

DIN EN ISO 12736

ICS 75.180.10; 25.220.20

**Erdöl- und Erdgasindustrie –
Wärmedämmschicht für Rohrleitungen, Anschlussleitungen, Zubehör
und Unterwasserkonstruktionen (ISO 12736:2014);
Englische Fassung EN ISO 12736:2014**

Petroleum and natural gas industries –
Wet thermal insulation coatings for pipelines, flow lines, equipment and subsea structures
(ISO 12736:2014);
English version EN ISO 12736:2014

Industries du pétrole et du gaz naturel –
Revêtements pour isolation thermique humide de canalisations, lignes d'écoulement et
structures sous-marines (ISO 12736:2014);
Version anglaise EN ISO 12736:2014

Gesamtumfang 90 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Dieses Dokument (EN ISO 12736:2014) wurde vom Technischen Komitee ISO/TC 67/SC 2 „Pipeline transportation systems“ 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 Arbeitsausschuss NA 109-00-02 AA „Fernleitungssysteme — Spiegelausschuss zu ISO/TC 67/SC 2“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

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

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

ISO 34 (all parts)	siehe	DIN ISO 34 (alle Teile)
ISO 62	siehe	DIN EN ISO 62
ISO 178	siehe	DIN EN ISO 178
ISO 527 (all parts)	siehe	DIN EN ISO 527 (alle Teile)
ISO 813	siehe	DIN ISO 813
ISO 844	siehe	DIN EN ISO 844
ISO 868	siehe	DIN EN ISO 868
ISO 1133 (all parts)	siehe	DIN EN ISO 1133 (alle Teile)
ISO 1172	siehe	DIN EN ISO 1172
ISO 1183 (all parts)	siehe	DIN EN ISO 1183 (alle Teile)
ISO 1817	siehe	DIN ISO 1817
ISO 2063	siehe	DIN EN ISO 2063
ISO 2808	siehe	DIN EN ISO 2808
ISO 2811-1	siehe	DIN EN ISO 2811-1
ISO 2884 (all parts)	siehe	DIN EN ISO 2884 (alle Teile)
ISO 3104	siehe	DIN EN ISO 3104
ISO 3219	siehe	DIN EN ISO 3219
ISO 4590	siehe	DIN EN ISO 4590
ISO 4624	siehe	DIN EN ISO 4624
ISO 4649	siehe	DIN ISO 4649
ISO 7619 (all parts)	siehe	DIN ISO 7619 (alle Teile)
ISO 8501-1	siehe	DIN EN ISO 8501-1
ISO 8502-3	siehe	DIN EN ISO 8502-3
ISO 8502-4	siehe	DIN EN ISO 8502-4
ISO 8503-1	siehe	DIN EN ISO 8503-1
ISO 11357 (all parts)	siehe	DIN EN ISO 11357 (alle Teile)
ISO 14896	siehe	DIN EN ISO 14896
ISO 15711	siehe	DIN EN ISO 15711
ISO 21809-1	siehe	DIN EN ISO 21809-1
ISO 21809-3	siehe	DIN EN ISO 21809-3

Nationaler Anhang NA (informativ)

Begriffe, Symbole und Abkürzungen

Die Benennung der folgenden Begriffe, Symbole und Abkürzungen ist identisch mit der Benennung in der Englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1

Auftragwerk

Unternehmen, das die Beschichtung nach den Festlegungen dieser Internationalen Norm aufträgt

3.2

Chargenzertifikat

vom Hersteller ausgestelltes Analysenzertifikat

Anmerkung 1 zum Begriff: Dabei handelt es sich um ein Dokument, welches die Ergebnisse der durch den Hersteller durchgeführten Prüfung beinhaltet.

3.3

Konformitätsbescheinigung

vom Hersteller ausgestellte Konformitätsbescheinigung

3.4

Abkühlzeit

Zeit, die ein in einer Rohrleitung enthaltenes Fluid benötigt, um ausgehend von einer festgelegten Anfangstemperatur (innen und außen), bei der der Fluidstrom gestoppt wurde, eine vorbestimmte Temperatur zu erreichen

3.5

Rückschnitt

(en: cutback)

bezüglich der Länge festgelegter unbeschichteter Bereich an den Enden jeden Rohres, der erforderlich ist, um eine Beschädigung des Beschichtungssystems zu verhindern, wenn die Rohrabschnitte zusammengeschweißt werden

3.6

Lebensende

Zustand des interessierenden Parameters am Ende der Betriebslebensdauer

3.7

Endnutzer

Unternehmen, das Eigentümer der Produktionsanlage ist und/oder sie betreibt

3.8

Ausrüstung

Komponenten, mit Ausnahme von Rohrleitungen und Anschlussleitungen, die bei der Beförderung des Fluids vom Bohrloch zur Verarbeitungsanlage verwendet werden

BEISPIEL Ventil, Manifold, Eruptionskreuz.

