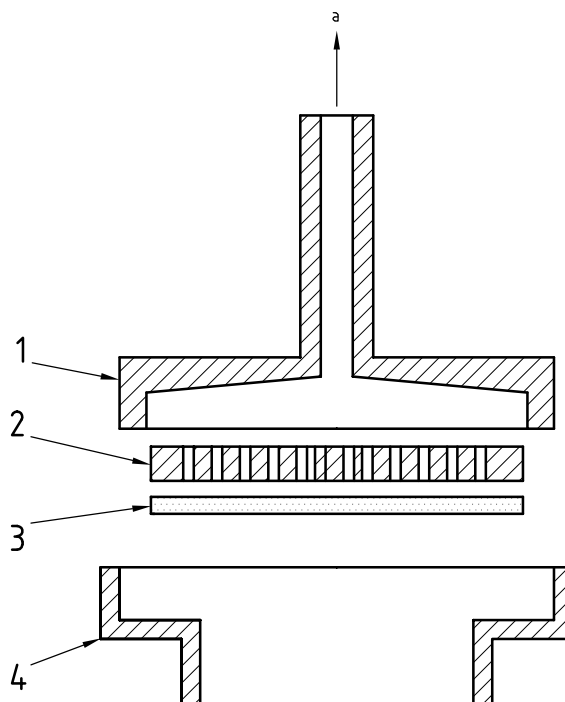
The procedure is repeated for other volumes of flocculant solution (V_F) used.

8.4 Filtration test

With reference to Figure 1, switch on the vacuum supply, close one two-way valve (5) and adjust the other two-way valve (3) to give the desired level of vacuum for the test. Insert the filter leaf (see Figure 4) with the appropriate filter cloth into the flocculated suspension and start the stop watch. At the same time, fully open the two-way valve (5). During the period of time that the filter leaf is immersed in the flocculated suspension (1 min 10 s or as per plant conditions), gently move the filter leaf up and down to maintain the flocculated pulp in suspension.

After the completion of the immersion time, remove the filter leaf from the flocculated suspension. Commence the drying time (2 min or plant time) with the filter leaf facing downwards. After half the drying time has elapsed, invert the filter leaf to face upwards for the remainder of the drying period.

After completion of the drying period, close one two-way valve (5) and vent the other two-way valve (3) to the atmosphere.



Key

- 1 filter leaf head
 - 2 filtrate drainage plate
 - 3 filter cloth
 - 4 head to be placed in the slurry
- a To vacuum pump/source.

Figure 4 — Exploded section of the filter leaf

8.5 Analysis of cake sample

Measure the thickness d , in millimetres, of the cake on the filter leaf at least three times across the diameter of the cake by inserting a millimetre-graduated steel ruler through the cake until it reaches the filter cloth. The cake thickness can be read from the lowest graduations visible on the steel ruler.

Remove the cake sample produced on the surface of the filter medium on the filter leaf and transfer to a pre-weighed Petri dish for weighing to determine the wet cake yield (wet cake mass = $m_{\text{wet}}\text{g}$). Place the Petri dish and sample in an oven at 105 °C until the mass of cake has decreased to a constant value, i.e. the cake has been dried (dry cake mass = $m_{\text{dry}}\text{g}$).

9 Clarity of the filtrate

Immediately after the cake thickness has been measured and the whole cake weighed, the clarity of the filtrate is evaluated according to ISO 10086-1. A turbidity-measuring instrument can also be employed for the evaluation of the clarity of filtrate.

10 Recording of results

Record the results for the cake yield on a data sheet (see Table B.1.). The characteristics of the slurry and filtrate shall also be recorded on this sheet.

Plot the cake yield (mass of dry solids produced) as a function of flocculant dosage for each flocculant, as illustrated in Figure A.1.

Plot the cake moisture content as a function of flocculant dosage for each flocculant, as illustrated in Figure A.1.

11 Repeatability

Duplicate results of tests should not differ by more than $\pm 1,0$ % cake moisture and ± 1 mm cake thickness.

12 Test report

The test report shall include the following information:

- a) date on which the test was carried out;
- b) description of the flocculant under test;
- c) details of slurry used;
- d) reference to this part of ISO 10086;
- e) the cake yield;
- f) the clarity of the filtrate;
- g) the cake moisture content;
- h) the filter and dosage rate;
- i) the vacuum used and the vacuum rate;
- j) the filter cloth used;
- k) the stirring time of the slurry after adding the flocculant.
- l) the immersion time;
- m) the drying time.

Annex A (informative)

Worked example

A test was performed on a slurry with a commercial flocculant at a dosage of Y mg of flocculant per litre of slurry. The test procedure was carried out according to this part of ISO 10086 using fixed immersion and drying times of 1 min 10 s and 2 min, respectively.

