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Forging (rolling) steel grinding balls

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Forging (rolling) steel grinding balls

1 Scope

This standard specifies the terms and definitions, classification and code, technical requirements, test methods, inspection rules, packaging, marking, transportation, storage of forging (rolling) steel balls.

This standard applies to forging (rolling) steel balls, which are used as grinding media in ball mills, semi-autogenous mills, etc.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 229 Metallic materials - Charpy pendulum impact test method

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 2828.1 Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

GB/T 8541 Terminology of forging and stamping

YB/T 081 Rule for rounding off of numerical values and judgement of testing values for technical standards of metallurgy

3 Terms and definitions

The terms and definitions defined in GB/T 8541, as well as the following terms and definitions, apply to this document.

3.1

Forging steel grinding balls

Steel grinding balls formed by forging process.

6.2 The chemical analysis and internal structure inspection of steel balls and blank materials shall be carried out in accordance with the methods specified in Appendix A and relevant regulations.

6.3 The test of impact energy absorption value shall be carried out using a 10 mm × 10 mm × 55 mm unnotched specimen, which is cut on the steel ball, in accordance with the provisions of GB/T 229.

6.4 The number of drop ball tests shall be carried out in accordance with the method specified in Appendix B.

6.5 The hardness test shall be carried out in accordance with the provisions of GB/T 230.1. When preparing the specimen, wire cutting or electric spark cutting shall be adopted, or the surface of the ball shall be ground into a flat surface for inspection; the grinding thickness shall be 2 mm ~ 5 mm.

6.6 The detection and calculation of the breakage rate of balls shall be carried out in accordance with the provisions of Appendix C of this standard.

6.7 The surface defects of the steel ball shall be detected by visual inspection.

6.8 The hardness uniformity of the steel ball can be expressed by the average volume hardness.

6.8.1 The calculation method of the average volume hardness of the steel ball is shown in formula (1).

$$AVH = 0.009HRC_{core} + 0.063HRC_{r/4} + 0.203HRC_{r/2} + 0.437HRC_{3r/4} + 0.289HRC_{surface} \dots\dots\dots(1)$$

Where:

AVH - Average volume hardness of steel ball (HRC);

HRC_{core} - Hardness at measurement point of steel ball core, which is point A in Figure 1 (HRC);

$HRC_{r/4}$ - Hardness at measurement point 1/4 of steel ball radius, which is point B in Figure 1 (HRC);

$HRC_{r/2}$ - Hardness at measurement point 1/2 of steel ball radius, which is point C in Figure 1 (HRC);

$HRC_{3r/4}$ - Hardness at measurement point 3/4 of steel ball radius, which is point D in Figure 1 (HRC);

$HRC_{surface}$ - Hardness value at the measuring point on the steel ball surface, which is point E in Figure 1 (HRC);

unqualified.

7.5 Inspection of the hardness of the steel ball core: For every 200t of steel balls of the same type and specification produced continuously (less than 200t is counted as one batch), steel balls with a surface hardness of the lower limit specified in Table 3 shall be sampled for inspection. If the inspection fails, it shall double the samples from this batch for re-inspection. If the chemical composition is qualified, re-heat treatment is allowed. If there are still unqualified results, the batch shall be unqualified.

7.6 Type inspection

If one of the following situations occurs, type inspection shall be carried out in accordance with all technical requirements specified in this standard. Whether the type inspection is qualified shall be determined according to the exit-factory inspection judgment rules.

- a) When a new product is trial-produced;
- b) When the production process has a major change that may affect the product quality;
- c) After mass production, it shall be inspected at least once every six months;
- d) When production is resumed after a long-term suspension;
- e) When the exit-factory inspection results are significantly different from the previous type inspection;
- f) When the national quality supervision agency proposes a type inspection requirement.

7.6.1 Dimensions and allowable deviations, shape and surface quality are sampled according to the normal secondary sampling plan in GB/T 2828.1, at general inspection level I, AQL = 6.5.

