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Rolling Bearings - Parts Made from High-carbon Chromium Bearing Steels - Specifications for Heat Treatment

滚动轴承　高碳铬轴承钢零件

热处理技术条件

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Foreword

This standard is drafted according to the rules given in GB/T 1.1-2009.

This standard replaces JB/T 1255-2001 *Specification for Heat-treatment of Rolling Bearing Parts Made from High Carbon Chromium Steel*.

Compared with JB/T 1255-2001, except editorial changes, this standard has the main technical changes as follows:

— The standard name is modified (see cover and first page of this edition; cover and first page of 2001 edition);

— Scope is partially modified (see Chapter 1 of this edition; Chapter 1 of 2001 edition);

— Technical requirements after spheroidizing annealing are modified (see Table 1 of this edition, Table 1 of 2001 edition);

— The hardness of partial bearing parts Martensite after quenching and tempering is modified (see Table 2 of this edition; Table 2 of 2001 edition);

— The requirements for microscopic structure of partial bearing parts Martensite after quenching and tempering are modified (see Table 4 of this edition; Table 4 of 2001 edition);

— The technical requirements of GCr15SiMo Bainite after isothermal quenching are added (see Table 5 of this edition);

— The technical requirements of bearing parts Bainite after isothermal quenching are modified (see Table 5 of this edition; Table 5 of 2001 edition);

— The technical requirements and test methods for residual austenite content and appearance quality are added (see Table 6 and Table 7 of this edition);

— The technical requirements, test methods as well as grade figures for fractures after quenching and tempering of bearing parts Martensite are deleted (see Table 5, Table 7 and Fifth Grade Figure of 2001 edition);

— The test of microscopic structure after 1000× magnification is added (Table 7 of 2001 edition);

— The grade figures of annealed, quenched and tempered structure under 500 times of magnification are modified and the grade figures under 500× magnification are added (see First and Second Grade Figures of this edition;

Rolling Bearings - Parts Made from High-carbon Chromium Bearing Steels - Specifications for Heat Treatment

1 Scope

This standard specifies the technical requirements and test methods of the annealed, quenched and tempered rolling bearing ring and rolling element (hereinafter referred to as "bearing parts") made from GCr15, GCr15SiMn, GCr15SiMo and GCr18Mo steels which meet those specified in GB/T 18254-2002.

This standard is applicable to the heat treatment quality test of bearing parts during process and finished parts made from above-mentioned steels and also applicable to the heat treatment quality test of bearing parts made from other high-carbon chromium steels. The bearing parts with special requirements shall be in accordance with corresponding product drawings.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the dated editions apply. For undated references, the latest editions (including any amendments) apply.

GB/T 230.1 Metallic Materials - Rockwell Hardness Test - Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

GB/T 231.1 Metallic Materials - Brinell Hardness Test - Part 1: Test Method

GB/T 1172 Conversion of Hardness and Strength for Ferrous Metal

GB/T 4340.1 Metallic Materials - Vickers Hardness - Part 1: Test Method

GB/T 6394 Metal - methods for Estimating the Average Grain Size

GB/T 17394 Metallic Materials - Leeb Hardness Test

GB/T 18254 High-carbon Chromium Bearing Steel

GB/T 24606 Rolling Bearings - Non-destructive Testing - Magnetic Particle Testing

Effective wall thickness of ring[a]	—	12	63	60~65	59~64	57~62	55~59	52	48
	12	30	62	59~64	57~62	56~60	54~58		
	30	—	60	58~63	56~61	55~59	53~57		
Nominal diameter of steel ball	—	30	64	61~66	60~65[c]	58~63[c]	56~60		
	30	50	62	59~64	58~63[c]	57~61	55~59		
	50	—	6l	58~64	57~62[c]	56~60	54~58		
Effective diameter of roller[a]	—	20	64	61~66	60~65[c]	58~63[c]	56~60		
	20	40	63	59~65	58~63[c]	57~61	55~59		
	40	—	61	58~64	57~62[c]	57~60	54~58		

Note: The division of dimension section and corresponding hardness requirements may be determined through negotiation between the manufacturer and user according to the working conditions and performance requirements of bearings.

[a] See Appendix A for the requirements of effective wall thickness of ring and effective diameter of roller, the same below.

