

Petroleum and natural gas industries — Cements and materials for well cementing —

Part 1: Specification

The European Standard EN ISO 10426-1:2000, including amendment A1:2002, has the status of a British Standard

ICS 91.100.10

National foreword

This British Standard is the official English language version of EN ISO 10426-1:2000, including amendment A1:2002. It is identical with ISO 10426-1:2000 including amendment 1:2002.

The start and finish of text introduced or altered by ISO amendment 1 is indicated in the text by tags **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee PSE/17, Materials for the petroleum and natural gas industries, 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 these international or European publications 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 EN ISO title page, the EN ISO foreword page, the ISO title page, pages ii to v, a blank page, pages 1 to 40, three national annex pages, the annex ZA, an inside back cover and a back cover.

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

Amendments issued since publication

Amd. No.	Date	Comments
13634 Incorporating Corrigendum No. 1	22 January 2002	Replaced the EN ISO foreword page and inserted the annex ZA page.
14067	13 January 2003	Revision of national annex also see national foreword

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 August 2000

© BSI 13 January 2003

**Petroleum and natural gas industries - Cements and materials
for well cementing - Part 1: Specification (ISO 10426-1:2000)
(including amendment A1:2002)**

Industries du pétrole et du gaz naturel - Ciments et
matériaux de cimentation des puits - Partie 1:
Spécifications (ISO 10426-1:2000+A1:2002)
(inclut l'amendement A1:2002)

Erdöl- und Erdgasindustrien - Zemente und Materialien für
die Zementation von Tiefbohrungen - Teil 1: Anforderungen
(ISO 10426-1:2000+A1:2002)
(enthält Änderung A1:2002)

This European Standard was approved by CEN on 18 February 2000. Amendment A1 was approved by CEN on 10 July 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

CORRECTED 2001-12-05

Foreword

The text of the International Standard ISO 10426-1:2000 has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum and natural gas industries", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 10426-1:2000 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to International Standards are listed in annex ZA (normative).

Foreword to amendment A1

This document EN ISO 10426-1:2000/A1:2002 has been prepared by Technical Committee ISO/TC 67, Materials, equipment and offshore structures for petroleum and natural gas industries, in collaboration with Technical Committee CEN/TC 12, Materials, equipment and offshore structures for petroleum and natural gas industries, the Secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2003, and conflicting national standards shall be withdrawn at the latest by February 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 10426-1:2000/Amd 1:2002 has been approved by CEN as a European Standard without any modifications.

INTERNATIONAL STANDARD

ISO
10426-1

First edition
2000-03-15

Incorporating Amendment 1
2002-08-01

Petroleum and natural gas industries — Cements and materials for well cementing —

Part 1: Specification

*Industrie du pétrole et du gaz naturel — Ciments et matériaux de
cimentation des puits —*

Partie 1: Spécifications



Reference number
ISO 10426-1:2000(E)

AVA Documents
Document Sharing Hub

Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Requirements	3
4.1 Specification, chemical and physical requirements	3
4.2 Sampling frequency, timing of tests and equipment	8
5 Sampling procedure	9
6 Fineness tests	9
6.1 Procedure	9
6.2 Requirements	9
7 Preparation of slurry for free fluid, compressive strength and thickening time tests	10
7.1 Apparatus	10
7.2 Procedure	11
8 Free-fluid test (free water)	11
8.1 Apparatus	11
8.2 Calibration	16
8.3 Procedure	17
8.4 Calculation of percent free fluid	17
8.5 Acceptance requirements	18
9 Compressive strength tests	18
9.1 Apparatus	18
9.2 Procedure	19
9.3 Test procedure (derived from ASTM C 109)	20
9.4 Compressive strength acceptance criteria	21
10 Thickening-time tests	22
10.1 Apparatus	22
10.2 Calibration	27
10.3 Procedure	30
10.4 Thickening time and consistency	36
10.5 Specification acceptance requirements	36
11 Marking	36
12 Packing	37
13 Bentonite	37
Annex A (informative) Calibration procedures for thermocouples, temperature-measuring systems and controllers	38
Bibliography	40

Foreword

ISO (the International Organisation for Standardisation) 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 organisations, 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 standardisation.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 10426 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10426-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 3, *Drilling and completion fluids, and well cements*.

ISO 10426 consists of the following parts, under the general title *Petroleum and natural gas industries — Cements and materials for well cementing*:

- *Part 1: Specification*
- *Part 2: Recommended practice for testing of well cement*

Annex A of this part of ISO 10426 is for information only.

Introduction

This part of ISO 10426 is based on API Specification 10A, 22nd edition, January 1995.