7.6.2 Randomly select 5 products, that pass the size and allowable deviation, shape and surface quality inspection, for mechanical properties inspection. Then randomly select 1 product from the 5 for chemical composition inspection.

8 Packaging, marking, transportation, storage

8.1 Packaging

Steel balls shall be packaged in iron barrels or woven bags or in bulk.

8.2 Marking

Appendix A

(Normative)

Standards for physical and chemical inspection methods for steel products

GB/T 223.3 Chemical analysis methods for steel and alloys: Determination of phosphorus content by dianthipyryl methane phosphate aluminate gravimetric method

GB/T 223.4 Alloyed steel - Determination of manganese content - Potentiometric or visual titration method

GB/T 223.5 Steel and iron - Determination of acid-soluble silicon and total silicon content - Reduced molybdosilicate spectrophotometric method

GB/T 223.11 Iron, steel and alloy - Determination of chromium content - Visual titration or potentiometric titration method

GB/T 223.12 Methods for chemical analysis of iron, steel and alloy - The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content

GB/T 223.13 Methods for chemical analysis of iron, steel and alloy - The ammonium ferrous sulfate titration method for the determination of vanadium content

GB/T 223.14 Methods for chemical analysis of iron, steel and alloy - The N-benzoyl-N-phenylhydroxylamine extraction photometric method for the determination of vanadium content

GB/T 223.16 Methods for chemical analysis of iron, steel and alloy - The chromotropic acid photometric method for the determination of titanium content

GB/T 223.17 Methods for chemical analysis of iron, steel and alloy - The dianthipyrylmethane photometric method for the determination of titanium content

GB/T 223.58 Methods for chemical analysis of iron, steel and alloy - The sodium arsenite-sodium nitrite titrimetric method for the determination of manganese content

GB/T 223.59 Iron, steel and alloy - Determination of phosphorus content - Bismuth phosphomolybdate blue spectrophotometric method and antimony phosphomolybdate blue spectrophotometric method

GB/T 223.60 Methods for chemical analysis of iron, steel and alloy - The perchloric acid dehydration gravimetric method for the determination of silicon content

GB/T 223.61 Methods for chemical analysis of iron, steel and alloy - The ammonium

Appendix B

(Normative)

Test method for grinding ball impact fatigue life

The grinding ball impact fatigue life test by falling ball method (hereinafter referred to as the falling ball test) is to use a falling ball impact fatigue testing machine (hereinafter referred to as the falling ball testing machine), to simulate the impact process of steel balls in a ball mill, under laboratory conditions.

The number of impacts is displayed by a counter. The number of impact fatigue failures reflects the impact fatigue life of the steel ball under this condition.

B.1 The falling distance of the falling ball machine is 8 m.

B.2 The specimens of the falling ball test shall be 20 steel balls randomly selected from the batch to be inspected as test balls; another 3 or more steel balls shall be selected as replacement balls. Marks shall be made on the surface of the replacement balls.

B.3 The falling ball test is conducted at room temperature.

B.4 The steel ball failure judgment and test procedure are as follows:

B.4.1 Steel ball failure judgment

- a) The average diameter of the peeling layer on the steel ball surface (the average of the maximum diameter and the minimum diameter) is greater than 20 mm, meanwhile the middle thickness is greater than 5 mm.
- b) The steel ball breaks along the middle.

B.4.2 Test procedure

B.4.2.1 First, put 16 test balls into the curved pipe. Start the test machine. Gradually put the remaining 4 test balls into the circulation conveying system, from the downhill slide.

B.4.2.2 Turn on the counter. Reset the counter. Clear the alarm. Turn the digital dial to the preset number (10000).

B.4.2.3 The test personnel shall observe carefully on site. When it is found that one test ball fails in accordance with the provisions of a) or b) in B.4.1, take out the failed ball and put in a replacement ball, until the third failed ball appears. Record the cumulative number of impacts received by the 3 test balls in the falling ball machine system when they fail. If the number of failed balls in the test has not reached the failed ball number

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