[b] The codes for high-temperature tempering temperature 200°C, 250°C, 300°C, 350°C and 400°C as well as the hardness requirements after tempering are corresponding to the high-temperature tempering codes S0, S1, S2, S3 and S4 specified in Table 9 of JB/T 2974-2004 respectively.

[c] Without special requirements, the rolling element may not be subjected to high-temperature tempering, and the hardness value is hardness after routine tempering.

Table 3 Hardness Difference of the Same Bearing Part after Quenching and Tempering of Martensite

Parts name		Ring (outside diameter) mm			Rolling element (effective diameter) mm		Miniature bearing parts
Finished size mm	>	—	100	400	—	22	—
	≤	100	400	—	22	—	
Hardness difference HRC	max.	1	2	3	l	2	Without inspection

3.2.2 Microscopic structure

The microscopic structure of bearing parts after quenching and tempering of Martensite shall be composed of cryptocrystal, tiny crystals or small acicular Martensite, evenly distributed tiny residual carbide and small quantity of residual austenite, besides micro bearing, a small quantity of acicular or massive Troostite is allowed. The microscopic structure after quenching and tempering shall be in accordance with those specified in Table 4.

Table 4 Microscopic Structure of Bearing Parts after Quenching and Tempering

Tolerance grade	Parts material	Finished size/mm			Microscopic structure	
		Effective wall thickness of ring	Nominal diameter of steel ball	Effective diameter of roller	Martensite (Second Grade Figure)	Troostite (Third Grade Figure)[b] ≤

Test items	Test method
	for test. The microscopic structure may be tested under quenched state, if there is any objection, it is tested under tempered state; d) The troostitic structure after quenching and tempering shall be tested according to shape, dimension and quantity of Troostite in accordance with Third Grade Figure. The acicular or massive Troostite are tested according to corresponding grade figures for Troostite, and the acicular and massive-mixed Troostite is tested according to morphotype of Troostite accounting for main portion below field of view; e) The Bainite structure shall be tested according to degree of thickness, dimension and quantity of residual carbide particles for Bainite in accordance with Fifth Grade Figure.
Network carbide	It shall be magnified 500 times with metallographic microscope for test. The annealed specimen is tested on cross section after normal quenching and tempering, 4% solution of nitric acid and alcohol is adopted for deep etching, and the test is according to dimension of carbide net and sealing degree in accordance with Fourth Grade Figure.
Decarburized layer depth and surface soft spot	a) Surface decarburization and soft spot may be tested with cold pickling, and see Appendix G for the test regulations; b) The decarburized layer depth shall be measured according to those specified in JB/T 7362. For hot upset steel ball, the grinding surface of specimen shall be perpendicular to hoop, if measured with metallographic method, 2% solution of nitric acid and alcohol shall be adopted for etching under annealing condition and 4% solution of nitric acid and alcohol shall be adopted for etching under quenching and tempering condition; c) The decarburized layer depth shall be measured at the deepest decarburized part.
Cracks	It shall be tested according to those specified in GB/T 24606 and may also be tested with cool or hot pickling (see Appendix G) and other instruments and methods. If there is any objection, it is tested with hot pickling method.
Crushing load of steel ball	It shall be tested according to those specified in Appendix B.
Deformation of ring	The deformation of small-dimension ring shall be inspected with dial indicator, passimeter, passatest and flatness instrument; the deformation of large-dimension ring shall be inspected with dial-gauge, bridge leveling ruler and feeler gauge.
Temper stability	The hardness difference between corresponding points before and after tempering is inspected after retempering of tested specimen or parts according to specification of former tempering technique.
Average grain size	It shall be test according to those specified in GB/T 6394.
Residual austenite content	It shall be measure with X-ray diffraction (XRD) method or magnetic method; if there is any objection, it is measured with X-ray diffraction (XRD) method.
Appearance quality	Visual inspection.

from *H*/3 of the inner ring surface (*H* is a half the difference between the inside diameter and outside diameter); in l)~n), B_e is wall thickness from *H*/3 of ring on large end face (*H* is the width of ring); In o)~p), B_e is the wall thickness from *H*/3 on ring face (*H* is the width of ring); in q), B_e and D_s are thickness and diameter of ring at the circle of contact; in r) and s), B_e is the wall thickness at rolling surface of ring.

