INTERNATIONAL STANDARD

ISO 10426-3

Second edition
2019-08

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

Part 3: Testing of deepwater well cement formulations

Industries du pétrole et du gaz naturel — Ciments et matériaux pour la cimentation des puits —

Partie 3: Essais de formulations de ciment pour puits en eau profonde

Reference number
ISO 10426-3:2019(E)

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Published in Switzerland

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 3, *Drilling and completion fluids, and well cements*.

This second edition cancels and replaces the first edition (ISO 10426-3:2003), which has been technically revised.

This document supplements API RP 10B-3, 2nd edition (2016).

The technical requirements of this document and API RP 10B-3 used to be identical. In the meantime, API RP 10B-3 has been technically revised as API RP 10B-3, 2nd edition (2016). The purpose of this document is to bring this document up-to-date, by referencing the current edition of API RP 10B-3 and adding supplementary content.

The main changes compared to the previous edition are as follows:

— A clause on numerical pressure and temperature simulation has been added in order to allow accurate determination of the pressure and temperature schedules required for the various tests;

— Strength determination at the casing shoe, the mudline, potential flow zones, top-of-liner and open- or cased hole plug and squeeze locations is treated separately;

— Directions for sonic strength testing data reporting have been included;

— The laboratory procedures for both sonic and destructive strength measurements have been expanded;

— A clause has been added on thickening time simulations for liner cementations with and without the use of either liner-top packers or expandable liner hangers.

A list of all parts in the ISO 10426 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The test methods contained in this document, though generally based on ISO 10426-2, consider the specialized sampling/testing requirements and unique downhole temperature profiles found in deepwater wells. ISO 10426-2 contains no applicable well simulation schedules for deepwater cementing operations.

In a deepwater cementing environment, several factors impact the thermal history of the cement slurry. These factors include: water depth, mud-line temperature, geothermal gradient, the presence or absence of a drilling riser, drilling fluid temperature, ocean current velocity, presence of thermoclines (layers of ocean water separated by temperature), ambient sea-surface temperature, cement mix-water temperature, bulk cement temperature, cement mixing rate, cement heat of hydration, displacement rate, prior circulating and static event history, drill pipe size and mass, casing size and mass, and hole size.

In this way, the testing of the cement formulation can reflect as closely as possible the actual temperature profile found during field cementing operations.

Numerical modelling can be used to determine the relative magnitude of the input variables so that "most likely" and "less likely" scenarios of temperature history can be assessed. The values of some input variables might not be known precisely, and a range of possible values needs to be employed. Physical laboratory testing can then be conducted at "most likely" conditions, with some additional testing at "less likely" conditions to determine the sensitivity to well conditions. Sound engineering judgement can then be applied to assess the risks.

These procedures serve not only for the testing of well cements under deepwater well conditions but can also be used in those circumstances where low seafloor temperatures are found at shallow water depths.

Well cements that can be used in deepwater well cementing can include those of ISO Classes A, C, G or H (as given in ISO 10426-1[1]), high-alumina cement, appropriate foamed cements, various types of ductile cement compositions, etc.

In this document, where practical, United States customary (USC) units are included in parentheses for information.

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

Part 3: Testing of deepwater well cement formulations

1 Scope

This document provides procedures for testing well cements and cement blends for use in the petroleum and natural gas industries in a deepwater environment, or areas with a low seafloor temperature, or areas where low well temperatures exist.

This document supplements API RP 10B-3, 2nd edition (2016), the requirements of which are applicable with the exceptions specified in this document.

This document excludes the mitigation of shallow water flow in deepwater wells.

NOTE This is addressed in API RP 65.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

API RP 10B-3, *2nd edition (2016), Recommended practice on testing of well cements used in deepwater well construction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in API RP 10B-3, 2nd edition (2016) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
deepwater
area where water depth is greater than 600 m and/or area where low seafloor temperature exists

3.2
transit time
measurement of sonic velocity that starts when the transmitter is fired and ends when a determined amplitude peak from the waveform arrives at the receiver, and is typically expressed in microseconds per inch

[SOURCE: API RP 10B-3, 2nd edition (2016), 3.36, modified — The term "sonic slowness" has been removed from entry.]

