
**Polyethylene (PE) materials for piping
systems — Determination of Strain
Hardening Modulus in relation to slow
crack growth — Test method**

*Matériaux polyéthylène (PE) pour systèmes de canalisations —
Détermination du module d'écroissage en relation avec la
propagation lente de fissures — Méthode d'essai*



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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

Introduction

Resistance to slow crack growth is related in general to the lifetime of polyethylene and thus, the lifetime of polyethylene products, e.g. pipes and fittings. The slow crack growth behaviour can be regarded as a combination of yield stress and the capability of disentanglement of tie molecules as reported by Kramer and Brown.[3],[6],[7] The disentanglement capability of a polymer will determine its resistance against slow crack growth.

The strain hardening modulus of a polymer is a measure of the disentanglement capability of the tie molecules of this polymer and is an intrinsic property. The strain hardening modulus of polyethylene is obtained from a stress-strain curve above the natural draw ratio. The stress-strain curve of a compression moulded sample is relatively easily obtained using a tensile test apparatus equipped with an optical extensometer. The test time of the strain hardening modulus is a consequence of the speed of tensile testing and is therefore constant for all measurements and independent of the slow crack growth property of the tested material itself.

The strain hardening modulus value allows discrimination between materials. It has been demonstrated that the strain hardening modulus corresponds very well with several environmental stress cracking test methods for high density polyethylene.[4],[5],[8]

Polyethylene (PE) materials for piping systems — Determination of Strain Hardening Modulus in relation to slow crack growth — Test method

1 Scope

This International Standard specifies a method for the determination of the strain hardening modulus which is used as a measure for the resistance to slow crack growth of polyethylene.

The strain hardening modulus is obtained from stress-strain curves on compression moulded samples. This International Standard describes how such measurement is performed and how the strain hardening modulus shall be determined from such a curve. Details of the required equipment, precision, and sample preparation for the generation of meaningful data are given.

This International Standard provides a method that is valid for all types of polyethylene, independent from the manufacturing technology, comonomer, catalyst type, that are used for pipes and fittings applications.

NOTE This method could be developed for materials for other applications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

3 Terms and definitions

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

NOTE The symbols and their terms and definitions, as given below, are in line with ISO 527-1 and/or ISO 16241.

3.1 gauge length

l_0

initial distance between the gauge marks on the central part of the test specimen

Note 1 to entry: It is expressed in millimetres (mm).

3.2 thickness

h

smaller initial dimension of the rectangular cross-section in the central part of a test specimen

Note 1 to entry: It is expressed in millimetres (mm).