Ball Drum Mill Load Control System

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A task

In the process of cement production, one of the main indicators affecting the quality of the finished product is the constant specified quality of grinding of raw materials (clinker).

The quality of grinding of raw materials (maintaining a constant level of grinding of raw materials to the required size) depends on several main interrelated factors:

- Different grinding capacity of clinker (different grinding ratio)
- The amount of material loaded into the mill
- Number and size of balls in the mill
- Mill lining condition

All of the above factors are interrelated and constantly changing during the operation of the mill.

Stabilization of a given level of grinding at the mill outlet in the automatic mode of material loading corresponds to an increase in the quality of grinding and a reduction in energy and material costs (electricity, ball consumption, lining wear), as well as an increase in overhaul periods.

Problem

Currently, the operator regulates the amount of materials loaded into the mill based on indirect indicators, indications of belt scales (if any) and periodic (several times per shift) sampling at the mill outle

The operator does not have objective information about the current state of the mill load and its grinding capacity, namely:

- grinding capacity of clinker,
- the amount of incoming material from the separator (if any),
- the quantity and distribution of the material in the chambers of the drum (especially when working with a separator),
- the degree of sticking of the material on the balls,
- the number and condition of the balls in the chambers,
- lining condition,

and accordingly, it cannot constantly make changes in the settings of the mill and ensure the specified grinding quality.

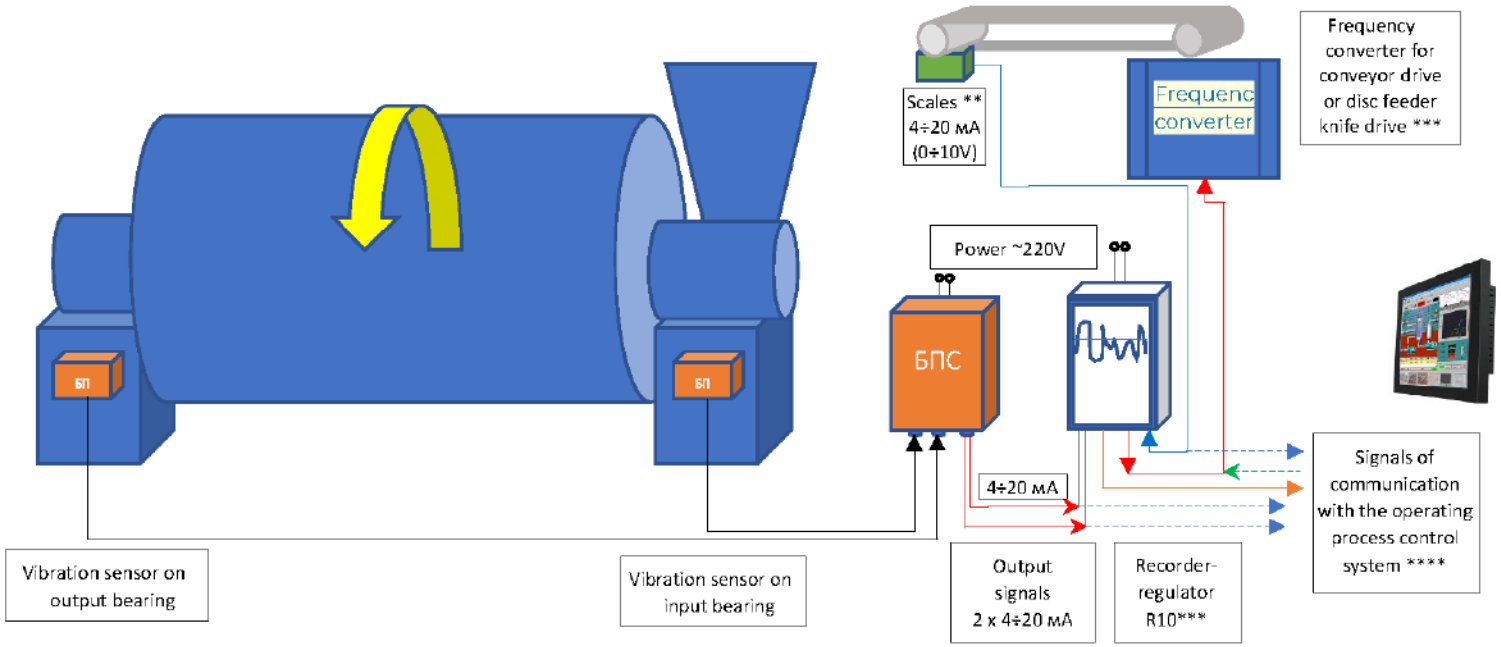
Solution to the problem

The proposed system of SKZ SBM allows you to:

