

Manufacturing Process and Strength Analysis of No-spark and Anti-wear Strengthen Cutting Pick

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Abstract: In this paper, the cutting pick of mining machinery is studied. In view of the disadvantages of the existing picks such as easy wear and poor safety, a method of non-sparking and anti-abrasion strengthening picks is proposed. The plasma pick- Surface made of composite coating, can effectively improve the wear resistance without sparking. Based on this, the strength of picks was analyzed by finite element method, and the stress and strain state of picks during cutting was obtained. The results show that the non-sparking anti-wear enhanced pick wear resistance, long service life, while contributing to the safe mining of coal mines.

1. Introduction

The pick is a tool that acts on coal and rock directly on the cutting head of shearer roller and roadheader. It is used for crushing coal and rock and its performance has an important influence on the work efficiency and service life of the whole machine. Due to the poor working environment of the cutting head, the wear and damage of the cutting teeth is very serious, and the picks become one of the wearing parts that often need to be replaced. The form of failure of picks is pick-toothed wear, cemented carbide head off, alloy head cracked, picks broken and so on. According to statistics, the number of picks consumed per ton of coal consumed in China's coal mines is between 400 and 800, the use efficiency of picks is generally low, and the demand for picks is very large [1]. More importantly, during the excavation process, a large amount of sparks are generated due to the friction between coal and rock and the base of the cutter. The risk of gas explosion is large, and the safety hazard is great.

At this stage of China's mining machinery cutting pick production process: tooth body cutting → forging → machining → brazing carbide tip → pick overall tempering or isothermal quenching → finished product. Quenching or isothermal quenching is necessary to meet the toughness requirements of tooth bodies, but the quenching and isothermal quenching in the process of heating and cooling, easy to produce in the brazing joints and cemented carbide micro-cracks, reducing the life of the pick; In addition, the heat treatment for improving the wear resistance of the pick is limited, during the use of tooth head will produce early wear and tear, making loss of support carbide head and premature exposure and loss, resulting in cutting teeth lose cutting ability. At present, many researches have been conducted on the surface treatment and strengthening of picks: Chen et al [2] used plasma beam surface metallurgy to make metallurgical bond with the substrate at the severed parts of shearer's picks Iron base composite coating to improve the wear resistance of picks; Feng Yuanyuan [3] and other computer simulation and experimental verification of the induction heat treatment after the pick of the hardness and the organization were predicted; Zhang Qiang [4] and other heavy-duty roadheaders The mechanism of pick failure and wear resistance improvement were studied. From the existing research situation, few researches on spark-proof anti-wear anti-wear cutting picks have been conducted. However, while improving the wear resistance of picks, sparks are avoided during mining, the production efficiency is improved, and the production safety is

ensured. In this paper, a method of non-sparking anti-wear strengthening picks is proposed. At the same time, the strength of picks is analyzed by the finite element method.

2. Non-spark anti-wear strengthen pick technology

In order to solve the problems of abrasion resistance and spark suppression of mining picks, we use plasma cladding alloy coating technology to produce a composite coating on the surface of the pick, which can effectively improve the wear resistance of picks Sparks

Plasma cladding alloy coating technology is developed on the basis of laser cladding and wear-resistant surfacing. The basic principle is that the alloy powder or the ceramic powder and the base body surface are quickly heated and melted, mixed, diffused, reacted and solidified in the metal table under the action of the flexible high-temperature plasma beam to obtain the high-hardness alloy ceramic layer which is metallurgically bonded Achieve the table and strengthen the hardening.

The non-sparking anti-wear strengthened pick composite coating by iron-based solid solution, boride, carbide composition, prepared by plasma cladding method, wherein: the original powder composition by weight percent, B is 4 to 8 % Of C, 1 to 5% of C, 20 to 55% of Cr, 1 to 4% of Si, 5 to 12% of Ni, 1% of each of Ti, V, Zr and Nb and the balance being Fe, 0.5 ~ 5mm. Hardening mechanism: a variety of borides and carbides of the second phase strengthening, dispersion strengthening, fine grain strengthening, solid solution strengthening.

The specific process is as follows:

1) Preparation of metal powder. According to the weight percentage of the above elements, the metal powder is arranged, and the powder can be added in the form of an alloy or a metal simple substance. The particle size of the metal powder is 10 to 200 μm .

2) pick pretreatment. The traditional cutting method is adopted to process the picks. After forging, machining, brazing cemented carbide tips, quenching and tempering or isothermal quenching, the basic production steps of the picks are completed.

3) plasma cladding. Using plasma cladding method, the above mixed powder cladding surface cladding. Plasma cladding, the use of automatic powder or pre-coated powder method; working current 140-300A, single-channel scanning width of 1-10mm, the nozzle distance from the workpiece 2-10mm, scanning speed 10-30cm / min. Ionization and shielding gas is inert gas or nitrogen.

