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Sintered metal materials — Specifications

Matériaux métalliques frittés — Spécifications

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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 3.

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.

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

International Standard ISO 5755 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 5, *Specifications for powder metallurgical materials (excluding hardmetals)*.

This second edition cancels and replaces the first edition (ISO 5755:1996), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Sintered metal materials — Specifications

1 Scope

This International Standard specifies the requirements for the chemical composition and the mechanical and physical properties of sintered metal materials used for bearings and structural parts.

When selecting powder metallurgical materials, it should be taken into account that the properties depend not only on the chemical composition and density, but also on the production methods. The properties of sintered materials giving satisfactory service in particular applications may not necessarily be the same as those of wrought or cast materials that might otherwise be used. Therefore liaison with prospective suppliers is recommended.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2738, *Sintered metal materials, excluding hardmetals — Permeable sintered metal materials — Determination of density, oil content and open porosity.*

ISO 2739, *Sintered metal bushes — Determination of radial crushing strength.*

ISO 2740, *Sintered metal material, excluding hardmetals — Tensile test pieces.*

ISO 2795, *Plain bearings — Sintered bushes — Dimensions and tolerances.*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature.*

3 Sampling

Sampling shall be carried out in accordance with the relevant International Standards.

4 Test methods for normative properties

4.1 General

The following test methods shall be used to determine the normative properties given in Tables 1 to 11.

4.2 Chemical analysis

Whenever possible, and always in cases of dispute, the methods of chemical analysis shall be those specified in the relevant International Standards. If no International Standard is available, the method may be agreed upon and specified at the time of enquiry and order.

4.3 Open porosity

The open porosity shall be determined in accordance with ISO 2738.

4.4 Radial crushing strength

The radial crushing strength shall be determined in accordance with ISO 2739.

4.5 Tensile strength

The ultimate tensile strength shall be determined in accordance with ISO 2740 and ISO 6892.

4.6 Tensile yield strength

The yield strength shall be determined in accordance with ISO 2740 and ISO 6892.

4.7 Mechanical properties

4.7.1 General

The mechanical properties given in Tables 1 to 11 were determined on pressed and sintered test pieces at mean chemical composition and are intended as a guide to initial selection of materials (see clause 1). They may also be used as a basis for specifying any special tests that may be indicated on the drawing.

The mechanical properties shall neither be calculated from hardness values, nor be determined on tensile test pieces taken from a component and used for verifying the values given in Tables 1 to 11. If the customer requires that a specified level of mechanical properties be obtained by tests on the component, these shall be agreed with the supplier and shall be stated on the drawing and/or any technical documentation of the customer referred to on the drawing.

4.7.2 Tensile properties

The normative values for yield strength shall be determined in accordance with ISO 6892, using pressed and sintered test pieces made in accordance with ISO 2740. For heat-treated materials, tensile strength and yield strength are approximately equal and in this case tensile strength, determined on machined test pieces according to ISO 2740, is specified.

4.7.3 Radial crushing strength

The radial crushing strength shall be determined in accordance with ISO 2739. The wall thicknesses of test pieces to be used shall be in the range covered by ISO 2795. For test pieces outside this range, the specified radial crushing strength values are different and shall be agreed between customer and supplier.

5 Specifications

The chemical composition and mechanical properties are given in Tables 1 to 11.

The liquid lubricant content of materials for bearings, impregnated with liquid lubricant, shall be not less than 90 % of the measured open porosity.

6 Designations

Designations shall be in accordance with annex A.

Table 1 — Materials for bearings: iron, iron-copper, iron-bronze and iron-carbon-graphite

Parameter	Symbol	Unit	Iron		Iron-copper		Iron-bronze [a]				Iron-carbon-graphite [a]		
			Grade [b]		Grade [b]		Grade [b]				Grade [b]		
Chemical composition			-F-00-K170	-F-00-K220	-F-00C2-K200	-F-00C2-K250	-F-03C36T-K90	-F-03C36T-K120	-F-03C45T-K70	-F-03C45T-K100	-F-03G3-K70	-F-03G3-K80	
C combined [c]		%	< 0,3	< 0,3	< 0,3	< 0,3	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	Normative values
Cu		%	—	—	1 to 4	1 to 4	34 to 38	34 to 38	43 to 47	43 to 47	—	—	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Sn		%	—	—	—	—	3,5 to 4,5	3,5 to 4,5	4,5 to 5,5	4,5 to 5,5	—	—	
Graphite		%	—	—	—	—	0,3 to 1,0	0,3 to 1,0	< 1,0	< 1,0	2,0 to 3,5	2,0 to 3,5	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	
Open porosity min.	P	%	22	17	22	17	24	19	24	19	20	13	
Radial crushing strength min.	K	MPa	170	220	200	250	90 to 265	120 to 345	70 to 245	100 to 310	70 to 175	80 to 210	
Density (dry)	ρ	g/cm^3	5,8	6,2	5,8	6,2	5,8	6,2	5,6	6,0	5,6	6,0	d
Coefficient of linear expansion [d]		10^{-6} K^{-1}	12	12	12	12	14	14	14	14	12	12	d

[a] The range of values given for radial crushing strength (K) indicates the necessity to maintain a balance between combined carbon and free graphite.

[b] All materials can be impregnated.

[c] On the basis of iron phase only.

[d] Informative values.