1. **Perform continuous measurement of the grinding capacity of the mill, determine the level of its loading with clinker and its distribution inside the mill;**
2. **Ensure constant maintenance of the specified quality of clinker grinding, taking into account all of the above changing factors, by constantly adjusting the amount of material loaded into the mill;**
3. **If necessary, ensure the maximum level of loading, as well as exclude even the potential possibility of blocking the mill with material;**
4. **Reduce the degree of wear of the ball charge, lining and armor of the mill, saves energy resources, increases the overhaul period;.**
5. **Make a simple inclusion and integration into any existing systems of automatic and manual control of the mill;**
6. **Significantly reduce the human factor in ensuring the quality of grinding.**

System operation

Scheme of installation of equipment of SKZ SHBM for operation at cement enterprises.



* All connection cables type: МКЭШвнг 2x2x1.0, КПВЭ -ВП 4x2x0.5 (or similar).

** Recording the readings of the belt scale sensors, if available (it is allowed to record and display other necessary signals, as well as their type as agreed by the parties).

*** Control signals for automatic control of the speed of the clinker conveyor or the disc feeder knife drive are negotiated and provided by agreement of the parties.

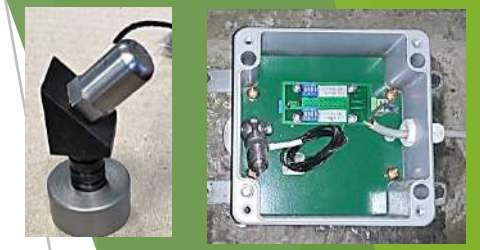
**** The number and types of measurement signals for displaying the recorder on the screen, recording readings, types of control signals to actuators are specified when ordering.

***** The device for recording, displaying and regulating, can be implemented on controllers of well-known world manufacturers, by agreement of the parties.

In progress mills measuring sensors vibration acceleration catch drum vibration through its front and rear bearings, process the received signals and transmit them in the form of 4 ÷ 20 mA to the recording device in the form of a current diagram or to the automated control system of the shop (or to any other automatic control system) for display on the operator's monitor and control of actuators.

System advantages:

- made on the basis of solid-state acceleration sensors in a sealed housing (photo 1);
- quickly and easily mounted on the mill (photo 2);
- does not require regular maintenance and is not afraid of external pollution;
- not afraid of noise and vibration from neighboring equipment;
- has high sensitivity of sensors;
- allows you to stabilize and ensure the quality of grinding;
- it is effective both in manual control mode and automatic, because it makes it easy to carry out local control or integrate it into an existing automated control system;
- allows to ensure the maximum loading of the mill, taking into account the return of the material from the separator and at the same time avoiding its “blockage”;
- allows you to measure and record the entire grinding process in dynamics;
- provides control over the work of the operating personnel of the shift;
- allows you to control the state of inter-chamber gratings;
- allows to work at failure of tape scales;
- the measuring part of the EMS system can be used to replace the "Acoustic ear" without significant modification of the existing control system;
- has a quick payback.