4) Surface treatment. Using diamond grinding wheel and other means of cladding finished pick surface reprocessing.

The non-sparking anti-abrasion strengthening pick produced by the method can achieve the hardness of 600-1500HV, the cladding layer is polished on the grinding wheel without sparks, and has excellent abrasion resistance, being 3-6 times of 35CrMnSi tooth body material . Shown in Figure 1 is the use of the production method of non-sparking anti-wear strengthening pick physical map.



Fig.1 Picture of no-spark and anti-wear strengthen cutting pick

3. Strength analysis of 2 non-spark wear-resistant picks

According to the force characteristics of the picks at the time of actual cutting, we reduced the force of the picks to a concentrated force, without considering the influence of dynamic loads and made the following assumptions:

- (1) The non-spark wear-resistant cutter head and the cutter as a whole;
- (2) Do not consider the non-sparking anti-wear strengthen the tooth pick in the rotation;
- (3) The load that the picks bear is the concentrated load, and it is concentrated in the cutter head part.

In order to make the loading of solid model in ANSYS reflect the true force of the pick, and taking into account the arrangement and mounting position of the pick, all nodes within 3mm from the tip of the pick are force points A node loads the cutting force (X), feed force (Y), lateral force (Z), and the loading ratio is the cutting force: feed force: lateral force = 1: 0.5: 0.4 [5].

3.1 Picks finite element model and meshing

Solid models of cutting picks are established in ANSYS. Parametric design language (APDL) can be used to perform finite element analysis easily and quickly. The unit type is Solid \ 10 node 92 with material properties of elastic modulus (EX) and Poisson's ratio 270 GPa and 0.3. Adopting intelligent grid division (level 6) to mesh the solid model and refine the bit area.

3.2 Constraints and loading

Define the full restraint at the root of the tooth and fix it; in all three nodes within 3 mm from the tip, exert a concentrated force in three directions. The constraints and loading results are shown in Figure 2.

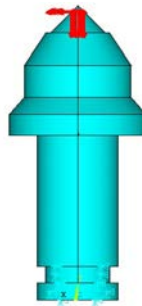


Fig.2 Load of cutting head

3.3 Solution and result analysis

After completing the above settings submitted for solving, analysis of the resulting stress cloud shown in Figure 3.

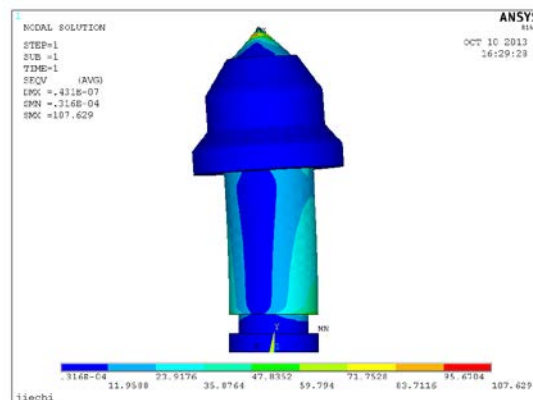


Fig.3 Von mises stress of cutting head

As can be seen from Figure 3, the maximum stress of non-sparking anti-wear strengthened pick appears in the bit, the maximum equivalent stress is 107.63MPa, which is mainly due to concentration, where excessive stress is caused by hard Alloy cutting head is an important reason. The non-sparking anti-wear enhanced pick here at the strengthening can effectively protect the cemented carbide head. In the actual excavation operation, only the alloy head part of pick is worn. With the increase of wear, the chances of pick shoulder contact with coal and rock greatly increase. And the wear of shoulder can accelerate the fall of alloy pick, which leads to the failure of pick. In this paper, the non-sparking anti-wear strengthening picks can be well prevented by the strengthening layer at the transition of alloy head and pick shoulder.

In the vicinity of the tail of cutter bar, due to the feed force and lateral force of pick in the actual excavation work, a larger bending moment is generated near the root of the pick, so the stress is greater. As the blade yield strength limit is 1500MPa far greater than the maximum force calculated head, so no anti-wear spark anti-wear picks will not produce failure. The minimum stress point appears above the tooth seat on which the pick is mounted. This area has a large diameter and is not easily deformed or damaged.

Summary

In this paper, aiming at the disadvantages of the existing picks such as easy wear and poor safety, a method of non-sparking and anti-abrasion strengthening picks is proposed. The plasma cladding method is used to make the composite picks on the surface of ordinary picks, Wear resistance at the same time does not produce sparks. On this basis, the static strength of non-spark wear-resisting pick was analyzed by finite element method, and the stress distribution during the cutting was obtained. The results show that the non-spark wear-resistant picks have good wear resistance, long service life and safe mining of coal mines.

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