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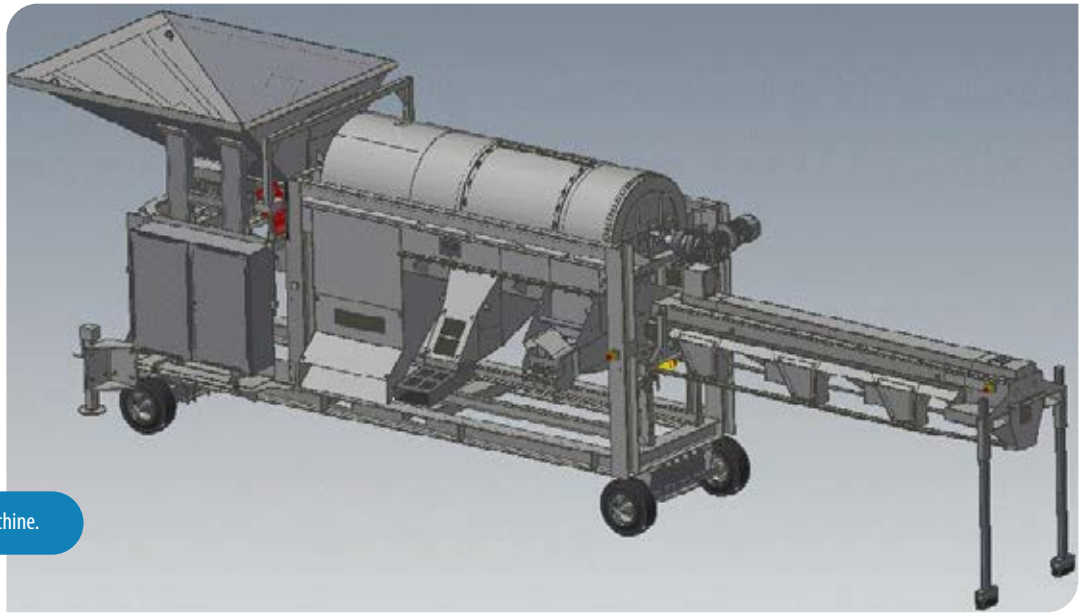
GOOD BALL SORTING = HIGH MILL EFFICIENCY

A good ball sorting machine can enhance grinding efficiency, an often overlooked aspect of cement production.

Efficient grinding plays an important role in the smooth running - and hence efficiency - of cement plants. However, mills also influence the efficiency of downstream processes. For example, the fine grinding of coal and petcoke is a key parameter in combustion control that is often neglected by operators. Indeed, careful fossil fuel control can enable greater proportions of alternative fuels to be used, decreasing overall plant emissions.

Elsewhere in the plant, minimising the amount of clinker in cement and the amount of cement in concrete can greatly reduce emissions. One way to increase activity is by using a booster mill to very finely grind some of the separator rejects from an existing mill. When it comes to alternative raw materials, the extraction of cement particles from recycled concrete also requires fine grinding. Otherwise, users won't reap the full benefits of using it in their mixes. Effective grinding is also critical when it comes to supplementary cementitious materials. For example, Portland limestone cement (PLC), which requires very fine grinding, is becoming increasingly prominent, particularly in the US.

As an aside, it should be noted that, for these new ternary cements, the fineness according to Blaine is becoming less and less indicative of compressive strength. This is because gypsum, limestone and clinker all have different Hardgrove indexes, making it hard to acheive the optimum particle size distribution (PSD). This is one reason why Iteca, the technical contributor to this article, is seeing increased interest in its automatic cement sampling



Render of an Iteca ball sorting machine.

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system and associated online PSD analyser. The information provided by the PSD analyser helps users to optimise their grinding processes and will show the benefits of good mill maintenance, including the benefits of using ball sorting machines for ball mills.