3.9

Montageverbindung

unbeschichteter Bereich, der entsteht, wenn zwei Rohrabschnitte oder ein Rohrabschnitt und ein Formstück mit Beschichtungs-Rückschnitten mittels Schweißen zusammengefügt werden

3.10

Beschichtung der Montageverbindung

Beschichtung, die aufgetragen wird, wenn zwei Rohrabschnitte mit Beschichtungs-Rückschnitt durch Schweißen vor Ort oder im Herstellwerk zusammengefügt werden

3.11

Planer von Montageverbindungen

Unternehmen, das das Montageverbindungssystem für die Qualifizierung nach dieser Norm vorschlägt

3.12

Anschlussleitung

Rohr, in dem das Fluid von einem Öl- oder Gasbohrloch zur Basis des Risers einer Verarbeitungsanlage transportiert wird

3.13

Wärmeübergangskoeffizient

U-Wert

Rate des Wärmeübergangs von einer Bezugs-Oberfläche unter Einfluss eines Temperaturgradienten

Anmerkung 1 zum Begriff: Angegeben in $W \cdot m^{-2} \cdot K^{-1}$.

3.14

Wärmedämmsystem

bestimmte Kombination aus Vorbehandlung, Korrosionsschutzbeschichtung, Dämmung und äußerer Schutzumhüllung zur Erreichung der in dieser Internationalen Norm beschriebenen Korrosionsschutz- und Wärmedämmeigenschaften

3.15

Lage

auf die zu dämmende Oberfläche in Einheiten mit diskreter Dicke aufgetragene Werkstoffe, die das Wärmedämmsystem bilden

3.16

Hersteller

Unternehmen, das für die Herstellung der Beschichtungsstoffe verantwortlich ist

3.17

Werkstoffdatenblatt

Formblatt, das Angaben bezüglich der physikalischen und mechanischen Eigenschaften eines bestimmten für den Beschichtungsprozess verwendeten Werkstoffes enthält und das Hinweise und Empfehlungen für seine Verarbeitung und Anwendung gibt

3.18

Material-Sicherheitsdatenblatt

Formblatt, das Arbeitern und Rettungs- und Sicherheitspersonal Maßnahmen zum sicheren Umgang und zum sicheren Arbeiten mit dem Werkstoff vermitteln soll und das physikalische Angaben, wie z. B. Entflammungspunkt, Toxizität und erste Hilfe enthält

3.19

maximaler Bemessungsdruck

äußerer Druck, für den die Dämmschichten entsprechend der Vorgaben durch den System-Planer ausgelegt sind

3.20**maximale und minimale Bemessungstemperatur**

Bedingungen, für die die Dämmschichten entsprechend der Vorgaben durch den System-Planer ausgelegt sind

3.21**Rohrleitung**

Rohr, das Gas, Rohöl oder weitere Endprodukte von einer Verarbeitungs- oder Sammeleinrichtung an einen anderen Ort, wie eine andere Verarbeitungsanlage, Raffinerie, Chemieanlage oder zum Endnutzer transportiert

3.22**PI Tape**

Präzisions-Feinmess-Bandmaß für die Umfangsmessung, das die direkte und genaue Messung des Durchmessers rohrförmiger Gegenstände ohne Notwendigkeit des Einsatzes von Messschiebern oder Mikrometern ermöglicht

3.23**Vorserienprüfung**

(en: pre-production test)

PPT

Reihe von Prüfungen, die unmittelbar vor Beginn der Produktion durchgeführt werden und für den Nachweis ausgelegt sind, dass die Anforderungen an ein zuvor qualifiziertes Beschichtungssystem wie in dieser Internationalen Norm und wie vom Käufer dargestellt erreicht werden

3.24**Verfahrensprüfung**

(en: procedure qualification test)

PQT

Reihe von Prüfungen, die vor Beginn der Produktion durchgeführt werden und für den Nachweis ausgelegt sind, dass die Beschichtungsstoffe, das Auftragswerk, die Beschichtungsausrüstungen und das Beschichtungsverfahren die in dieser Internationalen Norm und vom Käufer dargestellten Anforderungen erfüllen können

3.25**Käufer**

Unternehmen, das die Anforderungen an die Produktbestellung vorgibt

3.26**Betriebslebensdauer**

festgelegter Zeitraum für die Nutzung der Wärmedämmbeschichtung bei Betrieb

3.27**Rohrabschnitt**

(en: stalk)

endlos gefertigter Rohrstrang aus geschweißten Rohren mit beschichteter Montageverbindung, der zum Aufwickeln auf eine Haspel auf ein Rohrverleges Schiff hergestellt wird

Anmerkung 1 zum Begriff: Für eine Rohr- oder Anschlussleitung sind üblicherweise mehrere dieser Rohrabschnitte erforderlich.

3.28**Verbindung der Rohrabschnitte**

(en: stalk tie-in)

Schweißverbindung, gefolgt von der Beschichtung der Montageverbindung, die zwischen den Rohrabschnitten (en: stalks) beim Aufwickeln des Rohres fertiggestellt wird

3.29

Unterwasser-Konstruktion

bauliche Aufbauten oder Templates für die Positionierung, Auflagerung und den Schutz verschiedener Gegenstände der Produktionsausrüstung

Anmerkung 1 zum Begriff: Manifolde, Eruptionskreuze.

