

**DIN EN ISO 13678**

ICS 75.100; 75.180.10

Ersatz für  
DIN EN ISO 13678:2009-12**Erdöl- und Erdgasindustrie –  
Beurteilung und Prüfung von Gewindefetten zur Verwendung an Futter-,  
Steig- und Leitungsrohren und an Bohrgestängeteilen (ISO 13678:2010);  
Englische Fassung EN ISO 13678:2012**

Petroleum and natural gas industries –  
Evaluation and testing of thread compounds for use with casing, tubing, line pipe and drill  
stem elements (ISO 13678:2010);  
English version EN ISO 13678:2012

Industries du pétrole et du gaz naturel –  
Évaluation et essais des graisses pour filetage utilisées pour les tubes de cuvelage, les  
tubes de production, les tubes de conduites et les éléments de garnitures de forage  
(ISO 13678:2010);  
Version anglaise EN ISO 13678:2012

Gesamtumfang 56 Seiten

Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) im DIN

## Nationales Vorwort

Dieses Dokument (EN ISO 13678:2012) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“, Subkomitee SC 5 „Casing, tubing and drill pipe“ 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 109-00-01-05 AK „Futter-, Steig- und Bohrröhre — Spiegel-ausschuss zu ISO/TC 67/SC 5“ 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“, „ft · lb“, „gal (galone)“, „in (inch)“, „oz (ounce)“, „poise“, „psi“, und „r/min“ die in Deutschland 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)       |
| ft · lb          | Nm                | 1 ft · lb  | = 1,35 Nm             |
| gal (galone)     | l                 | 1 gal      | = 3,785 l             |
| in (inch)        | mm                | 1 inch     | = 25,4 mm             |
| oz (ounce)       | g                 | 1 oz       | = 28,35 g             |
| poise            | Pascal second     | 1 poise    | = 0,1 Pa · s          |
| psi (psig)       | kPa               | 1 psi      | = 6,894 757 kPa       |
| r/min            | min <sup>-1</sup> | 1 r/min    | = 1 min <sup>-1</sup> |

Für die in diesem Dokument zitierte Internationale Norm wird im Folgenden auf die entsprechende Deutsche Norm hingewiesen:

ISO 2176      siehe      DIN ISO 2176

### Änderungen

Gegenüber DIN EN ISO 13678:2009-12 wurden folgende Änderungen vorgenommen:

- a) Aktualisierung der Normativen Verweisungen;
- b) Aktualisierung der Literaturhinweise.

### Frühere Ausgaben

DIN EN ISO 13678: 2009-12

## Nationaler Anhang NA (informativ)

### Begriffe

Die Benennung der folgenden Begriffe ist identisch mit der Benennung in der englischen Fassung.

#### 4 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

##### 4.1

##### **API-Verbindung**

Leitungsbauteil, das aus zwei Verbindungsstücken mit Außengewinde (Gewindezapfen) und einem Verbinder mit zwei Verbindungsstücken mit Innengewinde (Gewindemuffen) oder einem Gewindezapfen und einer Integralmuffe, hergestellt nach ISO/API-Spezifikationen, besteht

##### 4.2

##### **modifiziertes Gewindefett nach API**

Fett, das in API BUL 5A2 [8] als „modifiziertes Gewindefett“ bezeichnet wird

ANMERKUNG API BUL 5A2 ist veraltet und wurde durch API RP 5A3 [9] ersetzt.

##### 4.3

##### **Gewindemuffe**

Verbindungsstück mit Innengewinde

##### 4.4

##### **Futter-, Steig- und Leitungsrohre CT and LP**

(en: casing, tubing and line pipe)  
Produktions- und Förderrohre

##### 4.5

##### **Bohrgestängeteile**

Bauteile der Bohrgarnitur, vom Spülkopf oder Drehkopf bis zum Bohrmeißel, bestehend aus Mitnehmerstange, Bohrstrang, Zwischenstücken, Schwerstangen und weiteren Untertagewerkzeugen, wie z. B. Stabilisatoren und Räumer

##### 4.6

##### **Gewindezapfen**

Verbindungsstück mit Außengewinde

##### 4.7

##### **Verbindung mit Dichtfläche**

Verbindung mit oder ohne Metaldichtung(en), die einen größeren Spielraum und/oder bessere Leistungseigenschaften als API-Verbindungen bieten kann

