SLOVENSKI STANDARD
oSIST prEN ISO 23936-1:2021

01-september-2021

Petrokemična industrija ter industrija za predelavo nafte in zemeljskega plina - Nekovinski materiali v stiku z mediji v povezavi s proizvodnjo nafte in plina - 1. del: Plastomeri (ISO/DIS 23936-1:2021)

Petroleum, petrochemical and natural gas industries - Non-metallic materials in contact with media related to oil and gas production - Part 1: Thermoplastics (ISO/DIS 23936-1:2021)

Erdöl, petrochemische und Erdgasindustrie - Nichtmetallische Werkstoffe mit Medienkontakt bei der Öl- und Gasproduktion - Teil 1: Thermoplaste (ISO/DIS 23936-1:2021)

Industries du pétrole, de la pétrochimie et du gaz naturel - Matériaux non métalliques en contact avec les fluides relatifs à la production de pétrole et de gaz - Partie 1: Matières thermoplastiques (ISO/DIS 23936-1:2021)

Ta slovenski standard je istoveten z: **prEN ISO 23936-1**

ICS:

75.180.01	Oprema za industrijo nafte in zemeljskega plina na splošno	Equipment for petroleum and natural gas industries in general

oSIST prEN ISO 23936-1:2021 **en,fr,de**

DRAFT INTERNATIONAL STANDARD

ISO/DIS 23936-1

ISO/TC **67**

Secretariat: **NEN**

Voting begins on:
2021-06-23

Voting terminates on:
2021-09-15

Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production —

Part 1: Thermoplastics

Industries du pétrole, de la pétrochimie et du gaz naturel — Matériaux non métalliques en contact avec les fluides relatifs à la production de pétrole et de gaz —

Partie 1: Matières thermoplastiques

ICS: 75.180.01

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 23936-1:2021(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*.

This second edition cancels and replaces the first edition (ISO 23936-1:2009), which has been technically revised.

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

— adds a short term, single temperature 28 day non-H_2S material stability evaluation as Level 2;

— adds a 56 day total duration target for the traditional three temperature Arrhenius material degradation evaluation as Level 3 and this is very similar to the previous edition;

— moves the life estimation analysis requirement to Level 4 and this new section has a 180 day total duration target for the Arrhenius material degradation evaluation;

— adds life estimation analysis examples for plastics.

A list of all parts in the ISO 23936 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

Non-metallic materials are used in the petroleum, petrochemical and natural gas industries for a wide range of components. The purpose of this document is to establish requirements and guidelines for systematic and effective planning, for non-metallic material selection to achieve cost effective technical solutions, taking into account possible constraints due to safety and/or environmental issues.

This document will be of benefit to a broad industry group ranging from operators and suppliers to engineers and authorities. It covers relevant generic types of non-metallic material (e.g. thermoplastics, elastomers, thermosetting plastics) and includes the widest range of existing technical experience. Coatings are excluded from the scope of this document.

This document complements the document for metallic materials in sour service (ISO 15156 series). It differs in the form of guidance provided to the user related to the potential degradation of desired properties when used in equipment for oil and gas production environments. The ISO 15156 series provides application limits and qualification requirements for metallic materials in H_2S-containing environments, which are related solely to relevant environmentally assisted cracking mechanisms.

This document provides general principles, requirements and recommendations for the assessment of non-metallic materials' comparative stability to aid selection and quality assurance. The document recognizes that a wider range of compounds and parameters influence the degradation of non-metallic materials and thus provides guidance to permit selection of materials for hydrocarbon exploration and production applications based upon stability in appropriate test conditions.

This document applies to the assessment of the stability of non-metallic materials in simulated hydrocarbon production conditions to aid the selection of materials for equipment designed and constructed using conventional design criteria. Designs utilizing other criteria are excluded from its scope.

Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production —

Part 1: Thermoplastics

CAUTION — Non-metallic materials selected using the parts of ISO 23936 are resistant to the given environments in the petroleum and natural gas industries, but not necessarily immune under all service conditions. This document allocates responsibility for suitability for the intended service in all cases to the equipment user.

1 Scope

This document presents general principles and gives requirements and recommendations for the assessment of the stability of non-metallic materials for service in equipment used in oil and gas exploration and production environments. This information aids in material selection. It can be applied to help avoid costly degradation failures of the equipment itself, which could pose a risk to the health and safety of the public and personnel or the environment. This document also provides guidance for quality assurance. It supplements but does not replace, the material requirements given in the appropriate design codes, standards or regulations.

This document addresses the resistance of thermoplastics to the deterioration in properties that can be caused by physical or chemical interaction with produced and injected oil and gas-field media, and with chemical treatment. Interaction with sunlight and ionizing radiation are excluded from the scope of this document.

This document is not necessarily suitable for application to equipment used in refining or downstream processes and equipment.

The equipment considered includes, but is not limited to, non-metallic pipelines, piping, liners, seals, gaskets and washers.

Blistering by rapid gas decompression is not included in the scope of this document.

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.

ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178, *Plastics — Determination of flexural properties*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 604, *Plastics — Determination of compressive properties*

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

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 2039-2, *Plastics — Determination of hardness — Part 2: Rockwell hardness*

ISO 3451-1, *Plastics — Determination of ash — Part 1: General methods*

ISO 6721-11, *Plastics — Determination of dynamic mechanical properties — Part 11: Glass transition temperature*

ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and step height*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*[1)]

ASTM D648, *Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position*[1)]

ASTM D695, *Standard Test Method for Compressive Properties of Rigid Plastics*[1)]

ASTM D785, *Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials*[1)]

ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*[1)]

ASTM D792, *Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*[1)]

ASTM E1640, *Standard Test Method for Assignment of the Glass Transition Temperature By Dynamic Mechanical Analysis*[1)]

ASTM D1708, *Standard Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens*[1)]

ASTM D2240, *Standard Test Method for Rubber Property-Durometer Hardness*[1)]

ASTM D5630, *Standard Test Method for Ash Content in Plastics*[1)]

3 Terms and definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1.1
batch
defined quantity of raw material, packaging material or product issued from one process or series of processes so that it could be expected to be homogeneous

[SOURCE: ISO 22716:2007, 2.3]

1) Available at https://www.astm.org/

3.1.2
certificate of conformance
⟨inspection⟩ document to be issued by the manufacturer in accordance with requirements stated in this document or in the purchase order

3.1.3
component
individual, finished thermoplastic shape

3.1.4
compound
intimate mixture of a polymer or polymers with other ingredients such as fillers, plasticizers, catalysts and colorants

[SOURCE: ISO 472:2013, 2.184]

3.1.5
conversion process
manufacturing process that converts a compound into a plastic shape or component

3.1.6
end user
oil and/or gas operating company

3.1.7
fluid
liquid or gas

3.1.8
gasket
sealing component compressed in a joint

3.1.9
glass transition temperature
temperature of a thermoplastic material at which its mechanical properties change from elastic (glassy) to viscous (rubbery)

3.1.10
liner
thermoplastic material for protection of medium-contacted surfaces of pipes, piping, pipelines or equipment

3.1.11
lot
part of a batch or part of a continuously manufactured thermoplastic material

3.1.12
maximum operating temperature
maximum temperature to which a component is subjected, including deviations from normal operations, such as start-up/shutdown

3.1.13
maximum rated temperature
upper limit temperature that the material can be used regardless the environment/fluid

3.1.14
neat resin
thermoplastic resin without additives

3.1.15
operating temperature
temperature to which a component is subjected during normal operation

3.1.16
pipeline
those components of a pipeline system connected together to convey fluids between stations and/or plants, including pipe, pig traps, components, appurtenances, spools, risers, isolating valves, and sectionalising valves

[SOURCE: ISO 13623:2017, 3.1.15 modified — Note 1 to entry has been deleted]

3.1.17
piping
pipe or system of pipes for the transport of fluids and gases

Note 1 to entry: Interruption by different components such as pumps, machines, vessels, does not preclude integration into one single piping system.

