SLOVENSKI STANDARD
oSIST prEN 13938-5:2021

01-april-2021

Eksplozivi za civilno uporabo - Smodniki in raketna goriva - 5. del: Ugotavljanje praznin in razpok

Explosives for civil uses - Propellants and rocket propellants - Part 5: Determination of voids and fissures

Explosivstoffe für zivile Zwecke - Treibladungspulver und Raketentreibstoffe - Teil 5: Bestimmung von Lunkern und Rissen

Explosifs à usage civil - Poudres propulsives et propergols pour fusées - Partie 5: Détermination des creux et des crevasses

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ICS:

71.100.30	Eksplozivi. Pirotehnika in ognjemeti	Explosives. Pyrotechnics and fireworks

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English Version

Explosives for civil uses - Propellants and rocket propellants - Part 5: Determination of voids and fissures

Explosifs à usage civil - Poudres propulsives et propergols pour fusées - Partie 5: Détermination des vides et des fissures

Explosivstoffe für zivile Zwecke - Treibladungspulver und Raketentreibstoffe - Teil 5: Bestimmung von Lunkern und Rissen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 321.

If this draft becomes a European Standard, 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.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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Contents

Page

European foreword

This document (prEN 13938-5:2021) has been prepared by Technical Committee CEN/TC 321 "Explosives for civil uses", the secretariat of which is held by UNE.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 13938-5:2004.

In comparison with the previous edition, the following technical modifications have been made:

a) the normative references have been updated;

b) Clause 4, *Principle*, has been added;

c) technical revision of the method for clarification purposes;

d) Annex ZA has been updated.

This document has been prepared under a Standardization Request (M/562) annexed to the Commission Implementing Decision C(2019)6634 final as regards Explosives for civil uses given to CEN by the European Commission and the European Free Trade Association, and supports Essential Safety requirements of Directive 2014/28/EU.

For relationship with Directive 2014/28/EU, see informative Annex ZA, which is an integral part of this document.

EN 13938, *Explosives for civil uses — Propellants and rocket propellants*, is currently composed of the following parts:

— *Part 1: Requirements*

— *Part 2: Determination of resistance to electrostatic discharge*

— *Part 3: Determination of deflagration to detonation transition*

— *Part 4: Determination of burning rate under ambient conditions*

— *Part 5: Determination of voids and fissures*

— *Part 6: Solid rocket propellants — Guide for the determination of integrity of inhibitor coatings*

— *Part 7: Determination of safe and reliable ignition and complete deflagration of black powder*

1 Scope

This document specifies a method for checking small rocket motors for voids and fissures and provides a list of non-destructive testing (NDT) methods for detecting voids and fissures in other solid rocket propellants.

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.

prEN 13857-1:2021, *Explosives for civil uses — Part 1: Terminology*

prEN 13938-1:2021, *Explosives for civil uses — Propellants and rocket propellants — Part 1: Requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 13857-1:2021 and prEN 13938-1:2021 and the following apply.

3.1
small rocket motor
rocket motor which does contain no more than 100 g of solid rocket propellant(s)

3.2
NDT method
discipline applying a physical principle in non-destructive testing

3.3
NDT technique
specific way of utilising an NDT method

3.4
NDT procedure
orderly sequence of rules, which describes step by step how and in which sequence a NDT technique should be applied to a specific field

3.5
void
unintended inclusion of a gas bubble

3.6
fissure
unintended longitudinal discontinuity in the propellant material

3.7
solid rocket propellant
propellant consisting of one or more blocks, usually with a central hole, designed to burn in a controlled manner

3.8
X- ray radiography
NDT method consisting in high-energy photons passing through the block of the propellant

Note 1 to entry: The difference in molecule size and material density has an influence on the absorption of the photons. The photons that do pass through the matter end up being dark spots on the film and parts of the film that do not catch photons result in light parts. Voids and fissures are visible as a dark spots in the material.

3.9
X- ray tomography
NDT method consisting in the gaining of the slide images in the different planes or instants on the base of the measurements in the perpendicular planes

Note 1 to entry: These measurements are non-invasive and are often done without contact with the product.

3.10
ultrasonic method
NTD method that consists of ultra sound waves (above 20 kHz) made up from vibrations that propagates inside the material

Note 1 to entry: Ultrasonic waves reflect on every interface between materials and these reflections are measured as long as the signals are not fully damped.

4 Principle

The presence of excessively large or numerous voids or fissures in solid rocket propellant can result in dangerously high pressures due to increased propellant burning surfaces. The maximum size and number of voids and fissures permitted in a solid rocket propellant to ensure safe functioning are therefore an essential part of the acceptance criteria for the product.

For small rocket motors this can be achieved by burning them in the way they are designed for and measuring the thrust continually. Significant voids and fissures can be recognized by a sudden increase of thrust.

5 NDT methods

Voids and fissures in solid rocket propellant grains can be detected by various NDT methods normally used for the testing of metals and welds. The NDT method and technique selected will depend on many factors, for example, the minimum size of voids and fissures to be detected, the type of propellant to be inspected, the type of inspection (continuous production line inspection or the individual inspection of samples) and the number of units to be inspected.

The main types of NDT methods used in the detection of voids and fissures are shown in Table 1.

Table 1 — NDT methods

NDT method	Requirements
Film radiography (X-ray or isotopes)	— suitable for all types of propellant units — involves a lot of pictures to cover all appropriate angles of incidence — personnel protection required
X- ray radioscopy	— suitable for all types of propellant units — no films involved — personnel protection required
X-ray tomography	— suitable for all types of propellant units — more expensive than X-ray radioscopy — personnel protection required
Ultrasonic	— a liquid or gel is required for sound transmission — may be well adapted for in-line inspection — no personnel protection required

6 Destructive testing of small rocket motors

6.1 Test pieces

For this test, 20 rocket motors with the same dimensions, chemical composition, assembly, nozzle, and finish shall be selected.

