Standards for
METAL BALLS

Contents

Metall Balls

Balls for rolling contact bearings and other uses

1. Scope:
This standard establishes the requirement for finished matal balls for rolling contact (ball) bearings and other uses.

2. Definitions and symbols:
The following definitions and symbols will be apply to terms used in this standard.

2.1 Nominal ball diameter, D_W

The diameter value that is used for the purpose of general identification of a ball size: ¼”, 6mm etc.

2.2 Single diameter of a ball, D_{WS}

The distance between two parallel planes tangent to the surface of a ball

2.3 Mean diameter of a ball, D_{WM}

The arithmetic mean of the largest and the smallest actual single diameter of a ball

2.4 Ball diameter Variation, V_{DWS}

The difference between the largest and the smallest actual single diameter of one ball

2.5 Deviation from spherical form, ΔR_W

The greatest radial distance in any radial plane between a spere circumscribed around the ball surface and any point on the ball surface

2.6 Lot
A definite quantity of balls manufactured under conditions which are presumed uniform and which is considered and identified as an entity.

2.7 Lot mean diameter, D_{wmL}

The arithmetic mean of the mean diameter of the largest ball and that of the smallest ball in the lot

2.8 Lot diameter variation, V_{DwL}

The difference between the mean diameter of the largest ball and that of the smallest ball in the lot.

2.9 Nominal ball diameter tolerance.

The maximum allowable deviation of any ball lot mean diameter from the nominal nall diameter.

2.10 Container marking increment

The standard unit steps, in micrometres or in millionthe of an inch, used to express the specific diameter

2.11 Specific diameter

The amount by which the lot mean diameter(DwmL) differs from the nominal diameter(Dw), accurate to the container marking increment for that grade (table D The specific diameter should be marked on the unit container

2.12 Ball grade

A specific combination of dimensional form and surface roughness tolerances. A ball grade is designated by a grade number

2.13 Ball gage, S

The prescribed small amount by witch the lot mean diameter should differ from nominal diameter, this amount being one of an established series of amounts. A ball gage, in combination with the ball grade and nominal ball diameter, should be Considered as the most exact ball size specification to be used by a costumer for ordering purposes.

2.14 Ball gage deviation, ΔS

The difference between the lot mean diameter and the sum of the nominal diameter and the ball gage.

2.16 Surface roughness, Ra

Surface roughness consists of all those irregularities which from surface relief and which are conventionally defined within the area where deviations of form and waviness are eliminated

2.17 Waviness

The more widely spaced circumferential component of surface texture. (Lacking standardized practices in this field, the specifications and tolerances for waviness are subject to agreement between consuner and manufacturer).

2.18 Hardness

The measure of resistance to penetration of the ball surface or truncated flat of the ball by a sprcific indenting shape as determined by specified methods.

2.19 Case depth

The distance measured radially from the surface of the ball to a point where the hardness becomes the equivalent to R_c 50. This term is applicable to case hardened balls only.

2.20 Passivation

A chemical treatment to remove corrodible surface impurities and to provide a protective film. This term is applicable to corrosion resisting balls only.

3. Requirements

3.1 Materials

The material list in table A are the most commonly used, however other materials are available from individual suppliers. For typical chemical analysis and a cross reference of other applicable specifications refer to the Unified Numbering System for metals and alloys published by SAE, Warrendale, Pennsylvania.

3.2 Hardness

Hardness of balls manufactured of the materials in 3.1 shall be agreed between manufacturer and purchaser. Table A shows typical hardness values.

3.3 Case depth

Carbon steel balls shall be processed to provide the minimum case depths specified in table B

3.4 Quality of surface

Surface appearance of balls manufactured from the material specified in 3.1 shall meet the requirement specified below.

3.4.1 Chrome alloy, Corrosion resistant hardened and alloy tool steel balls

These shall be free from cracks, pits, rust and indications of soft spots visible without magnification, excapt that grades 3, 5 and 10 in sizes 3mm (1/8") diameter and smaller may be inspected by microscopic examination not exceeding 10 power.

3.4.2 Corrosion resisting unhardened steel balls

These shall be free from cracks, pits and rust when examined visually without magnification.

3.4.3 Carbon steel balls

These shall be free from rust and indications of soft spots when examined visually without magnification.

3.4.4 Silicon Molybdenum steel balls

These shall be free from cracks, pits, rust, dacarburization and soft spots when examined visually without magnification.

3.4.5 Non-ferrous metal balls

Balls of non-ferrous alloys, aluminium, aluminium bronze, brass, bronze, monel metal and K-monel metal shall be free from cracks when examined visually without magnification.

3.4.5 Tungsten carbide balls

These shall be free from cracks when examined visually without magnification.

3.5 Geometric Quality

Tolerance for size, form and surfaces roughness are listed in tables C and D for the various grades.

3.5.1 Master balls and comparative measurements

All measurements for size and size variation shall be based on comparative measurements made relative to master balls, the sizes of witch are traceable to the National Bureau of Standards. The size of master balls shall be corrected to zero gage pressure and to a temperature of 20°C (68°F).

