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Internal combustion engines — Piston rings —

Part 3: Material specifications

Moteurs à combustion interne — Segments de piston —

Partie 3: Spécifications des matériaux

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain and powertrain fluids*.

This third edition cancels and replaces the second edition (ISO 6621-3:2000), which has been technically revised.

The main changes compared to the previous edition are as follows:

— a material's new subclass was added.

A list of all parts in the ISO 6621 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is one of a number of series of International Standards dealing with piston rings for reciprocating internal combustion engines. Others are ISO 6622-1[5] and ISO 6622-2[6], ISO 6623[7], ISO 6624-1[8], ISO 6624-2[9], ISO 6624-3[10] and ISO 6624-4[11], ISO 6625[12], ISO 6626[13], ISO 6626-2[14], ISO 6626-3[15], and ISO 6627[16].

This document provides a user guide to the types of materials available for piston rings.

Many such materials are available, made by different manufacturers using different casting and machining techniques, with each suited to a particular application. In many instances, their chemical compositions differ, but the method of manufacture and the heat treatment, if any, result in materials from different manufacturers with similar mechanical properties. The performance of rings made from two different materials might be very similar; i.e. several subclasses of materials could meet a given requirement.

In ring manufacture it is convenient to group materials into classes according to their moduli, since for a ring of given dimensions, the pressure it exerts on the cylinder wall is determined only by the modulus. The material strength is also generally related to modulus, i.e. the higher the modulus, the greater the strength, although there are exceptions depending on the method of manufacture. Material hardness, on the other hand, is determined by both chemical composition and heat treatment; this is made clear by the division of classes into subclasses. Because of this, the final choice of material and subclass is agreed between the manufacturer and client.

Internal combustion engines — Piston rings —

Part 3: Material specifications

1 Scope

This document classifies materials intended for the manufacture of piston rings, based on their mechanical properties and the stresses the materials are capable of withstanding.

This document is applicable to piston rings for reciprocating internal combustion engines up to and including those of 200 mm in diameter. It is also applicable to piston rings of compressors working under similar conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

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 https://www.electropedia.org/

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

4 Mechanical properties

The choice of material made in accordance with the mechanical strength criteria given in Table 1 shall also take into account the final coating of rings, engine characteristics (rating, liner surface, etc.) and microstructural features such as graphite, cementite and ferrite. ISO 6507-1 shall be used when measuring hardness of the piston ring base material.

Table 1 — Piston-ring materials and their mechanical properties

Class	Mechanical properties MPa or N/mm²		Material						Typical applications
	Typical modulus of elasticity	Minimum bending strength	Type	Minimum hardness [a] HV30	HRB	HRC	Specific details	Subclass code	
10	90 000	300	Grey cast iron	200	93	—	Non-heat treated	MC 11	Compression rings, scraper rings, and oil control rings
	90 000	350		205	95	—		MC 12	
	100 000	390		205	95	—		MC 13	
20	115 000	450	Grey cast iron	255	—	23	Heat treated	MC 21	Compression rings, and scraper rings
		450		290	—	28		MC 22	
		450		390	—	40		MC 23	
		500		320	—	32		MC 24	
	130 000	650		365	—	37		MC 25	
30	145 000	550	Carbidic cast iron	265	—	25	Heat-treated pearlitic	MC 31	
		500		300	—	30	Heat-treated martensitic	MC 32	
40	160 000	600	Malleable cast iron	210	95	—	Heat-treated pearlitic	MC 41	Compression rings, scraper rings, and narrow-width oil-control rings
		600		250	—	22	Heat-treated martensitic	MC 42	
		600		300	—	30	Heat-treated martensitic	MC 43	
		1 000		280	—	27	Heat-treated carbidic	MC 44	
50	160 000	1 100	Spheroidal graphite cast iron	255	—	23	Heat-treated martensitic	MC 51	
		1 300		255	—	23	Heat-treated martensitic	MC 52	
		1300		290	—	28	Heat-treated martensitic	MC 53	
		1 300		210	95	—	Pearlitic	MC 54	
				225	97	—	Ferritic	MC 55	
		1 300		345	—	35	Heat-treated martensitic	MC 56	
60	210 000	—	Steel	370	—	38	CrMoV-alloyed	MC 61	Compression rings
				390	—	40	CrSi-alloyed	MC 62	Coil springs, and compression rings
				485	—	48	CrSi-alloyed	MC 63	Compression rings
				450	—	45	CrSi-alloyed	MC 64	
				270	—	26	Martensitic (11 % Cr min.)	MC 65	Compression rings, 2 pieces oil-control rings, and rails
				270	—	26	Martensitic (17 % Cr min.)	MC 66	
				— [b]	—	—	Austenitic (16 % Cr min.)	MC 67	Expanders

[a] The hardness values are averages from three measurements on one ring, one being at the gap and the others 90° and 180° around from the gap. HV30 hardness testing is in accordance with ISO 6507-1. HRB and HRC are given for reference only. The application of the hardness measuring methods HRB and HRC is restricted, due to the geometry and the material of piston rings. The hardness values stated are used only for classifying the materials into the individual subclasses. Other hardness-measuring methods and their equivalent values shall be agreed between manufacturer and client.

All hardness figures refer to the finished piston rings and rails. However, in the case of nitrided steel rings the given hardness figures apply to the core hardness only.

[b] Hardness for expanders depends on the manufacturing process. Values for finished parts shall be agreed between manufacturer and client.

Table 1 *(continued)*

Class	Mechanical properties MPa or N/mm²		Material						Typical applications
	Typical modulus of elasticity	Minimum bending strength	Type	Minimum hardness [a] HV30	HRB	HRC	Specific details	Subclass code	
				450 [b]	—	—	Unalloyed	MC 68	Coil springs, expanders, and rails
				270	—	26	Martensitic (5 % Cr min.)	MC 69	Compression rings, 2 pieces oil-control rings, and rails

[a] The hardness values are averages from three measurements on one ring, one being at the gap and the others 90° and 180° around from the gap. HV30 hardness testing is in accordance with ISO 6507-1. HRB and HRC are given for reference only. The application of the hardness measuring methods HRB and HRC is restricted, due to the geometry and the material of piston rings. The hardness values stated are used only for classifying the materials into the individual subclasses. Other hardness-measuring methods and their equivalent values shall be agreed between manufacturer and client.

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