6.2 Apparatus

The apparatus consists of the following parts (see Figure 1):

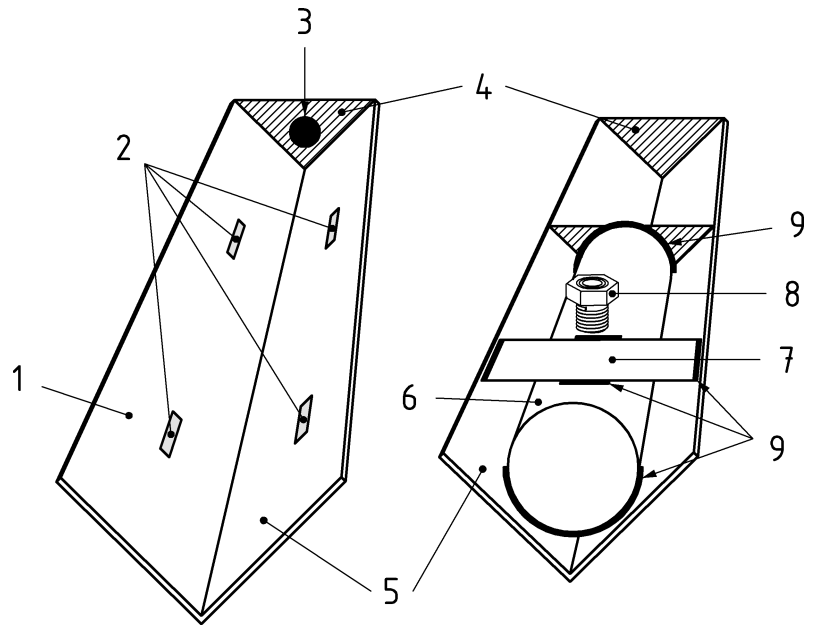
6.2.1 V-shaped carrier made of steel onto which a steel tube is welded providing a mounting for the test piece. Additionally, a steel plate is welded onto the top of the tube and to the carrier. The test piece is fixed in the tube by a fastening screw at the top part of the steel tube. The rear end of the tube is closed by a steel plate which is also welded to the carrier. The tube shall be fixed in a way that the thrust of the test piece operates precisely along the length of the carrier. The rear end of the carrier is closed by a steel plate and can be additionally fitted with a steel bolt or similar to transfer the thrust force onto the force transducer.

6.2.2 V-shaped steel trough equipped with a force transducer at the rear end and with ball bearers built into the sidewalls to provide a virtual frictionless movement of the carrier. The trough is firmly mounted on a base made of steel or concrete.

6.2.3 Transient recorder or a x-t-plotter to record the signal of the force transducer during the test with a resolution of at least 2 ms.

6.2.4 Igniter as stipulated by the manufacturer of the small rocket motors.

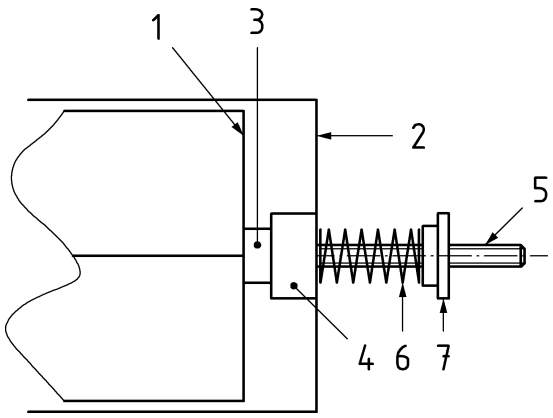
To avoid effects of inertia the force transducer is preloaded with a certain force, for example 10 N to 30 N. This can be accomplished in several ways, e.g. a spring, a weight, tilting the trough (see Figure 2).



Key

1 trough
2 ball bearers
3 force transducer
4 rear steel plates
5 front end
6 steel tube
7 steel plate
8 fastening screw
9 weld seams

Figure 1 — Apparatus for measuring the thrust of small rocket motors



Key

1 carrier (rear end)
2 trough (rear end)
3 adapter to transfer the thrust to the transducer (attached to the carrier)
4 force transducer (attached to the trough)
5 threaded bolt
6 spring
7 thumb screw

Figure 2 — Preloading the force transducer

6.3 Procedure

Insert the test piece into the steel tube until the end opposite the nozzle comes in touch with the rear steel plate. If the test piece is too short, i.e. the nozzle does not stick out of the tube for about 10 mm, insert a piece of metal of suitable thickness before the test piece. Fix the test piece by means of the fastening screw. Mount the igniter as prescribed by the manufacturer to give a reliable ignition of the test piece. The recording of the force measurement is started and the igniter is triggered. The thrust (in N) is measured during the complete burning duration.

Repeat the procedure for each of the remaining 19 test pieces.

This distance should be determined after disconnection of the hot wire and the cooling of the trough.

6.4 Evaluation of test results

For each test piece determine from the recordings (see Figure 3) the maximum and the mean thrust (overall mean) between t_3 and t_4, the burning duration ($t_5 - t_1$) and the total impulse (in Ns^{-1}) by integrating the recorded thrust vs. time data from t_3 to t_5. Then calculate the mean impulse and the standard deviation from the 20 results.

To determine whether significant voids and fissures are present, examine the recordings as follows:

Divide the range from t_3 to t_4 into ten parts and calculate for each part the mean thrust (partial mean). Calculate the differences between the partial means and the overall mean determined in accordance with the previous paragraph. If any of the differences is greater than 10 % of the overall mean record it.