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The association of independent consultants in geology, mineral resources, mining and metal industry

Steel Grinding Balls Market Research in Russia and Forecast of Its Development in Conditions of the Economic Crisis

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Annotation

The report is devoted to investigation of current standing of market of steel grinding balls in Russia and forecast of the market development up to 2015. The report consists of 6 Sections, contains 164 pages, including 41 Figures, 61 Tables and 3 Appendices. This work is desk study. As information sources, we used data of Rosstat, Inter-State Committee on Statistics of CIS countries, Federal Customs Service of Russia, official domestic railage statistic of JSC RZhD, sectoral (industrial) and regional press, annual and quarterly reports of companies, as well as data from web-sites of company-producers and consumers of steel grinding balls. Notice that, in Russia, trucking of freight is not liable to obligatory statistic account, so the report considers only data on railage of the product.

The first Section of the report presents review of technology of production and requirements, imposed on quality of steel grinding balls, produced in Russia. The second Section is devoted to analysis of production statistics for the period of 1998-2008, including data on steel grinding balls output in Russia, dynamics of production of the commodity products, regional pattern of the production, as well as consideration of current standing of key large producers of steel grinding balls. The Section presents data on technology of production and applied equipment, range and grade of products, the production volumes, plans on enterprise development, as well as data on volumes and flows (destinations) of supplies of the products for 2002-2008.

The third Section is devoted to analysis of Russian foreign trade in steel grinding balls in 1998 - 2008. Besides, the Section presents brief description of markets of steel grinding balls of the main country-consumers of the production: Ukraine, Kazakhstan, Uzbekistan.

The fourth Section is devoted to analysis of prices on steel grinding balls in Russia, including data on release domestic prices of the main Russian producers, as well as analysis of export-import prices from 1999 to 2008.

The fifth Section presents analysis of consumption of steel grinding balls in Russia. The Section presents supply-demand balance of the product. Description of the main end-uses of steel grinding balls (mining and cement industries) and characteristics of the greatest consumers of steel grinding balls (including dynamics of their production) in Russia are given. Besides, the Section presents forecasts of development of the main end-uses of steel grinding balls.

The sixth, final Section of the report presents forecast of production of steel grinding balls in Russia for 2009-2015 and forecast of consumption of steel grinding balls for the period.

The Appendices include addresses and contact information on the main enterprise-producers of steel grinding balls and large consumers of the products in iron ore, nonferrous metallurgy, gold-producing, cement, power-generating sectors.

Introduction

Grinding balls, as follows from their name, are used in mill crushing facilities as mill medium. The balls are characterized by wear-resistance, density and shape, and are produced from cast iron and steel, including alloyed one.

Crushing-mill facilities are subdivided generally into: 1) aerodynamic or jet mills (without mill bodies) and 20 mechanical mills (with mill bodies). In turn, the mechanical mills are subdivided into 4 groups: rotary, roll-ring, cup and disc.

At concentrators, mainly rotary-type mills are applied, in which, as mill bodies, steel and cast iron balls, rods, natural pebble and ore lumps are used.

Steel grinding balls (especially alloyed-steel ones) are more wear-resistant than cast iron ones. Steel grinding balls are manufactured in accordance with GOST 7524-89 and also with TU (Specifications).

Total consumption and specific consumption of grinding balls are determined by type of equipment used, material, of which grinding ball produced, and their production technology. According to official statistics, most of the balls produced belongs to steel balls.

1. Review of production technologies and grade of products

1.1. The main processes of grinding ball production

Steel grinding balls are manufactured by screw rolling method at helical rolling ball mills from round billet at screw pass (2 rolls). At one-entry sizing (grooving), one ball is rolled per one rolls revolution; at multi-entry sizing – quantity of balls produced is equal to number of entries of screw pass. Then balls are cooled and quenched in water to provide required hardness. Screw passes are prepared using special devices at screw-cutting lathe machines. Making balls by rolling provides 2-8 times higher productivity and 10-15% less metal consumption compared with forging method. In Russia and other CIS countries, technological complexes for manufacturing high-grade grinding balls have been created, including billet heating furnace, ball-rolling mill, quenching and transporting facilities.

Besides, in forgeries of enterprises, ***forged and stamped steel balls*** are manufactured. JSC Novokuznetsk Iron&Steel Integrated Works (NKMK) manufactures large-diameter (120 mm) balls by forging-stamping methods, which demonstrate increased strength (service-life of such balls is 3 times as great as that of balls, produced at ball-rolling mills).

In Russia, steel grinding balls are produced by main enterprise-producers in special ball-rolling shops at ball-rolling mills.

According to results of the «InfoMine» investigation, obvious leaders and even monopolist in production of ball-rolling mills (SHPS) is VNIIMetmash.