3.30

syntaktischer Kunststoff

Dämmstoff, der durch Verteilung von Hohlpartikeln innerhalb einer Polymermatrix gebildet wird

Anmerkung 1 zum Begriff: Polyurethan-, Epoxidharz-, Phenolharz-, Polypropylen- (PP-), Silikon sind Beispiele für Polymere.

3.31

Systemplaner

Unternehmen, das das Dämmsystem zur Qualifizierung nach dieser Internationalen Norm vorschlägt

3.32

Wärmeleitfähigkeit

k-Wert

Fähigkeit eines Werkstoffs, Wärme zu leiten, die im Allgemeinen in Form des Wärmestroms durch eine Längeneinheit des betreffenden Werkstoffs unter dem Einfluss einer genormten Temperaturdifferenz gemessen wird

Anmerkung 1 zum Begriff: Angegeben in $\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$.

3.33

Produktionseinheit

UP

Anzahl von Rohren mit dreilagiger Polypropylenbeschichtung, die sich auf derselben Stufe in der Beschichtungsfolge befinden, und bei denen die endgültige Dämmdicke durch Mehrfachauftrag der einzelnen Lagen gebildet wird

Anmerkung 1 zum Begriff: Die einzelnen Lagen sind die Dämmschichten und die Deckschicht.

4 Symbole und Abkürzungen

3LPP dreilagige Polypropylenbeschichtung (en: three layer polypropylene)

4LPP vierlagige Polypropylenbeschichtung (en: four layer polypropylene)

APS Spezifikation des Auftragsverfahrens (en: application procedure specification)

CD kathodische Enthftung (en: cathodic disbondment)

CP kathodischer Korrosionsschutz (en: cathodic protection)

DMA dynamisch-mechanische Analyse (en: dynamic mechanical analysis)

DSC dynamisches Differenz-Kalorimeter (en: differential scanning calorimeter)

FBE schmelzverbundenes Epoxidharz (en: fusion bonded epoxy)

FJC Beschichtung der Montageverbindung (en: field joint coating)

GSPP glassyntaktisches Polypropylen (en: glass syntactic polypropylene)

GSPU	glassyntaktisches Polyurethan (en: glass syntactic polyurethane)
HDPE	hochdichtes Polyethylen (en: high density polyethylene)
ID	Innendurchmesser (en: internal diameter)
ITP	Inspektions- und Prüfplan (en: inspection and test plan)
MFR	Schmelzflussrate (en: melt flow rate)
OD	Außendurchmesser (en: outer diameter)
PE	Polyethylen (en: polyethylene)
PP	Polypropylen (en: polypropylene)
PU	Polyurethan (en: polyurethane)
RH	relative Luftfeuchte (en: relative humidity)
SPU	syntaktisches Polyurethan (en: syntactic PU)
UV	ultraviolett (en: ultraviolet)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 62, *Kunststoffe — Bestimmung der Wasseraufnahme*

DIN EN ISO 178, *Kunststoffe — Bestimmung der Biegeeigenschaften*

DIN EN ISO 527 (alle Teile), *Kunststoffe — Bestimmung der Zugeigenschaften*

DIN EN ISO 844, *Harte Schaumstoffe — Bestimmung der Druckeigenschaften*

DIN EN ISO 868, *Kunststoffe und Hartgummi — Bestimmung der Eindruckhärte mit einem Durometer*

DIN EN ISO 1133 (alle Teile), *Kunststoffe — Bestimmung der Schmelze-Massefließrate (MFR) und der Schmelze-Volumenfließrate (HVR) von Thermoplasten*

DIN EN ISO 1172, *Textilglasverstärkte Kunststoffe — Prepregs, Formmassen und Lamine — Bestimmung des Textilglas- und Mineralfüllstoffgehalts; Kalzinierungsverfahren*

DIN EN ISO 1183 (alle Teile), *Kunststoffe — Verfahren zur Bestimmung der Dichte von nicht verschäumten Kunststoffen*

DIN EN ISO 2063, *Thermisches Spritzen — Metallische und andere anorganische Schichten — Zink, Aluminium und ihre Legierungen*

DIN EN ISO 2808, *Beschichtungsstoffe — Bestimmung der Schichtdicke*

DIN EN ISO 2811-1, *Beschichtungsstoffe — Bestimmung der Dichte — Teil 1: Pyknometer-Verfahren*

DIN EN ISO 2884 (alle Teile), *Beschichtungsstoffe — Bestimmung der Viskosität mit Rotationsviskosimetern*

DIN EN ISO 3104, *Mineralölerzeugnisse — Durchsichtige und undurchsichtige Flüssigkeiten — Bestimmung der kinematischen Viskosität und Berechnung der dynamischen Viskosität*

DIN EN ISO 3219, *Kunststoffe — Polymere/Harze in flüssigem, emulgiertem oder dispergiertem Zustand — Bestimmung der Viskosität mit einem Rotationsviskosimeter bei definiertem Geschwindigkeitsgefälle*

DIN EN ISO 4590, *Harte Schaumstoffe — Bestimmung des Volumenanteils offener und geschlossener Zellen*

DIN EN ISO 4624, *Beschichtungsstoffe — Abreißversuch zur Beurteilung der Haftfestigkeit*