Table 2 — Non-ferrous materials for bearings

Parameter		Symbol	Unit	Bronze			Bronze with graphite			
				Grade [a]			Grade [a]			
Chemical composition				-C-T10-K110	-C-T10-K140	-C-T10-K180	-C-T10G-K90	-C-T10G-K120	-C-T10G-K160	
Cu			%	Balance	Balance	Balance	Balance	Balance	Balance	Normative values
Sn			%	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	
Graphite			%	—	—	—	0,5 to 2,0	0,5 to 2,0	0,5 to 2,0	
Total other elements max.			%	2	2	2	2	2	2	
Open porosity	min.	P		27	22	15	27	22	17	
Radial crushing strength	min.	K		110	140	180	90	120	160	
Density (dry)		ρ	g/cm^3	6,1	6,6	7,0	5,9	6,4	6,8	[b]
Coefficient of linear expansion [b]			10^{-6} K^{-1}	18	18	18	18	18	18	[b]

[a] All materials can be impregnated.

[b] Informative values.

Table 3 — Ferrous materials for structural parts: iron and carbon steel

Parameter		Symbol	Unit	Iron			Carbon steel								
				Grade			Grade								
Chemical composition				-F-00-100	-F-00-120	-F-00-140	-F-05-140	-F-05-170	-F-05-340H [a]	-F-05-480H [a]	-F-08-210	-F-08-240	-F-08-450H [b]	-F-08-550H [b]	
C combined			%	< 0,3	< 0,3	< 0,3	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	Normative values
Cu			%	—	—	—	—	—	—	—	—	—	—	—	
Fe			%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.			%	2	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength	min.	$R_{p0,2}$	MPa	100	120	140	140	170			210	240			
Ultimate tensile strength	min.	R_m	MPa						340	480			450	550	
Apparent hardness			HV5	62	75	85	90	120	280 HV10	300 HV10	120	140	320 HV10	360 HV10	Informative values
			Rockwell	60 HRF	70 HRF	80 HRF	40 HRB	60 HRB	20 HRC	25 HRC	60 HRB	70 HRB	28 HRC	33 HRC	
Density		ρ	g/cm^3	6,7	7,0	7,3	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	
Tensile strength		R_m	MPa	170	210	260	220	275	410	550	290	390	520	620	
Tensile yield strength		$R_{p0,2}$	MPa	120	150	170	160	200	a	a	240	260	c	c	
Elongation		A_{25}	%	3	4	7	1	2	nm [d]	nm [d]	1	1	nm [d]	nm [d]	
Young's Modulus			GPa	120	140	160	115	140	115	140	115	140	115	140	
Poisson's ratio				0,25	0,27	0,28	0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact			J	8	24	47	5	8	4	5	5	7	5	7	
Compressive yield strength		(0,1 %)	MPa	120	125	130	210	225	300	420	290	290	400	550	
Transverse rupture strength			MPa	340	500	660	440	550	720	970	510	690	790	950	
Fatigue limit 90 % survival [e]			MPa	65	80	100	80	105	160	220	120	170	210	260	

NOTE These materials may be supplied with additives to improve machinability. The properties remain unchanged.

[a] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[b] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[c] Tensile strength and tensile yield strength are approximately the same for heat treated materials.

[d] nm = not measurable.

[e] 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 4 — Ferrous materials for structural parts: copper steel and copper-carbon steel

Parameter	Symbol	Unit	Copper steel		Copper-carbon steel								
			Grade		Grade								
Chemical composition			-F-00C2-140	-F-00C2-175	-F-05C2-270	-F-05C2-300	-F-05C2-500H [a]	-F-05C2-620H [a]	-F-08C2-350	-F-08C2-390	-F-08C2-500H [b]	-F-05C2-620H [b]	
C combined		%	< 0,3	< 0,3	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	Normative values
Cu		%	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	140	175	270	300	c	c	350	390	c	c	
Ultimate tensile strength min.	R_m	MPa					500	620			500	620	
Apparent hardness		HV5	70	90	115	150	310 HV 10	390 HV 10	140	165	360 HV 10	430 HV 10	Informative values
		Rockwell	26 HRB	39 HRB	57 HRB	68 HRB	27 HRC	36 HRC	70 HRB	78 HRB	33 HRC	40 HRC	
Density	ρ	g/cm^3	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	
Tensile strength	R_m	MPa	210	235	325	390	580	690	390	480	570	690	
Tensile yield strength	$R_{p0,2}$	MPa	180	205	300	330	c	c	360	420	c	c	
Elongation	A_{25}	%	2	3	nm [d]	1	nm [d]	nm [d]	nm [d]	nm [d]	nm [d]	nm [d]	
Young's Modulus		GPa	115	140	115	140	115	140	115	140	115	140	
Poisson's ratio			0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact		J	7	8	7	10	5	7	7	8	6	6	
Compressive yield strength	(0,1 %)	MPa	160	185	380	400	560	660	450	480	560	690	
Transverse rupture strength		MPa	390	445	620	760	800	930	800	980	830	1 000	
Fatigue limit 90 % survival [e]		MPa	80	89	130	200	220	260	150	200	230	270	
Fatigue limit 50 % survival [f]		MPa			110	160			120	150			

NOTE These materials may be supplied with additives to improve machinability. The properties remain unchanged.

[a] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[b] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[c] Tensile strength and tensile yield strength are approximately the same for heat-treated materials.

[d] nm = not measurable.

[e] 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

[f] 50 % fatigue endurance limit in 4-point plane bending. Non-machined test pieces in accordance with ISO 3928.