Plastics piping and ducting systems - Determination of the longterm hydrostatic strength of thermoplastics materials in pipe form by extrapolation

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EESTI STANDARDI EESSÕNA **NATIONAL FOREWORD**

Käesolev Eesti standard EVS-EN ISO 9080:2004 sisaldab Euroopa standardi EN ISO 9080:2003 ingliskeelset teksti. Käesolev dokument on jõustatud 23.11.2004 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN ISO 9080:2004 consists of the English text of the European standard EN ISO 9080:2003. This document is endorsed on 23.11.2004 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: This International Standard describes a method for estimating the long-term hydrostatic strength of thermoplastics materials by statistical extrapolation. The method is applicable to all types of thermoplastics pipe at applicable temperatures. It was developed on the basis of test data from pipe systems. The dimensions of the pipes to be tested may be specified in the relevant product/system standards and, if so, are included in the test report.	**Scope:** This International Standard describes a method for estimating the long-term hydrostatic strength of thermoplastics materials by statistical extrapolation. The method is applicable to all types of thermoplastics pipe at applicable temperatures. It was developed on the basis of test data from pipe systems. The dimensions of the pipes to be tested may be specified in the relevant product/system standards and, if so, are included in the test report.

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Plastics piping and ducting systems

Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
(ISO 9080 : 2003)

Systèmes de canalisations et de gaines en matières plastiques – Détermination de la résistance hydrostatique à long terme des matières thermoplastiques sous forme de tubes par extrapolation
(ISO 9080 : 2003)

Kunststoff-Rohrleitungs- und Schutzrohrsysteme – Bestimmung des Zeitstand-Innendruckverhaltens von thermoplastischen Rohrwerkstoffen durch Extrapolation (ISO 9080 : 2003)

This European Standard was approved by CEN on 2003-02-28.

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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

The European Standards exist 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 Management Centre has the same status as the official versions.

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CEN

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Foreword

International Standard

ISO 9080 : 2003 Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation,

which was prepared by ISO/TC 138 'Plastics pipes, fittings and valves for the transport of fluids' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 155 'Plastics piping systems and ducting systems', the Secretariat of which is held by NEN, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by September 2003 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 9080 : 2003 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to international publications are listed in Annex ZA (normative).

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Introduction

General

ISO/TR 9080, upon which this International Standard is based, is the result of considerable discussion within working group 10 of subcommittee 5 of technical committee 138 of the International Organization for Standardization (ISO) (referred to hereafter as ISO/TC 138/SC 5/WG 10), which was entrusted with the development of the standard, which represents an agreed compromise incorporating features of several accepted national procedures.

Furthermore, it is emphasized that the standard extrapolation method (SEM) described is not intended to be used to disqualify existing procedures for arriving at design stresses or allowable pressures for pipelines made of plastics materials, or to disqualify pipelines made of materials proven by such procedures, which long years of experience have shown to be satisfactory. This SEM is meant to be used to qualify a material in pipe form prior to the introduction of such a material on the market.

A software package has been developed for the SEM analysis as described in Annex A and Annex B. A Windows-based programme is available on diskette (see Annex D).

NOTE Use of this software package is recommended.

Principles

The suitability for use of a plastics pressure pipe is first of all determined by the performance under stress of its material of construction, taking into account the envisaged service conditions (e.g. temperature). It is conventional to express this by means of the hydrostatic (hoop) stress which a plastics pipe made of the material under consideration is expected to be able to withstand for 50 years at an ambient temperature of 20 °C using water as the internal test medium. The outside environment can be water or air.

In certain cases, it is necessary to determine the value of the hydrostatic strength at either shorter lifetimes or higher temperatures, or on occasion both. The method given in this International Standard is designed to meet the need for both types of estimate. The result obtained will indicate the lower prediction limit (LPL), which is the lower confidence limit of the prediction of the value of the stress that can cause failure in the stated time at a stated temperature (the ultimate stress).

NOTE The MRS value (at 20 °C) is usually based on data obtained using water as the internal and external test medium. It is obvious that indeed all data are used for validation of regression curves at higher temperatures (e.g. 70 °C), including the data obtained with air as the external medium (e.g. at 110 °C).

