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Ersatz für
DIN EN ISO 10426-1:2007-01**Erdöl- und Erdgasindustrie –
Zemente und Materialien für die Zementation von Tieflochbohrungen –
Teil 1: Anforderungen (ISO 10426-1:2009 + Cor.1:2010);
Englische Fassung EN ISO 10426-1:2009 + AC:2010**

Petroleum and natural gas industries –
Cements and materials for well cementing –
Part 1: Specification (ISO 10426-1:2009 + Cor.1:2010);
English version EN ISO 10426-1:2009 + AC:2010

Industries du pétrole et du gaz naturel –
Ciments et matériaux pour la cimentation des puits –
Partie 1: Spécification (ISO 10426-1:2009 + Cor.1:2010);
Version anglaise EN ISO 10426-1:2009 + AC:2010

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Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) im DIN

Nationales Vorwort

Dieses Dokument (EN ISO 10426-1:2009 + AC:2010) wurde vom ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“, Subkomitee SC 3 „Drilling and completion fluids, and well cements“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ (Sekretariat AFNOR, Frankreich) erarbeitet.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-03 AK „Bohrspülung und Zemente - Spiegelausschuss zu ISO/TC 67/SC 3“ im Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) des DIN Deutsches Institut für Normung e. V. mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO Norm.

Diese Norm enthält neben den gesetzlichen Einheiten auch die Einheiten „°F“, „atm“, „ft“, „BTU/(lb·°F)“, „ft“, „inch“, „lb“, „lbf“, „psi“, „qt“, „r/min“ und „r/s“, die im Deutschen Normenwerk nicht zugelassen sind. Es wird ausdrücklich darauf hingewiesen, dass die Anwendung dieser Einheiten im nationalen amtlichen und geschäftlichen Verkehr aufgrund des Gesetzes über Einheiten im Messwesen nicht zulässig ist.

Umrechnung:

Nicht-SI-Einheit	SI-Einheit	Umrechnung	
°F	°C	°C	= (5/9) (°F-32)
atm	Pa	1 atm	= 1,013 25 · 10 ⁵ Pa
BTU/(lb·°F)	kJ/(kg·K)	1 Btu/(lbm °F)	= 4,186 8 kJ/ (kg K)
ft	m	1 ft	= 0,304 8 m
in (inch)	mm	1 in	= 25,4 mm
lb (pound)	kg	1 lb	= 0,453 592 37 kg
lbf	N	1 lbf	= 4,448 222 N
psi (psig)	kPa	1 psi	= 6,894 757 kPa
qt (quart)	l	1 quart	= 0,946 l
r/min	min ⁻¹	1 r/min	= 1 min ⁻¹
r/s	U/s	1 r/s	= 1 U/s

Für die in diesem Dokument zitierten Internationalen Normen wird im Folgenden auf die entsprechenden Deutschen Normen hingewiesen:

ISO 3310-1	siehe	DIN ISO 3310-1
ISO 13500	siehe	DIN EN ISO 13500
ISO 24450	siehe	DIN EN ISO 24450

ISO 10426 *Petroleum and natural gas industries — Cements and materials for well cementing* besteht aus den folgenden Teilen:

- *Part 1: Specification*
- *Part 2: Testing of well cements*
- *Part 3: Testing of deepwater well cement formulations*
- *Part 4: Preparation and testing of foamed cement slurries at atmospheric pressure*
- *Part 5: Determination of shrinkage and expansion of well cement formulations at atmospheric pressure*
- *Part 6: Methods for determining the static gel strength of cement formulations*

Änderungen

Gegenüber DIN EN ISO 10426-1:2007-01 wurden folgende Änderungen vorgenommen:

- a) Aktualisierung der normativen Verweisungen;
- b) Zementklassen E und F wurden entfernt;
- c) Aktualisierung von Bild 1 „Example of a typical cement-mixing device“ und Bild 2 „Mixing-blade assembly“;
- d) Änderung von Bild 8 „Typical gear drive consistometer for pressurized specification thickening-time test“, Bild 9 „Typical magnetic drive consistometer for pressurized specification thickening-time test“ und Bild 11 „Typical potentiometer calibrating device“;
- e) Aktualisierung des Literaturverzeichnisses;
- f) Norm wurde redaktionell überarbeitet;
- g) die Europäische Berichtigung EN ISO 10426-1:2009/AC:2010 wurde eingearbeitet.

Frühere Ausgaben

DIN EN ISO 10426-1: 2002-05, 2007-01

Nationaler Anhang NA (informativ)

Begriffe und Definitionen

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1 (Zement-)Zusatz

einer Zementbrühe hinzugefügtes Material, um eine gewünschte Eigenschaft zu verändern oder zu verbessern

ANMERKUNG Die Eigenschaften, die im Allgemeinen verändert werden, sind unter anderem Erstarrungszeit (bei Anwendung von Abbindeverzögerern oder -beschleunigern), Flüssigkeitsverlust, Viskosität usw.