3.1.18
preconditioning
exposure to defined conditions in relevant fluids prior to ageing

3.1.19
room temperature
temperature **of (23 ± 2) °C**

3.1.20
seal
deformable polymeric device designed to separate different environments

3.1.21
swelling
increase in volume due to absorption of fluids

3.1.22
thermoplastics
plastics that are capable of being repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the plastics and, in the softened state, of being repeatedly shaped by flow into articles by moulding, extrusion or forming

[SOURCE: ISO 15750-3:2002, 3.3]

3.1.23
washer
flat plate of a material with a centralized hole used to seat bolt heads and nuts, among others

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

Af	acceleration factor
CDF	critical degradation factor
COC	certificate of conformance
COV	coefficient of variation
DMA	dynamic mechanical analysis

DSC	differential scanning calorimetry
FEP	fluorinated ethylene propylene
HDT	heat distortion temperature
KCl	potassium chloride
PA	polyamides
PFA	perfluoroalkoxy
PEEK	polyether-ether ketone
PTFE	polytetrafluoro-ethylene
PTFEm	polytetrafluoro-ethylene modified
PVDF	polyvinylidene fluoride
QC	quality control
ST	softening temperature

4 Technical requirements

4.1 General requirements

Thermoplastic selection depends upon material property characteristics and fluid ageing behaviour. This document establishes four levels of testing for the purpose of comparing the properties of various thermoplastic materials. Material property data will be generated at the four levels to allow consistent comparison of the subject materials. Generic data shall be derived per Level 1 and Level 2 including threshold criteria, solely for the purpose of producing information for preselection. Where the user requires accelerated ageing material stability data in a multi-phase H_2S containing fluid, Level 3 shall apply. Where the user requires the material stability data beyond 56 days and an attempted long term life estimation, Level 4 shall apply.

Level 1 conformance consists of the characterization and documentation of material properties in a material data report. It includes a COC for batch quality control testing. See 5.1 and Table 1 for a list of the required material properties to be documented. Physical and mechanical properties shall be characterized on materials in their unaged condition. These standard properties assist with the selection of materials that meet a design specification. Some property tests are also used for quality assurance and control. Level 1 testing establishes a baseline for higher level testing.

Level 2 conformance pertains to material stability (ageing) behaviour and shall be accompanied by a report. Clause 6 provides requirements for Level 2 conformance. The effect of the first three fluids listed in 6.2.4 on material properties shall be investigated with real time ageing studies. A material's resistance to chemical/physical/mechanical change is determined.

Level 3 conformance pertains to material stability (accelerated ageing) behaviour and shall be accompanied by a report. Clause 7 provides requirements for Level 3 conformance. The effects on material properties of three temperature aging evaluations shall be investigated. The intent of Level 3 evaluations is to accelerate material property changes specifically in multi-phase H_2S-fluids.

Level 4 conformance pertains to a material stability (long term) assessment of 180 days or longer following the methodology as shown by Annex B. Level 4 attempts life estimation and shall be accompanied by a report. Clause 8 provides requirements for Level 4 conformance. The intent of Level 4 assessment is to predict the material's progressive degradation, hence conformance threshold recommendations are offered for life estimation purposes. The report shall include a thorough account

of data analysis, extrapolation, life estimation, and statistical confidence. Users shall evaluate the threshold criteria, life estimation results and all methodology to determine the suitability of materials for application.

All reports shall detail the testing and analysis that was performed as well as the edition of this document utilized at time of testing.

Laboratory studies using standard test conditions may not derive data that can be used for design purposes. The user may require fit-for-purpose testing or alternative testing to simulate production conditions to allow materials selection for final application. Component functional testing is not detailed in this document.

