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Study on Impact and Wear Properties of ZGMn13 High manganese steel Materials under Dry, Water and Sand Conditions

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Extended Abstract

High manganese steel, known for its excellent wear resistance and high toughness, is widely used in mining, metallurgy, construction and other heavy-load working environments[1]. Among various high manganese steel alloys, ZGMn13 high manganese steel has become a focus of research due to its higher manganese content and superior mechanical properties. This study aims to experimentally analyze the impact and wear performance of ZGMn13 high manganese steel under different impact energies by incorporating third medium of water or quartz sand, and to explore the surface damage characteristics, wear behavior, and mechanisms.

In this research, an MLD-10 Load Abrasive Wear Testing Machine was used to conduct experiments on ZGMn13 and GCr15 friction pair, which are common material in mining and agriculture. The tests were conducted at different impact energies of 1J, 2J, and 3J, respectively, using three experimental groups: dry impact, with added third medium quartz sand, and with added third medium water. The quartz sand was mixed in a ratio of 100 mesh, 325 mesh, and 1000 mesh at 1:2:1, with an abrasive flow rate controlled at 25 cm^3/min to simulate the wind and sand in an extremely dry environment, and a water flow rate of 100 ml/min to simulate the paddy field environment. Through detailed experimental setup and parameter control, the impact of impact energy and the third medium on the surface hardness, wear rate, and surface damage of impact-resistant materials was analyzed in depth.

The results indicate that in dry impact wear, ZGMn13 high manganese steel exhibits lower wear resistance at an energy of 1J, while at 3J, its wear resistance is the best. Moreover, its wear resistance increases with higher impact loads. The main reason affecting wear resistance is that high manganese steel possesses impact toughness and work hardening properties[2],which improve with the increase in impact energy.Using Scanning Electron Microscopy (SEM) and a 3D pro filometer, we observed the surface morphology of the impact wear friction pair. It is evident that both the upper and lower t est samples show significant signs of rolling deformation. The number of pitting marks from impact abrasive wear is notab ly higher than that from dry impact, with a greater degree of deformation. The surface affected by quartz sand abrasive is r ough and uneven, displaying traces of repeated pitting deformation. As wear time increases, the metal surrounding the inde ntations and grooves formed by the compression of quartz sand into the substrate undergoes deformation and cracking due to repeated rolling, ultimately leading to spalling under sliding friction[3]. After adding water, significant cracks and corrosion appeared on the sample surface, and the grooves on the surface decreased[4], giving way to the formation of large spalling pits forming instead.

As wear time increases, the duration of the material's operation in a moist environment also extends, leading to continu ous and expanding corrosion on the surface.Additionally, instrumentation reveals that in dry impact wear, the wear degree of ZGMn13 high manganese steel gradually increases with the rise of impact energy. At an impact load of 3J, the surface s hows minimal spalling and remains smooth. After incorporating quartz sand, ZGMn13 exhibits insignificant work hardenin g under a low impact load of 1J, allowing the abrasive to easily embed and move, resulting in lower wear resistance. In con trast, at an impact load of 3J, the scratches are lighter and shorter. In a moist environment, as impact energy increases, crac ks on the substrate surface gradually expand, leading to spalling.

These comprehensive studies indicate that the impact toughness and work hardening properties of ZGMn13 high mang anese steel increase with higher impact energy. In practical applications, an increase in the speed of tillage tools could be b eneficial to extending their service life. The addition of a third medium not only influences the friction and wear forms and rates of the material but also impacts its impact toughness and work hardening properties. Future research should further in

vestigate the material's performance under various medium influences and explore the composite or alloying studies of hig h manganese steel with other novel materials to enhance the environmental adaptability and safety of agricultural tools.

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