3.2 atmosphärisches Konsistometer

Gerät, das zum Umrühren und Konditionieren der Zementbrühe eingesetzt wird

ANMERKUNG Das Gerät ist nicht für die Bestimmung der Verdickungszeit vorgesehen.

3.3 Bearden unit of consistency Bearden Consistency

B_c
Maß für die Konsistenz einer Zementbrühe, wenn dieses in einem atmosphärischen Konsistometer bestimmt wird

3.4 Zement Portlandzement

gemahlener Klinker, der im Allgemeinen aus hydraulischen Calciumsilikaten und -aluminaten besteht und der üblicherweise eine oder mehrere Form(en) von Calciumsulfat, beispielsweise als Zumahlstoff, enthält

3.5 Zementklasse

nach dem ISO-System erhaltene Bezeichnung zur Klassifizierung von Bohrlochzement entsprechend seines vorgesehenen Verwendungszweckes

3.6 Zementgüte

nach dem ISO-System erhaltene Bezeichnung zur Kennzeichnung der Beständigkeit einer bestimmten Zementart gegen Schwefel

3.7 Zementmischung

Gemisch aus Trockenzement und anderen trockenen Materialien

3.8 Klinker

während der Herstellung von Zement im Ofen erzeugte geschmolzene Materialien, die für die Fertigung von Zement gemeinsam mit Calciumsulfat vermahlen werden

3.9**Druckfestigkeit**

Kraft je Flächeneinheit, die erforderlich ist, dass eine erstarrte Zementprobe unter Druck versagt

3.10**Konsistenzmesser****Konsistometer**

Gerät, das unter Berücksichtigung von Temperatur und Druck zur Ermittlung der Verdickungszeit einer Zementbrühe verwendet wird

3.11**Filtrat**

Flüssigkeit, die während einer Filtrationsverlustprüfung aus einer Zementbrühe herausgepresst wird

3.12**ungebundene Flüssigkeit**

farbige oder farblose Flüssigkeit, die unter statischen Bedingungen von einer Zementbrühe abgesondert wird

3.13**Behälter für Zementbrühe**

Behälter in einem atmosphärischen Konsistometer, der für Konditionierungszwecke oder für die Prüfung der Verdickungszeit zur Aufnahme der Zementbrühe angewendet wird

3.14**Verdickungszeit**

Zeitraum, in dem eine Zementbrühe einen speziellen B_c -Wert, bei dem die Brühe als nicht pumpfähig angesehen wird, erreicht

ANMERKUNG Das Ergebnis eines Verdickungszeittests liefert eine Indikator der Zeitlänge in der die Zementbrühe pumpbar bleibt.

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN ISO 3310-1, *Analysensiebe — Technische Anforderungen und Prüfung — Teil 1: Analysensiebe mit Metalldrahtgewebe*

DIN EN ISO 13500, *Erdöl- und Erdgasindustrie — Bohrspülungen — Spezifikationen und Prüfungen*

DIN EN ISO 24450, *Laborgeräte aus Glas — Erlenmeyer-, Rund- und Stehkolben, weithalsig*

English Version

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Erdöl- und Erdgasindustrie —
Zemente und Materialien für die Zementation von
Tieflochbohrungen —
Teil 1: Anforderungen
(ISO 10426-1:2009 + Cor.1:2010)

This European Standard was approved by CEN on 14 December 2009.

This corrigendum becomes effective on 1 April 2010 for incorporation in the three official language versions of the EN.

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Foreword

This document (EN ISO 10426-1:2009 + AC:2010) has been prepared by Technical Committee ISO/TC 67 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical 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 June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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Endorsement notice

The text of ISO 10426-1:2009 has been approved by CEN as a EN ISO 10426-1:2009 without any modification.

The text of ISO 10426-1:2009/Cor 1:2010 has been approved by CEN as a EN ISO 10426-1:2009/AC:2010 without any modification.

Introduction

This part of ISO 10426 is based on ISO 10426-1:2005 with the intent that the 24th edition of API Spec 10A will be identical to this part of ISO 10426.

It is necessary that users of this part of ISO 10426 be aware that further or differing requirements can be required 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 can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this part of ISO 10426 and provide details.

In this part of ISO 10426, where practical, US Customary (USC) or other units are included in brackets for information. The units do not necessarily represent a direct conversion of SI to USC units, or USC to SI. Consideration has been given to the precision of the instrument making the measurement. For example, thermometers are typically marked in 1° increments, thus temperature values have been rounded to the nearest degree.