##### 4.8

##### **eigentumsrechtlich geschützte Verbindung**

Verbindung ohne veröffentlichte Spezifikationen, gefertigt und vermarktet von Unternehmen mit ausschließlichen Rechten auf die Herstellung und/oder den Verkauf

#### 4.9

##### **Bezugsstandardformulierung**

〈Futter-, Steig- und Leitungsrohre〉 nach den Anforderungen von Anhang B, einschließlich der Beschränkungen und Toleranzen in den Tabellen B.1, B.2 und B.3, formuliertes Gewindefett

#### 4.10

##### **Bezugsstandardformulierung**

〈drehende Schulteransatz-Gewindeverbindung〉 nach den Anforderungen von I.4.2.3 formuliertes Gewindefett

ANMERKUNG Die Bezugsstandardformulierungen sind nicht für die allgemeine Außenmontage vorgesehen.

#### 4.11

##### **drehende Schulteransatz-Gewindeverbindung**

##### **RSC**

(en: rotary shouldered connection)

bei Bohrgestängeteilen verwendete Verbindung mit Gewinden und Dichtschultern (Dichtkanten)

#### 4.12

##### **Dichtung**

Barriere, die dem Durchgang von Fluiden, Gasen und Flüssigkeiten entgegenwirkt

#### 4.13

##### **Lagerungsfett**

Substanz, die nur bei dem Versand und/oder der Lagerung zum Schutz vor Korrosion auf die Gewinderohrverbindungen aufgebracht wird und die nicht für die Montage der Verbindung verwendet wird

#### 4.14

##### **Gwindefett**

Substanz, die für die Schmierung während der Montage und Demontage und zum Unterstützen beim Abdichten gegen Innen- und Außendruck vor dem Zusammenschrauben auf die Gewinderohrverbindungen aufgebracht wird

ANMERKUNG Einige Gwindefette können auch Substanzen enthalten, die Eigenschaften von Lagerungsfett aufweisen.

#### 4.15

##### **Gwindefett-/Verbindungs-System**

System, das aus verschiedenen kritischen Bauteilen der Gewinderohrverbindung besteht, einschließlich der Verbindungsgeometrie und der einzelnen Werkstoffe und Beschichtungen der Verbindung in Kombination mit dem Gwindefett

#### 4.16

##### **Gestängeverbinder**

Gwindeverbinder, der zum Verbinden der Abschnitte des Bohrgestänges verwendet wird

## **Nationaler Anhang NB** (informativ)

### **Literaturhinweise**

DIN ISO 2176, *Mineralölerzeugnisse — Schmierfette — Bestimmung des Tropfpunktes*

— Leerseite —

English Version

Petroleum and natural gas industries —  
Evaluation and testing of thread compounds for use with casing,  
tubing, line pipe and drill stem elements  
(ISO 13678:2010)

Industries du pétrole et du gaz naturel —  
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This European Standard was approved by CEN on 3 December 2011.

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, 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.



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## **Foreword**

The text of ISO 13678:2010 has been prepared by Technical Committee ISO/TC 67 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 13678:2012 by 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 July 2012, and conflicting national standards shall be withdrawn at the latest by July 2012.

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.

This document supersedes EN ISO 13678:2009.

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, 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 13678:2010 has been approved by CEN as a EN ISO 13678:2012 without any modification.

## Introduction

This International Standard is based on API RP 5A3<sup>[9]</sup>, second edition, July 2003, with errata and inclusion of all clauses of API RP 7A1<sup>1)</sup><sup>[13]</sup>, first edition, November 1992, incorporated into Annex I.

This International Standard specifies requirements and gives recommendations for the manufacture, testing and selection of thread compounds for use on casing, tubing, line pipe and drill stem elements based on the current industry consensus of good engineering practice.

It is intended that the words casing and tubing apply to the service application, rather than to the diameter of the pipe.

