



BSI Standards Publication

Gas cylinders — Guidance for design of composite cylinders

Part 1: Stress rupture of fibres and burst
ratios related to test pressure

National foreword

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Gas cylinders — Guidance for design of composite cylinders —

Part 1: Stress rupture of fibres and burst ratios related to test pressure

*Bouteilles à gaz — Directives pour la conception des bouteilles en
matière composite —*

*Partie 1: Fracture sous contrainte des fibres et indice d'éclatement
relatifs à la pression 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 13086-1 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

Introduction

Composite reinforced cylinders have been used in commercial service for about 40 years. In the first years of use, glass fibres were the reinforcement of choice. Design guidelines, including safety factors, were established when these cylinders were first developed.

Additional fibres for reinforcing composite cylinders have become available in following years, including aramid and carbon. Different design configurations have been established over the years, including hoop wrapped, full wrapped with a metal liner, and full wrapped with a non-metallic liner. Different applications have developed, including breathing cylinders, emergency inflation cylinders, fuel tanks for vehicles powered by compressed natural gas or hydrogen, accumulators, and many other uses.

Standards for these composite cylinders have developed in different ways. Some are design based, others are performance based. Some were developed for a single fibre or application. Some of these have remained static, while others evolved as materials and designs changed. Other standards were developed with a broad scope of materials and applications. Safety factors have been treated differently in these different standards.

The entire industry, including manufacturers, customers, and regulatory bodies, would benefit from a cohesive foundation of the technical issues from which safety factors for composite cylinders are developed, so that a consistent approach to safety factors is taken in composite cylinder standards. The elements of foundation currently exist, but need to be collected and organized for maximum benefit. This foundation will also serve as a base for evaluating new materials, designs, and applications that develop in the future.

A foundation of the technical issues supporting safety factors for composite cylinders will be built under this part of ISO/TR 13086. Elements involving the composite cylinder materials, designs, and applications will be incorporated. This Technical Report will be updated with additional topics periodically and can be referenced in the development of standards for composite cylinders.

Gas cylinders — Guidance for design of composite cylinders —

Part 1:

Stress rupture of fibres and burst ratios related to test pressure

1 Scope

This part of ISO/TR 13086 gives guidance for the design of composite cylinders, relating to stress rupture reliability and burst ratio as a function of test pressure. Related issues, such as cyclic fatigue of the liner and composite, damage tolerance, environmental exposure, and life extension will be addressed in subsequent parts.

The topics covered by this part of ISO/TR 13086 are to support the development and revision of standards for fibre composite reinforced pressurized cylinders.

2 Normative reference

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 10286:2007, *Gas cylinders — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10286:2007, Annex A, and the following apply.

3.1

autofrettage pressure

pressure to which a metal lined composite pressure vessel is taken, prior to the test pressure cycle, in order to yield the liner, and therefore establish a compressive stress in the liner at zero pressure

3.2

burst ratio

the ratio of the minimum required burst pressure and the working pressure

3.3

stress ratio

the ratio of the minimum strength of the fibre, as determined through burst testing of a pressure cylinder, divided by the stress in the fibre at working pressure

3.4

stress rupture

phenomenon by which a reinforcing fibre can fail under an applied tensile load over time, and is dependent on the stress level