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Investigation of the jaw crusher operation with backlash eliminators

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Abstract. The condition for the appearance of additional dynamic forces in the presence of gaps in the journal bearings of the jaw crusher is determined. The design of the backlash eliminator equipped with pneumatics is described. It was experimentally established that the use of pneumatic devices for backlash elimination in the interfaces of the moving links, using journal bearings, during the operation of the jaw crusher, reduce the magnitude of accelerations and, therefore, increase the reliability of the crusher as a whole.

1. Introduction

The reliability of machines, including jaw crushing machines, is determined by the number of failures in its work, expressed in hours spent on the breakdown elimination. It is known that a large number of equipment downtime is associated with the destruction of plain bearing brasses, which directly depends on their catastrophic wear [1]. Contact wear of the material from which the liners are made is caused by the fact that it is acted upon by the forces of technological resistance arising during machine operation.

2. State of the problem

Since the elements of the jaw crusher work with acceleration, the dynamic forces caused by the acceleration also act on them. Moreover, there is a technological gap between the liners and the journal, which allows the links to move relative to each other. Due to the presence of gaps in the junctions of the links of the swing mechanism of the movable jaw during operation, the journal periodically moves from one surface of the liner to another, accompanied by impacts, which is the reason for the appearance of additional dynamic forces, the magnitude of which may exceed the values of the forces arising during the technological operation of crushing [2]. It should also be noted that the action of dynamic forces not only increases the wear of the plain bearing shells, but also generates vibrations that negatively affect both the performance of the machine and the working conditions of the operating personnel.

Thus, the elimination of additional dynamic forces will obviously reduce the wear rate of the plain bearing shells and increase the reliability of the machine.



3. Object of the research

One of the ways to eliminate the causes of the appearance of additional dynamic forces is the use of devices for sampling gaps in the interfaces of the moving links. These devices can be different in principle of operation and design. The analysis of existing structures showed that the best option for such device is the use of pneumatics of various types in them, for example, made in the form of a cylinder with a radially limited direction of deformation relative to the trunnion axis [3]. Pneumatics are built into bearing assemblies, consisting of two half-supports, so that the force of technological resistance acts on a fixed half-support that is not in contact with the pneumatic. During the operation of the crusher, the pneumatic in contact with the movable half-bearing constantly presses the movable half-bearing against the journal, thereby preventing the gap from opening. Moreover, this design of the clearance sampling device automatically helps to compensate for the wear of the journal bearing brass.

To assess the effect of pneumatics on the value of the magnitude of accelerations arising during the operation of the crusher, an experimental jaw crusher was designed and manufactured, in the bearing assemblies of which pneumatic devices for backlashes elimination were built (figure 1). The magnitude of the accelerations was recorded by accelerometers mounted on the horizontal and vertical racks of the bed.



Figure 1. General view of the research unit.

At the first stage of the experiments, the influence of the presence of backlashes in the bearing assemblies on the magnitude of accelerations was investigated. At the second stage, pneumatic backlash eliminators were built into the sliding bearing nodes. The number of revolutions of the crank shaft at all stages is 60 min^{-1} .

4. Results and discussion

From the analysis of the experimental results, it follows that in the horizontal plane, if there are backlashes in the bearing assemblies, then the value of the frame accelerations at idle speed of the crank shaft is $0.4 \div 0.5 \text{ m/s}^2$, and during crushing, peaks up to 5 m/s^2 are observed (figure 2 a). With pneumatic devices installed in the bearing assemblies, the value of accelerations at idle speed slightly decreases and is equal to $0.3 \div 0.4 \text{ m/s}^2$, and during crushing, the magnitude of the peaks is $2 \div 2.5 \text{ m/s}^2$ (figure 2 b).

