

## Face Scraping Machine Design and Analysis

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### Abstract

Scraper conveyor transport is an important part of mining machinery . Design and manufacture of scraper conveyor cover the movement of conversion, power transmission , the transmission mechanism , structural design, casting and forging machinery design and manufacturing process content. The design is based on coal actual transport conditions , to train for the purpose of improving the overall design capabilities , in the design of new design ideas and methods as much as possible , choose a more rational structure and technical specifications , and strive to improve the quality of scraper conveyor , reduce production costs, the existing infrastructure to fully absorb learning scraper conveyor design experience, the reference to the relevant design information , refer to " mechanical Design Manual " and other books, designed in accordance with the mechanical engineering design process , methods, and technical specifications. Scraper conveyor with hydraulic support large-scale mechanized mining equipment for use in the face , Shearer , Shearer completion of the face under the coal mining transportation , transit transport equipment on the follow-up to the task , and to provide the appropriate means of connection . Because of this design is given in thin seam coal, considering the seam dip, thickness, and production and other factors, the choice MG240/300-WB Shearer, Shearer and supporting the use of this type of scraper is SGZ630/220 conveyors, scraper conveyors the volume to meet the high demand, reliable, large-scale mechanized mining equipment is an excellent model.

### Keywords

Scraper conveyor; Optimized design; Mine haulage machinery.

### 1. Introduction

Heavy - duty underground coal mining machinery, very harsh conditions. Therefore, there are higher requirements on the strength, stiffness, willfulness and wear resistance of work construction. In general, the chain is the most reasonable moving component of machinery. As an important face scraper in coal mining machinery. Because of its simple structure, long service cycle, safety and reliability, long working distance and convenient installation and maintenance, it has been widely used in various important industries.

As the selection and design of working face scraper, the work we need to finish is roughly: the purpose of designing working face scraper and its current market demand; Understand the design process and design process; Clear design parameters and materials. Complete the design smoothly with the method of participating in the factory internship and the guidance of the teacher.

#### 1.1 Basic Structure Working Principle

As a machine for transportation. The load-bearing device is the chute, and the scraper chain can play the role of traction, which needs to be combined with the head and tail sprocket to produce the effect [1]. After the motor is started, under the action of the reducer, the motion of the scraper chain causes the coal in the chute to be transferred from the machine head to the machine tail.

Working face scraper is made up of head, fuselage and tail.

General situation of working face scraper:

Head: head frame and sprocket plus coupling, reducer and motor.

Tail section: approximately the same as the nose.

Fuselage part: assembly of the stripper chain and other devices.

Auxiliary equipment: chain, shift, anchor and other devices.

### **1.2 Basic Types and Application Scope of Working Face Scraper**

The face scraper is mainly used for working face with mining face Angle not more than 25 degrees.

The motor power used in the working face scraper is between 7.5kw-1000kw conveying capacity and 30t/h-3000t/h, which are classified as follows[2] :

Traction number classification: single medium chain, side double and middle double chain and three-chain working face scraper.

Chute layout classification: overlapping and parallel chute face scraper.

Classification of chute structure: open bottom type and seal bottom type face scraper.

How to unload classification: end unloading side and unloading working face scraper and other classification methods.

### **1.3 Status Quo and Prospect**

#### **1.3.1 Technology Status**

Since the end of the last century, China began long arm mechanical coal mining. Later, China has developed and manufactured the ability of working face scraper, and successfully developed the machine that is suitable for Chinese use and put into use in mass production. Now the various equipment technology of our country can be compared with the international leading country.

#### **1.3.2 Development Prospect**

With the passage of time and the development of the industry, the requirements of working face scraper conveyor will be higher and higher, and international competition will be intensified. Scientific innovation and international cooperation have become the general trend.

The working face scraper must adapt to the working environment of coal mining, the complete machine design of transmission department and central trough, the machine head and the machine tail are placed in the lane at both ends, the machine head and the machine tail frame can be adjusted flexibly and the height can be changed.