Factors that affect ball mill efficiency

Ball mills are still the most common mill used by the global cement sector. To the naked eye they seem not to have changed much over the past 50 years, but grinding media and other components used have seen many improvements, including the introduction of new diaphragm and separator designs and novel air circuits, as well as enhanced grinding aids.

The electrical energy consumption of a ball mill depends on several factors including, but not limited to, feed particle size, hardness, its dimensions and operating conditions, (mill filling, speed, ball quality), as well as the particle size distribution required for the final product.

Today, finish mills generally consume ~45kWh of electrical power per tonne of cement produced, but there are many ways to reduce this further. Ball quality is one approach. Finely structured, more uniform balls - for example those cast using rapidly-cooling metal moulds rather than slower-cooling sand-based moulds - will produce harder, longer-lasting balls that are more efficient.

However, regardless of quality, all grinding media will eventually wear down, deform and break, reducing efficiency. Usually, the entire ball charge must be replaced every 12 months. Severely-worn balls in the first chamber must be removed and the remaining ones sorted to be re-introduced into the second chamber. Broken balls and scraps must be removed to prevent them from becoming stuck in the diaphragm, which would reduce the draft.

Furthermore, the balls don't stay in their original compartment during operation. It is therefore necessary to put them back in the right place according to their diameter. The correct proportion of ball sizes in each of the chambers must be targeted to achieve the optimum energy to grinding ratio.

A good ball sort

Mill charging and discharging usually takes place during a cement plant's main shutdown. For larger mills it can take up to a week, with two 10hr shifts. To discharge the balls, the mill is emptied of material as much as possible and the door is opened. The mill is then rotated to discharge the balls onto the ground. The total weight varies greatly, but a large mill could contain ~80t in the first compartment and ~150t in the second. A small mill might have ~30t of balls in the first compartment and ~50t in the second. Once emptied, the balls are taken to a ball sorting machine using a front-end loader.

A high-quality ball sorting machine will be used infrequently, but will provide a safe, fast and efficient ball sorting operation. This means the ability to classify balls properly and precisely according to their size categories, and as rapidly as possible while maintaining safety. It is important to note that there can be discrepancies in the sorting efficiencies declared by producers, as values are usually quoted for the efficiency of sorting the largest balls. However, the efficiency drops dramatically as the diameter of the sorted grinding balls decreases. Yet, the smallest balls are the most important, as they ensure the final particle size reduction. Look out for what the maker states for *these* balls, not just the headline 'efficiency.'

Iteca's ball sorting machine

Iteca's ball sorting machine was first conceived of 40 years ago and has since been refined with an emphasis on safety and practicality. The machine offers sorting classes for balls of 15-100mm in diameter. This leads to better sorting accuracy, better accuracy of load charge, and thus better grinding performance. In addition, there is the automatic removal of broken and oddly-shaped balls through the use of extra small rollers. Larger broken balls are removed in the first section of the machine using large rollers.

The machine can be customised for individual plants to best suit their needs. For instance, it can be bolted to a flat-bed trailer for easier set-down, transport and set-up. Other plants may prefer to set it up on the ground.

Plant experiences

The Holcim Éclépens plant in Switzerland bought

the latest version of the Iteca ball sorting machine in 2022 for its annual ball sorting operation. It previously used an older Iteca machine from the 1980s. The main reasons for the upgrade were:

1. The additional safety features of the newer machine;

2. The gain in time, especially due to the automatic elimination of scrap. Larger balls are sorted in 10% less time than previously, while smaller balls are sorted in up to 30% less time;

3. The larger vibrating feeding hopper. This allows for a charge of 1t to be offloaded easily.

The sorting speed, in t/hr, depends on the amount of scrap and cement mixed with the balls, which depends on how well the mill has been emptied. A minimum of two operators, one on each side of the machine, and a supervisor, are needed for an efficient operation of the machine.

