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# Influence of mine water on corrosion of Long-Distance coal pipeline transportation in hongliulin coal mine

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**Abstract.** In order to improve the economic efficiency of coal transportation in Shenwei pipeline and reduce the investment cost. According to the location characteristics of Shenmu head end pulping plant, it is convenient to take hongliulin mine water, and it can be considered as the second water source. This paper mainly compares the changes of water quality indexes before and after Fugu water and hongliulin mine water are used as coal handling water, and analyzes the influencing factors of corrosion and scaling tendency, so as to provide theoretical guidance and suggestions for the later optimization of coal handling water. The analysis shows that the water quality of Fugu water and hongliulin mine is weakly alkaline, and the ion content before and after pulping is relatively low, which has little impact on the corrosion. However, several key factors such as conductivity and Cl- content should be considered when studying the corrosion of the pipeline during long-term operation.

**Key words:** Mine water; Corrosion and scaling; Cl - ; Conductivity

## 1. Introduction

As the first coal transportation pipeline in China, Shenwei long-distance coal transportation pipeline is a great innovative practice for China's coal transportation mode and has epoch-making strategic significance [1]. Shenwei coal transportation pipeline takes Fugu water as the carrier to grind the raw coal mined by hongliulin coal mine into coal slurry with appropriate particle size gradation and concentration. It is delivered to the end user through pipeline through diaphragm pump relay. Long distance coal transportation pipeline has the advantages of less land occupation, strong adaptability to terrain, strong disaster resistance to severe weather, no transportation loss on the way, no environmental pollution and less transportation links. It is an economic and environmental protection transportation mode.

At present, the overall technical level and reuse rate of mine water treatment in China are not high. In order to better respond to the country's expansion of the utilization scale of mine water, considering that the head end pulping plant is located in Shenmu hongliulin coal mine, the mine water is convenient to take water and can be used as the first choice of the second water source. In recent years, a large number of studies have shown that the water quality characteristics of mine water in China are high suspended solids and high salinity, and the underground environment of coal mines is complex. The use of mine water will further accelerate the corrosion of coal conveying pipelines[2,3]. By comparing the changes of water quality indexes before and after Fugu water and hongliulin mine water are used as coal handling water, this paper analyzes the influencing factors of corrosion and scaling tendency, so as to provide theoretical guidance and suggestions for the later optimization of coal handling water.

## 2. Materials and Experiment

### 2.1 Main reagents and instruments

Complete set of oven, Electronic balance,Jaw crusher, Fine crusher, Sieve (14 mesh, 20 mesh, 35 mesh, 48 mesh, 100 mesh), Six unit electric mixer and suction filtration equipment.

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### 2.2 Experimental method

#### 2.2.1 Preparation method of coal slurry

1. Water sample preparation

The water for preparing coal slurry selected from the water sample is: Fugu water, Hongliulin mine water (mine water only treated by underground magnetic flocculation) and 15L of desalted water used in the comparative test.

2. Coal sample preparation

Prepare 20kg hongliulin raw coal, and determine The total moisture content of coal sample by using GB / t211-l996 method for determination of total water in coal[8]. The calculation formula is shown in Formula 1. Then use jaw crusher and fine crusher to dry grind the coal successively. The milled coal particles are screened according to the particle size grading corresponding to 14 mesh, 20 mesh, 35 mesh, 48 mesh and 100 mesh sieves respectively. The requirements of particle size grading is shown Table 1.

Tab. 1 The particle size grading of qualified coal slurry

| d/mm | 1.2 | 0.83 | 0.425 | 0.3 | 0.15 | 0.075 | 0.045 | Average |
|---|---|---|---|---|---|---|---|---|
| d<p（%） | 100 | 94~95 | 77~85 | 59~75 | 41~45 | 28~30 | 20~22 | 0.31~0.37 |

3. Coal slurry preparation

Two groups of parallel tests were set up in the test. The coal slurry with a weight ratio of 53% was prepared from fugu water, hongliulin mine water and demineralized water. The coal slurry was stirred for 72 hours and left to stand for 36 hours for separation. After the supernatant was filtered, the relevant indexes were detected. See formula (2, 3) for relevant calculation formula of coal slurry.

$$\mathrm{M_t} = \frac{m_1}{m_2} * 100\% \quad (1)$$

$$c = \frac{m_1}{(m_1 + m_3)} \quad (2)$$

$$\mathrm{m_1} = \frac{\mathrm{m_4}}{(1 - M_t)} \quad (3)$$

Where: $\mathrm{M_t}$ is the total moisture measured; m1 is the mass of coal sample, g; m2 is the mass of coal sample after drying, g; m3 is the water mass, g; m4 is the mass of dry base coal sample, g; c is the concentration of coal slurry.

