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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

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Explosifs à usage civil - Cordeaux détonants et mèches lentes - Partie 5: Propergols solides pour autopropulsion - Guide pour la détermination des vides et des fissures

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

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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 Central Secretariat has the same status as the official versions.

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Contents

Foreword

This document (EN 13938-5:2004) has been prepared by Technical Committee CEN/TC 321 "Explosives for civil uses", the secretariat of which is held by AENOR.

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of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This document is one of a series of standards with the generic title *Explosives for civil uses – Propellants and rocket propellants.* The other parts of this series are listed below:

prEN 13938-1 Part 1: Requirements

prEN 13938-2 Part 2: Determination of resistance to electrostatic energy

EN 13938-3 Part 3: Determination of deflagration to detonation transition

EN 13938-4 Part 4: Determination of burning rate under ambient conditions

EN 13938-6 Part 6: Guide for the determination of integrity of inhibitor coatings

EN 13938-7 Part 7: Determination of properties of black powder

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

Introduction

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.

1 Scope

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

2 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.

EN 13857-1:2003, *Explosives for civil uses - Part 1: Terminology*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:1999)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13857-1:2003 and the following apply.

3.1
small rocket motor
rocket motor which does contain not more than 100 g of solid rocket propellant(s)

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

NOTE An example of an NDT method is ultrasonic testing.

3.3
NDT technique
specific way of utilising an NDT method

NOTE An example of an NDT technique is immersion ultrasonic testing.

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

4 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. Among them it may be useful to distinguish:

- a) minimum size of voids and fissures to be detected;
- b) type of propellant to be inspected;
- c) type of inspection (continuous production line inspection or the individual inspection of samples);
- d) 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	**Comments**
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 expansive 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

5 Destructive testing of small rocket motors

5.1 Test pieces

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

5.2 Apparatus

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

— **5.2.1** a 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;

— **5.2.2** a 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;

— **5.2.3** a 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;

— **5.2.4** an 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 for an example).