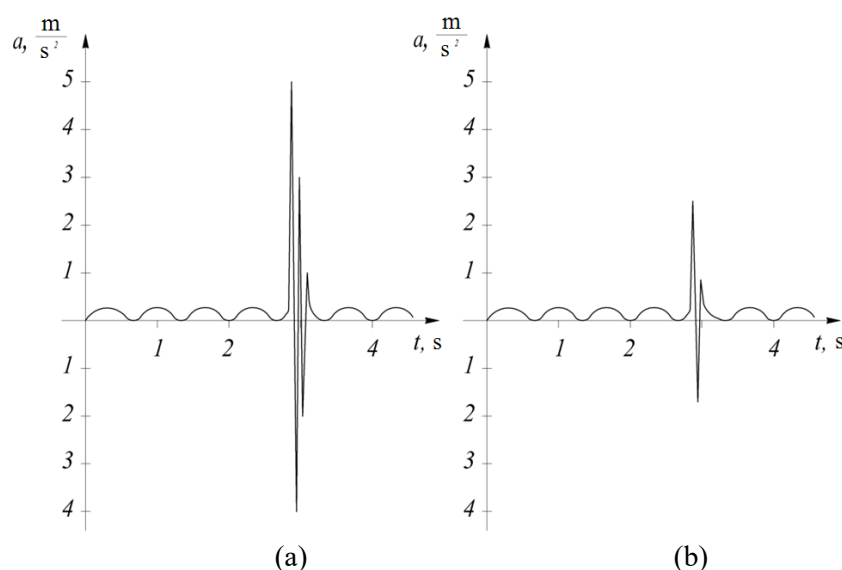


Figure 2. Oscillograms of the frame acceleration in the horizontal plane: a – with backlashes in the bearing units; b – if there are pneumatic devices in the bearing units.

In the vertical plane, in the presence of backlashes in the bearing assemblies, the value of the frame accelerations at idle revolutions of the crank shaft is $0.3 \div 0.4 \text{ m/s}^2$, and during crushing, the magnitude of the peaks is $1.5\text{-}2 \text{ m/s}^2$ (figure 3 a). In the presence of pneumatic devices in the bearing assemblies, the value of the frame accelerations practically did not change (figure 3 b).

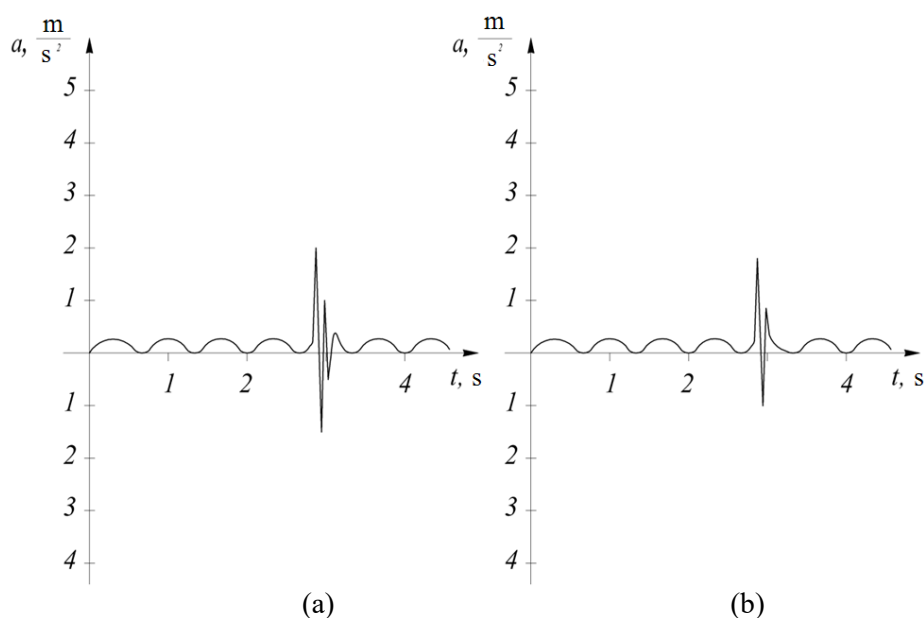


Figure 3. Oscillograms of the frame acceleration in the vertical plane: a – with backlashes in the bearing units; b – if there are pneumatic devices in the bearing units.

It was also experimentally established that the oscillations damping of the acceleration values in the presence of backlashes in the bearings occurs in $3 \div 4$ periods of oscillation, while when using

pneumatics in bearing assemblies, the damping of oscillations occurs almost immediately. This indicates the high damping capacity of pneumatic devices.

5. Conclusion

The condition for the appearance of additional dynamic forces in the presence of backlashes in the journal bearings of the jaw crusher is determined. The design of the backlashes elimination device equipped with pneumatics is described. It was experimentally established that the use of pneumatic devices for backlashes elimination in the interfaces of the moving links, using journal bearings, during the operation of the jaw crusher, reduce the magnitude of accelerations and, therefore, increase the reliability of the crusher as a whole.

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