ELSTOMANA
Steel balls for grinding
1164 Sofia, Bulgaria
Hristo Smirnenski 15
Tel: +359/02/963 33 24
Fax: +359/02/963 36 86
E-mail:
elstomana@elstomana.com

Spherical milling bodies

Comparison between High-Chrome grinding media and Low-Chrome deep hardened and quenched grinding balls.

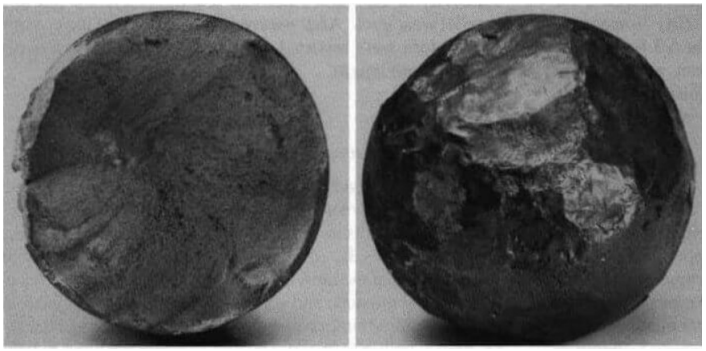
Author: Boris Zarev

In order to achieve high hardness of grinding media (>60 HRC), there are usually two methods used.

One way to do so is using alloy with high addition of chrome, which forms hard chrome carbides, when bonding with carbon - Cr3C2, Cr7C3and Cr23C6. In this way pockets of carbides are formed inside the ball, however without further heat treatment, the rest of the media is a mixture of higher and lower hardness zones, as it consists of austenite and perlite as forms of steel.

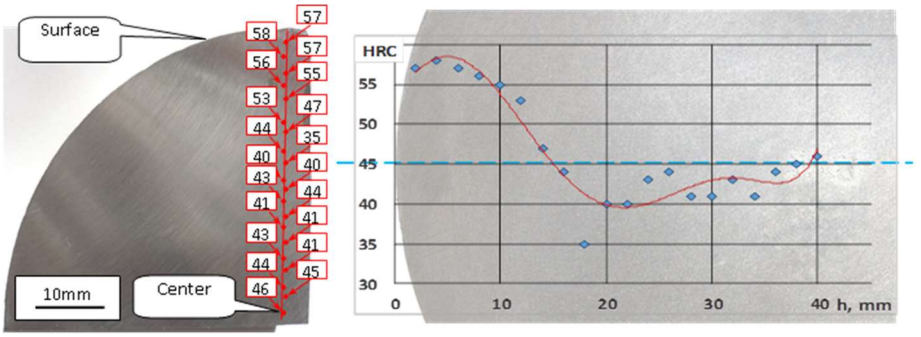
The results in an uneven hardness of the ball, with HRC varying from 64 to below 50. Several outcomes are common, when using such grinding media – higher deformation of the balls, not spherical forms and higher rate of breakage. All this results in bigger consumption and lower quality of the grind – which leads to loss of profit for the client.

Examples #1 and #2:



#1

Unevenly distributed hardness



#2

The other way to achieve high hardness is using heat treatment process for specially preselected alloy steels with normal grades of chromium – max.1,4.

The steel bars (incoming material) should be produced with modern metallurgical processes, including vacuum degassing and strict laboratory control of the alloys and oxides. The appropriate carbon micro-alloyed steel is a must, before entering into production for hot rolling.

Due to the method of rolling balls is identical to a high-temperature thermo-mechanical processing (VTMO) – austenite deformed in area of its thermodynamic stability and then subjected to hardening on martensite followed by tempering – that significantly increasing the mechanical properties of the steel.

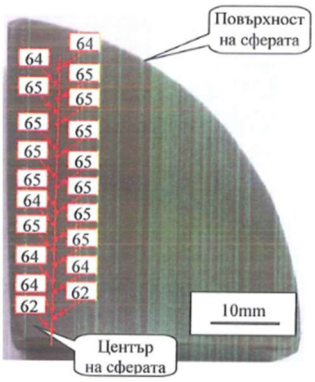
When using the appropriate technology, uniform hardness above 62HRC thorough the ball radius is achievable. The process should involve air cooling, water cooling and tempering.

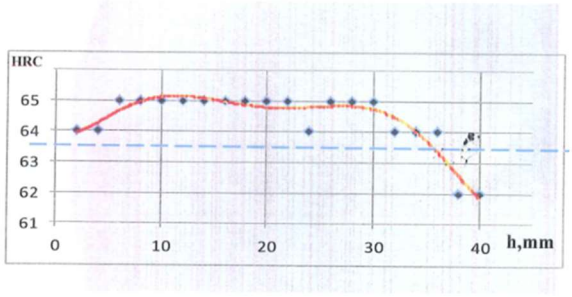
As conclusion, higher HRC means greater abrasion resistances and lower wear. Uniformity of the hardness produces equal wear:

Examples #3 and #4:

#3

Deep quenched Martensite ball





#4

Function of the grinding bodies inside the mill:

They are performing two physical processes:

- Raw material Crushing: through impacts on larger ore fragments / relies mainly on bigger size balls, the heavier ones /

- Grinding: by grinding of the raw material between them / relies mainly on the smaller size balls with a larger grinding surface relative to their weight /.

Proper selection of the balls used in each case is paramount, when striving to achieve:

- High quality grinding

- High productivity

- Low electricity costs

- Low consumption of balls, lining, bearings, gears, etc.

Note:

Properly preselected balls are a requisite for excellent results, but so is the compliance to the grinding technology.

The two main components to consider, when **choosing the size** of grinder bodies are:

- Lack of required large milling bodies /insufficient impact crushing/ leads to reduced productivity and under-grinding.

- Lack of smaller bodies /excessive impacts/ results in low productivity, high smudge rate of the balls and over-grinding.

Size distribution in the milled pulp.

The presence of an adequate ball load from smaller dimensions ensures good compaction / high bulk density / - respectively intense grinding of the milled raw material.

Smaller sized balls have larger specific surface area for the same bulk volume / i.e. larger work surface / vs. larger balls, they wear out faster and disappear. For this reason, it is of particular importance that the balls feed to the mill should be deeply hardened - with high hardness even towards the center /i.e. constant high hardness with decreasing dimensions of ball, when experiencing wear due to grinding/. Sometimes, in order to provide finer grinding, small-sized balls are also loaded in addition with the main ones.

El Stomana LTD produces balls in sizes 60mm-125mm, further sizes (20-60mm) will be available starting from year 2020.

For every ton of grinded ore, balls produced and deep hardened by El Stomana LTD, contribute to:

1. Reduction in electrical power used during ore processing.
2. Reduced grinding balls consumption.
3. Excellent grinding and lowered over-grinding percentage.
4. Better extraction during froth flotation.

5. Reduced lining wear.
6. Longer service intervals and life of gearings, couplings, bearings, etc.

Sofia, 01.11.2019

Boris Zarev
Commercial Manager
El Stomana LTD
Mobile: +359 888 420889
Fax: +359 2 963 3686
boris.zarev@elstomana.com
www.elstomana.com