## **2. Overall Design**

Modern mechanical coal mining needs to reduce or prevent excessive artificial openings, to achieve the coal mining machine from opening the gap, which requires that the head and tail height of the face scraper should not be too high and the length should not be too long. Must do, reduce the number of sprocket teeth; Reduce the reduction ratio, increase the speed of the chain and reduce the volume of the reducer. Multiple motors are also used to reduce the size of the mechanism.

### **2.1 Machine Head**

As the usual driving part of the working face scraper, of course the tail also has the driving device. By contrast, the nose is a little taller and slightly longer than the tail, and the rest need to be roughly the same.

#### **2.1.1 Headstock**

The frame is the support of the whole head part. The stiffness and strength must be achieved. It is suitable for welding with thick steel plate. The common point of general machine head frame is bilateral symmetry, reducer is installed on both sides, so the left and right sides are suitable for coal mining; To facilitate down-hole disassembly, the reducer extends the shaft and connects the sprocket with the blind shaft support.

### 2.1.2 Blind Shaft

The blind shaft is used to support the sprocket. The blind shaft assembly is a chainwheel of conical cylindrical gear reducer matched with the connecting assembly, which is fixed by bolts on the bearing seat of the headstock.

### 2.1.3 Primary of Coupling

The test motor of the coupling is connected with the reducer, which is divided into elastic coupling and hydraulic coupler. Because of the thin coal seam, there will not be too much coal production and the shaft torque is relatively small, so the relatively light working face scraper is selected, and the hydraulic coupler will have a better performance. First, the motor starts up with light load. Overload protection is also available; Shock vibration is also effectively reduced; Load can be evenly distributed.

### 2.1.4 Sprocket Assembly

Sprocket assembly includes sprocket and connecting barrel. The sprocket as a transmission component is subject to static, pulse and impact loads. Sprocket has high requirements on strength, wear resistance, toughness and the ability to withstand impact loads[3]. By figure 1, the connecting barrel and sprocket are connected together, and the internal spline is connected with the output shaft and blind shaft of the reducer. This is easy to disassemble and repair. Sprocket is modulated by high quality steel after forging, and chain socket and tooth form are quenched.

According to the technical conditions of mine ring sprocket (MT/Z9--80). General technical conditions of working face scraper (MT150--1993) stipulates that sprocket of light working face scraper must be replaced once a year, and that of medium and heavy working face scraper must be replaced once a year and a half.

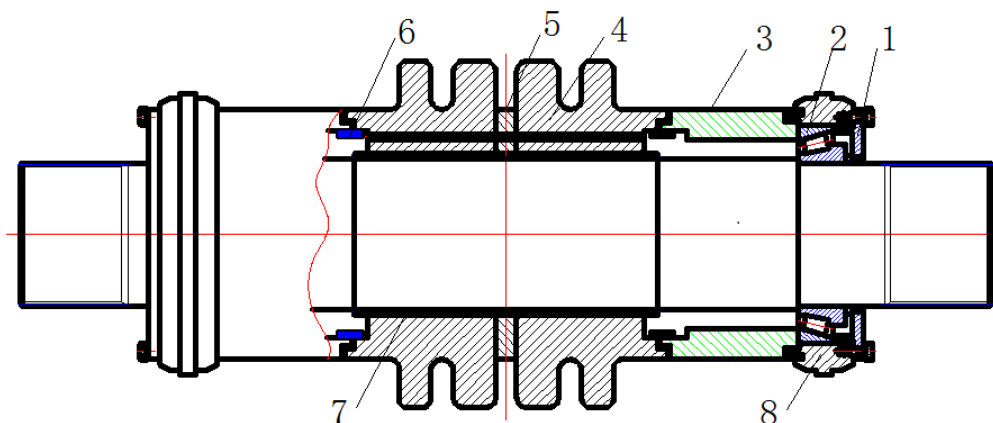


Fig 1. Sprocket assembly diagram

### 2.1.5 Reducer

Considering the installation size of thin coal seam shaft, the reducer of face scraper is chosen as three-stage transmission conical cylindrical gear reducer of parallel arrangement. Suitable for gear with circumferential speed less than 18m/s; The installation of 1° and 25° Angle; The rotation speed of high-speed shaft is less than 1500r/min; Reducer operating temperature - 20 ° C to + 35 ° C; And it can be positive or negative[4].

