ENERGY CONTROL ON THE LININGS WEAR OF SEMI-AUTOGENOUS MILLS

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ABSTRACT. A method is proposed for determining the linings wear of semi-autogenous mills using data from the load schedule of the electric motor.

Keywords: semi-autogenous drum mill, specific electricity consumption, wear of linings and lifters

ЕНЕРГИЕН КОНТРОЛ ВЪРХУ ИЗНОСВАНЕТО НА ОБЛИЦОВКИТЕ НА ПОЛУАВТОГЕННИ МЕЛНИЦИ

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РЕЗЮМЕ. Предложен е метод за определяне износването на облицовките на полуавтогенни мелници с използване на данните от товаровия график на електрическия двигател.

Ключови думи: полуавтогенна мелница, специфичен разход на електроенергия, износване на облицовки и лифтери

Introduction

The mills are the main consumers of electricity in the ore processing plants. Considering their installed power capacity, each cease in their operation should be minimised.

A major problem is the wear of linings and lifters. Their control is usually performed by a direct measurement (a mechanical one with template patterns and a roulette, and in some cases more advanced methods are used - for example, with 3D scanners). The periodical ceases of operation of these mills for such measurements in practice result in the stopping of the entire production line.

In this article a method of wear control is proposed through its prediction by the indications of the energy control system, namely by measuring average power for a certain period of time. The wear of linings and lifters is not quick, it is a long-time process within the range of several months. Of course, the weight of the material and the weight of the balls, as well as the RPMs, will influence the instrument readings.

Object of investigation

A semi-autogenous drum mill type METSO-SAG 8.5 X 5.3 is studied, shown in Fig. 1. The indications on the figure are as follows:

- 1 - drum;
- 2 - side bottoms;
- 3 - rear sliding bearing;
- 4 - front sliding bearing;
- 6 - engine;
- 9 - reducer;
- 7 - shaft - tooth gear;
- 5 - tooth ring gear;
- 8 - assistant engine with brake (used for the technical maintenance and the repair of the mill).

The driving engine is asynchronous with a dual power supply of 5.4 MW, a stator voltage of 6 kV, and an additional frequency feed to the rotor to allow the control of RPMs.

As Minin has stated in his paper (Minin, 2011), in accordance with the suggested mathematical model, the wear of the linings and the lifters, which increases the inner diameter and the length of the drum, is almost linearly dependent on the amount of the processed ores.

Results and discussion

The records for three years are taken from the data collection. They include:

- data on energy consumption;
- amount of processed ore;
- periods between measurements of linings wear;
- rotation frequency.

The data on linings wear is presented by Minin (Minin, 2013). After the processing of the obtained results, the average weekly power is calculated for the period before the measurement of lifters wear (Table 1).

The number of the drum diameter measurements is averaged to 1-4 times in one month (the measurements are not in precise periods since all ceases for running repairs, emergency stops, etc. are used).

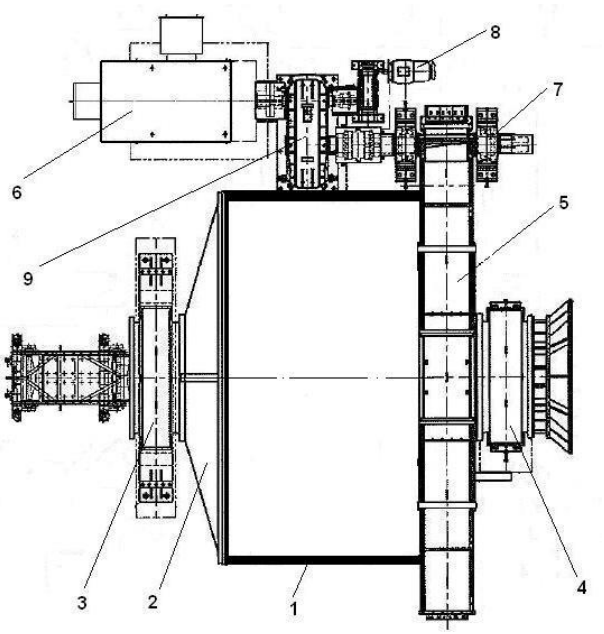

Fig. 1. Overall view of a mill type SAG 8,5 X 5,3

At first sight, the wear of the lifters (made of manganese steel with a density of 7900 kg/m^3), the engine load should be reduced because the grinding media has a lower density (water, steel balls and ore with a density of 3725 kg/m^3) and would fill the volume of worn elements. As Minin has concluded on the basis of his calculations made in (2013), this is exactly the opposite. These conclusions are also confirmed by the results in Table 1 and Figure 2.

Table 1.

