The Fe-C-Cr alloys used for production of working elements of impact crushers

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The aim of the research presented in the work was mechanical and microstructural analysis of the rotor crusher components of the SANDVIK CV117 centrifugal crusher working in the melafir mine. Microscopic studies have shown diversity in the material used for individual working elements of the crusher rotor. Such a significant difference in materials causes disproportion of properties that the tested elements exhibit. The result of the research may be surprising, because despite the very similar nature of the work, the materials from which the tested components are made differ radically from each other.

Keywords: centrifugal crusher, material structure, Fe-C-Cr alloy

1. Introduction

Impact crushers are used both for initial, secondary and third-degree crushing [1, 2]. The crushing process occurs when the energy supplied by the rotor is greater than the decohesion energy of the grain. The forces that act on the grain in the rotating rotor include: centrifugal, gravitational, frictional, inertial/fictitious, pressure on the rotor blade, the Coriolis force, buoyancy and resistance created by other grains. Modern materials used as elements of crushers must therefore demonstrate reliability, durability and long service life [2].

2. Materials and Methods

The aim of this study was to determine the impact of the Fe-C-Cr alloy structure on selected mechanical and operational properties of an impact crusher. The research focused on the working elements of the crusher, such as crushing hammers and the bushing (fig. 1). All elements had direct contact with the aggregate (melaphyre), and their service life was about 1,400 operating hours.

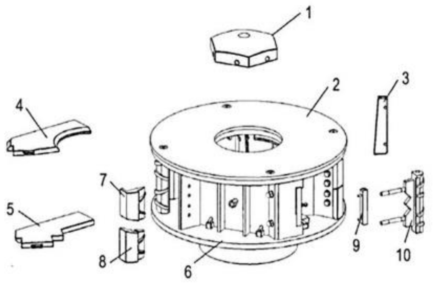

Figure 1. Construction of the centrifugal crusher rotor: 1- distributor partition, 2- rotor body plate, 3- plate guide, 4- upper plate, 5- lower abrasion-resisting plate, 6- body, 7,8- hammer assembly, 9- spare bit, 10-rotor bit assembly

3. Results and Discussion

Macroscopic examination showed that the reason for replacing the examined elements was their excessive wear. The bushing reduced its volume by 25% and the hammer unit by 13% in relation to the unused elements. The microscopic examination showed a variation in the structure of the material used for individual working elements of the crusher. The bushing and hammers were made of Fe-C-Cr alloy but differed in their structural properties. In the microstructure of the bushing material, primary needle inclusions of M_7C_3 chromium carbide in the ferritic-austenitic matrix were visible; in the hammer material, apart from M_7C_3 chromium carbide inclusions in the ferritic-austenitic matrix, $M_{23}C_6$ carbide inclusions were observed (fig. 2 and 3).

Differences in the material structure of both elements resulted from differences in chemical composition. The chromium content was 30% in the hammer material and 27% in the bushing material. According to the literature data, the content of carbides in the structure increases with the increase of Cr/C ratio. Structural changes also have a direct impact on mechanical and operational properties of the elements. The hammer material had a significantly higher hardness (819HV10) than the bushing material (710HV10). The analysis of the static friction coefficient showed that the friction coefficient is higher for the hammer material than for the bushing. The analysis of the depth and shape of the wear trace made with an interferometer (profilometer) showed small differences in the depth of the wear trace, in both cases the furrows were formed along the wear trace.

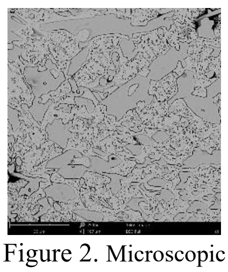

Figure 2. Microscopic image of the material of the rotor hammer. SEM

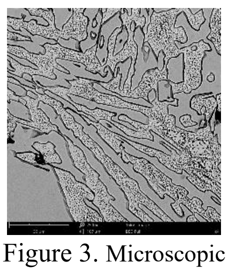

Figure 3. Microscopic image of the directional sleeve material. SEM

4. References

[1] Pangfei C., at all., “Design and property study of a new type centrifugal crusher wear block”, Integ. Ferroel.,197, (1), 2019, 83-98.

[2] Depover T., Verbeken K., Hydrogen trapping and hydrogen induced mechanical degradation in lab cast Fe-C-Cr alloys, Mater. Sc. and Eng., 669, 2016, 134-149.