In this part of ISO 10426, calibrating an instrument refers to assuring the accuracy of the measurement. Accuracy is the degree of conformity of a measurement of a quantity to its actual or true value. Accuracy is related to precision, or reproducibility, of a measurement. Precision is the degree to which further measurements or calculations will show the same or similar results. Precision is characterized in terms of the standard deviation of the measurement. The results of calculations or a measurement can be accurate, but not precise, precise but not accurate, neither or both. A result is valid if it is both accurate and precise.

1 Scope

This part of ISO 10426 specifies requirements and gives recommendations for six 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 and D, which are the products obtained by grinding Portland cement clinker and, if needed, calcium sulfate as an interground additive. Processing additives can be used in the manufacture of cement of these classes. Suitable set-modifying agents can be interground or blended during manufacture of class D cement.

This part of ISO 10426 is also applicable to well cement classes G and H, which are the products obtained by grinding clinker with no additives other than one or more forms of calcium sulfate, water or chemical additives as required for chromium (VI) reduction.

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 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*

ISO 24450, *Laboratory glassware — Wide-necked boiling flasks*

ASTM C109/C109M, *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50-mm] Cube Specimens)*

ASTM C115, *Standard Test Method for Fineness of Portland Cement by the Turbidimeter*

ASTM C465, *Standard Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements*

ASTM E1404-94(2008), *Standard Specification for Laboratory Glass Conical Flasks*

EN 196-1, *Methods of testing cement — Part 1: Determination of strength*

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*

3 Terms and definitions

For the purposes of this document, 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

atmospheric pressure consistometer

device used for stirring and conditioning the cement slurry

NOTE The device is not intended to measure thickening time.

3.3

Bearden unit of consistency

B_c

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

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 under the ISO system for classification of well cement according to its intended use

3.6

cement grade

designation achieved under 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 produced in the kiln during cement manufacturing that are interground with calcium sulfate to make cement

3.9

compressive strength

force per unit area required to cause a set cement sample to fail under compression

3.10

consistometer

device used to measure the thickening time of a cement slurry under temperature and under 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 that separates from a cement slurry under static conditions

3.13

slurry container

slurry cup

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

3.14

thickening time

time after which the consistency of a cement slurry has become so high that the slurry is considered unpumpable

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

4 Requirements

4.1 Specification, chemical and physical requirements

4.1.1 Classes and grades

4.1.1.1 General

Well cement shall be specified using classes A, B, C, D, G and H and the grades: ordinary (O), moderate sulfate-resistant (MSR) and high sulfate-resistant (HSR).

A well cement that 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.

Processing additives, set modifying agents or chemical additives used to reduce chromium (VI) shall not prevent a well cement from performing its intended functions.

4.1.1.2 Class A

This product is obtained by grinding 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 that such materials in the amounts used have been shown to meet the requirements of ASTM C465.

This product is intended for use when special properties are not required and is available only in O grade, similar to ASTM C150, type I.

4.1.1.3 Class B

This product is obtained by grinding 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 that such materials in the amounts used have been shown to meet the requirements of ASTM C465.

This product is intended for use when conditions require moderate or high sulfate resistance and is available in both MSR and HSR grades, similar to ASTM C150, type II.

4.1.1.4 Class C

This product is obtained by grinding 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 that such materials in the amounts used have been shown to meet the requirements of ASTM C465.

This product is intended for use when conditions require high, early strength and is available in O, MSR and HSR grades, similar to ASTM C150, type III.

4.1.1.5 Class D

This product is obtained by grinding 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 that such materials in the amounts used have been shown to meet the requirements of ASTM C465. 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 and is available in MSR and HSR grades.

4.1.1.6 Class G

This product is obtained by grinding 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. Chemical additives, as required for chromium(VI) reduction, are permitted, provided that such additives do not prevent the well cement from performing its intended purpose.

This product is intended for use as a basic well cement and is available in MSR and HSR grades.

4.1.1.7 Class H

This product is obtained by grinding 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. Chemical additives, as required for chromium(VI) reduction, are permitted, provided that such additives do not prevent the well cement from performing its intended purpose.

This product is intended for use as a basic well cement and is available in MSR and HSR grades.

4.1.2 Chemical requirements

Well cements shall conform to the respective chemical requirements of classes and grades referenced in Table 1. It is not intended that this manufacturing compliance be applicable to field conditions. This part of ISO 10426 is not applicable to the use of cements that do not conform to the chemical requirements of classes and grades as set forth in Table 1.

Chemical analyses of hydraulic cements shall be carried out as specified in EN 196-2.

NOTE For the purposes of this provision, ASTM C114 is equivalent to EN 196-2.