The performance requirements of thread compounds for use with casing, tubing, line pipe, premium connections and rotary shouldered connections include:

- a) consistent frictional properties that allow both proper and uniform connection engagement;
- b) adequate lubrication properties to resist galling or damage of connection contact surfaces during make-up and breakout;
- c) adequate sealing properties for thread-type seal connections and/or not inhibiting the sealing properties of non-thread sealing connections (e.g. metal-to-metal seals, polytetrafluoroethylene seals, etc.) depending upon service requirements;
- d) physical and chemical stability both in service and in expected compound storage conditions;
- e) properties that allow effective application to the connection contact surfaces in expected service conditions and environment.

In addition, compounds for rotary shouldered connections provide:

- lubrication of the connection members during make-up to achieve the proper axial bearing stress;
- an effective seal between connection shoulders to prevent wash-out by drilling fluids;
- more uniform distribution of circumferential bearing stress if shoulders are not parallel;
- resistance to additional make-up down hole.

When evaluating the suitability of a thread compound, the user can define the service conditions and then consider field trials and field service experience in addition to laboratory test results. Appropriate supplementary tests can be utilized for specific applications which are not evaluated by the tests herein. The user and manufacturer are encouraged to discuss service applications and limitations of the compound being considered.

Representatives of users and/or other third-party personnel are encouraged to monitor tests wherever possible. Interpolation and extrapolation of test results to other products, even of similar chemical composition, are not recommended.

Testing in compliance with this International Standard does not in itself ensure adequate thread compound/connection system performance in field service. The user has the responsibility of evaluating the results obtained from the recommended procedures and test protocols and determining whether the thread compound/connection system in question meets the anticipated requirements of that particular field service application.

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1) Obsolete. Incorporated into this International Standard.

## 1 Scope

This International Standard provides requirements, recommendations and methods for the testing of thread compounds intended for use on threaded casing, tubing, and line pipe connections; and for thread compounds intended for use on rotary shouldered connections. The tests outlined are used to evaluate the critical performance properties and physical and chemical characteristics of thread compounds under laboratory conditions.

These test methods are primarily intended for thread compounds formulated with a lubricating base grease and are not applicable to some materials used for lubricating and/or sealing thread connections. It is recognized that many areas can have environmental requirements for products of this type. This International Standard does not include requirements for environmental compliance. It is the responsibility of the end user to investigate these requirements and to select, use and dispose of the thread compounds and related waste materials accordingly.

## 2 Conformance

### 2.1 Dual citing of normative references

In the interest of world-wide application of this International Standard, Technical Committee ISO/TC 67 has decided, after detailed technical analysis, that certain of the normative documents listed in Clause 3 and prepared by ISO/TC 67 or another ISO Technical Committee are interchangeable in the context of the relevant requirement with the relevant document prepared by the American Petroleum Institute (API), the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI). These latter documents are cited in the running text following the ISO reference and preceded by "or", for example "ISO XXXX or API YYYY". Application of an alternative normative document cited in this manner will lead to technical results different from those obtained from the use of the preceding ISO reference. However, both results are acceptable and these documents are thus considered interchangeable in practice.

### 2.2 Units of measurement

In this International Standard, data are expressed in both the International System (SI) of units and the United States Customary (USC) system of units. For a specific order item, it is intended that only one system of units be used, without combining data expressed in the other system.

Products manufactured to specifications expressed in either of these unit systems shall be considered equivalent and totally interchangeable. Consequently, compliance with the requirements of this International Standard as expressed in one system provides compliance with requirements expressed in the other system.

For data expressed in the SI system, a comma is used as the decimal separator and a space as the thousands separator. For data expressed in the USC system, a dot (on the line) is used as the decimal separator and a space as the thousands separator. In the text, data in SI units are followed by data in USC units in parentheses.

## 3 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 2137, *Petroleum products and lubricants — Determination of cone penetration of lubricating greases and petrolatum*

ISO 2176, *Petroleum products — Lubricating grease — Determination of dropping point*

ASTM D217, *Standard Test Methods for Cone Penetration of Lubricating Grease*

ASTM D2265, *Standard Test Method for Dropping Point of Lubricating Grease Over Wide Temperature Range*

ASTM D4048, *Standard Test Method for Detection of Copper Corrosion from Lubricating Grease*

## 4 Terms and definitions

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

### 4.1

#### **API connection**

pipe assembly consisting of two external threaded connectors (pins) and a coupling with two internal threaded connectors (box) or one pin and an integral box manufactured in accordance with ISO/API specifications

### 4.2

#### **API modified thread compound**

compound designated as “modified thread compound” in API BUL 5A2<sup>[8]</sup>

NOTE API BUL 5A2 is obsolete and has been replaced by API RP 5A3<sup>[9]</sup>.