The reducer box should be symmetrical up and down for the convenience of head and tail. It is necessary to increase the smoothness of the gears and bearings in order to fit the working face scraper to work at a larger Angle. In order to change the speed of the chain, the reducer is suitable for changing gears, so that the transmission ratio can be adjusted.

## 2.2 Tail Section

The tail section has two conditions with and without the drive device. There is a rear part of the drive, without unloading height, except the head of the tail frame is different and roughly the same as the head part. The tail part without drive only includes the part of the scraper chain steering. This design

sgz630/220 face scraper includes automatic chain adjusting equipment with retractable rear[5]. In this way, the tightness of the scraper chain can be changed manually or automatically, the working condition of the scraper chain can be improved, the power of trial start can be reduced, and the overall effect can be improved.

Automatic control of the scraper chain slack equipment, the scraper chain and the head and tail sprocket separated below the tension sensor. Chain over feed and over tighten, control the elastic jack or expansion or contraction, to maintain normal tension.

### 2.3 Chute and Accessories

The chute is also an essential part of the equipment and an important supporting device. The larger the size of the chute section of the face scraper, the stronger the transport capacity. The chute of working face scraper is the capacity of lifting load of coal board installed on the side of goaf. The side wall is equipped with a coal deflector to clean up the tunnel. There are two forms of the chute, the open base and the back cover. Because the bottom chute shows good performance under the working environment with low hardness of the bottom plate, the running resistance is effectively reduced. So the bottom - type chute application and this design.

The middle chute is the body part of the face scraper machine, welded with the middle plate through the chute. The feed tank is the upper load-bearing tank, and the lower tank is used for the reentry of the scraper chain.

The central chute is divided into three types, namely single chain type, double chain type and medium double chain type[6].

The adjustment chute and the central chute have the same basic mechanism, which is used to adjust the length of the face scraper.

The excessive chute ACTS as a link between the head, tail and middle chute, linking the three parts into a body.

Both the coal baffle board and the coal shoveling board are accessories. The coal baffle board, which is a multi-functional combination, is installed on the bracket of the hollow side slot side of the face scraper machine. The shovel coal plate is installed on the bracket on the side of the middle chute coal wall, and some extra coal cinders can be cleaned when being pushed[7].

### 2.4 Shifting Device

The work face scraper is pushed in the direction of the coal wall under working conditions. The integrated coal face scraper is used for the displacement of hydraulic cylinder, and the common coal face is used for the displacement of an automatic or manual hydraulic pusher every certain distance.

### 2.5 Scraper Chain

The scraper chain mainly plays the role of traction, gravitation transfer and direct transport of coal in the equipment. The scraper chain consists of three parts: the scraper, the traction chain and the link. Generally, medium single chain, medium double chain and side double chain are used. The scraper can push the coal from the head to the tail of the machine and it is not easy to leave the cinder in the chute wall. The operating conditions of the chain require friction, so higher requirements are required for strength, impact toughness, fatigue strength, rust resistance and corrosion resistance. It is usually welded with alloy steel and requires heat treatment and stretching.