A.1 Calculation

Mass of wet cake produced = m_w g

Mass of cake after drying = m_d g

Therefore

Moisture content of wet cake, in percentage by mass, $w_{\text{wet}} = 100 \times \frac{(m_{\text{wet}} - m_d)}{m_{\text{wet}}}$

and the solids content of the wet cake, in percentage by mass, $w_d = 100 \times \frac{m_d}{m_{\text{wet}}}$

The yield may be expressed as mass, in grams, of dry solids per unit area, in square centimetres, of the filter leaf to give a figure that is independent of the filtration area:

$$m_d/A \text{ (g} \cdot \text{cm}^{-2}\text{)}$$

where A , in square centimetres, is the filtration area of the filter leaf.

The flocculant dosage rate is calculated 8.3

$$2\,000 \times \frac{m_F \times V_F}{m_W \times c_S} \text{ g of flocculant per kg of dry solids}$$

or

$$1\,000 \times 2\,000 \times \frac{m_F \times V_F}{m_W \times c_S} \text{ g of flocculant per tonne of dry solids}$$

where

m_F is the mass of flocculant dissolved in m_W g of water;

m_W is the mass of water used to prepare the flocculant;

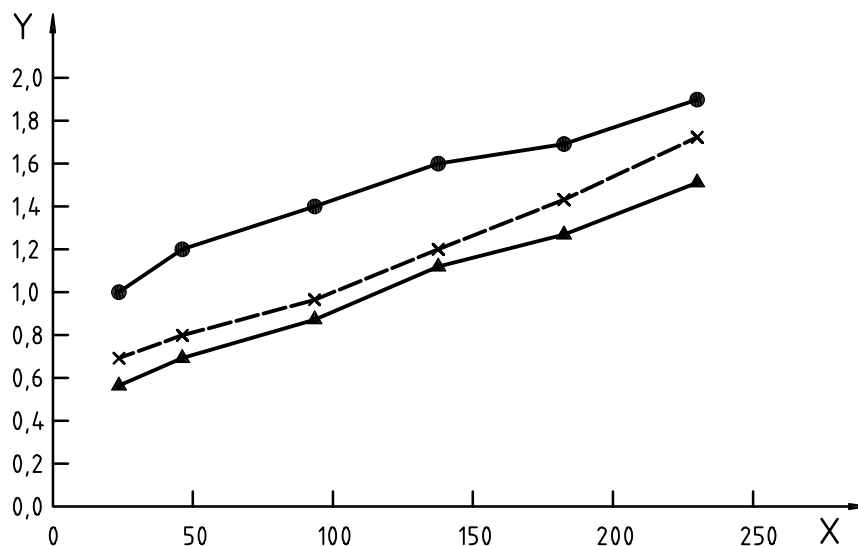
V_F is the volume of flocculant solution used in the test;

c_S is the solids concentration of the slurry used in the test.

A series of tests was carried out at different dosages, enabling the cake yield/dosage plot (Figure A.1) to be prepared. A further series of tests was then carried out with different flocculants.

In Figure A.1, for a desired cake (dry solids) yield of $1,5 \text{ g}\cdot\text{cm}^{-2}$, this is achieved at a lower dosage with flocculant A than with flocculants B or C, at a dosage rate of approximately 2 mg/L of slurry.

Filtrate clarity and cake moisture content are taken into consideration where recirculation of the filtrate and product dryness are of importance.



Key

- Flocculant A
- -x- - Flocculant B
- ▲— Flocculant C

X Flocculant dosage rate (kg/tonne of solids)

Y Yield (mass of dry solids per square centimetre of filtration area) (g/cm^2)

Figure A.1 — Effect of flocculant dosage rate for vacuum filtration

Annex B (informative)

Data recording sheet

Table B.1 — Cake yield and moisture content

Slurry characteristics												
Source:			Operator:									
Date of sampling:			Date of test:									
% Solids (g.l ⁻¹):			Flocculant tested									
			Manufacturer's name:									
Size and ash analysis			Flocculant name:									
Sieve size (mm)	% Retained	% Ash	Batch number:									
2,000			Flocculant type: Solid/liquid									
1,000			Water Source: Date of sampling: pH:									
0,500												
0,250												
0,125												
0,063												
0,045												
0,020												
Test number	1	2	3	4	5	6	7	8	9	10		
Filter-leaf area (m ²)												
Conditioning time												
Immersion time(s)												
Drying time(s)												
Vacuum rate (bar)												
Flocculant solution volume (ml)												
Flocculant dosage (g.tonne ⁻¹)												
Cake thickness (mm)												
Wet cake weight (g)												
Dried cake weight (g)												
Notes												

Bibliography

- [1] ISO 1171:1997, *Solid mineral fuels — Determination of ash*
- [2] ISO 1953:1994, *Hard coals — Size analysis by sieving*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover.
Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001.
Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at <http://www.bsi-global.com>.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre.
Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration.
Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001.
Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at <http://www.bsi-global.com/bsonline>.

Further information about BSI is available on the BSI website at <http://www.bsi-global.com>.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

Details and advice can be obtained from the Copyright & Licensing Manager.
Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553.
Email: copyright@bsi-global.com.