3.5.1.1 Master balls

Master balls shall be made of chrome steel or tungsten carbide, Rc 64 hardness or higher. For balls sizes 1.5mm (1/16") diameter and smaller master balls may be of 440C steel, Rc 60 hardness or higher. The permissible diameter variation shall be $1/10^{th}$ of the allowable diameter variation per ball for the grade of balls to be measured, or 0.05 micrometers (2 micro-inches), whichever is larger. The calibrated diameter of the master ball is defined as the mean of at least twenty (20) randomly oriented diameters and must be known to an accury equal to plus or minus the magnitude of the permissible diameter variation of the master ball or plus or minus 0.08 micrometers (3 micro-inches), witchever is larger.

3.5.1.2 Gage pressure

Gage contact material shall have at least the same hardness as the ball measured. Gage contacts must be flat, or if convex, have a contact radius not less than 3mm or 0.125".

Maximum measuring pressures at gage contacts shall not exceed 1.1 Newtons (4 ounces) for balls up to and including 25mm (1”) nominal diameter and not exceed 2.2 Newtons (8 ounces) for larger nominal diameter, including ball weight if significant.

3.5.1.3 Size corrections for balls of other materials

For production measurements of balls of materials other than that of the master ball, corrections shall be made to zero gage pressure and to a temperature of 20°C (68°F).

3.6 Corrosion resistance

Corrosion resistant steel balls, hardened and unhardened of materials specified in table A shall be subject to the following requirements

3.6.1 Passivation

Balls shall be passivation surface treated to remove all traces of corrodible impurities

3.6.2 Corrosion test

Finished balls shall be capable of passing the following corrosion test.

A sample of balls shall be immersed in distilled water at 38°C±3C (100°F±5°F) for a period of one hour, followed by air drying 38°C±3°C (100°F±5°F) for a period of one hour.
This cycle shall be repeated for a total period of 24 hours.
At the end of the 24 hour period, the sample balls shall be examined for surface corrosion. No ball in the sample may be exhibit corrosion visible under 10 power magnification.

4. Standard and preferred sizes by materials and grades

4.1 Standard nominal sizes

Table E1,E2,E3 lists standard nominal diameter sizes in the size range 0.3 – 115 mm (1/64 – 4-1/2 inches)

4.2 Preferred nominal size ranges by materials and grades

Table A lists preferred grades and nominal size ranges by spezified materials

5. Quality assurance provisions

5.1 Grades 3-24 inclusive

Unless otherwise required, product shall be capable of passing acceptance inspection in accordance with MIL-STD-105, as required in specification MIL-B-1083, as stipulated in table F.

5.2 Grades 48 – 1000

Quality assurance provisions for thes grades are not standardized and shall be subject to agreement between manufacturer and purchaser.

5.3 Methods of inspection

All inspection operations shall be carried out in an environment suitable for the grades furnished, by skilled personnel and with equipment of accuracy and magnification suitable for the various operations required by this standard, as enumerated in 3 and in accordance with table F

5.3.1 Ball diameter variation

Measure and record the largest and the smallest diameter of each ball in the sample and compute the diameter variation of each ball. Record the largest variation found on any one ball. Compute in accordance with 2.4

5.3.2 lot diameter variation

Using the information obtained from 5.3.1, compute the mean diameter of the largest ball in the sample and that of the smallest ball. Compute and record the lot diameter variation in accordance with 2.8.

5.3.3 Deviation from ball gage

Using the information obtained from 5.3.2, compute the lot mean diameter in accordance with 2.7. Compute the deviation from ball gage in accordance with 2.14 using the nominal diameter D_w and the ball gage S as ordered.

5.3.4 Deviation from spherical form

Pending further standardization of methods, the use of either of the methods specified in appendix I is permissible

5.3.5 Surface roughness

For those grades where surface roughness requirement apply, mesurements shall be made on equipment meeting the requirements of and in accordance with ANSI standards B46.1.

5.3.6 Surface appearance

Examination sshall be conducted in accordance with the requirements of 3.4 for the material specified.

5.3.7 **hardness**

Rockwell hardness measurements shall be made in accordance with ASTM standards E-18. Hardness of balls up to 2,5mm (3/32”) shall be subjected to microhardness testing, recommendations for which are given in appendix II.1. Balls from 2,5mm (3/32”) to 5mm (3/16”)
Shall be subjected to microhardness testing or shall be checked on parallel flats on the HR30N scale and converted to hardness R_c. Hardness of balls from 5mm (3/16”) and larger shall be tested on the HR_C scale.Hardness of carbon steel balls 3mm (1/8”) to 6mm (1/4”) may be taken using HR30N scale. Hardness of carbon steel balls 6mm (1/4”) and larger using a HRC scale are subject to the correction factors in table K, appendix II.3. Hardness of corrosion resisting unhardened steel, aluminium, aluminum bronze, brass, bronze, Monel and K-Monel balls 3mm (1/8”) and larger may be taken using a superficial hardness test.

5.3.8 Surface Corrosion

The appropriate visual examination for balls of the various materials as stated in 3.4 shall be conducted using no magnification or microscopic inspection as there stated.

5.3.9 Prosity of tungsten carbide balls

Inspection for porosity of balls of this material shall be conducted in accordance with ASTM standard B-276

6. Ordering specifications and package marking
Please see Standard

List of Tables:

Table number	Discription
A	Commonly used material specification reference chart
B	Case depth requirement for carbon steel balls
C	Tolerances by grade for individual balls
D	Tolerances by grade for lots of balls
E1,E2,E3	Prefered ball sizes
F	Applicable inspection levels and AQL
G	Magnification factor
H	Ball hardness corrections for curvatures
K	Density of common ball materials
L1,L2	Number of balls
M1,M2	Weight of balls