International Standard 2605/3

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Steel products for pressure purposes — Derivation and verification of elevated temperature properties — Part 3: An alternative procedure for deriving the elevated temperature yield or proof stress properties when data are limited

Produits en acier pour récipients à pression — Dérivation et vérification des valeurs à température élevée — Partie 3: Autre méthode de dérivation des valeurs de limites apparente et conventionnelle d'élasticité à température élevée à partir de données réduites

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2605/3 was prepared by Technical Committee ISO/TC 17, *Steel*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Steel products for pressure purposes — Derivation and verification of elevated temperature properties — Part 3: An alternative procedure for deriving the elevated temperature yield or proof stress properties when data are limited

0 Introduction

In the ISO rules for the construction of stationary boilers[1] (ISO/R 831) minimum lower yield stress, R_{eL}, or proof stress, R_p, at elevated temperature is listed as one of the design criteria. Accordingly, International Standards for pressure vessel steels or national standards conforming to the above rules should specify lower yield stress or proof stress properties at elevated temperatures. (See note 1.)

For such International Standards, these values are derived statistically from a body of data by using the procedures given in ISO 2605/1 and ISO 2605/2. This statistical derivation may also be used for national standards. However, the data requirements of ISO 2605/1 and ISO 2605/2 have frequently proved difficult to achieve in the case of International Standards and may prove to be impossible to meet in the case of national standards or newly developed steels, and this alternative procedure provides a means by which minimum properties may be derived when data are limited.

NOTES

1 Where this part of ISO 2605 subsequently makes reference to proof stress, it should be understood that lower yield stress also applies where appropriate.

2 Whilst the validity of the derivation procedure has been examined in relation to data for a variety of steels, further experience may indicate that modifications are desirable, particularly in relation to the minimum quantity and distribution of data required by the derivation procedure.

3 All tests used to implement this procedure at room temperature or at elevated temperature should be carried out in conformity with the appropriate ISO documents (for example ISO 6892, at room temperature, and ISO/R 783 at elevated temperatures). However, data previously obtained using other test methods may be used for an interim period.

1 Scope and field of application

This part of ISO 2605 defines an alternative to the method specified in ISO 2605/1 and ISO 2605/2, for deriving minimum elevated temperature lower yield stress or proof stress values for steel products for pressure purposes.

It does not define a verification procedure; where verification of elevated temperature properties is required this shall be by hot testing until the requirements of ISO 2605/1 and ISO 2605/2 can be satisfied.

2 References

ISO/R 783, *Mechanical testing of steel at elevated temperatures — Determination of lower yield stress and proof stress and proving test.*

ISO/R 831, *Rules for construction of stationary boilers.*

ISO 2605, *Steel products for pressure purposes — Derivation and verification of elevated temperature properties —*

Part 1: Yield or proof stress of carbon and low alloy steel products.

Part 2: Proof stress of austenitic steel products.

ISO 6892, *Metallic materials — Tensile testing.*

3 Procedure for deriving minimum properties

3.1 Basis of method

3.1.1 The elevated temperature proof stress properties are derived from a well-defined body of data on the basis of a regression analysis of normalized values of proof stress against temperature. The elevated temperature proof stress values are normalized by expressing each elevated temperature value as a ratio to the room temperature value for the same cast. The regression curve developed represents the average temperature variation of proof stress and may be identified as "the average proof stress ratio trend curve".

3.1.2 For a specific grade of steel, minimum proof stress values, for elevated temperature, are obtained by factoring the average ratio trend curve against the specified minimum proof stress at room temperature for that grade, and then subtracting

1) Pressure vessels and shell boilers will form the subjects of future International Standards.

from these values a fixed level of stress determined as 10 % of the specified minimum proof stress value at room temperature:

$$R_p(\theta) = R_p 20\,(r - 0{,}1)$$

where

$R_p(\theta)$ is the proof stress at temperature θ;

R_p 20 is the specified minimum proof stress at room temperature;

r is the average proof stress ratio at elevated temperature θ.

3.2 Basic requirements

3.2.1 The method shall be applied separately for each thickness range, section size range or heat treatment condition for which elevated temperature proof stress properties are to be specified in the relevant specification, unless it can be shown that the data being considered belong to the same population.

3.2.2 The data utilized shall be obtained using test samples which

a) are representative of the thickness or section size range and heat treatment to which the specified properties apply;

b) provide room temperature proof stress values spanning fairly uniformly a range related to the specified tensile strength range at room temperature.

3.2.3 In each case, the test pieces for the room temperature and elevated temperature proof stress determinations shall be taken as close to each other as possible.

3.3 Number of data required for derivation of minimum values

Test points from at least eight casts are required at temperature intervals of approximately 50 °C covering the range over which properties are to be specified. Preferably more than one producer should contribute to this body of data.