Figure A.1 Schematic Diagram for Effective Wall Thickness of Ring and Effective Diameter of Roller

Appendix B

(Normative)

Test Specifications for Crushing Load of Steel Ball and Crushing Load Values

B.1 Scope

This Appendix specifies the test specifications for crushing load of ø3mm~ø50.8mm steel balls and their crushing load values.

B.2 Test specifications for crushing load of steel ball

B.2.1 Take three groups of heat treated steel balls (nine) from each batch for the crushing load test and the steel balls shall have the same dimension tolerance.

B.2.2 When the heat treated rerolled steel balls are subjected to the crushing test, the steel ball surface shall be free from grinding wheel defects, stain, bump or hard spots, etc.

B.2.3 In the crushing test, loading speed may be according to 980N/s~5880N/s.

B.2.4 In steel ball crushing test, if the applied loads are over the limit, the steel balls shall be unloaded even though they are not crushed; where there are special requirements, the steel balls may be loaded until they are crushed.

B.2.5 Take down the ball mould from the tester, open the protecting casing and take the balls out into the covered iron case for fear that the steel ball is crushed to do harm to the people and record the test results.

B.2.6 During the test, the inaccurate results, caused by shedding of balls at improper position or the cracked balls, shall be cancelled and the sample shall be retaken for the test.

B.2.7 If the crushing load has reached the specified standard during the test, while steel balls crush during the unloading, the results shall be regarded as qualified.

B.2.8 In the test, loading speed shall not be suddenly changed; midway unloading is not allowed.

B.2.9 The tester will vibrate greatly with pointer bounced and reading inaccurate when the steel balls crush; the attention shall be paid to the load reading when the

steel balls are about to crush.

B.2.10 The crushing mould is so designed to suit the steel ball size, at an angle of 90°; the mould may be made of tool carbon steel or bearing steel and has 60HRC~65HRC hardness after quenching and tempering.

B.3 Crushing load values of steel ball

See Table B.1 for crushing load values of steel ball.

Appendix C

(Informative)

Decarburized Layer Depth of Bearing Parts after Quenching and Tempering

See Table C.1 for decarburized layer depth of bearing parts after quenching and tempering.

Table C.1 Decarburized Layer Depth of Bearing Parts After Quenching and Tempering

Ring			Steel ball			Roller		
Nominal diameter [a]		Decarburized layer depth	Nominal diameter		Decarburized layer depth	Nominal diameter		Decarburized layer depth
mm		mm	mm		mm	mm		mm
>	≤	max.	>	≤	max.	>	≤	max.
—	30	0.03	—	19.05	0.05	—	20	0.03
30	180	0.05	19.05	30.1625	0.06	20	50	0.05
180	250	0.06	30.1625	42.8625	0.08	50	80	0.08
250	500	0.15	42.8625	76.2	0.12	80	—	0.10
500	—	0.20	76.2	—	0.15			

[a] Nominal inside diameter of inner ring or nominal outside diameter of outer ring.

Appendix D

(Informative)

Allowable Deformation of Bearing Ring after Quenching and Tempering

See Table D.1~Table D.4 for allowable deformation of bearing ring after quenching and tempering.

Table D.1 Allowable Variation of Outside Diameter V_{Dsp} and Outside Diameter Allowance of Bearing Outer Ring after Quenching and Tempering

mm

Nominal outside diameter		Diameter series 2, 3, 4	Diameter series 8, 9, 0, 1	Dimension series 08, 09, 00, 01, 82, 83	Outside diameter allowance (recommended value)	
>	≤	V_{Dsp}max.			min.	max.
—	30	0.06	0.08	0.10	0.15	0.25
30	80	0.12	0.16	0.18	0.20	0.30
80	150	0.20	0.25	0.30	0.30	0.45
150	200	0.25	0.30	0.35	0.35	0.55
200	250	0.30	0.40	0.50	0.50	0.70
250	315	0.45	0.55	0.65	0.65	0.85
315	400	0.50	0.60	0.70	0.80	1.10
400	500	0.65	0.70	0.85	1.10	1.30
500	630	0.80	0.85	1.00	1.20	1.55