DIN EN ISO 8501-1, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Visuelle Beurteilung der Oberflächenreinheit — Teil 1: Rostgrade und Oberflächenvorbereitungsgrade von unbeschichteten Stahloberflächen und Stahloberflächen nach ganzflächigem Entfernen vorhandener Beschichtungen*

DIN EN ISO 8502-3, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Prüfungen zum Beurteilen der Oberflächenreinheit — Teil 3: Beurteilung von Staub auf für das Beschichten vorbereiteten Stahloberflächen*

DIN EN ISO 8502-4, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Prüfungen zum Beurteilen der Oberflächenreinheit — Teil 4: Anleitung zum Abschätzen der Wahrscheinlichkeit von Taubildung vor dem Beschichten*

DIN EN ISO 8503-1, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Rauheitskenngrößen von gestrahlten Stahloberflächen — Teil 1: Anforderungen und Begriffe für ISO-Rauheitsvergleichsmuster zur Beurteilung gestrahlter Oberflächen*

DIN EN ISO 11357 (alle Teile), *Kunststoffe — Dynamische Differenz-Thermoanalyse (DSC)*

DIN EN ISO 14896, *Kunststoffe — Polyurethanrohstoffe — Bestimmung des Isocyanatanteils*

DIN EN ISO 15711, *Beschichtungsstoffe — Bestimmung des Widerstandes gegen kathodische Enthftung von Beschichtungen in Meerwasser*

DIN EN ISO 21809-1, *Erdöl und Erdgasindustrie — Umhüllungen für erd- und wasserverlegte Rohrleitungen in Transportsystemen — Teil 1: Polyolefinumhüllungen*

DIN EN ISO 21809-3, *Erdöl- und Erdgasindustrie — Umhüllungen für erd- und wasserverlegte Rohrleitungen in Transportsystemen — Teil 3: Nachumhüllung der Schweißverbindungen*

DIN ISO 34 (alle Teile), *Elastomere oder thermoplastische Elastomere — Bestimmung des Weiterreißwiderstandes*

DIN ISO 813, *Elastomere oder thermoplastische Elastomere — Bestimmung der Haftung zu starren Materialien - 90°-Schälverfahren*

DIN ISO 1817, *Elastomere oder thermoplastische Elastomere — Bestimmung des Verhaltens gegenüber Flüssigkeiten*

DIN ISO 4649, *Elastomere oder thermoplastische Elastomere — Bestimmung des Abriebwiderstandes mit einem Gerät mit rotierender Zylindertrommel*

DIN ISO 7619 (alle Teile), *Elastomere oder thermoplastische Elastomere — Bestimmung der Eindringhärte*

— Leerseite —

English Version

Petroleum and natural gas industries —
Wet thermal insulation coatings for pipelines, flow lines,
equipment and subsea structures (ISO 12736:2014)

Industries du pétrole et du gaz naturel —
Revêtements pour isolation thermique humide de
canalisations, lignes d'écoulement et structures sous-
marines (ISO 12736:2014)

Erdöl- und Erdgasindustrie —
Wärmedämmschicht für Rohrleitungen, Anschlussleitungen,
Zubehör und Unterwasserkonstruktionen (ISO 12736:2014)

This European Standard was approved by CEN on 8 November 2014.

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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

This document (EN ISO 12736:2014) 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 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

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.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 12736:2014 has been approved by CEN as EN ISO 12736:2014 without any modification.

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	3
4 Abbreviated terms	6
5 General recommendations and requirements	6
6 Qualification dossier	7
6.1 General	7
6.2 Content of qualification dossier	7
6.3 Anti-corrosion coating documentation	7
7 Layer test requirements	8
7.1 General	8
7.2 Ageing tests	8
7.2.1 General	8
7.2.2 Water absorption kinetic test	9
7.2.3 Wet heat ageing behaviour	10
7.2.4 Full insulation system ageing test (optional)	10
7.2.5 Weathering and UV resistance	11
8 Insulation system test requirements	11
8.1 General	11
8.2 Full scale test program	12
8.2.1 Test summary	12
8.2.2 Baseline tests (optional)	12
8.2.3 Simulated bend test	13
8.2.4 Cyclic (fatigue) bend test	13
8.2.5 Simulated tensioner test (optional)	13
8.2.6 Impact test	14
8.2.7 Simulated service test (factory applied coating)	14
8.2.8 Simulated service test (field joint)	14
8.2.9 Simulated service test (subsea equipment) (optional)	15
9 Application process and quality control	15
9.1 General	15
9.2 Qualification of operators	16
9.3 Application procedure specification (APS)	16
9.4 Procedure qualification test (PQT)	16
9.5 Pre-production test (PPT)	17
9.6 Production tests	17
9.6.1 General	17
9.6.2 Polypropylene insulation system	17
9.6.3 Polyurethane insulation systems	19
9.6.4 Silicone insulation systems	23
9.6.5 Rubber insulation systems	25
9.6.6 Epoxy insulation systems	29
9.6.7 Phenolic insulation systems	31
9.7 Final documentation	33
10 Requirements for field joints	33
10.1 General	33
10.2 Specific information relevant for field joint design and qualification	34
10.3 Qualification requirements	34