Users of this part of ISO 10426 should be aware that further or differing requirements may be needed for individual applications. This part of ISO 10426 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this part of ISO 10426 and provide details.

In this part of ISO 10426, where practical, U.S. Customary units are included in brackets for information.

Petroleum and natural gas industries — Cements and materials for well cementing —

Part 1: Specification

1 Scope

This part of ISO 10426 specifies requirements and gives recommendations for eight classes of well cements, including their chemical and physical requirements and procedures for physical testing.

This part of ISO 10426 is applicable to well cement Classes A, B, C, D, E and F, which are the products obtained by grinding Portland cement clinker and, if needed, calcium sulfate as an interground additive. Processing additives may be used in the manufacture of cement of these classes. Suitable set-modifying agents may be interground or blended during manufacture of Classes D, E and F.

This part of ISO 10426 is also applicable to well cement Classes G and H, which are the products obtained by grinding Portland cement clinker with no additives other than calcium sulfate or water.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10426. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10426 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*.

ISO 13500, *Petroleum and natural gas industries — Drilling fluid materials — Specifications and tests*.

ASTM C 109/C 109M, *Standard test method for compressive strength of hydraulic cement mortars (using 2-in or [50-mm] cube specimens)*.

ASTM C 114, *Standard test methods for chemical analysis of hydraulic cement*.

ASTM C 115, *Standard test methods for fineness of Portland cement by the turbidimeter*.

ASTM C 183, *Standard practice for sampling and the amount of testing of hydraulic cement*.

ASTM C 204, *Standard test method for fineness of Portland cement by air permeability apparatus*.

ASTM C 465, *Standard specification for processing additions for use in the manufacture of hydraulic cements*.

ASTM E 220, *Standard test method for calibration of thermocouples by comparison techniques*.

ASTM E 1404, *Standard specification for laboratory class conical flasks*.

DIN 12385, *Laboratory glassware, conical flasks, wide neck.*

EN 196-2, *Methods of testing cement — Part 2: Chemical analysis of cement.*

EN 196-6, *Methods of testing cement — Part 6: Determination of fineness.*

EN 196-7, *Methods of testing cement — Part 7: Methods of taking and preparing samples of cement.*

EN 196-21, *Methods of testing cement — Part 21: Determination of the chloride, carbon dioxide and alkali content of cement.*

3 Terms and definitions

For the purposes of this part of ISO 10426, the following terms and definitions apply.

3.1

additive

material added to a cement slurry to modify or enhance some desired property

NOTE Properties that are commonly modified include: setting time (by use of retarders or accelerators), fluid loss, viscosity, etc.

3.2

Bearden unit of consistency

B_c

measure of the consistency of a cement slurry when determined on a pressurized consistometer

3.3

bulk density

mass per unit volume of a dry material containing entrained air

3.4

cement

Portland cement

ground clinker generally consisting of hydraulic calcium silicates and aluminates and usually containing one or more forms of calcium sulfate as an interground additive

3.5

cement class

designation achieved using the ISO system of classification of well cement according to its intended use

3.6

cement grade

designation achieved using the ISO system for denoting the sulfate resistance of a particular cement

3.7

cement blend

mixture of dry cement and other dry materials

3.8

clinker

fused materials from the kiln in cement manufacturing that are interground with calcium sulfate to make cement

3.9

compressive strength

force per unit area required to crush a set cement sample

3.10**consistometer**

device used to measure the thickening time of a cement slurry under temperature and pressure

3.11**filtrate**

liquid that is forced out of a cement slurry during a fluid loss test

3.12**free fluid**

coloured or colourless liquid which has separated from a cement slurry

3.13**neat cement slurry**

cement slurry consisting of only cement and water

3.14**pressure vessel**

vessel in a consistometer into which the slurry container is placed for the thickening time test

3.15**slurry container****slurry cup**

container in a pressurized consistometer used to hold the slurry for conditioning purposes or for the thickening time test

3.16**thickening time**

time for a cement slurry to develop a selected B_c

NOTE The results of a thickening time test provide an indication of the length of time a cement slurry will remain pumpable under the test conditions.

4 Requirements

4.1 Specification, chemical and physical requirements

4.1.1 Classes and grades

Well cement shall be specified using the following Classes (A, B, C, D, E, F, G and H) and Grades (O, MSR and HSR).

A processing additive or set-modifying agent shall not prevent a well cement from performing its intended functions.

a) Class A

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the manufacturer, processing additives may be used in the manufacture of Class A cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465.

This product is intended for use when special properties are not required. Available only in ordinary (O) Grade (similar to ASTM C 150, Type I).

b) Class B

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the

manufacturer, processing additives may be used in the manufacture of Class B cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465.