Table D.4 Allowable Diameter Deformation V_{dsp}, Planeness Ape and Height Allowance of Thrust Bearing Gasket and Spacer after Quenching And Tempering

mm

Nominal diameter [a]		Diameter series 2, 3, 4 gasket				Diameter series 0, 1 gasket				Spacer			
>	≤	V_{Dsp}	Height allowance (recommended value)		Ape	V_{Dsp}	Height allowance (recommended value)		Ape	V_{Dsp}	Height allowance (recommended value)		Ape
		max.	min.	max.	max.	max.	min.	max.	max.	max.	min.	max.	max.
30	50	0.15	0.30	0.40	0.15	0.15	0.35	0.45	0.20	—	—	—	—
50	80	0.25	0.35	0.45	0.25	0.25	0.40	0.50	0.35	—	—	—	—
80	120	0.25	0.40	0.52	0.35	0.35	0.45	0.57	0.35	1.0	0.50	0.65	0.45
120	180	0.30	0.45	0.57	0.40	0.40	0.50	0.62	0.45	1.0	0.60	0.75	0.55
180	250	0.35	0.50	0.65	0.45	0.45	0.60	0.75	0.55	1.0	0.80	1.00	0.70
250	300	0.40	0.60	0.78	0.55	0.55	0.80	0.98	0.70	1.2	0.90	1.10	0.80
300	400	0.45	0.70	0.90	0.65	0.65	0.90	1.10	0.75	1.2	1.00	1.25	0.90
400	500	0.55	0.80	1.00	0.70	0.70	1.00	1.20	0.85	1.2	1.20	1.45	1.10
500	600	0.60	0.90	1.15	0.80	0.80	1.05	1.35	0.95	1.5	1.40	1.70	1.20

[a] Nominal inside diameter of inner ring or nominal outside diameter of outer ring.

Appendix E

(Informative)

Residual Austenite Content of Bearing Parts after Quenching and Tempering

See Table E.1 for residual austenite content of bearing parts after quenching and tempering.

Table E.1 Residual Austenite Content of Bearing Parts After Quenching And Tempering.

Bearing tolerance class	P2, P4	P0, P5, P6, P6X
Residual austenite content	≤5%	≤15%
Note: The residual austenite content, subjected to special heat treatment, may be subject to the users' requirements.		

Appendix G

(Normative)

Acid Cleaning Inspection Specifications

G.1 Cold pickling

This specification is used to inspect the surface soft spot, decarbonization and parts cracks after quenching and tempering. Before acid cleaning, the parts shall be subjected to sand blasting and degreasing cleaning to clean surface scale and oil stain. The cold pickling is carried out at room temperature.

G.1.1 Cold pickling process flow

G.1.1.1 Pickling treatment

Place the bearing parts into 6%~30% (volume ratio) nitric acid water solution pickling tank for 1min and wash them in the flowing cold water tank for 1~2min.

The nitric acid concentration in the tank is only for reference and may be adjusted according to the surface darkness and dimension consumption of the parts after acid cleaning. The nitric acid concentration may adopt 6% when the acid cleaned parts surface is subjected to decarbonization.

G.1.1.2 First purifying treatment

In the first purifying tank, purify the acid cleaned parts for 10s~20s and wash them in the flowing cold water tank for 1~2min. The mixture ratio of purifying tank solution composition may select any one in Table G.1.

Table G.1 Mixture Ratio of Solution Composition in the First Purifying Tank

Chemical composition	Type	
	1	2
	Volume ratio	
Phosphoric acid	—	10%~15%
Sodium hydroxide	3%~5%	—
Potassium permanganate	3%~5%	3%~5%
Trisodium phosphate	6%~9%	—
Sulfuric acid	—	—
Water	Allowance	Allowance
Note: The solution is prepared by adding sulfuric acid after water to avoid splashing.		

G.1.1.3 Second purifying treatment

a) Qualified surface: uniform and consistent dark gray;

b) Surface soft spot: loud-shape dark black spot, and the periphery is incomplete;

c) Decarburization: grey-white or dark black stain;

d) Crack: dark black smaller-strips.

G.2 Hot pickling

This specification is used to inspect the surface crack of bearing parts after quenching and tempering. Before acid cleaning, the parts shall be subjected to sand blasting and degreasing cleaning to clean surface scale and oil stain.

G.2.1 The bearing parts shall be subjected to stress tempering before hot pickling and the tempering temperature shall be greater than 350°C for 2h~3h.

G.2.2 Place the bearing parts into 50% hydrochloric acid water solution, heat the solution to 60°C±5°C for pickling 10~30min and then wash them in the flowing cold water tank for 1~2min.

G.2.3 The parts subjected to hot pickling shall be observed under floodlight immediately after being dried.

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