CASE STUDY

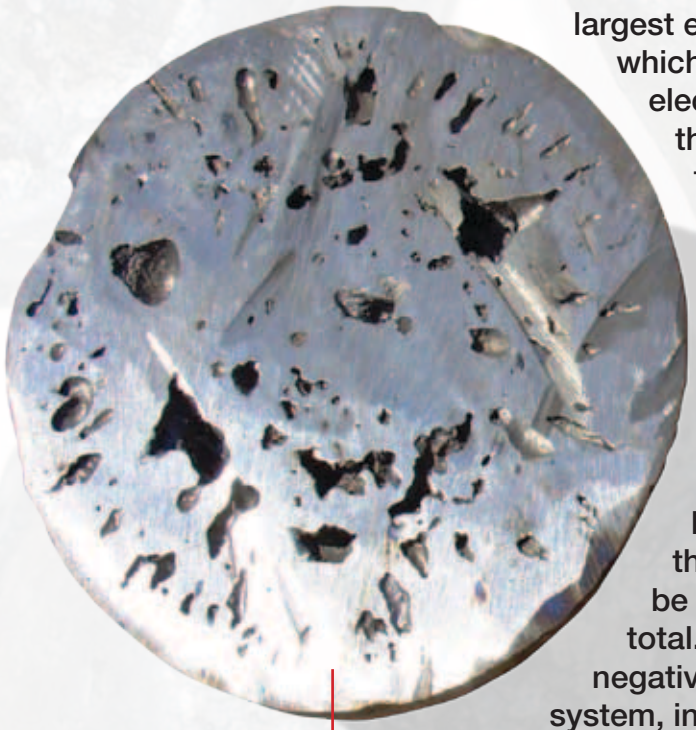
Example 1: Procuring grinding media steel balls

Overview

Over the past year, the prospects for mining companies have been adversely affected by the slump in commodity prices. With waning demand, slump in commodity prices and pressure to ensure profitability at mining operations and maximising shareholder return cutting costs is the theme. A recent research by Kemcore found many mining companies are sourcing or planning to source for mining consumables such as grinding media and mining chemicals from low cost base production countries such as China.

This paper highlights leading risks with traditional grinding media procurement from China—risks you can avoid when you work with us.

Introduction



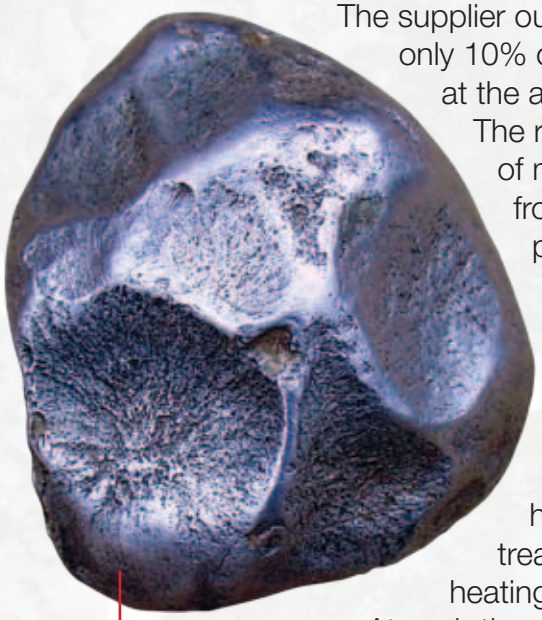
POROUS CAST BALL:
INVITING DISASTER-1

Energy consumption in the milling process involves significant quantities and costs. The largest energy consumer is communition, which accounts for 1%of global electricity consumption. Both imply that it is important to maximise the throughput for a given grinding task; which in turn implies it is important to select the best quality grinding media, which is related to the efficiency of communition. Comminution costs constitute mainly electricity, grinding balls and liners. Of these three components, grinding balls form the major portion of the consumable costs, and can be as high as 40% – 45% of the total. Poor quality grinding ballshave negative impact on the entire grinding system, including higher rate of ball consumption,effectiveness of grinding, power consumption and so forth.[5]

Demonstration of current sourcing trends on grinding media steel balls:

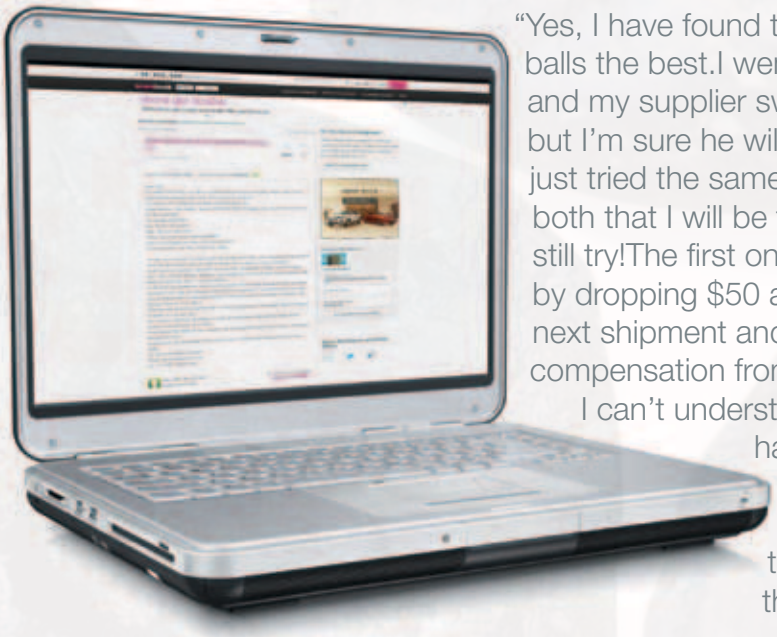
A supplier in Asia promotes steel balls sourced from various B2B portals, such as Alibaba.com. Sometimes the supplier visits the factories briefly, but not always. In most cases, the supplier does not own the production facilities. In order to win business, the suppliers are under great pressure to promote the most attractive price to potential customers. As a result, theywill often advertise a specific product specification, then outsource the orders to any number of low-cost production facilities where coal is used for heat treatment, lax or zero quality control measures-etc.

Let's say a mining firm places an order with the supplier based on the advertised specification. The supplier outsources this order, with only 10% of the outsourced order at the advertised specification. The remaining 90% is now of mixed quality, sourced from other third-party producers or suppliers. The quality of raw materials accounts for 80% of the final cost of grinding balls, with the effectiveness of grinding balls depending on high-quality raw materials treated with the appropriate heating and cooling methods. At such times, suppliers often use a deceptive packing technique. High specification balls are packed on the top, with the quality decreasing towards the bottom. This means that during random batch inspection, it is impossible to test the lower, substandard balls. Only the best quality items are tested and pass inspection. In the worst cases, rocks are added at the bottom to make the correct weight.



EFFECTS OF SOFT CENTRE OF A CAST BALL: DIMPLED BALL

The customer only becomes aware of the quality issue (orlack of real ordered product) once the order is delivered either to the milling operation for inspection, or to the millball itself for use.



"Yes, I have found that the first shipment of balls the best.I went over there in August and my supplier swears he won't try it again but I'm sure he will, and the other one has just tried the same thing.I've warned them both that I will be testing them but they still try!The first one has compensated me by dropping $50 a ton off the price of the next shipment and I'm now trying to get compensation from the other one. I can't understand the mentality as I have the potential to place them with many orders from other mine sites but they don't seem to care – they live for today."

Dimpled roll forged mill ball, indicating a soft core

How to improve grinding ball quality and reduce risks

An efficient milling process demands high-quality grinding media supplies. The quality and overall strength of the grinding ball feedstock are critical. We source from manufacturers who specialise in the use of high carbon steel bars that incorporate the proper alloying elements. Our superior raw materials and proven process deliver maximum impact-resistance, greatly improving your milling efficiency.

1. Develop and maintain a quality control programme (QC) to ensure that grinding balls received meet specified manufacturers specification.
2. Monitoring of grinding media quality and service on a regular basis
3. Inspection of each shipment – from production (raw materials) to receipt of each shipment to catch any occurrences of bad quality grinding balls.
4. Steel Balls must be free of defects on visual inspection with the naked eye.
5. Deviation from a true spherical form.
6. Preforming Grinding media test report chemistry.