This product is intended for use when conditions require moderate or high sulfate-resistance. Available in both moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades (similar to ASTM C 150, Type II).

c) **Class C**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the manufacturer, processing additives may be used in the manufacture of Class C cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465.

This product is intended for use when conditions require high early strength. Available in ordinary (O), moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades (similar to ASTM C 150, Type III).

d) **Class D**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the manufacturer, processing additives may be used in the manufacture of Class D cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465. Further, at the option of the manufacturer, suitable set-modifying agents may be interground or blended during manufacture.

This product is intended for use under conditions of moderately high temperatures and pressures. Available in moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades.

e) **Class E**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the manufacturer, processing additives may be used in the manufacture of Class E cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465. Further, at the option of the manufacturer, suitable set-modifying agents may be interground or blended during manufacture.

This product is intended for use under conditions of high temperatures and pressures. Available in moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades.

f) **Class F**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. At the option of the manufacturer, processing additives may be used in the manufacture of Class F cement, provided such materials in the amounts used have been shown to meet the requirements of ASTM C 465. Further, at the option of the manufacturer, suitable set-modifying agents may be interground or blended during manufacture.

This product is intended for use under conditions of extremely high temperatures and pressures. Available in moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades.

g) **Class G**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. No additives other than calcium sulfate or water, or both, shall be interground or blended with the clinker during manufacture of Class G well cement.

This product is intended for use as a basic well cement. Available in moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades.

h) **Class H**

The product obtained by grinding Portland cement clinker, consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an interground additive. No additives other than calcium sulfate or water, or both, shall be interground or blended with the clinker during manufacture of Class H well cement.

This product is intended for use as a basic well cement. Available in moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR) Grades.

A well cement which has been manufactured and supplied in accordance with this part of ISO 10426 may be mixed and placed in the field using water ratios or additives at the user's discretion. It is not intended that manufacturing compliance with this part of ISO 10426 be based on such field conditions.

4.1.2 Chemical requirements

Well cements shall conform to the respective chemical requirements of classes and grades referenced in Table 1.

Chemical analyses of hydraulic cements shall be carried out as specified in ASTM C 114 (or EN 196-2, EN 196-21).

4.1.3 Physical and performance requirements

Well cement shall conform to the respective physical and performance requirements referenced in Table 2 and specified in clauses 6, 7, 8, 9 and 10.