Note 1 to entry: "Sonic slowness" is not a common term in physics and is not used in API RP 10B-3, 2nd edition (2016). It is reproduced here for clarity.

4 Supplements to API RP 10B-3, 2nd edition (2016)

4.1 General requirements

The requirements specified in API RP 10B-3, 2nd edition (2016) shall apply, with the exceptions specified in 4.2 and 4.3.

4.2 Procedure for compressive strength determination

The requirements specified in API RP 10B-3, 2nd edition (2016), 7.6.2 apply with the following exception.

Reference to ASTM C109/109M is applicable instead of the reference to ASTM C109/109M-07. This is referenced in 7.6.2, paragraph 1 and 7.6.2, b).

4.3 Thickening-time schedule determination

4.3.1 Testing method and procedures for a casing or liner without a liner-top packer or non-expandable liner hanger system

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.2.2 apply with the following exception.

Instead of the instructions under 8.4.2.2 e), the following applies: "the final pressure and temperature shall be held until 70 Bc (or 100 Bc) is reached. Record both the entire thickening time curve and the time to 70 Bc (or 100 Bc). In case of a regular build-up of consistency, the 70 Bc (or 100 Bc) value will give the safe time to operate. In case of an unexpected build-up of consistency, the slurry design might have to be re-assessed."

4.3.2 Testing method for a liner with a liner-top packer or expandable liner hanger system

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.3.2 apply with the following exception.

Instead of the instruction under 8.4.3.2 h), the following applies: "the final pressure and temperature shall be held until 70 Bc (or 100 Bc) is reached. Record both the entire thickening time curve and the time to 70 Bc (or 100 Bc). In case of a regular build-up of consistency, the 70 Bc (or 100 Bc) value will give the safe time to operate. In case of an unexpected build-up of consistency, the slurry design might have to be re-assessed."

4.3.3 Testing method for open-hole or closed-hole plug

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.4.1 apply with the following exception.

In the fourth sentence, the quantity and unit of 325 m (1 070 ft) applies in place of the quantity and unit of 325 m (800 ft).

4.3.4 Thickening-time test procedure

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.4.2 apply with the following exception.

Instead of the instruction under 8.4.4.2 e), the following applies: "the final pressure and temperature shall be held until 70 Bc (or 100 Bc) is reached. Record both the entire thickening time curve and the time to 70 Bc (or 100 Bc). In case of a regular build-up of consistency, the 70 Bc (or 100 Bc) value will give the safe time to operate. In case of an unexpected build-up of consistency, the slurry design might have to be re-assessed."

4.3.5 Testing method for continuous-pumping squeeze cementing

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.5.2 apply with the following exception.

Instead of the instruction under 8.4.5.2 e), the following applies: "the final pressure and temperature shall be held until 70 Bc (or 100 Bc) is reached. Record both the entire thickening time curve and the time to 70 Bc (or 100 Bc). In case of a regular build-up of consistency, the 70 Bc (or 100 Bc) value will give the safe time to operate. In case of an unexpected build-up of consistency, the slurry design might have to be re-assessed."

4.3.6 Testing method for hesitating-pumping squeeze cementing

The requirements specified in API RP 10B-3, 2nd edition (2016), 8.4.6.2 apply with the following exception.

Instead of the instruction under 8.4.6.2 e), the following applies: "the final pressure and temperature shall be held until 70 Bc (or 100 Bc) is reached. Record both the entire thickening time curve and the time to 70 Bc (or 100 Bc). In case of a regular build-up of consistency, the 70 Bc (or 100 Bc) value will give the safe time to operate. In case of an unexpected build-up of consistency, the slurry design might have to be re-assessed."