10.4	Qualification of operators.....	34
10.5	Field joint coating APS/PQT/PPT.....	34
10.6	Production tests.....	35
10.6.1	Polypropylene field joint using injection moulded technique.....	35
10.6.2	Polyurethane field joint using casting technique.....	36
10.6.3	Elastomeric field joint coatings.....	39
10.7	Final documentation.....	41
11	Handling, storage and transportation requirements.....	41
Annex A	(normative) Hydrostatic compressive behaviour/Tri-axial test procedures	42
Annex B	(normative) Simulated bend test	47
Annex C	(normative) Cyclic (fatigue) bend test.....	49
Annex D	(normative) Simulated tensioner test.....	50
Annex E	(normative) Simulated impact test.....	52
Annex F	(normative) Simulated service test (factory applied coating)	53
Annex G	(normative) Simulated service test (field joint)	55
Annex H	(informative) Simulated service test (subsea equipment).....	57
Annex I	(normative) Ring shear test procedure.....	65
Annex J	(normative) Determination of mass ratio of glass microspheres, density of glass microspheres after processing and entrapped air ratio for glass syntactic materials	66
Annex K	(informative) End of life through thickness water profile calculation.....	69
Bibliography		74

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

Introduction

Users of this International Standard are advised that further or differing requirements can be required for individual applications.

Petroleum and natural gas industries — Wet thermal insulation coatings for pipelines, flow lines, equipment and subsea structures

1 Scope

This International Standard defines the minimum requirements for qualification, application, testing, handling, storage and transportation of new and existing wet thermal insulation systems for pipelines, flowlines, equipment and subsea structures in the petroleum and natural gas industries. The purpose of these systems is to provide external corrosion protection and thermal insulation.

This International Standard is applicable to wet thermal insulation systems submerged in seawater.

This International Standard is not applicable to thermal insulation in the annulus of a steel pipe-in-pipe system.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 34 (all parts), *Rubber, vulcanized or thermoplastic — Determination of tear strength*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 62, *Plastics — Determination of water absorption*

ISO 178, *Plastics — Determination of flexural properties*

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 813, *Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90 degree peel method*

ISO 844, *Rigid cellular plastics — Determination of compression properties*

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1133 (all parts), *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 1172:1996, *Textile-glass-reinforced plastics — Prepregs, moulding compounds and laminates — Determination of the textile-glass and mineral-filler content — Calcination methods*

ISO 1183 (all parts), *Plastics — Methods for determining the density of non-cellular plastics*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 2781, *Rubber, vulcanized or thermoplastic — Determination of density*

ISO 2808:2007, *Paints and varnishes — Determination of film thickness*

ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pycnometer method*

ISO 2884 (all parts), *Paints and varnishes — Determination of viscosity using rotary viscometers*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3219, *Plastics — Polymers/resins in the liquid state or as emulsions or dispersions — Determination of viscosity using a rotational viscometer with defined shear rate*

ISO 4590, *Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells*

ISO 4624, *Paint and varnishes — Pull-off test for adhesion*

ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*

ISO 4897, *Cellular plastics — Determination of the coefficient of linear thermal expansion of rigid materials at sub-ambient temperatures*

ISO 6502, *Rubber — Guide to the use of curemeters*

ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

ISO 7822:1990, *Textile glass reinforced plastics — Determination of void content — Loss on ignition, mechanical disintegration and statistical counting methods*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 8502-3, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*

ISO 8502-4, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 4: Guidance on the estimation of the probability of condensation prior to paint application*

ISO 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces*

ISO 11357 (all parts), *Plastics — Differential scanning calorimetry (DSC)*

ISO 14896, *Plastics — Polyurethane raw materials — Determination of isocyanate content*

ISO 15711, *Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water*

ISO 21809-1:2011, *Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)*

ISO 21809-3:2008, *Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 3: Field joint coatings*

EN 253, *District heating pipes — Preinsulated bonded pipe systems for directly buried hot water networks — Pipe assembly of steel service pipe*

ASTM D4060, *Standard test method for abrasion resistance of organic coatings by the taber abraser*

3 Terms and definitions

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

3.1

applicator

company which undertakes the coating application in accordance with the provisions of this International Standard

3.2

certificate of analysis

batch certificate issued by the manufacturer

Note 1 to entry: It is a document that contains the results of tests performed by the manufacturer.

3.3

conformity certificate

certificate of conformity issued by the manufacturer

3.4

cool down time

time taken for a fluid contained within a pipeline to reach a pre-determined temperature from specific start temperatures (internal and external) when fluid flow is stopped

3.5

cutback

uncoated area defined in terms of length at the ends of each pipe which is required to prevent damage to the coating system when the pipe sections are welded together

3.6

end of life

condition of parameter of interest at the end of the service life

3.7

end user

company that owns and/or operates the production system

3.8

equipment

components other than pipelines and flowlines through which fluid flows from the well to the processing facility

EXAMPLE Valve, manifold, christmas tree.