### 2.6 Startup Mode

In order to achieve high-speed start, it is necessary to operate at a low speed and adopt a two-speed start device. However, due to the excessive starting torque, the inertia and impulse at the start are both large, and the motor system is not guaranteed[8]. Just as the hydraulic coupler can have the function of overload protection, it can well guarantee the electromechanical system, the starting current is very small, sprocket and chain can be well protected, the centrifugal valve control hydraulic coupler can also effectively make use of the maximum torque when starting, the speed-regulating hydraulic coupler is the only choice.

### 3. Selection Design Calculation

In the mine design time or in the production site, the working face transportation equipment choice, generally according to the scraper conveyor product series and the manufacturer product specification introduced technical characteristics and applicable conditions to choose the model, and determine its number. But laying length are usually listed in the product manual for horizontal length or a certain Angle of coal seam, such as  $10^\circ$  Angle downward coal, when in fact laid length and the length of working face and coal seam dip Angle, thickness of coal seam conditions such as different, so you need to check the selected transport capacity of scraper conveyor and strength of the scraper chain and motor power, and to determine should lay a few sets of scraper conveyor, scraper conveyor should be installed each several electric motor.

There are many types of scraper conveyors in China. No matter it is gunning, mechanical mining or comprehensive mechanized coal mining, there are adaptive scraper conveyors, which can basically meet the use under various conditions. Proper selection of scraper conveyor is the first step of safe use of scraper conveyor.

#### 3.1 Design Parameters and Requirements

The original parameters of mechanical design are very important basis, both design and analysis are important reference. The original design parameters are as follows: mainly used for coal seam 0.8 ~ 1.6 meters, and the Angle of  $< 20^\circ$ ; roof  $f=6$ , floor  $f=4-6$ ; 3.1.2 parameters at the technical level; Length of design: 200 m; Length of supply: 200 m; Transport capacity: 450 t/h; The drag chain speed is 1.04 m/s.

Working face scraper is used for inclined coal face. Of course, there's the mechanical difference between going up and down. During flat production, the fixed face scraper matches the coal for each bunker.

Working face scraper per second transport capacity:

$$Q = qv \text{ kg/m} \quad (1)$$

Unit time transport capacity:

$$Q = 3.6qvt/h \quad (2)$$

$$\text{By the type on } Q = 3.6qvt/h \quad (3)$$

$$F = \frac{Q}{3600\eta V \gamma} = \frac{450}{3600 \times 0.85 \times 1.04 \times 0.9} = 0.148 \text{ m}^2 \quad (4)$$

The size of the central groove is  $1500 \times 630 \times 270$  mm, and the size of the circular chain is determined by the weight per unit length of the "High-strength circular chain for mining" 12718-2001.

### 4. Conclusion

I have never consulted so many professional books before. I have borrowed a lot of books this time. I not only exercised my literature retrieval ability, but also exercised the writing ability of professional papers, which benefited a lot! The machinery industry is a pillar industry of the national economy and its importance is inexplicable. It is necessary to continuously develop the theory and method of mechanical design. Mastering the theory and method of mechanical design is the ability that our robots must have. To establish the international status of China's machinery industry, we must strengthen the study of mechanical design methods and design ideas.

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## References

- [1] Wang hongxin, li mu, liu bingzhong. Mechanical design engineering [I]. Xuzhou: China university of mining press, 2004.
- [2] Cheng jushan. Mining machinery [D]. Xuzhou: China university of mining press, 1997.
- [3] Gan yongli. Geometric tolerance and measurement [D]. Shanghai: Shanghai science and technology press, 2003.
- [4] Cheng da xian. Mechanical design manual [M]. Beijing: chemical industry press, 2004.
- [5] Shan huizu. Material mechanics [M]. Beijing: advanced education press, 1999.
- [6] Cheng zhihong, tang dafang. Mechanical design [M]. Nanjing: southeast university press, 2006.
- [7] Bai jieping. Mechanical engineering testing technology [M]. Xuzhou: China university of mining press, 1997.
- [8] Fan weitang. Use and maintenance of coal mining mechanization equipment [D]. Heilongjiang science and technology press, 1988.