All-Russian scientific-research and designing institute of metallurgical machine building (VNIIMETMASH), found in 1959 on the base of TsKBMM and Perovsky machine building plant, for a long time is one of leading producers of wide range of machine-building products for metallurgical, aerospace, oil-gas, nuclear, transport and other industries.

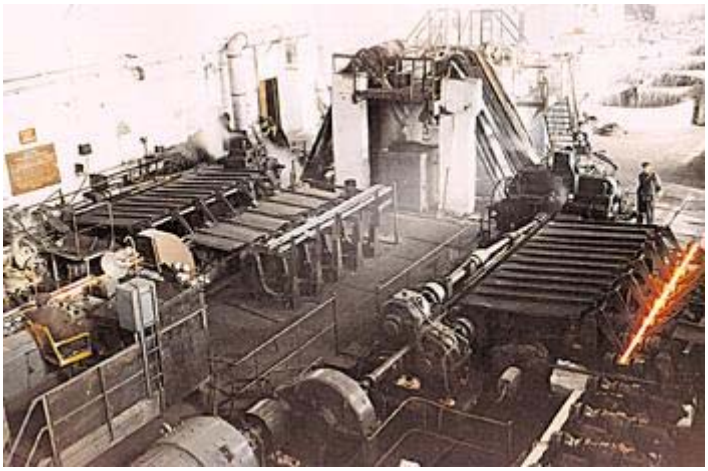
Now state scientific center of RF – join-stack holding company VNIIMetmash named after academician A. Tselikov has unique experimental and production base, providing realizing complete cycle of works on creation, manufacturing, supply, services and modernizing of industrial facilities, including for metallurgical sector.

VNIIMetmash structure includes Moscow Experimental Plant (MOZ), manufacturing facilities, elaborated by the Institute.

VNIIMetmash ball-rolling mills (Fig. 1) are designated for manufacturing grinding balls of diameter from 20 to 125 mm by hot screw rolling in screw sizers of carbon- low- and medium-alloyed round rod steel. Ball-rolling mills and technology of rolling are original elaborations. Practically all producers of steel grinding balls in Russia, CIS, and many ones in other countries apply SHPS, elaborated by VNIIMetmash. Currently the Institute offers the following services:

- Elaboration, manufacturing and complex supply of equipment for rolling grinding balls. Mounting and adjusting the equipment. Guaranty and post-guaranty services;
- Supply of rolls and devices for treating passes of rolls;
- Sale of licenses.

Figure 1. Ball-rolling complex SHPS 40-100, elaborated by VNIIMETMASH



Source: VNIIMETMASH

For many years of existence, ball-rolling mills elaborated by VNIIMetmash, were installed at many metallurgical enterprises of the world (Table 1).

Table 1. Ball-rolling mills of VNIIMetmash at metallurgical enterprises in the world

Type of mill	Owner	Country	Supplied	Rolled items
SHPS 80 - 120	APO «Uzbek iron&steel integrated works»	Uzbekistan	2001	Grinding balls Ø100, 120 mm
MS-64 ***modernisation***	JV «Erdenet-Metall»	Mongolia	1999	Grinding balls Ø60, 80, 100 mm
SHPS 40 - 80/100 ***modernisation***	APO «Uzbek iron&steel integrated works»	Uzbekistan	1998	Grinding balls Ø68, 80, 92, 100 mm
SHPS 20 - 60	Firm «Kinnera Steel Limited»	India	1998	Grinding balls Ø68, 80 mm
SHPS 25 - 50	Firm «Litzkuns Niderwippen GmbH»	Germany	1997	Hot-rolled balls Ø20, 25, 30, 35, 40, 50 60 mm
SHPS 40 - 80	APO «Uzbek metallurgical plant, Bekabad	Uzbekistan	1993	Hot-rolled balls Ø65, 80, 100 mm
SHPS 25 - 50	Kursk «20 APZ»	Russia	1993	Semis for bearing balls Ø1»...2», grinding balls Ø40, 50 mm
SHPS 40 - 80	Gur'evsk Metallurgical Works	Russia	1991	Hot-rolled balls Ø40, 50, 60, 80, 100 mm
SHPS 40 - 90	Firm «Bemsya»	Mexico	1989	Hot-rolled balls Ø2», 2½» 3», 3½»
SHPS 25 - 50	Bishkek repair-mechanical plant	Kyrgyzstan	1986	Hot-rolled balls Ø24,2; 25; 27; 28,2; 30,2; 33,7 mm
SHPS 25 - 50	Firm «NKhB Bearings Ltd.»	India	1984	Hot-rolled balls Ø25; 40; 50,6 mm
KHPSH 6	Plant «Krasny Kotel'shchik», Taganrog	Russia	1980	Cold-rolled balls Ø6 mm
SHPS 60 - 125	Kommunarsky (Alchevsky) metallurgical plant	Ukraine	1977	Hot-rolled balls Ø80, 90, 100, 110, 120 mm
SHPS 80 - 100	Kuznetsky iron&steel integrated works	Russia	1977	Hot-rolled balls Ø80, 90, 100 mm
SHPS 40 - 80	Kuznetsky iron&steel integrated works	Russia	1977	Hot-rolled balls Ø40, 50, 60, 80 mm
PSH 25 - 50	Firm «Fagersta»	Sweden	1977	Grinding balls Ø25, 30, 35, 40, 50 mm
PSH 25 - 50	Firm «Cord und Rosh»	Germany	1977	Grinding balls Ø25, 30, 35, 40, 50 mm
SHPS 25 - 50	4-i GPZ,	Russia	1975	Hot-rolled semis for bearing balls