This International Standard provides a definitive procedure incorporating an extrapolation using test data at different temperatures analysed by multiple linear regression analysis. The results permit the determination of material-specific design values in accordance with the procedures described in the relevant system standards.

This multiple linear regression analysis is based on the rate processes most accurately described by $\log_{10}$(stress) versus $\log_{10}$(time) models.

In order to assess the predictive value of the model used, it has been considered necessary to make use of the estimated 97,5 % lower prediction limit (LPL). The 97,5 % lower prediction limit is equivalent to the lower confidence limit of the 95 % confidence interval of the predicted value. This convention is used in the mathematical calculations to be consistent with the literature. This aspect necessitates the use of statistical techniques.

The method can provide a systematic basis for the interpolation and extrapolation of stress rupture characteristics at operating conditions different from the conventional 50 years at 20 °C. Taking into account the extrapolation factors (see 5.1.4), the extrapolation time limit can go up to 100 years.

It is essential that the medium used for pressurizing the pipe does not have an adverse effect on the pipe. In general, water is considered to be such a medium.

Long consideration was given to deciding which variable should be taken as the independent variable to calculate the long-term hydrostatic strength. The choice was between time and stress.

The basic question the method has to answer can be formulated in two ways as follows.

a) What is the maximum stress (or pressure) that a given pipe system can withstand at a given temperature for a defined time?

b) How long will a pipe system last when subjected to a defined stress (or pressure) at a given temperature?

Both questions are relevant.

If the test data for the pipe under study does not show any scatter and if the pipe material can be described perfectly by the chosen empirical model, the regression with either time independence or stress independence will be identical. This is never the case because the circumstances of testing are never ideal nor will the material be 100 % homogeneous. The observations will therefore always show scatter. The regressions calculated using the two optional independent variables will not be identical and the difference will increase with increasing scatter.

The variable that is assumed to be most affected by the largest variability (scatter) is the time variable and it has to be considered as a dependent variable (random variable) in order to allow a correct statistical treatment of the data set in accordance with this method. However, for practical reasons, the industry prefers to present stress as a function of time as an independent variable.

Use of the methods

This extrapolation method is designed to meet the following two requirements:

a) To estimate the lower prediction limit[1)] (at 97,5 % probability level) of the stress which a pipe made of the material under consideration is able to withstand for 50 years at an ambient temperature of 20 °C using water or air as the test environment.

b) To estimate the value of the lower prediction limit (at 97,5 % probability level) of the stress, either at different lifetimes or at different temperatures, or on occasion both.

There are several extrapolation models in existence, which have different numbers of terms. This SEM will use only models with two, three or four parameters.

Adding more terms could improve the fit but would also increase the uncertainty of the predictions.

The SEM describes a procedure for estimating the lower prediction limit (at 97,5 % probability level) whether a knee (which demonstrates the transition between type A and type B crack behaviour) is found or not (see Annex B).

The materials have to be tested in pipe form for the method to be applicable.

The final result of the SEM for a specific material is the lower prediction limit (at 97,5 % probability level) of the hydrostatic strength, expressed in terms of the hoop stress, at a given time and a given temperature.

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1) In various ISO documents, the lower prediction limit (LPL) is referred to as the lower confidence limit (LCL), where LCL is the 97,5 % lower confidence limit for the mean hydrostatic strength.

1 Scope

This International Standard describes a method for estimating the long-term hydrostatic strength of thermoplastics materials by statistical extrapolation.

The method is applicable to all types of thermoplastics pipe at applicable temperatures. It was developed on the basis of test data from pipe systems. The dimensions of the pipes to be tested may be specified in the relevant product/system standards and, if so, are included in the test report.

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.

ISO 1167, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method*

ISO 2507-1:1995, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method*

ISO 3126:—[2)], *Plastics piping systems — Plastics piping components — Measurement and determination of dimensions*

ISO 3146:2000, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

3 Terms and definitions

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

3.1
internal pressure
p
force per unit area, in bars, exerted by the medium in the pipe

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2) To be published. (Revision of ISO 3126:1974)