3.9

field joint

uncoated area that results when two pipe sections, or a pipe section and a fitting with coating cutbacks, are assembled by welding

3.10

field joint coating

coating applied after two pipe sections with coating cutbacks have been assembled, by welding, in the field or a fabrication site

3.11

field joint designer

company that proposes the field joint system for qualification in accordance with this International Standard

3.12

flowline

pipe that transfers fluid from an oil or gas well to the riser foot of a processing facility

3.13

heat transfer coefficient

U-value

rate of heat transfer from a reference surface under the influence of a thermal gradient

Note 1 to entry: Expressed in $\text{W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$.

3.14

insulation system

specific combination of pre-treatment, anti-corrosion coating, insulation and protective outer sheath to achieve the corrosion protection and insulation properties as described in this International Standard

3.15

layer

materials applied to the surface to be insulated in units of discrete thickness to build up the insulation system

3.16

manufacturer

company responsible for the manufacture of coating materials

3.17

material data sheet

form containing data regarding the physical and mechanical properties of a particular material used in the coating process including guidelines and recommendations for its processing and use

3.18

material safety data sheet

form intended to provide workers and emergency personnel with procedures for handling and working with the material in a safe manner including physical data such as flash point, toxicity, first aid

3.19

maximum rated pressure

external pressure for which the insulation layers are designed, according to the system supplier

3.20

maximum and minimum rated temperature

conditions for which the insulation layers are designed, according to the system supplier

3.21

pipeline

pipe that transfers fluid from a processing or storage facility to another location be it another processing facility, refinery, chemical plant or end user

3.22

PI tape

precision vernier periphery tape that allows the direct and accurate measurement of the diameter of tubular objects without the need for callipers or micrometers

3.23

pre-production test

PPT

series of tests performed immediately before the start of production, designed to demonstrate that the requirements of a previously qualified coating system are achieved, as outlined in this International Standard and as outlined by the purchaser

3.24

procedure qualification test

PQT

series of tests designed to demonstrate that the coating materials, coating applicator, coating equipment and coating procedure can meet the requirements as outlined in this International Standard and as outlined by the purchaser

3.25

purchaser

company responsible for providing the product order requirements

3.26

service life

specified period of use of the insulation coating in service

3.27

stalk

continuous string of welded and field joint coated pipe, which is prepared in readiness for pipe spooling onto a reel lay barge

Note 1 to entry: A number of stalks will normally be required to make up a flowline or pipeline.

3.28

stalk tie-in

weld connection followed by field joint coating, which is completed between stalks during pipe spooling

3.29

subsea structure

structural foundation or template for the positioning, support and protection of various items of production equipment

EXAMPLE Manifolds, trees.

3.30

syntactic foam

insulation material formed by dispersing hollow particles within a polymer matrix

Note 1 to entry: Polyurethane, epoxy, phenolic and PP, silicone are examples of polymers.

3.31

system supplier

company that proposes the insulation system for qualification in accordance with this International Standard

3.32

thermal conductivity

k-value

ability of a material to conduct heat, generally quantified in terms of the heat flow through a unit length of material under the influence of a standardized temperature difference

Note 1 to entry: Expressed in $\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$.

3.33

unit of production

quantity of three layer polypropylene coated pipes, at the same stage in the coating sequence, where the final insulation thickness is built up by multiple application of the constituent layers

Note 1 to entry: The constituent layers are the insulation layers and the top coat.

4 Abbreviated terms

3LPP	three layer polypropylene
4LPP	four layer polypropylene
APS	application procedure specification
CD	cathodic disbondment
CP	cathodic protection
DMA	dynamic mechanical analysis
DSC	differential scanning calorimetry
FBE	fusion bonded epoxy
FJC	field joint coating
GSPP	glass syntactic polypropylene
GSPU	glass syntactic polyurethane
HDPE	high density polyethylene
ID	internal diameter
ITP	inspection and test plan
MFR	melt flow rate
OD	outer diameter
PE	polyethylene
PP	polypropylene
PU	polyurethane
RH	relative humidity
SPU	syntactic PU
UV	ultraviolet

5 General recommendations and requirements

A quality management system and an environmental management system should be applied to assist compliance with the requirements of this International Standard.

NOTE ISO/TS 29001 gives sector-specific guidance on quality management systems and ISO 14001 gives guidance on the selection and use of an environmental management system.

The applicator shall be responsible for complying with all of the applicable requirements of this International Standard. It shall be permissible for the purchaser to make any investigation necessary in order to have assurance of compliance by the applicator and to reject any material and/or coating that does not comply.

6 Qualification dossier

6.1 General

A qualification dossier of the proposed insulation system in accordance with this clause shall be presented by the system supplier for review, when requested by purchaser. The requirements of this clause shall apply to all layers present in the insulation system. The content of such a dossier shall be in accordance with [6.2](#) and [6.3](#).

Historical data may be included in this qualification dossier and will be subject to review and approval by purchaser.

6.2 Content of qualification dossier

The system supplier shall provide qualification documentation which shall include the following as a minimum.