### 4.3

#### **box**

connector with internal threads

### 4.4

#### **casing, tubing and line pipe**

##### **CT and LP**

production and delivery tubulars

### 4.5

#### **drill stem elements**

components of the drilling assembly from the swivel or top drive to the bit, composed of the kelly, drill string, subs, drill collars and other down-hole tools such as stabilizers and reamers

### 4.6

#### **pin**

connector with external threads

### 4.7

#### **premium connection**

connection with or without metal-to-metal seal(s) that can provide greater clearance and/or higher performance properties when compared to the API connections

### 4.8

#### **proprietary connection**

connection, without published specifications, made and marketed by companies with exclusive rights to manufacture and/or sell

### 4.9

#### **reference standard formulation**

⟨casing, tubing and line pipe⟩ thread compound formulated, in accordance with the requirements of Annex B, to include the limitations and tolerances specified in Tables B.1, B.2 and B.3

### 4.10

#### **reference standard formulation**

⟨rotary shouldered connection⟩ thread compound formulated in accordance with the requirements of I.4.2.3

NOTE The reference standard formulations are not intended for general field service.

### 4.11

#### **rotary shouldered connection**

##### **RSC**

connection used on drill stem elements, which has threads and sealing shoulders

#### 4.12

##### **seal**

barrier resisting the passage of fluids, gases and liquids

#### 4.13

##### **storage compound**

substance applied to threaded pipe connections for protection against corrosion, during shipment and/or storage only, that is not used for connection make-up

#### 4.14

##### **thread compound**

substance applied to threaded pipe connections prior to make-up for lubrication during assembly and disassembly and for assistance in sealing internal and external pressures

NOTE Some thread compounds can also contain substances that provide storage compound properties.

#### 4.15

##### **thread compound/connection system**

system consisting of the various critical threaded pipe connection components, including the specific connection geometry and the individual connection materials and coatings combined with the thread compound

#### 4.16

##### **tool joint**

threaded connector used to join sections of drill pipe

## 5 Thread compound characteristics

### 5.1 Product characteristics

This International Standard outlines tests to characterize the performance of thread compounds under service conditions, rather than specifying the formulation. Thus, the purchaser and the manufacturer should agree on the product characteristics to be provided, such as the following:

- thickener type;
- fluid type;
- appearance;
- dropping point;
- mass density;
- oil separation;
- flash point;
- water-absorption resistance;
- gas evolution;
- rheological properties;
- compound/copper reaction;

- extreme-pressure properties;
- fluid sealing properties;
- frictional properties;
- corrosion inhibition;
- brushing/adherence;
- service applications;
- storage and service-life limitations.

The thread compound manufacturer shall revise product bulletins when any modification in formulation is implemented which would result in a change of any critical performance characteristics. All documentation shall provide data which are representative of a typical production batch.

Test and inspection records generated under this International Standard shall be retained by the manufacturer and shall be available to the purchaser for a minimum of three years after the date of manufacture.

## **5.2 Physical and chemical characteristics**

### **5.2.1 General**

The physical and chemical characteristics of performance-based thread compounds are specified in Table 1. These properties can vary widely and the formulation of many of the available compounds is proprietary. Therefore, the user should consider the performance properties and recommendations given by the compound manufacturers, in addition to the physical and chemical characteristics outlined in Table 1.