Table 1 — Chemical requirements

	Cement Class					
	A	B	C	D, E, F	G	H
ORDINARY GRADE (O)						
Magnesium oxide (MgO), maximum, %	6,0	NA	6,0	NA	NA	NA
Sulfur trioxide (SO ₃), maximum, %	3,5 ^a	NA	4,5	NA	NA	NA
Loss on ignition, maximum, %	3,0	NA	3,0	NA	NA	NA
Insoluble residue, maximum, %	0,75	NA	0,75	NA	NA	NA
Tricalcium aluminate (C ₃ A), maximum, %	NR	NA	15	NA	NA	NA
MODERATE SULFATE-RESISTANT GRADE (MSR)						
Magnesium oxide (MgO), maximum, %	NA	6,0	6,0	6,0	6,0	6,0
Sulfur trioxide (SO ₃), maximum, %	NA	3,0	3,5	3,0	3,0	3,0
Loss on ignition, maximum, %	NA	3,0	3,0	3,0	3,0	3,0
Insoluble residue, maximum, %	NA	0,75	0,75	0,75	0,75	0,75
Tricalcium silicate (C ₃ S) maximum, %	NA	NR	NR	NR	58 ^b	58 ^b
Tricalcium silicate (C ₃ S) minimum, %	NA	NR	NR	NR	48 ^b	48 ^b
Tricalcium aluminate (C ₃ A), maximum % ⁽³⁾	NA	8	8	8	8	8
Total alkali content, expressed as sodium oxide (Na ₂ O) equivalent, maximum, %	NA	NR	NR	NR	0,75 ^c	0,75 ^c
HIGH SULFATE-RESISTANT GRADE (HSR)						
Magnesium oxide (MgO), maximum, %	NA	6,0	6,0	6,0	6,0	6,0
Sulfur trioxide (SO ₃), maximum, %	NA	3,0	3,5	3,0	3,0	3,0
Loss on ignition, maximum, %	NA	3,0	3,0	3,0	3,0	3,0
Insoluble residue, maximum, %	NA	0,75	0,75	0,75	0,75	0,75
Tricalcium silicate (C ₃ S) maximum, %	NA	NR	NR	NR	65 ^b	65 ^b
Tricalcium silicate (C ₃ S) minimum, %	NA	NR	NR	NR	48 ^b	48 ^b
Tricalcium aluminate (C ₃ A), maximum, %	NA	3 ^b	3 ^b	3 ^b	3 ^b	3 ^b
Tetracalcium aluminoferrite (C ₄ AF) plus twice the tricalcium aluminate (C ₃ A), maximum, %	NA	24 ^b	24 ^b	24 ^b	24 ^b	24 ^b
Total alkali content expressed as sodium oxide (Na ₂ O) equivalent, maximum, %	NA	NR	NR	NR	0,75 ^c	0,75 ^c
NR = No Requirement; NA = Not Applicable ^a When the tricalcium aluminate content (expressed as C₃A) of the cement is 8 % or less, the maximum SO₃ content shall be 3 %. ^b The expressing of chemical limitations by means of calculated assumed compounds does not necessarily mean that the oxides are actually or entirely present as such compounds. When the ratio of the percentages of Al₂O₃ to Fe₂O₃ is 0,64 or less, the C₃A content is zero. When the Al₂O₃ to Fe₂O₃ ratio is greater than 0,64, the compounds shall be calculated as follows: $C_3A = (2,65 \times \% Al_2O_3) - (1,69 \times \% Fe_2O_3)$ $C_4AF = 3,04 \times \% Fe_2O_3$ $C_3S = (4,07 \times \% CaO) - (7,60 \times \% SiO_2) - (6,72 \times \% Al_2O_3) - (1,43 \times \% Fe_2O_3) - (2,85 \times \% SO_3)$ When the ratio of Al₂O₃ to Fe₂O₃ is less than 0,64, the C₃S shall be calculated as follows: $C_3S = (4,07 \times \% CaO) - (7,60 \times \% SiO_2) - (4,48 \times \% Al_2O_3) - (2,86 \times \% Fe_2O_3) - (2,85 \times \% SO_3)$ ^c The sodium oxide equivalent (expressed as Na₂O equivalent) shall be calculated by the formula: $Na_2O \text{ equivalent} = (0,658 \times \% K_2O) + (\% Na_2O)$						

Table 2 — Summary of physical and performance requirements

Well cement Class				A	B	C	D	E	F	G	H
Mix water, % mass fraction of cement (Table 5)				46	46	56	38	38	38	44	38
Fineness tests (alternative methods) (clause 6)											
Turbidimeter (specified surface, minimum m ² /kg)				150	160	220	NR	NR	NR	NR	NR
Air permeability (specified surface, minimum m ² /kg)				280	280	400	NR	NR	NR	NR	NR
Free fluid content, maximum % (clause 8)				NR	NR	NR	NR	NR	NR	A ₁ 5,9(A ₁)	A ₁ 5,9(A ₁)
Compressive strength test (8-h curing time) (clause 9)	Schedule number, Table 6	Final curing temp. °C (°F)	Final curing pressure MPa (psi)	Minimum compressive strength MPa (psi)							
	NA	38 (100)	atm.	1,7 (250)	1,4 (200)	2,1 (300)	NR	NR	NR	2,1 (300)	2,1 (300)
	NA	60 (140)	atm.	NR	NR	NR	NR	NR	NR	10,3 (1 500)	10,3 (1 500)
	6S	110 (230)	20,7 (3 000)	NR	NR	NR	3,4 (500)	NR	NR	NR	NR
	8S	143 (290)	20,7 (3 000)	NR	NR	NR	NR	3,4 (500)	NR	NR	NR
	9S	160 (320)	20,7 (3 000)	NR	NR	NR	NR	NR	3,4 (500)	NR	NR
Compressive strength test (24-h curing time) (clause 9)	Schedule number, Table 6	Final curing temp. °C (°F)	Final curing pressure MPa (psi)	Minimum compressive strength MPa (psi)							
	NA	38 (100)	Atm.	12,4 (1 800)	10,3 (1 500)	13,8 (2 000)	NR	NR	NR	NR	NR
	4S	77 (170)	20,7 (3 000)	NR	NR	NR	6,9 (1 000)	6,9 (1 000)	NR	NR	NR
	6S	110 (230)	20,7 (3 000)	NR	NR	NR	13,8 (2 000)	NR	6,9 (1 000)	NR	NR
	8S	143 (290)	20,7 (3 000)	NR	NR	NR	NR	13,8 (2 000)	NR	NR	NR
	9S	160 (320)	20,7 (3 000)	NR	NR	NR	NR	NR	6,9 (1 000)	NR	NR