- a) System summary:
 - 1) description of the insulation system tested;
 - 2) maximum rated temperature and pressure;
 - 3) minimum and maximum temperature guidelines for storage, handling, installation and corresponding recommendations.
- b) Insulation system materials:
 - 1) material or layer technical data sheet and material safety data sheet;
 - 2) recommended shelf life and storage instructions;
 - 3) material, or layer when applicable, conformity certificate and material certificate of analysis from the manufacturer with the following information:
 - i) product name and manufacturer;
 - ii) manufacturing plant;
 - iii) date of manufacture;
 - iv) batch number;
 - v) properties to be tested with every batch and corresponding conformity ranges;
 - vi) date of issue;
 - vii) signature of authorized personnel (with name and function);
 - 4) test data for each individual layer, in accordance with [Clause 7](#).
- c) As applied coating: qualification data for the application process, in accordance with [Clause 9](#).
- d) Full scale testing: test data for the complete system as applied, in accordance with [Clause 8](#).

6.3 Anti-corrosion coating documentation

The purpose of this International Standard is not to define a proper qualification program for anti-corrosion coating. The wet insulation system supplier can select any anti-corrosion coating suitable for the maximum rated temperature of its insulation system and with which the system will pass the qualification requirements of this International Standard.

If the anti-corrosion coating selected by the end user is different from the one used by the system supplier for qualification, both parties shall agree on a test program to ensure that anti-corrosion coating and wet insulation are compatible up to the maximum rated temperature of the insulation system.

7 Layer test requirements

7.1 General

Each layer of the insulation system or each insulation material shall be tested as specified in this clause.

[Table 1](#) specifies general properties to be tested for each layer where applicable.

[Table 2](#) specifies properties to be tested on a case by case basis by agreement with the purchaser.

Each property measurement shall be documented along with the acceptance criteria for use in [Clause 9](#).

Requirements for the qualification of repair materials shall be by agreement.

Table 1 — General properties

Layer property	Test specification	Test temperature 23°C ± 2°C	Maximum rated temperature	Minimum rated temperature
Thermal conductivity	ISO 8301	✓	✓	
Specific heat capacity	ISO 11357	✓	✓	
Hydrostatic compressive behaviour	Annex A	✓	✓	
Water absorption	ISO 62, ISO 1817 ^a	✓	✓	
Density	ISO 1183	✓		
Tensile properties	ISO 527, ISO 37 ^b	✓	✓	✓
Hardness	ISO 868	✓		
DSC	ISO 11357-2	Temperature range		
DMA	N/A	Temperature range		
a ISO 1817 for elastomers.				
b ISO 37 for elastomers.				

Table 2 — Specific properties

Material property	Test specification	Test temperature 23°C ± 2°C	Maximum rated temperature	Minimum rated temperature
Compressive strength	ISO 844	✓	✓	✓
Abrasion resistance	ASTM D 4060 / ISO 4649 ^a	✓		
Coefficient of linear thermal expansion	ISO 4897		✓	✓
UV resistance	See 7.2.5			
^a ISO 4649 for elastomers				

7.2 Ageing tests

7.2.1 General

The purpose of the ageing tests is to estimate the thermal, chemical and mechanical stability for the material's service life. The tests shall account for:

- all expected ageing phenomena, (including thermal and chemical ageing);
- the failure mechanism of the insulation material,

- any water absorption and pressure effects.

For certain materials, physical changes can produce results in tensile testing that are not indicative of chemical change. In such cases additional testing may be performed in order to explain and to understand the extent and criticality of these physical changes. This may include the use of general and material specific analysis techniques that lie outside of this specification. The results of such investigative work shall be included in the test dossier.

End of life properties should be determined and considered based on relevant application specific acceptance criteria. These shall be defined and explained by the system supplier with the ageing test results.

For each individual layer (or material) available in a range of density, the ageing tests are required only for one density, provided the data in [Table 1](#) are documented for the relevant range of density.

In order to estimate the potential degradation of an insulation system due to wet ageing, two tests shall be performed:

- determination of the water absorption kinetic of each layer in the insulation system ([7.2.2](#));
- determination of the degradation of the thermo-mechanical properties of each layer due to water ageing ([7.2.3](#)).

Ageing tests are not required for anti-corrosion and adhesive layers.

An optional full insulation system ageing test may be carried out in accordance with [7.2.4](#) to verify the long term behaviour.

7.2.2 Water absorption kinetic test

The objective shall be the determination of the end of life, through thickness, water profile.

Ageing media shall be either fresh water or seawater. Artificial seawater, if used, shall be prepared in accordance with ISO 15711.

The test shall be performed as follows:

- four temperatures:
 - 4°C;
 - maximum rated temperature minus 30°C;
 - maximum rated temperature minus 15°C;
 - maximum rated temperature (as defined in [6.2](#));
- duration: 1 year;
- pressure: maximum rated pressure (as defined in [6.2](#));
- 5 samples of each size per ageing temperature;
- sample sizes for ageing tests shall be (50 x 50 x 4) mm and (50 x 50 x 8) mm. Moulded samples should be used whenever possible;
- weighing intervals: 1, 2 weeks and 1, 3, 6 and 12 months. After removal from water, samples shall be dried with a clean dry cloth or filter paper and weighed. These six data points shall be reported on a graph and the absorption kinetic (diffusion coefficient and saturation) of the material(s) shall be determined. The test media shall be replaced at each sampling interval.

