Monitoring Surfaces of Working Bodies of Transport and Technological Machines

Vladimir Velikanov[1,2][a], Natalja Dyorina[3][b], Elena Pikalova[3][c], and Ekaterina Lomakina[3][d]

[1]UrFU named after the first President of Russia B.N. Yeltsin, Yekaterinburg, Russia

[2]LLC "Laboratory of terotechnologies of ground transport and technological complexes", Yekaterinburg, Russia

[3]NMSTU, Magnitogorsk, Russia

nataljapidckaluck@yandex.ru

Keywords: Mineral, Crusher, Crusher, Wear, Cone, Armour.

Abstract: The crushing process is one of the most energy-intensive in the technological chain of mineral processing. At the current stage of development of ore processing technology, cone crushers for fine and medium crushing are widely used. The efficiency of cone crushers operation is determined not only by the degree of crushing and particle size distribution of crushed ore, but also by the condition of lining armour.

1 INTRODUCTION

Mining companies are suppliers of mineral raw materials, closely linked to the companies in the defence industry, energy, manufacturing and other sectors. The widespread use of digital technologies is a hallmark of super-industrialised industrial production - Industry 4.0.

In 2018, the Russian Federation approved the national programme "Digital Economy of the Russian Federation", the aim of the programme is system-wide development and implementation of digital technologies in all areas of life. The term "Industry 4.0" is generally used to describe new, advanced and potentially breakthrough technologies, including full digitalisation and artificial intelligence, as well as the creation of a new generation of equipment integrated into one digital ecosystem. Digital transformation in mining is primarily aimed at increasing productivity; the goal is to increase labour productivity fivefold and to increase at least 2-3 times the main indicators of the level of industrial and environmental safety (Peters, 2017; Velikanov, Dyorina, Korotkova, Dyorina, 2021).

2 LITERATURE REVIEWS OF MAJOR SOURCES

It is well known that the crushing process is one of the most energy-intensive technological processes in the processing of useful minerals. The course of the process is to achieve the required coarseness of the processed raw material, which depends on the influence of a number of major factors: multi-dimensionality, multi-connectivity, non-linearity, physical and mechanical properties of the mineral, shape and size of rock pieces, the position of the crushed material inside the crushing chamber, the speed of movement of the pieces, wear of the lining armour and elements of the unit, as well as the design parameters of the crusher.

In the technological chain of mineral processing, the efficiency of the crushing process can be achieved by the implementation of rational operating parameters of crushing equipment, providing a given productivity and particle size distribution of crushed ore at minimum energy consumption.

It should be noted that the statistics on forced stops of crushers is about 16-20 % of their working time fund, downtime is caused by the need to replace physically worn parts. The average utilisation rate of

[a] https://orcid.org/0000-0001-5581-2733
[b] https://orcid.org/0000-0002-0613-0864
[c] https://orcid.org/0000-0002-1841-3714
[d] https://orcid.org/0000-0003-3303-2984

crushing equipment at domestic mining and processing enterprises is 0.75-0.86 % (Goncharov, Tulinov, Ivanov, 2016; Boyko, Mnatsakanyan, 2011; Velikanov, Ismagilov, 2009; Velikanov, 2020).

Cone crushers are the main type of high-tech mining equipment presented at domestic mining enterprises with a wide range of types and modifications. The cone crusher realises material destruction by crushing and abrasion between fixed and moving surfaces (Fig. 1).

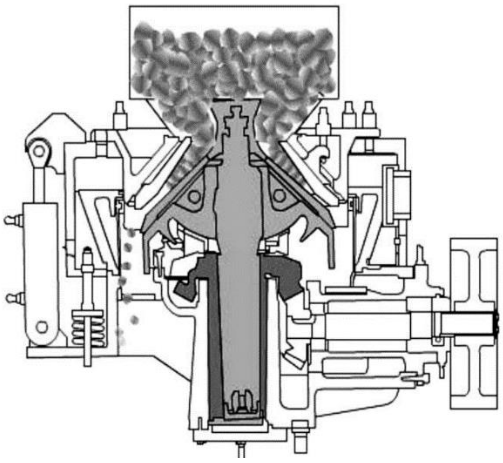

Figure 1: Cone crusher for medium crushing.

In the process of crushers operation, their main components are subjected to significant dynamic loads, leading to surface wear, sinks and cracks. Studies show that liner armour of medium (MCC) and fine (FCC) cone crushers are the least wear-resistant and subject to intensive wear due to constant contact with abrasive rock and have the shortest resource compared to other units. Intensive wear of the lining armour leads to a change in the size of the discharge slot towards an increase, which eventually leads to an increase in the coarseness of the crushed product, which negatively affects not only the qualitative and quantitative characteristics of the crushing process, but also leads to an increase in power consumption when approaching the maximum capacity of the crushing chamber. In addition. increasing the size of discharge slots allows high feed capacity, but is accompanied by a decrease in the degree of crushing and an increase in the weighted average size of a piece of material in the crusher discharge.

