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Experimental research on wear of conical pick interacting with coal-rock☆

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ABSTRACT

For severe wear of a conical pick on tunneling and mining equipment, the influence of pick cutting types, structure and working angle parameters on pick wear is studied using an experimental apparatus for cutting coal-rock. The influence of pick wear on cutting performance is analyzed, which provides an experimental basis for reducing pick wear. The results indicate that the pick wears on only one side under asymmetrical cutting types, which increases the pick's working life. The larger the height of carbide tip and cone angle of pick tip are, the easier it is to protect the head face of the pick-body from interference with coal-rock and avoid carbide tip loss due to wear of the pick-body. In the range of research, the suitable height of the carbide tip is found to be 20 mm ~ 24 mm, and the cone angle of the pick tip should be approximately 80°. The wear area on the pick-body increases with the head face diameter of the pick-body, and a suitable range for the head face diameter is found to be 20 mm–22 mm. Pick wear decreases with cutting angle, but the cutting angle should be maintained at 45°–50°, considering the pick cutting load and coal-rock caving effect. For picks with an inclined angle, pick wear increases with incline angle, however, wear differences on the two sides of the pick form and increase gradually, which improves the pick's self-rotatory ability. The mean peak of pick cutting torque increases with wear degree, and the largest increase percentage was found to be 30%. Furthermore, a worn pick is unfavorable for the caving of coal-rock and the coal-rock fragment size of <2 mm increases by 14% compared to a pick without wear.

1. Introduction

Coal is one of the most widely used fuels, and its use is expected to be prolonged over decades. The shearer drums and the cutting heads of road-headers are the main components used in the coal mining process, which consumes 80%–90% of the power of the entire shearer and road-header. Conical picks, repeatedly interacting with coal in the mining process, are regularly arranged on the helix drums and cutting heads [1–2]. Their performance has direct influence on the cutting performance and efficiency of the working mechanism. They generally consist of a carbide tip, pick-body and pick-handle, which is installed on the

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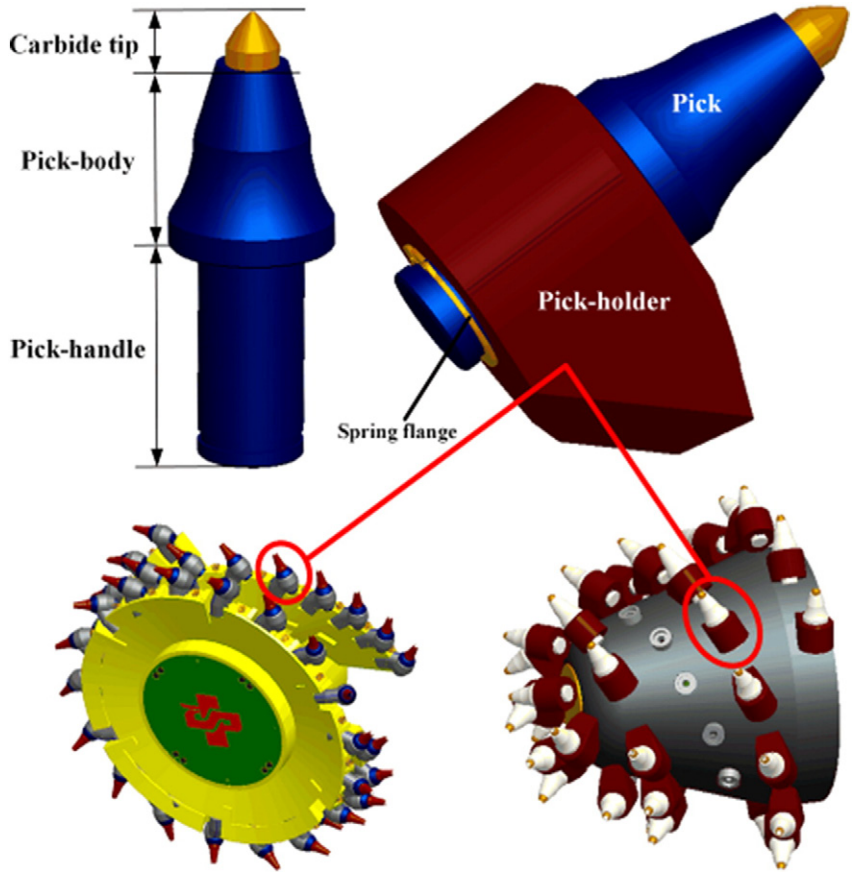

Fig. 1. Conical pick and its installation.

pick-holder and fixed by a spring flange, as shown in Fig. 1. They are used to break coal-rock when the pick-holder is welded on the cutting head.

The working condition of a pick is severe, complex and dynamic. Conical picks work under high impact and stress conditions, which often results in failure. Many researchers have paid increasing attention to pick failure, and have noted that the failure styles mainly include premature wear, carbide tip drop off, tipping, fracture and normal wear. Among them, failure due to wear such as normal wear, premature wear and carbide tip drop off, account for approximately 75% of the failures.

To study how conical picks wear during use, on one hand, researchers are gradually studying the load on pick cutting coal-rock by simulation and experiment. For simulation, researchers mainly use the finite element method [3–5] and discrete element method [6–8]. For experimentation, researchers established different testing apparatuses, such as a Coal-Rock Cutting Test-Bed [9–11], Automated Rotary Coal/rock Cutting Simulator (ARCCS) [12–14], Single Pick Cutting Test-Bed [15–16], full-scale cutting rig [17–18] and reconstructive test apparatus [19–20]. However, researchers have found that not all the load on a pick resulted in wear, and there was little study on load resulting in wear. This is the main reason that the wear mechanism of picks remains underexposed.

On the other hand, researchers are gradually conducting more studies on pick wear directly [20–23]. Pick wear was tested under multiple cutting tests to mainly study the wear types of the picks. Under these conditions, pick wear was light with only some surface scratches, and the tested wear mass loss was under one mg. Due to serious limitations, the results of this study are not yet enough to show the wear characteristics of a pick. Pick wear characteristics should include pick wear states in cutting processes and the influence of wear on pick cutting performance.

Based on this, the influence of pick cutting types, structural and working angle parameters on pick wear is studied in this paper using an experimental apparatus for cutting coal-rock, and the influence of pick wear on cutting performance is analyzed to provide an experimental basis for reducing pick wear.

2. Experiment methodology

Experiments were conducted on a Coal-Rock Cutting Test-Bed to simulate the process of a conical pick cutting coal-rock. The test-bed includes a main and auxiliary transmission system, cutting apparatus, hydraulic control system and