Type of mill	Owner	Country	Supplied	Rolled items
	Samara			Ø1...2"
PSH 25 - 50	Firm «Metalles»	Brazil	1972	Grinding balls Ø25, 30, 35, 40, 50 mm
SHPS 40 - 80	Gur'evsk Metallurgical Works	Russia	1968	Hot-rolled balls Ø40, 50, 60, 80, 100 mm
PSH 80 - 125	Metallurgical plant named after Lenin	Bulgaria	1967	Hot-rolled balls Ø80, 90, 100, 110, 120 mm
PSH 40 - 80	Metallurgical plant Vitcovice	Czech	1965	Hot-rolled balls Ø30, 40, 50, 60, 80 mm
PSH 80 - 125	Nizhny Tagil iron&steel integrated works	Russia	1965	Hot-rolled balls Ø80, 90, 100, 110, 120 mm
PSH 40 - 80	Nizhny Tagil iron&steel integrated works	Russia	1965	Hot-rolled balls Ø40, 50, 60, 80 mm
PSH 25 - 50	Firm «Helipebs»	England	1965	Grinding balls Ø25, 30, 35, 40, 50 mm
SHPS 25 - 50	1-i GPZ, Moscow	Russia	1964	Hot-rolled semis for bearing balls Ø1...2"
PSH 40 - 80	Dneprovsky iron&steel integrated works, Dneprodzerzhinsk	Ukraine	1963	Hot-rolled balls Ø30, 40, 50, 60, 80 mm
SHPS 80 - 125	Iron&steel integrated works «Azovstal», Mariupol	Ukraine	1959	Hot-rolled balls Ø80, 90, 100 mm
SHPS 40 - 80	Iron&steel integrated works «Azovstal», Mariupol	Ukraine	1959	Hot-rolled balls Ø40, 50, 60, 80 mm
SHPS 40 - 80	Voskresensk mashplant	Russia	1957	Hot-rolled balls Ø40, 50, 60, 70, 80, 100 mm
SHPS 40 - 80	Katav-Ivanovsk casting-mechanical plant	Russia	1955	Hot-rolled balls Ø40, 50, 60, 70, 80, 90 mm
SHPS 25 - 50	4-i GPZ, Samara	Russia	1955	Hot-rolled semis for bearing balls Ø1...2"
SHPS 25 - 50	Kalininsky plant im. 1 Maya, Tver	Russia	1954	Hot-rolled balls Ø25, 30, 40, 50, mm
SHPS 25 - 50	1-i GPZ, Moscow	Russia	1951	Hot-rolled semis for bearing balls Ø1...2"

Source: VNIIMETMASH

According to the first deputy director of VNIIMetmash **B. Sivak**, in 90s, in the ex-USSR, 80% of BOC steel, 70% of rolled steel, 50% of hot-rolled and 30% of welded pipes, **above 90% of steel balls** were manufactured at facilities, elaborated by the institute.

According to the VNIIMetmash leaders, only one Italian company, besides VNIIMetmash, attempted to elaborated ball-rolling mills in the world, but failed and left the market soon.

Metallurgical equipment to VNIIMetmash projects was manufactured at the Moscow plant of VNIIMetmash, Starokramatorsk machine building plant, Novokramatorsk machine building plant, Yuzhno-Uralsky machine building plant, Electrostal' plant of heavy machine building, Uralsky plant of heavy machine building, Almaty plant of heavy machine building, Kolomensky plant of heavy machine building (latches), Pskov plant of heavy electro-welding equipment and other Russian and foreign enterprises.

1.2. Requirements, imposed on quality of steel grinding balls

1.2.1. Requirements imposed on grade of steel grinding balls

Steel grinding balls в in the CIS are produced in accordance with GOST 7524-89 «Balls steel grinding for ball mills». Come into force 01.01.1990.

The GOST regulates production of rolled, forged, stamped steel grinding balls, applied for grinding ores, coal, clinker, etc. in ball mills.