Vincent Maeder, Process Manager at the plant said "The plant has very efficient operation of the mills especially due to its close attention to the charge/the quality of the balls. We modified the machine so that the balls don't discharge directly back into the drums but to 'gutters.' If time permits, we perform a final visual/manual check before the balls fall into the drums. This enables us to achieve near-perfect sorting efficiency."

Added extras

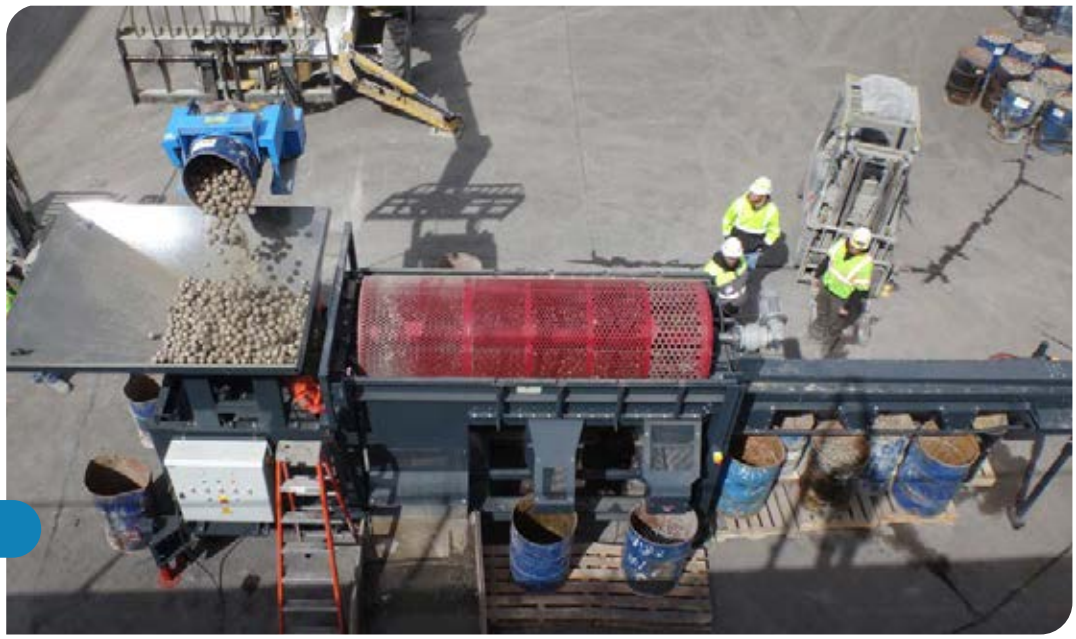
The newest Iteca ball sorting machines also offer automatic ball cleaning, first in the vibrating feeder and then in the rotary screen. All build-up/coating is removed by the action of the balls rubbing up against each other in the rotary screen.

This helps the machine provide accurate sorting. The balls only fall through the right screen plate, so as to preclude jamming of the sieves. On the sorting rollers, at the exit of the rotary screen, the larger balls (>40mm) fall into place individually.

Finally, the improvements over the past 40 years have resulted in a more compact machine. When the rollers are stored in the resting position, the total length of the machine is about 5.0m, or 6.5m with a vibrating hopper. The feed hopper is fitted directly to the machine, and does not need to be towed separately. It is also lighter, weighing less than 6t, including the hopper. As a result, it can easily be installed on a flat-bed truck if needed to be moved from plant to plant. For instance, Ash Grove Cement's Montana and Durkee plants have shared an Iteca ball sorting machine for several years.

Conclusions

Ball mills remain critical to the global cement industry. Indeed, they are likely to become even more important in the increasingly fractured cement markets of the future and as environmental considerations rise up the list of producers' prorities. However, a ball mill is only as good as its balls. A high-quality ball sorting machine, while representing a financial investment, will pay dividends over many years. Indeed a 10% reduction in electricity consumption is typical after a good ball sorting operation.



A ball sorting machine in use.