Australian/New Zealand Standard™

AS/NZS 1462.29:2006

Methods of test for plastics pipes and fittings

Method 29: Plastics piping and ducting systems—Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation (ISO 9080:2003, MOD)

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee PL-045, Plastics Pipe Systems Test and Calculation Methods.

This Standard is an adoption with national modifications and has been reproduced from ISO 9080, Ed. 1.0 (2003), *Plastics piping and ducting systems—Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*, and has been varied as indicated to take account of Australian/New Zealand conditions.

Variations to ISO 9080:2003 are indicated at the appropriate places throughout this standard. Strikethrough (~~example~~) identifies ISO text, tables and figures which, for the purposes of this Australian/New Zealand Standard, are deleted. Where text, tables or figures are added, each is set in its proper place and identified by shading (example). Added figures are not themselves shaded, but are identified by a shaded border.

As this Standard is reproduced from an International Standard, the following applies:

(a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.

(b) In the source text ISO 9080 should read AS/NZS 1426.29.

(c) A full point should be substituted for a comma when referring to a decimal marker.

(d) Any French text on figures should be ignored.

The terms ‘normative’ and ‘informative’ are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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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 97.5% confidence limit for the predicted value. ~~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.

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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.