#### 2.2.2 Water quality analysis method

Fugu tap water, hongliulin mine water, desalted raw water and 53% coal slurry stirred static filtrate were analyzed pH, conductivity, COD, ammonia nitrogen, chloride ion, hardness, sulfate, alkalinity, calcium ion and magnesium ion indexes, and the water type was judged according to the Sulin classification method.

## 3. Results and discussion

### 3.1 Preparation of 53% coal slurry

The total moisture content of coal sample measured in the test is 13.76%. According to the requirements of 53% qualified coal slurry, the mass and water quality of coal samples with different particle sizes are calculated. The total coal sample (dry basis) is 8.10 kg. The total coal sample received is 9.40 kg, and the water required is 5.89 kg. See Table 2 for the proportion of pulverized coal in the coal sample.

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Tab. 2 The ratio of 53% coal slurry and pulverized coal

| Sample | 20 mesh sieve | 35 mesh sieve | 48 mesh sieve | 100 mesh sieve | Surplus |
|---|---|---|---|---|---|
| quality/g | 103.38 | 253.76 | 263.16 | 451.12 | 808.284 |

### 3.2 Analysis on corrosion tendency of Fugu water and hongliulin mine water

1) Analysis of water corrosion tendency

The water quality analysis of desalted water, Fugu water and hongliulin mine is shown Table 3

Tab. 3 The quality analysis of demineralized water, Fugu water and hongliulin mine water

| Project | Fugu water | Hongliulin mine | Desalted water |
|---|---|---|---|
| pH | 7.88 | 7.8 | 7.03 |
| Conductivity（us/cm） | 684 | 1943 | 1.434 |
| COD（mg/L） | 16.33 | 48.98 | / |
| $NH_3$-N（mg/L） | / | 0.27 | / |
| $Cl^-$（mg/L） | 53.72 | 315.1 | / |
| Alkalinity（mg/L） | 152.91 | 203.88 | / |
| $SO_4^{2-}$（mg/L） | 68 | 118 | / |
| Total hardness（mg/L） | 295.4 | 426.2 | / |
| $Mg^{2+}$（mg/L） | 113.58 | 117.54 | / |
| $Ca^{2+}$（mg/L） | 181.82 | 308.68 | / |

The existing water quality analysis show that the water quality of Fugu water and hongliulin is weakly alkaline, the pH is between 7.0 and 8.0, the easy scaling ions are Ca2+ and Mg2+, and the water type is calcium chloride type. Fugu water and hongliulin mine water are characterized by low salinity, relatively low concentration of various ions and little change. A large number of experimental studies show that low salinity and low content of COD, Cl- and SO42- have little impact on corrosion.

### 3.3 Evaluation on corrosivity of Fugu water and hongliulin mine water after slurry mixing

#### 3.3.1 Comparison of water quality between Fugu water and hongliulin mine water after slurry mixing

The coal slurry prepared by Fugu tap water, hongliulin mine water and desalted water is stirred for 72 h and then stand still to take the supernatant. The water quality analysis results are shown in Table 5.

Tab. 5 The water quality analysis of coal slurry static supernatant

| Project | Fugu water | Fugu water Supernatant | Hongliulin mine | Hongliulin mine Supernatant | Desalted water | Desalted water Supernatant |
|---|---|---|---|---|---|---|
| pH | 7.88 | 8.02 | 7.8 | 8.18 | 7.03 | 8.48 |
| Conductivity（us/cm） | 684 | 3190 | 1943 | 4900 | 1.434 | 2220 |
| COD（mg/L） | 16.33 | 72.61 | 48.98 | 53.23 | / | 2.89 |
| $NH_3$-N（mg/L） | / | 2.383 | 0.27 | 2.627 | / | 4.49 |
| $Cl^-$（mg/L） | 53.72 | 941.925 | 315.1 | 1429.05 | / | 737.78 |
| Alkalinity（mg/L） | 152.91 | 68.3 | 203.88 | 61.16 | / | 71.36 |
| $SO_4^{2-}$（mg/L） | 68 | 198 | 118 | 366 | / | 100 |
| Total hardness（mg/L）（mg/L） | 295.4 | 879.25 | 426.2 | 1116.19 | / | 582.36 |
| Mg（mg/L） | 113.58 | 170.76 | 117.54 | 202.84 | / | 83.4 |
| Ca（mg/L） | 181.82 | 708.265 | 308.68 | 934.49 | / | 913.35 |