Acceptable Griding Media Quality - Compositional effects

Steel grinding balls are produced from a range of carbon/iron (Fe/C or Fe-C) alloys to be used in milling conditions. The alloy systems used include AISI 1020 mild steel, high carbon low alloy forged steel, forged martensitic stainless steel, forged austenitic stainless steel, Ni-Hard,20% chromium, 27% chromium and 30% chromium white cast irons. By increasing the carbon content to produce cast irons, both the hardness and wear resistance are improved significantly. High carbon content of the cast steel leads toa microstructure consisting of primary carbides instead of austenite or one of its transformation products (i.e. pearlite, martensite, etc.) as a primary phase.[5]

Usually, the C content of the steel balls is kept between 0.70% and 0.80%. Also, the Cr content should not be less than 0.5% in order to ensure a minimum hardness gradient.The balance of the composition is Fe with only incidental impurities, such as sulphur (S) and phosphorus (P). Mn is added to supplement the Cr content, particularly in balls of larger diameter. A high C content (i.e. >0.85%) in the forged steel balls leads to a reduction in toughness, which usually causes spalling of grinding balls. This is due to an increased tendency to retained austenite in high carbon steels.[5]

Ball Type	Elements			Hardness (HB)
	C	Cr	Mn	
Cast Steel	~3.50	~3.0	1 max	530
Forged steel	0.80max	1.0max	1 max	675

Production of Forged Steel balls.

- A steel bar is cut into shots, then reheated and hammered at least 30 times to compact and harden it.

- The bar undergoes a process of hot rolling—followed by rapid cooling, reheating, and hammering—to change the microstructure from pearlitic to martensitic.
- In the forging process, the structure of the steel grain aligns and stretches, creating a stronger, more compact steel from which to make the grinding balls.
- The bars are heated to make them malleable enough to form near-perfect spheres.
- Finally, the balls are quenched and reheated for tempering and relieving stress

Maximise the throughput in your milling operations by selecting the correct grinding media.

Kemcore's competitive advantage:

For a customer, "value in use" is determined by ball performance and price per unit. Kenmore offers three unparalleled advantages:

1. QUALITY

- Our products offer consistently superior media-wear performance as compared to alternative products, where quality may vary.
- Our products eliminate the cost increase sincurred with inferior product performance. (Many competitors offer reduced prices by supplying poor quality grinding media, which increase your costs down the road.)

2. SUPPLY ASSURANCE

- Our supply chain is located close to the Qingdao shipping port, for flexible and timely product delivery.
- We offer short supply chains and production within 30 days of order (the significantly longer supply chains of our competitors increase the risk of substantial delays).

3. TECHNICAL SUPPORT

- We provide high-value, customer-centric technical support, as compared to our competitors

The impact of low-quality grinding balls on milling

- An underweight order or lack of useable materials has a serious impact on process/yield efficiency.
- Grinding balls may be too light to have the sufficient kinetic energy to break rock.
- Mill flow rates are reduced. Inferior grinding balls cause peening when they are hammered against the discharge rate, cushioning the rocks being hammered and causing ineffective breakage.
- Energy consumption increases.The lightweight balls are pinned to the mill shell and carried to a point before leaving the shell on its trajectory, adding more load to the motor.
- Steel consumption is increased,which generates iron ions detrimental to flotation, depresse ssulphide minerals, and increase ssodium cyanide consumption.
- Elements of the final received order may be scraped, taking up space that could be occupied by pure ore. Freight costs reflect the total weight, which does not represent the true content.