3.4 Analysis of data

3.4.1 The data are plotted in the form of a proof stress ratio/temperature graph as shown in the figure.

3.4.2 If examination of the data reveals two or more populations due to factors other than those listed in 3.2.1, each population should be treated separately. The number of data in each population shall comply with the requirements of 3.3.

NOTE — If two or more populations are treated together, this may result in an abnormally wide scatter band.

3.4.3 The average proof stress ratio trend curve is then obtained by fitting a curve passing through a ratio of 1,0 at 20 °C and through the proof stress ratio/temperature data by a least squares method.

3.5 Derivation of minimum proof stress

3.5.1 Values taken from the average proof stress ratio trend curve defined in 3.4.3, which has a value of unity at 20 °C, are factored against the specified minimum proof stress value at room temperature to define values of proof stress at elevated temperature. The elevated temperature values thus obtained are reduced by a stress value, defined as 10 % of the specified minimum proof stress value at room temperatures to define the minimum proof stress values at elevated temperatures, i.e. $R_p(\theta) = R_p 20\,(r - 0{,}1)$.

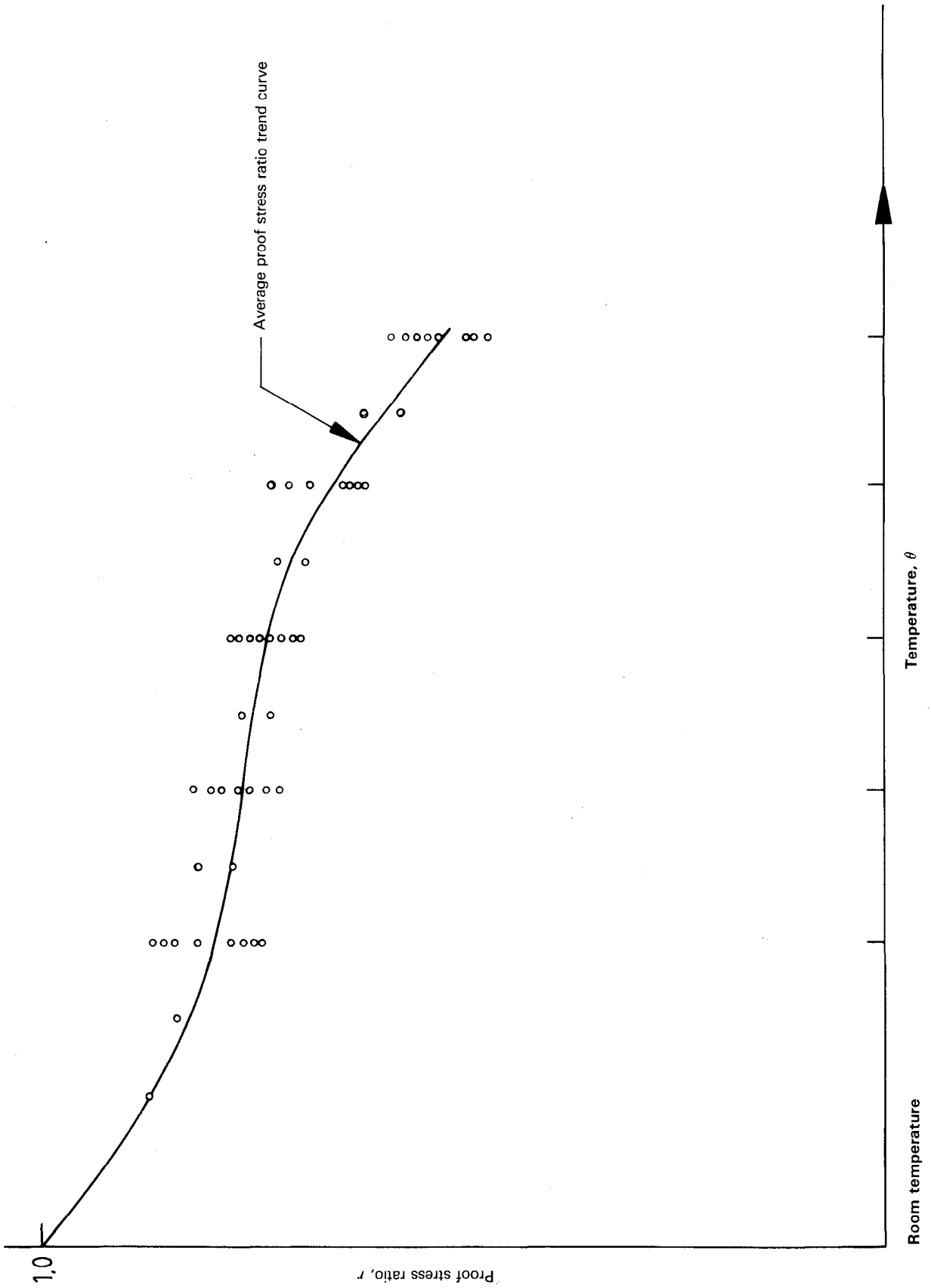

Figure — Typical regression plot for determining average stress ratio trend curve