Management of modern industrial production relies on the use of information of large volume and different nature. One of the types of information used in control systems is images, on the basis of which decisions are made not only about the quality of finished products, but also about the need for repair or other actions for technological equipment. In (Kulchitsky, Naseri, Sharkunov, 2020) an original approach in digital recognition of the degree of wear of threaded joints of drilling tools (Fig. 2, a) is implemented, in studies (Velikanov, Bochkov, Derina, Bochkova, 2022; Grishin, Bochkov, Velikanov, Derina, Surovtsov, Moreva, 2022) the principle of implementation of video endoscopic observations of the condition of the lining armour of a cone crusher is presented. Visual monitoring of any point of the working zone of the cone crusher is carried out through technological holes in the moving and stationary cone of the crusher during its maintenance or technological stop (Fig. 2, b).

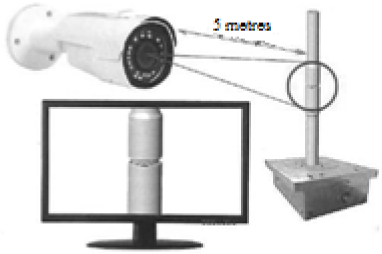

Figure 2 a: Studies on digital recognition of wear of threaded joints of drilling tools.

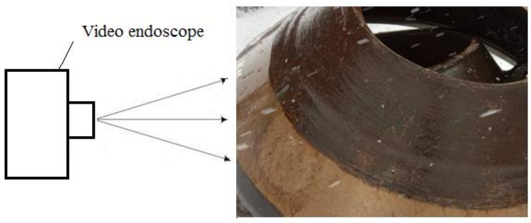

Fig.ure 2 b: Principle of implementation of video monitoring of the crusher lining armour condition.

The complexity of algorithms used in obtaining and processing visual information limits the range of its application, and up to the present time, as a rule, human resources are involved to obtain and make decisions, which allow presenting the results of expert evaluation. The main disadvantages of the method of visual image assessment are: the presence of erroneous decisions when classifying defects; high labour costs; dependence of the result on the experience of the expert. The automated method of obtaining expert information is also not without disadvantages, among which the most significant is the lack of responsibility in case of incorrect decisions about the development of defects.

3 CONCLUSION

Based on the analysis of scientific literature, we found that a promising direction of control and diagnostics are visual methods, which are implemented with the help of imaging systems and automated image processing systems (AIPS).

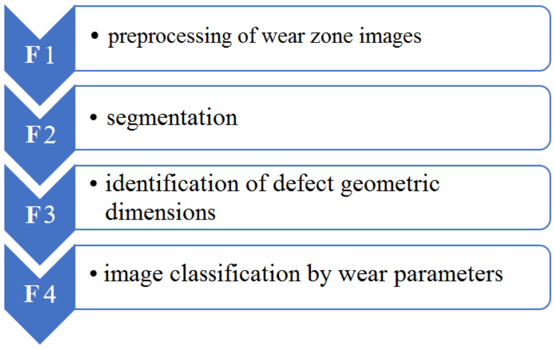

Figure 3: AIPS functionality.

Imaging of the wear zone of the lining armour of cone crushers is carried out as follows. There are two variants of obtaining the image of the zones. The first one is the simplest, at the moment of crusher stoppage when carrying out any repair action. The pre-cleaned lining armour of the crushing cone is oriented relative to the digital camera, illuminated, and the reflected light flux falls on the digital camera of the imaging system.

REFERENCES

Platform "Industry 4.0", https://www.plattformi40/

Peters, H., 2017. Ferrous metals, **7**, 56.

Velikanov, V.S., Dyorina, N.V., Korotkova, A.N., Dyorina, K.S., 2021. News of the Ural State Mining University, 2(62), 154.

Goncharov, A.B., Tulinov, A.B., Ivanov, V.A., 2016. Mining inform-analyst. *Bulletin*, 9, 22.

Boyko, P.F., Mnatsakanyan, V.U., 2011. *Mining Journal*, 6, 52.

Velikanov, V.S., Ismagilov, K.V., 2009. *Mining Information and Analytical Bulletin*, 2, 30.

Velikanov, V.S., 2020. *Journal of Mining Institute*, 241, 29.

Kulchitsky, V.V., Naseri, Ya., Sharkunov, P.A., 2020. Construction of oil and gas wells on land and at sea, 4(328), 32.

Velikanov, V.S., Bochkov, V.S., Derina, N.V., Bochkova, K.V., 2022. *Mining Information and Analytical Bulletin*, 11–2, 159.

Grishin, I.A., Bochkov, V.S., Velikanov, V.S., Derina, N.V., Surovtsov, M.M., Moreva, Yu.A., 2022. *Bulletin of Nosov Magnitogorsk State Technical University*, 20 (2), 13.