**Table 1 — Thread compound physical and chemical characteristics tests**

| Property <sup>a</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   | Test method                                           | Performance value <sup>b</sup>         |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------------|----------------------------------------|-------------|
| Dropping point, °C (°F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | M | ISO 2176 or ASTM D2265                                | 138 (280) min.                         | S           |
| Evaporation, % volume fraction loss<br>24 h at 100 °C (212 °F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | M | See Annex D                                           | 3,75 max.                              | S           |
| Gas evolution, cm <sup>3</sup><br>120 h at 66 °C (151 °F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | M | See Annex G                                           | 20 max.                                | S           |
| Oil separation, % volume fraction<br>24 h at 100 °C (212 °F) (nickel gauze cone)                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | M | See Annex E                                           | 10,0 max.                              | S           |
| Penetration, mm × 10 <sup>-1</sup><br>Worked, 60 strokes at 25 °C (77 °F)<br>Production acceptability range (min. to max.)<br>Worked, 60 strokes at -7 °C (19 °F)                                                                                                                                                                                                                                                                                                                                                                                        | M | See Annex C                                           | ±15 max.<br>Report typical             | S<br>R      |
| Mass density, % variance<br>From production mean value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | M | Manufacturer's controls                               | ±5,0 max.                              | S           |
| Water leaching, % mass fraction loss<br>2 h at 66 °C (151 °F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M | See Annex H                                           | 5,0 max.                               | S           |
| Application and adherence<br>Cold application<br>Adherence at 66 °C (151 °F), % mass fraction loss                                                                                                                                                                                                                                                                                                                                                                                                                                                       | M | See Annex F                                           | Applicable at -7 °C (19 °F)<br>25 max. | S<br>R<br>R |
| Copper corrosion<br>Specified corrosion level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M | ASTM D4048                                            | 1B or better                           | R           |
| Corrosion inhibition, % area corrosion<br>500 h at 38 °C (100 °F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | I | See Annex L                                           | <1,0                                   | R           |
| Compound stability, 12 months' storage<br>Penetration change, mm × 10 <sup>-1</sup><br>Oil separation, % volume fraction                                                                                                                                                                                                                                                                                                                                                                                                                                 | M | Manufacturer's controls<br>See Annex C<br>See Annex E | ±30 max.<br>10,0 max.                  | R<br>R      |
| Compound stability, field service<br>24 h at 138 °C (280 °F), % volume fraction loss                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | I | See Annex M                                           | 25,0 max.                              | R           |
| <p>NOTE The values in this table are not intended to be consistent with Table A.3, which presents the original values and requirements of API BUL 5A2<sup>[8]</sup> (obsolete, replaced by API RP 5A3<sup>[9]</sup>). They have been revised to take into account the high-temperature requirements of current field operating conditions and the mass density variations between different proprietary thread compound formulations.</p> <p><sup>a</sup> M mandatory;<br/>I informative.</p> <p><sup>b</sup> S specification;<br/>R recommendation.</p> |   |                                                       |                                        |             |

### **5.2.2 Dropping point**

The dropping point test measures the tendency of grease to soften and flow when hot. Results of the dropping point test may be used as an indication of the maximum temperature to which a grease can be exposed without liquefaction or oil separation, as a means of determining the type of grease and establishing manufacturing or quality control limits for this characteristic. Results are not considered as having any direct bearing on service performance unless such correlation has been established.

In the case of a thread compound, the dropping point is considered to be an indicator of the thermal stability of the base grease and other lubricant additives. Poor thermal stability could adversely affect thread compound performance in high-temperature field service. In order to meet present-day requirements for high-temperature service, the minimum dropping point temperature shall be 138 °C (280 °F), as measured in accordance with ISO 2176 or ASTM D2265.

NOTE Extreme-temperature field-service conditions can require a higher performance limit.

### **5.2.3 Evaporation**

The evaporation test indicates a thread compound's physical and chemical stability at elevated temperatures, which is related to the base grease/oil or other additives. Due to the wide variation in mass density of thread compounds currently in service, percentage mass fraction does not provide a reliable basis for comparison; therefore, evaporation loss shall be measured as a percentage volume fraction. The evaporative loss, when evaluated in accordance with the test method in Annex D for 24 h at a temperature of 100 °C (212 °F), shall not exceed a 3,75 % volume fraction.

### **5.2.4 Gas evolution**

The gas evolution test indicates a thread compound's chemical stability at elevated temperatures. When evaluated in accordance with the test method in Annex G, the volume of gas evolution shall not exceed 20 cm<sup>3</sup>.

### **5.2.5 Oil separation**

The oil separation test indicates a compound's physical and chemical stability at elevated temperatures, which is related to the base grease/oil. Due to the wide variation in mass density of thread compounds currently in service, percentage mass fraction does not provide a reliable basis for comparison; therefore, oil separation loss shall be measured as a percentage volume fraction. In order to meet current requirements for high-temperature service, the maximum oil separation loss when evaluated in accordance with the test method in Annex E shall be a 10,0 % volume fraction.