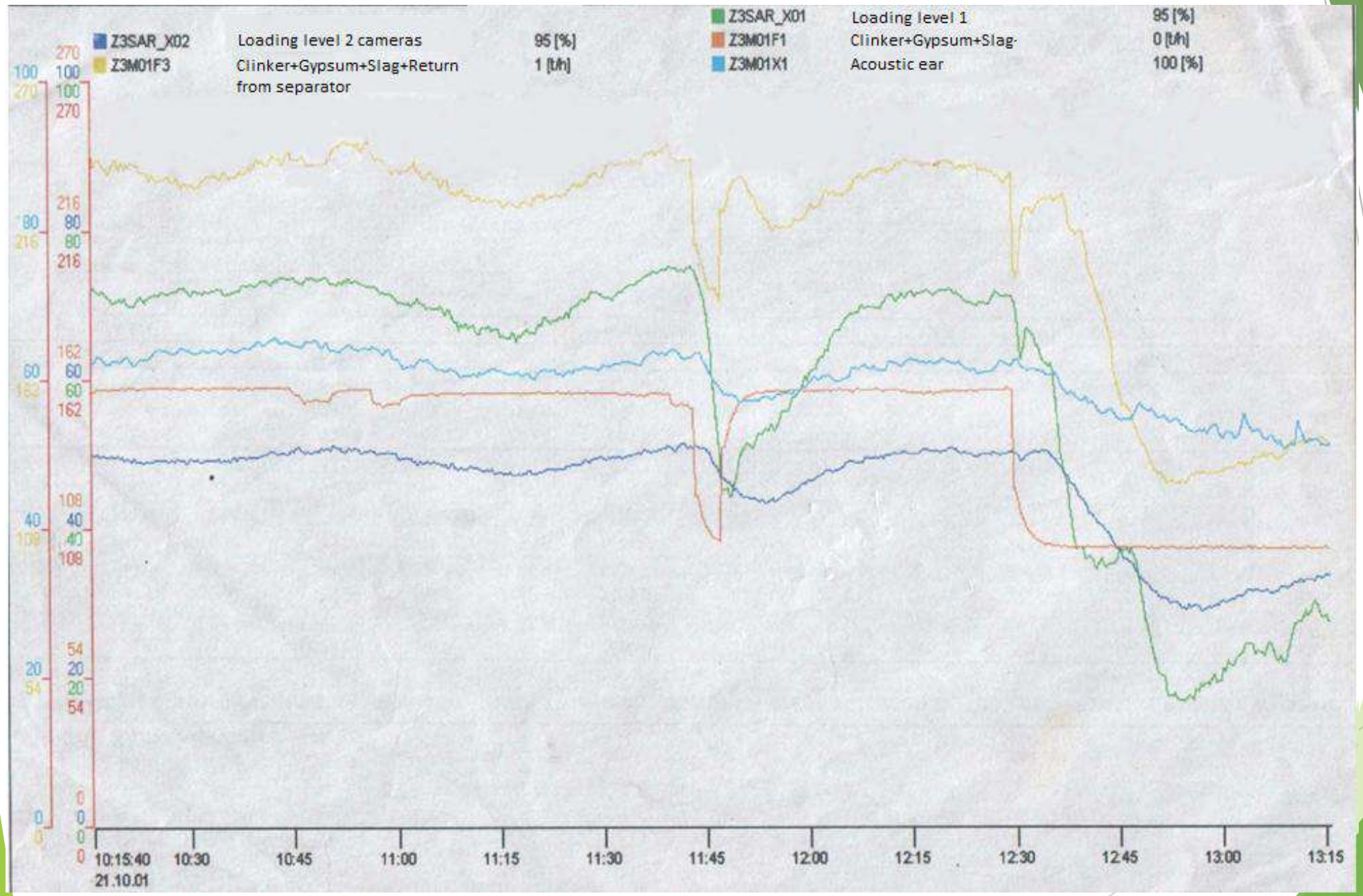


A photo 1

A photo 2

Diagnostics of the operation of a ball drum mill using the SHBM loading control system (SKZ SHBM).

- We will consider the diagnostic capabilities of the SCZ SBM, which is part of the automatic control and optimization system for a ball drum mill (SARiO SBM), using the example of a two-chamber cement mill. The figure below shows the graphs of the main technological parameters of the grinding process, namely:
- brown curve - Processed material (total amount of unground material - clinker + gypsum + slag (stone));
- yellow curve - Total load (total amount of unground material + return from the separator);
- blue curve - "Acoustic Ear" (readings of the device "acoustic ear" for comparison)
- green curve – Loading level of the inlet chamber (loading level of the inlet chamber, indication of RMS SHBM);
- blue curve - Loading level of the exit chamber (loading level of the exit chamber, indication of RMS SHBM);


Z3SAR_X02
Z3M01F3
Loading level 2 cameras
Clinker+Gypsum+Slag+Return from separator
95 [%]
1 [t/h]
Z3SAR_X01
Z3M01F1
Z3M01X1
Loading level 1
Clinker+Gypsum+Slag
Acoustic ear
95 [%]
0 [t/h]
100 [%]
100
80
60
40
20
0
270
216
162
108
54
0
10:15:40
21.10.01
10:30
10:45
11:00
11:15
11:30
11:45
12:00
12:15
12:30
12:45
13:00
13:15