№ Of the measurement	Inner diameter	Average productivity	RPMs	Average power
	m	t/h	min^{-1}	kW
1.	8.268	245	1069.5	4877
2.	8.288	244	1047.7	4991
3.	8.308	243	1052.3	5160
4.	8.334	238	1069	5155
5.	8.354	238	1069	5190
6.	8.374	240	1090	5352
7.	8.385	240	1090.4	5393
8.	8.405	238	1090.6	5383
9.	8.100	255	1069.5	4347
10.	8.120	255	1062.5	4455
11.	8.122	255	1038.3	4616
	8.150	261	1004.3	4669
13.	8.154	261	1004.3	4671
14.	8.150	261	1004.4	4671
15.	8.166	253	1014.4	4833
16.	8.179	254	1014.5	4855
17.	8.186	254	1014.7	4941
18.	8.210	241	1012	5049
19.	8.220	241	1012.9	5060
20.	8.240	241	1013.6	5060
21.	8.250	248	1015.1	5065
22.	8.254	249	1015.3	5065
23.	8.256	249	1015.6	5071
24.	8.257	247	1010.2	5076
25.	8.260	247	1069.5	5049
26.	8.270	247	1011	5092
27.	8.280	248	1011	5173
28.	8.300	231	1017.8	5211
29.	8.330	231	1043.7	5265
30.	8.343	231	1044	5281
31.	8.344	248	1044.2	5319
32.	8.353	248	1017.8	5496
33.	8.390	222	1017.8	5453
34.	8.400	222	1062.6	5493
35.	8.402	222	1062.6	5345
36.	8.100	262	1062.6	4556
37.	8.110	262	1005.3	4613
38.	8.111	262	1005.3	4616
39.	8.120	267	1005.4	4669
40.	8.120	267	951.6	4671
41.	8.122	267	977.4	4671
42.	8.160	262	991.8	4833
43.	8.168	263	963.4	4855
44.	8.169	264	963.3	4941
45.	8.210	253	933.7	5049
46.	8.220	253	971.6	5076
47.	8.222	253	974	5049
48.	8.225	248	964.4	5092
49.	8.230	249	878.6	5173
50.	8.228	250	876	5211
51.	8.260	243	877	5265
52.	8.300	243	1034.5	5281
53.	8.100	272	1033.1	4239

54.	8.110	272	880.6	4347
55.	8.130	272	880.6	4401
56.	8.150	266	879.8	4423
57.	8.159	266	1004.3	4509
58.	8.165	266	1004.2	4715
59.	8.200	258	1004.2	4671
60.	8.221	258	939.6	4833

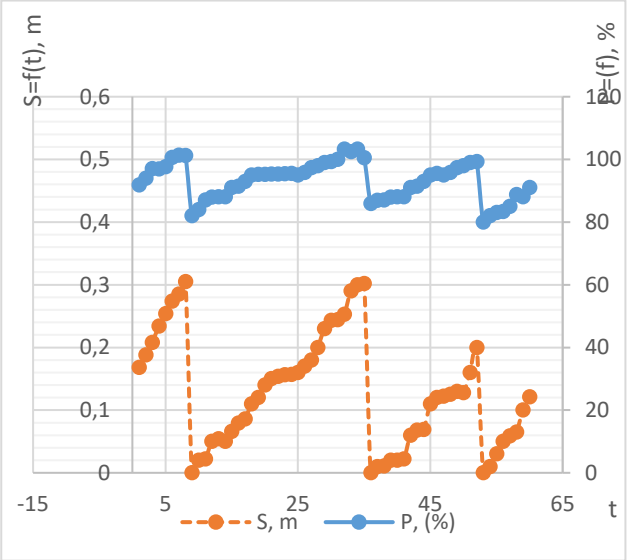

Fig. 2. The dependence of the wear, the average power and the time

The times when the lifters and the linings have been changed could be seen clearly from Figure 2. The electrical power is decreased with about 4% to 7%.

The relation between the electricity consumption and a final product is called a specific power consumption (E). This indicator for semi-autogenous mills has been studied by Hristova (2015). It establishes the dependences between the different factors affecting the specific energy consumption. The methodology for the determination of the lifters replacement period according to the power consumption and the price of processed ore has been proposed by Hristova (2018). In most cases the mining companies prefer to replace the lifters and the linings at a full wear. In our case, the presentation of the specific energy consumption depending on the wear of the lifters in time is presented at Figure 3.

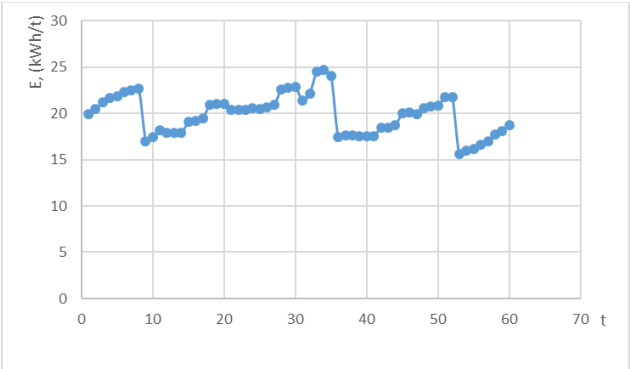

Fig. 3. The dependence of the specific energy consumption on the wear of the lifters in time

Figure 4 shows the relation of the specific electricity consumption to the linings wear.

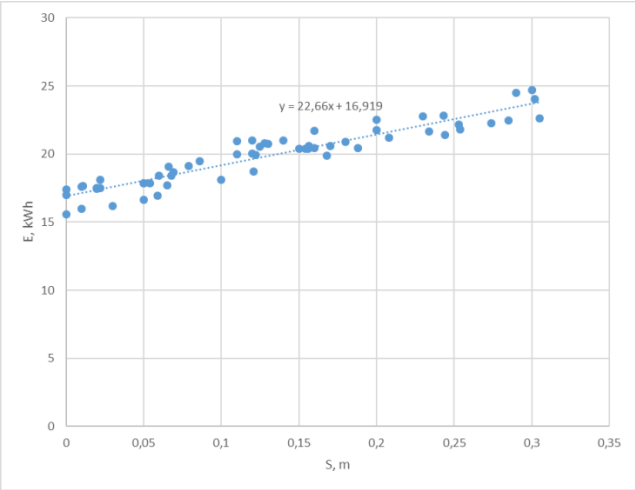

Fig. 4. The dependence of the specific electricity consumption on the linings wear

Conclusion

On the basis of the obtained measurements and results it could be concluded that:

1. It is permissible to control the wear of the lifts of semi-autogenous mills using the readings of the dispatching system.
2. The ceases or stops of the mill can be reduced in order to control the wear.
3. The power averaging time may be longer than the seven days period.
4. The greater interval for averaging will minimise the influence of the variable parameters - water quantity, balls, type of the ore and RPMs of the drum.

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