For some highly resistant polymers, the chemicals used for ageing in Level 3 and Level 4 will not have any significant thermal-chemical effect on the polymer even at higher temperatures. In such cases, the first observable change in property would be related to fluid absorption or melting phase change rather than a degradation mechanism induced by the chemical. Fully fluorinated polymers (e.g. PTFE, PTFEm, PFA, FEP) either unfilled or filled exclusively with carbon based fillers (e.g. graphite, carbon black, carbon fibre) are known to behave as such and shall be exempt from Level 3 or Level 4 evaluation. Performance of Level 3 or Level 4 testing may reveal other polymers e.g. PVDF in fluid 3.1 and fluid 3.2 in 7.4 also falling into this category.

If blistering by rapid gas decompression is a concern, a test should be performed according to API 17J 4th edition section 6.2.3.3.

4.2 Cautionary remarks

Designers should not assume that properties provided in a material data report as defined in Clause 5 will accurately represent those properties found in finished product geometries. The method of conversion is known to have an impact on these properties and that impact should be accounted for during design.

Life estimation usefulness and certainty can increase when longer term data are used to establish the degradation trend. Level 3 testing at durations up to 56 days are most useful for shorter term (up to 1 year) life estimations and can have reduced certainty for long term (greater than 1 year) life estimations. Level 4 testing requires up to 180 day or longer data in an effort to create higher certainty in long term life estimation.

In some cases, progressive degradation of thermoplastics over long periods of time at temperatures well above the target service temperature is not observed. The data and the attempted life estimation are still valuable because they demonstrate material stability in that test environment.

4.3 Traceability

For a final component to maintain its ISO 23936-1 conformance, it shall be made from a thermoplastic material that conforms with this document. The entire compound manufacturing process shall be fully traceable. Conformance records shall state the edition of this document used in the assessment. Reference to conformance with ISO 23936 shall include the part and edition (year) of the document used, e.g. ISO 23936-1:20YY.

Each compound and accompanying COC shall be traceable back to the compound manufacturer. Each company that participates in the manufacture of a compound that conforms with this document shall maintain traceability records for a minimum of 10 years that include its own manufacturing procedures, locations, and dates.

Further requirements on conformance and traceability over the supply chain can be found in relevant product standards and agreed between interested parties.

4.4 Test specimen identification

4.4.1 Coding overview

The specimen fabrication details shall be reported using the following identification code system:

— moulding (for individual codes see 4.4.2):

— orientation (for individual codes see 4.4.3):

— form (for individual codes see 4.4.4):

— post treat (for individual codes see 4.4.5):

— shaping (for individual codes see 4.4.6):

The test specimen identification shall give the following information:

a) test standard;

b) specimen type;

c) test speed;

d) identification code.

EXAMPLE Sample test call out for an ISO 527-1 or ASTM D638 tensile test with injection moulded Type 1BA and Type V specimens respectively:

1) ISO 527-1, 1BA, 50 mm/min (MI/OA/FN/PA/SN);

2) ASTM D638 – TV, 2''/min (MI/OA/FN/PA/SN).

4.4.2 Moulding

Process used to convert a pellet, flake, powder, resin, etc. into a shape and is the final forming step:

a) injection (MI): process of moulding a material by injection under pressure from a heated cylinder through a sprue into the cavity of a closed mould;

b) compression (MC): load/pour material into mould, heat, and then consolidate melted polymer under uniaxial or isostatic compression;

c) transfer (MT): process of moulding a material by passing it from a heated pot into the cavity of a closed, heated mould;

d) extrusion (ME): transfer melted material into a shape using a die in a continuous process;

e) rotational moulding (MR): load material in mould, heat and rotate, where inertial forces are used to consolidate the thermoplastic;

f) casting (MS): transfer melted material into a mould with only the force of gravity acting on the thermoplastic;

g) additive (MA): manufacturing methods that add layers of material by a melt process;

h) new methods (MZ).