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BSI Standards Publication

Gas cylinders — Guidance for design of composite cylinders

Part 3: Calculation of stress ratios

bsi.

National foreword

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Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
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Contents

Page

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Foreword

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This document was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

A list of all parts in the ISO 13086 series can be found on the ISO website.

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Gas cylinders — Guidance for design of composite cylinders —

Part 3: Calculation of stress ratios

1 Scope

This document addresses the topic of calculation of stress ratios when analyzing filament wound composite cylinders. This document is applicable to cylinders of Types 2, 3, and 4. The calculation of stress ratios supports the development and revision of standards for fibre reinforced composite pressurized cylinders.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

4 Background

Stress rupture, also known as static fatigue, is the broadly defined mechanism where a material fails under sustained static load. Stress ratio, the ratio of maximum fibre stress at minimum cylinder design burst pressure divided by the maximum fibre stress at cylinder working pressure, allowing assessment of the likelihood of stress rupture of the reinforcing fibres. Other performance may be affected by the amount of fibre on the part, as reflected by the stress ratio, but there are other means to accomplish improvements in other performance areas (e.g. drop, impact, gunfire, flaw resistance), and performance testing is a better means to assess other performance factors. It is assumed that a time-based relationship between the applied static load and the breakdown of the material can be defined. The goal of defining a mathematical relationship between applied stress and time to failure is to make accurate predictions of the material's performance for safe use. In the simplest of terms, the greater the sustained load, the sooner the occurrence of failure (stress rupture). A full and accurate understanding of the material's working stress state in service is imperative in order to assure that the stress ratios are calculated accurately, and therefore the reliability of the cylinder in service is known.

Burst ratios and stress ratios are theoretically the same for Type 4 cylinders with a single structural reinforcing fibre, but not for Type 2 or Type 3 cylinders due to the effect of autofrettage. While use of a burst ratio for Type 2 and Type 3 cylinders is normally conservative, poor design and autofrettage practice may cause higher stress in the reinforcing fibre, causing premature failure by rupture. This unsafe condition can result when using non-traditional materials, very thick liner and/or thin composite materials, and/or high autofrettage pressures. Some amount of calculation is also required for Type 4 cylinders using hybrid construction, which is the use of more than one structural reinforcing fibre (see 6.3).

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