- Let's start the analysis of the operation of the ball drum mill (hereinafter BMM) from 10:15 to 11:40. As can be seen from the graph, the “Material being processed” almost does not change and averages somewhere around 160 tons per hour. At the same time, the “Total Load” varies from somewhere around 228 tons per hour to 259 tons per hour. These changes are caused not only by the quality characteristics of the unground material (size, humidity, temperature, etc.), but also by the grinding potential of the mill and the filtering potential of the separator. The same changes play the most important role in the grinding process, since the critical value of "Total load" can lead to an emergency situation - blockage (steaming) of the mill. Moreover, this critical value, in turn, strongly depends on the unground return from the separator

- To prevent an emergency, various mill load level control systems were used - load level control systems based on the mill current consumption value, load level control systems based on the pressure drop across the mill drum, load level control systems based on acoustic noise. The latter system is widely used today. This system requires the exclusion of the possible influence on the measured acoustic signal of the operation of other mills or other equipment. When two or more mills are in operation, it is impossible to even approximately determine the level of mill loading. But in the case of one operating mill and the exclusion of acoustic interference from other operating equipment, it is still possible to approximately determine the level of mill loading. We will consider such an example of the work of the acoustic ear "Acoustic Ear" in the graph below. The same figure shows the SHBM developed by us.

- Let's analyze the work of the VCS SBM and compare its readings with the readings of the acoustic ear in the graph below. As you can see, from 10:15 to 11:40, the "Entrance chamber load level" curve not only practically repeats the "Total load" curve, but is also more sensitive to material changes, especially from 11:40 to 12:00. That is, by measuring the loading level of the inlet chamber (chamber No. 1 of the mill) using the RMS of the SHBM, it is possible to diagnose the grinding potential of the mill (the potential for grinding the material that is in the 1st chamber of the mill, regardless of its characteristics) **online.** In other words, the load level curve of the inlet chamber of the mill displays. the real reaction of the ball charge of the mill to the material in it. At the same time, as can be seen on the graph, the curve from the acoustic ear (Acoustic Ear) changes its value by only a few percent.

- SKZ SHBM almost instantly reacts to hanging of material in feeders. This can be clearly seen at 11:42 am by the sharp drop in the Loading level of the inlet chamber. This reaction makes it possible to instantly respond to this emergency and eliminate it. As you can see from the graph, the elimination of the situation lasted only a couple of minutes. Practice shows that such hang-ups of material in feeders happen very often, and with a delayed reaction of the personnel, this, in turn, leads not only to a decrease in the productivity of the mill, but also to additional wear of the balls and the armor of the mill.
- The system of automatic control and optimization of the ball drum mill loading, built on the basis of the SKZ SHBM, makes it possible to:
- Perform continuous measurement of the grinding capacity of the mill, determine the level of its loading with clinker and its distribution inside the mil
- Ensure constant maintenance of the specified quality of clinker grinding, taking into account all of the above changing factors, by constantly adjusting the amount of material loaded into the mill;
- If necessary, ensure the maximum level of loading, as well as exclude even the potential possibility of blocking the mill with material;
- Reduce the degree of wear of the ball charge, lining and armor of the mill, saves energy resources, increases the overhaul period
- Significantly reduce the human factor in ensuring the quality of grinding
- In addition, the loading level of the outlet chamber makes it possible to control the quality of the (approximately) grinding material leaving the mill **online** without waiting for the results from the laboratory. This, in turn, makes it possible to instantly respond to changes in the quality of cement and take measures to correct the situation.
- **SKZ SHBM makes it possible to significantly improve the grinding process at enterprises both with a high level of automation and with an initial one.**

Test results at LLP «Bukhtarma. Cement Company»"

- **An increase in the quality of grinding was recorded (Content of class - 0.056 mm in the unloading of the mill) when operating in the automatic mode of loading the mill with ore according to the signals of the SKZ SHBM up to 14.16 %.**
- The system for controlling the loading of ball drum mills **allows you to automatically adjust the performance of the head mills** both when the size of the clinker and its hardness changes, and when the level of the ball load changes, while preventing overloading of the mills, and also reduces the operating time with low material productivity.
- SKZ SHBM **allows to increase the average productivity of head mills at the level of 5-10%,** by optimizing the input load of the material and reducing the time of work with low productivity
- The use of SKZ SHBM **allows to reduce the periods of operation of the mill with a minimum load by up to 80-90% and ensure energy savings.**