NOTE 1 Using the classical diffusion law (Fick), these data allow (knowing the through thickness temperature profile) an estimation of the end of life through thickness water profile of the structure (see detailed guidance as information in [Annex K](#)).

NOTE 2 In the case of non-Fickian diffusion (Langmuir, loss of weight), more complex analysis can be performed in order to estimate the through thickness long term behaviour of the insulation system (see [Annex K](#)).

7.2.3 Wet heat ageing behaviour

The potential degradation shall be verified by testing of tensile properties at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Flexural testing may be carried out in place of tensile testing for brittle materials.

Sample preparation shall be fully described.

Tensile tests shall be performed in accordance with ISO 527 for thermoplastics or ISO 37 Type 1 for elastomers. Flexural testing for brittle materials shall be performed in accordance with ISO 178.

Ageing media shall be either fresh water or seawater. Artificial seawater, if used, shall be prepared in accordance with ISO 15711.

The ageing test shall be performed as follows:

- three temperatures:
 - maximum rated temperature minus 30°C ;
 - maximum rated temperature minus 15°C ;
 - maximum rated temperature (as defined in [6.2](#)).
- duration: 1 year;
- pressure: maximum rated pressure (as defined in [6.2](#));
- 5 samples per ageing temperature and sampling step;
- sampling intervals: 1, 3, 6 and 12 months.

Before mechanical testing, samples shall be kept in water (identical to the one used for the ageing test) at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for a period of 24 h minimum, and tested immediately after being taken out of water.

At sampling intervals, samples shall be dried after removal from water with a clean dry cloth or filter paper, weighed and tested in accordance with relevant standard without any reconditioning (no drying of samples). The test media shall be replaced at each sampling interval.

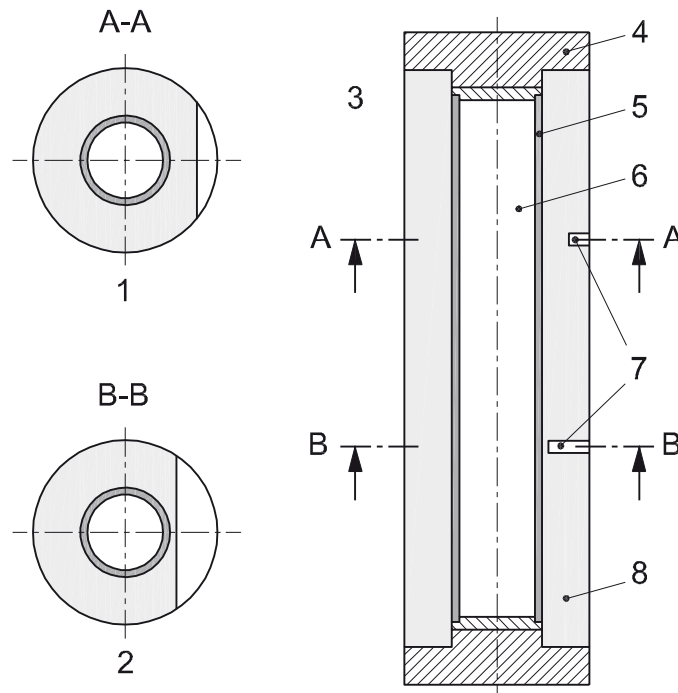
7.2.4 Full insulation system ageing test (optional)

An approximately 1 m long tube, minimum 25 mm in diameter and coated with approximately 50 mm of the full insulation system (see [Figure 1](#) for details), shall be used for the full insulation system ageing test.

Ageing media shall be either fresh water or seawater. Artificial seawater, if used, shall be prepared in accordance with ISO 15711.

The ageing test shall be performed as follows:

- internal temperature: maximum rated temperature (as defined in [6.2](#));
- external temperature: $20^{\circ}\text{C} \pm 3^{\circ}\text{C}$;
- duration: 1 month to 6 months;
- pressure: atmospheric pressure (or under pressure if necessary);
- in case of seawater, CP will be provided with a sacrificial anode.



Key

- 1 notch depth: half of the thickness through thickness
- 2 notch depth: full thickness down to the anticorrosion layer
- 3 water temperature = $+ 20^{\circ}\text{C} \pm 3^{\circ}\text{C}$
- 4 end closure
- 5 steel tube
- 6 fluid at maximum rated temperature
- 7 4 mm width cracks
- 8 insulation system

Figure 1 — Schematic of the full insulation system ageing test

After ageing, any visible degradation (e.g. crack, indication of local hydrolysis) shall be assessed. Additional physical and chemical testing can be performed and the results provided within the qualification dossier.

7.2.5 Weathering and UV resistance

Data shall be provided by the insulation system supplier to demonstrate that the system can resist UV exposure. Alternatively, specific storage conditions or protection from atmospheric exposure shall be detailed by the insulation system supplier.

NOTE Weathering and UV resistance is a concern during storage of components or pipes and for parts exposed to atmospheric conditions. This effect is mainly superficial and concerns the outer layers of the insulation system.

8 Insulation system test requirements

8.1 General

In this clause, the properties that shall be tested for the complete insulation system are defined.

A detailed test program shall be prepared by the system supplier in accordance with [Table 3](#) to define the design basis of the insulation system in terms of pressure and temperature range, installation