Table 1 — Chemical requirements

	Cement class					
	A	B	C	D	G	H
Ordinary grade (O)						
Magnesium oxide (MgO), maximum, percent	6,0	NA ^a	6,0	NA	NA	NA
Sulfur trioxide (SO ₃), maximum, percent ^b	3,5	NA	4,5	NA	NA	NA
Loss on ignition, maximum, percent	3,0	NA	3,0	NA	NA	NA
Insoluble residue, maximum, percent	0,75	NA	0,75	NA	NA	NA
Tricalcium aluminate (C ₃ A), maximum, percent ^d	NR ^c	NA	15	NA	NA	NA
Moderate sulfate-resistant grade (MSR)						
Magnesium oxide (MgO), maximum, percent	NA	6,0	6,0	6,0	6,0	6,0
Sulfur trioxide (SO ₃), maximum, percent ^b	NA	3,0	3,5	3,0	3,0	3,0
Loss on ignition, maximum, percent	NA	3,0	3,0	3,0	3,0	3,0
Insoluble residue, maximum, percent	NA	0,75	0,75	0,75	0,75	0,75
Tricalcium silicate (C ₃ S) maximum, percent ^d minimum, percent ^d	NA	NR	NR	NR	58	58
	NA	NR	NR	NR	48	48
Tricalcium aluminate (C ₃ A), maximum percent ^d	NA	8	8	8	8	8
Total alkali content, expressed as sodium oxide (Na ₂ O) equivalent, maximum, percent ^e	NA	NR	NR	NR	0,75	0,75
High sulfate-resistant grade (HSR)						
Magnesium oxide (MgO), maximum, percent	NA	6,0	6,0	6,0	6,0	6,0
Sulfur trioxide (SO ₃), maximum, percent ^b	NA	3,0	3,5	3,0	3,0	3,0
Loss on ignition, maximum, percent	NA	3,0	3,0	3,0	3,0	3,0
Insoluble residue, maximum, percent	NA	0,75	0,75	0,75	0,75	0,75
Tricalcium silicate (C ₃ S) maximum, percent ^d minimum, percent ^d	NA	NR	NR	NR	65	65
	NA	NR	NR	NR	48	48
Tricalcium aluminate (C ₃ A), maximum, percent ^d	NA	3	3	3	3	3
Tetracalcium aluminoferrite (C ₄ AF) plus twice the tricalcium aluminate (C ₃ A), maximum, percent ^d	NA	24	24	24	24	24
Total alkali content expressed as sodium oxide (Na ₂ O) equivalent, maximum, percent ^e	NA	NR	NR	NR	0,75	0,75
<p>^a NA indicates "not applicable".</p> <p>^b When the tricalcium aluminate content (expressed as C₃A) of the cement is 8 % or less, the maximum SO₃ content shall be 3 %, or 3,5 % for class C cement.</p> <p>^c NR indicates "no requirement".</p> <p>^d 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. The compounds are calculated according to the ratio of the mass percentages of Al₂O₃ to Fe₂O₃, where <i>w</i> is the percentage mass fraction of the compound indicated in the subscript:</p> <ul style="list-style-type: none"> When $w_{\text{Al}_2\text{O}_3} / w_{\text{Fe}_2\text{O}_3}$ is greater than 0,64, the compounds shall be calculated as follows: $\text{C}_3\text{A} = 2,65w_{\text{Al}_2\text{O}_3} - 1,69w_{\text{Fe}_2\text{O}_3}$ $\text{C}_3\text{S} = 4,07w_{\text{CaO}} - 7,60w_{\text{SiO}_2} - 6,72w_{\text{Al}_2\text{O}_3} - 1,43w_{\text{Fe}_2\text{O}_3} - 2,85w_{\text{SO}_3}$ $\text{C}_4\text{AF} = 3,04w_{\text{Fe}_2\text{O}_3}$ When $w_{\text{Al}_2\text{O}_3} / w_{\text{Fe}_2\text{O}_3}$ is 0,64 or less, the C₃A content is zero. The C₃S and C₄AF shall be calculated as follows: $\text{C}_3\text{S} = 4,07w_{\text{CaO}} - 7,60w_{\text{SiO}_2} - 4,48w_{\text{Al}_2\text{O}_3} - 2,86w_{\text{Fe}_2\text{O}_3} - 2,85w_{\text{SO}_3}$ $\text{C}_4\text{AF} = 3,04w_{\text{Fe}_2\text{O}_3}$ <p>^e The sodium oxide equivalent, expressed as Na₂O equivalent, shall be calculated by the formula: Na₂O equivalent is equal to $0,658w_{\text{K}_2\text{O}} + w_{\text{Na}_2\text{O}}$.</p>						