The main parameters and sizes

Balls, in hardness, are subdivided into the following groups:

1 – normal hardness of common purpose;

2 – increased hardness of common purpose;

3 – high hardness for grinding ferrous ores;

4 – very hard for grinding nonferrous ores, cement and refractories.

Sizes, limits of deviation, calculated nominal mass and volume of the balls must correspond Table 2.

Table 2. Sizes of balls in mm

Conditional diameter	Nominal diameter	Limit of deviation from nominal diameter	Calculated nominal volume, cm^3	Calculated nominal weight, kg
15	15.0	±1.0	1.76	0.014
20	20.0		4.18	0.033
25	25.0		8.18	0.064
30	31.5	±2.0	16.4	0.128
40	41.5		37.4	0.294
50	52.0	±3 0	74	0.58
60	62.0		125	0.98
70	73.0		204	1.60
80	83.0		299	2.35
90	94.0	±4.0	435	3.41
100	104.0		589	4.62
110	114.0		776	6.09
120	125.0	±5.0	1023	8.03

Notes: 1. Deviations from geometric shape of ball must be below deviations from nominal diameter

2. Volume and mass of ball are calculated by nominal diameter at steel density of 7.85 g/cm^3

3. Top limit of balls hardness can be regulated in accordance with agreement between producer and customer.

Source: GOST 7524-89

Example of notation of ball with diameter 80 mm of increased hardness (2):

Ball 80-2 GOST 7524-89

Technical requirements

Balls of groups 1 and 2 are manufactured from carbon-, low-alloyed and alloyed structural steel.

Content of carbon in carbon steel must be at least:

0.40 % - for balls with conditional diameter 15-60 mm;

0.60 % - for balls with conditional diameter 70-120 mm.

Carbon equivalent of low-alloyed and alloyed structural steel must be at least:

0.50 % - for balls with conditional diameter 15-60 mm;

0.70 - for balls with conditional diameter 70-120 mm.

Balls of group 3 are manufactured of steel types according to GOST 24182, group 4 — from tools alloyed steel of types KH and KHGS according to GOST 5950. Manufacture of balls from steel of other types according to GOST 5950 is permitted on condition of providing required hardness.

Hardness of balls must meet norms, given in Table 3.

Table 3. Hardness of balls according to GOST 7524-89

Conditional diameter of ball, mm	Hardness HRC_E (HB), at least, for groups				
	1	**2**	**3**	**4**	
	at ball surface				At a depth of 1/2 of ball radius
15-70	43(401)	49(461)	55(534)	55(534)	45(415)
80-100	40(352)	42(375)	52(495)		
110-120	35(302)	38(331)	50(477)		

Note: Balls of group 4 are designated for grinding nonferrous ores, cement and refractories.

Source: GOST 7524-89

At surface of balls defects above deviation limits are prohibited.

Balls of diameter up to 30 mm (and more to customer demand) are packed into specialized containers or boxes; boxes are jointed into transport packages.

Approval

Balls are approved in lots, composed of balls of similar group, size, covered by a single document (certificate) of grade, including:

— name and trade mark of producer;

— lot number;

— stamp of technical inspection;

— results of hardness tests;

— notation of balls.

Mass of lot is allowed 150 t maximum.

For inspection, at least 10 balls are taken from at list 5 sites of a lot.

In case of unsatisfactory results on even one parameter, doubled quantity of balls from the lot are inspected again.

Maximum 10% of balls, taken for inspection, are allowed to be not meeting requirements of the current standard in sizes and grade of surface.

Inspection methods

Sizes of balls are inspected by caliper square according to GOST 166 or other tools, providing required preciseness.

Hardness of balls are measured by Rockwell method (GOST 9013) or Brinell method (GOST 9012).

Hardness at ball surface is determined at 2 diameter-opposite sites.

Hardness at depth of ½ of radius is determined at one site of flat surface, prepared according to requirements of GOST 9013 and GOST 9012.

Rockwell hardness is determined by 4 measurements at each site (4 in angles of hypothetic triangular with side of 6-8 mm, and the fourth in the center – this fourth measurement is taken as valuable, included in inspection protocol (the other are experimental).

Brinell measurements are conducted as follows: one measurement at each site.

Hardness is taken as average value of measurements for all inspected balls.

Carbon equivalent of steel Ce in percents is calculated by formula:

$$Ce=C+Mn/6+Si/24+Cr/5+Ni/40+Cu/40+V/14,$$

where C, Mn, Si, Cr, Ni, Cu, V - — mass shares of carbon, manganese, silicon, chrome, nickel, copper, vanadium, %.

Grade of balls surface is inspected visually without special instruments.

Transportation and storing

Balls are transported by any transports in accordance with rules, approved by Ministry of Ways. Balls are transported in open cars (in covered cars to customer demand). By railway, balls are shipped by cars and small shipments.