### **5.2.6 Penetration**

The penetration test measures the consistency, i.e. "thickness" or "stiffness" of a lubricating grease, and relates to the ease of application or "brushability" of a thread compound. The compound manufacturer shall measure and record the penetration of each production batch of thread compound and report the mean value for that specific compound. When evaluated in accordance with the test method in Annex C, the penetration acceptability range (minimum to maximum) at 25 °C (77 °F) shall not be greater than 30 cone penetration points. An acceptability range for penetrations is used because thread compounds with penetrations between 265 and 385 can be used for different applications. For information purposes, cold temperature penetration, at -7 °C (19 °F), is reported as a typical value. Mass density affects the values obtained from this procedure. Therefore, it is not a useful measurement for relative comparisons of materials with widely varying mass densities.

NOTE 1 Brookfield viscosity (ASTM D2196<sup>[27]</sup>) is not substantially affected by material mass density and can therefore provide a closer correlation to brushability than the cone penetration. The range below was determined using several different supplier samples of API modified thread compound as well as proprietary thread compounds used currently with casing, tubing and line pipe connections. It is appropriate that a specific spindle size, rotational frequency and test temperature be utilized to develop viscosity data for comparison. The Brookfield viscosity range, as measured with a

#7 Spindle, at 10 r/min and 25 °C, was 200 000 mPa·s to 400 000 mPa·s. A typical value for API modified thread compounds could range from 200 000 mPa·s to 240 000 mPa·s.

NOTE 2 The SI unit of viscosity is the pascal second (Pa·s). The pascal second is rarely used in scientific and technical publications today. The most common unit of viscosity is the dyne second per square centimetre (dyne·s/cm<sup>2</sup>), which is given the name poise (P) after the French physiologist Jean-Louis Poiseuille (1799-1869). Ten poise equal one pascal second (Pa·s) making the centipoise (cP) and millipascal second (mPa·s) identical.

— 1 pascal second = 10 poise = 1 000 millipascal second

— 1 centipoise = 1 millipascal second

### **5.2.7 Mass density**

The mass-density test result of a thread compound depends on the type and quantity of the constituents utilized in the formulation. The range of mass densities between production batches for a particular thread compound is an indication of the consistency of manufacture. The compound manufacturer shall measure and record the mass density of each production batch of thread compound and report the mean value for that specific compound. The mass density of a particular thread compound batch shall not vary by more than 5,0 % from the manufacturer's established mean value.

### **5.2.8 Water leaching**

The water-leaching test indicates the physical and chemical stability of compounds when exposed to water at elevated temperatures. When evaluated in accordance with the test method in Annex H, the compound mass loss shall not exceed 5,0 %.

### **5.2.9 Application and adherence properties**

Thread compounds should be applied in a manner consistent with the compound manufacturer and thread manufacturer's recommendations and in sufficient quantity to provide effective lubrication and/or sealing characteristics for threaded connections. The thread compound shall be brushable and capable of adherence over a temperature range of –7 °C (19 °F) to 66 °C (151 °F) without either agglomerating or sliding off the connector.

Laboratory tests for determining the thread compound application and adherence properties shall be performed and recorded. The laboratory test methods described in Annex F are intended to provide a means for comparing thread compound performance, but it is possible for them not to be representative of field service.

### **5.2.10 Corrosion inhibition and protection properties**

Thread compounds are often utilized to provide shipping and storage corrosion protection on threaded connections, as well as lubrication and sealing properties. Certain field exposure conditions, particularly on offshore platforms and in-service conditions, such as sour gas environments, require corrosion protection and inhibition. Therefore, the thread compounds with corrosion protection shall provide an effective barrier against (and not contribute to) corrosive attack of connection threads and seals. The corrosion-inhibition properties of thread compounds depend on application variables such as the following:

- compound-additive types and treatment levels;
- type and condition of threading process fluids and residue remaining on thread surfaces;
- compound application method and equipment utilized;
- type of thread protector and application method (“knock-on” or “screw-on”);
- specific user application procedures and environmental conditions;