It can be seen from table 5 that the variation range of water conductivity, Cl-, SO42-, Ca2+, Mg2+ content of raw water after pulping is small. According to the analysis, the supernatant water

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type of Fugu tap water and hongliulin mine water after pulping is calcium chloride type, and the mineralization degree is about 1000-2000 mg/L. Generally speaking, the pipeline scaling trend is small.

### 3.2.2 Corrosion evaluation

There are many factors affecting pipeline corrosion, mainly due to the scouring of water in the pipeline, and the substances in the pipeline have undergone chemical corrosion and biological corrosion[11]. Chemical corrosion is mainly due to the chemical reaction between raw water and substances in the pipeline, forming corrosion products on the pipeline. Under the action of water scouring, the area expands continuously, resulting in leakage of the pipeline. Among them, the main influencing factors that may affect the chemical reaction of substances in Shenwei pipeline are: temperature, Cl-, flow rate and conductivity.

1) Influence of pipeline operating temperature on corrosion

The influence of temperature on corrosion is mainly that temperature will affect the diffusion rate of corrosive medium, thus increasing the corrosion reaction rate. According to relevant literature research[3-7]: when the temperature of carbon steel J55 is 30 ℃, the produced water of oilfield with salinity of 100000 mg/L is used as corrosion medium, and the corrosion rate is as high as 0.3324mm/a; When the temperature is 30 ℃, 20# steel is selected, and the recycled sewage water is used as the corrosion medium. The corrosion rate is as high as 0.1883 mm/a. Temperature is an important factor that may cause pipeline corrosion.

2) Effect of Cl- content on Corrosion[9-10]

Cl- is a small radius ion with strong penetration ability. When chloride ions reach the metal surface, the metal will react with soluble compounds, destroy the oxide film on the metal surface and promote metal corrosion. A large number of studies show that the higher the Cl- content is, the higher the corrosion rate is, and it will also cause local corrosion. By comparison, the supernatant of hongliulin mine water has more Cl- content than Fugu water. The influence of Cl- content on corrosion should be considered when transporting slurry.

3) Effect of flow rate on Corrosion[7]

Metal has dynamic corrosion and static corrosion. Compared with the two, the erosion caused by dynamic corrosion is more serious than static corrosion. Some solid coal particles carried in the fluid will form a huge impact on metal materials and cause certain physical damage to metal at the same time of corrosion.

4) Effect of conductivity on corrosion

The corrosion of water to metal mainly depends on ionic conductivity, which is usually expressed by the conductivity of water. The conductivity of water quality mainly depends on the salt content and water temperature[13,14]. The higher the salt content, the higher the temperature, the higher the conductivity and the greater the corrosion effect on metals. The results show that the influence of conductivity on the corrosion of carbon steel is much greater than that of other materials. In flowing water, the effect of conductivity on the corrosion of carbon steel is jumping, and there is a critical conductivity value. When it is lower than the critical conductivity, the conductivity has no obvious effect on the corrosion. According to relevant literature, for carbon steel in flowing water, the critical conductivity is generally in the range of 40-400 us/ cm. Combined with the analysis of Fugu water and hongliulin mine water quality, it is found that hongliulin mine water has a relatively large impact on pipeline corrosion.

## 4. Conclusions and suggestions

The water quality of Fugu water and Hongliulin mine is weakly alkaline, and the ion content before and after pulping is relatively low, which has little impact on the corrosion. However, when studying the corrosion of the pipeline during long-term operation, several key factors such as conductivity and Cl- content should be considered. In addition, in order to better predict the

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corrosivity of Shenwei pipeline, simulation experiments should be conducted according to the specific corrosion medium of the project to study the possible corrosion influencing factors.

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