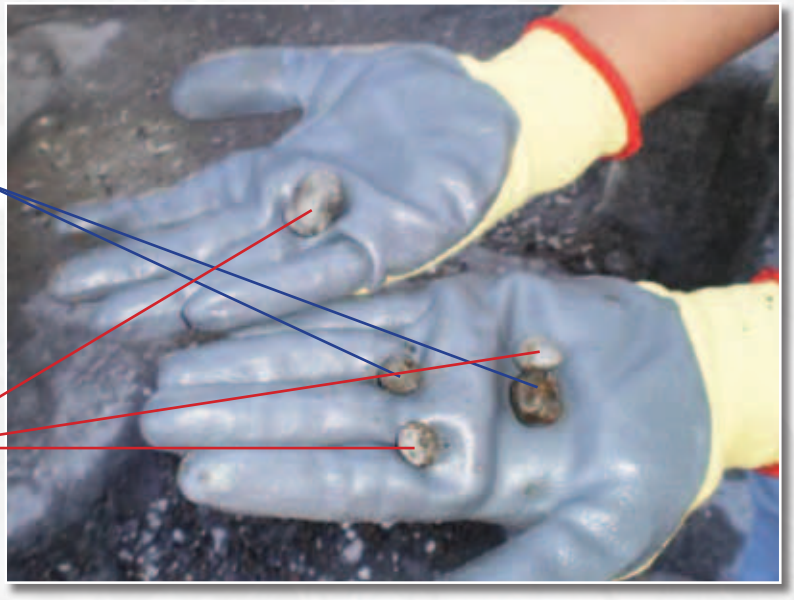
POOR QUALITY

BALLS OF OTHER SUPPLIER, ALWAYS FINISH IN THE SAME SHAPES AND COLOR

POOR QUALITY BALLS, END UP IN A SORTS OF SHAPES

BALLS OF OTHER SUPPLIER, KEEP MOST OF THE METAL COLOUR AS SCRAP

POOR QUALITY BALLS, DO NOT LOOK, FEEL OR WEIGH LIKE STEEL ANY MORE

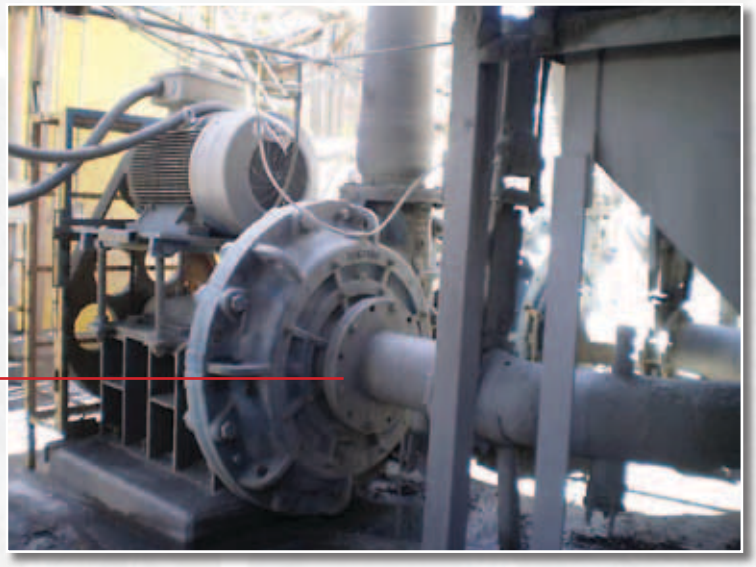


THE BALLS ARE SUCKED ON TO THE BELT THAT SEND THEM INTO BALL MILL BY THIS ELECTRIC HAMMER.

THE MINE WEIGHS RANDOM LOTS OF 100 BALLS BEFORE THEY POUR THE BALLS INTO THIS POND, AND 100 UNITS OF REFLEX BALLS GOT DIFFERENT WEIGHTS.

THIS IS THE BALL MILL THAT TESTED THE 2.5" POOR QUALITY BALLS

POOR QUALITY BALLS PASSED THE SCREENS BECAUSE THEY ENDED UP SMALL AND RAN INTO THIS PUMP, AND DAMAGED THE INSIDE OF THIS PUMP. THE MINE HAS TO STOP PRODUCTION TO CLEAR OUT THE BALLS AND FIX THE PUMP, MANY TIMES, WHICH CAUSED A TOTAL LOSS OF USD 50,000 BECAUSE OF THE STOP OF THE PRODUCTION.



Conlusion.

A full chemical analysis, hardness profile and micro structure, can play an intergral role in selecting cost effective grinding media balls. This should also be complemented with a good quality control program to ensure a consistency in the supply chain. Kemcore assist mining executives in cutting costs without cutting corners!

About the author.

Calisto Radithipa,
Managing Director

+852 3478 7314
+852 944 67494
Calisto.r@kemcore.com

Calisto has over 10 years' experience in mining-chemical sourcing, procurement, and supplier auditing. He has personally inspected over 50 chemical factories in China, South Korea, Taiwan, India, Philippines and the Czech Republic. Calisto has worked with diverse clients providing procurement strategies to facilitate cost-effective, high-quality chemical procurement. As Managing Director, Calisto drives Kemcore strategy and oversees the company's global sourcing and supply chain management platform. Calisto holds a Bachelor's Degree in Commerce with a major in Finance from Bond University, Australia.

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KEMCORE®

Kemcore International, Part of 300CC Asia Pacific Ltd.
Address: Unit 7/f Alliance Comm Building,
133 Connaught Road Central, Hong Kong
Tel: +852 3478 7314
fax +852 3975 2800
Mob. +852 944 67494
www.kemcore.com