# Analysis of Characteristics of Coal Resources in Shuicheng, Guizhou Province

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**Abstract:** Coal industrial analysis, multi-element analysis and heat-producing capability measurement were conducted for 11 samples from different coal mine in Shuicheng, Guizhou province. Based on the analysis results and the main indicators for different types of coal in China, the coal samples were categorized. As a result, some advise is proposed for the comprehensive utilization of coal resources in the region.

**Keywords:** Guizhou Shuicheng , coal quality analysis, comprehensive utilization.

## Introduction

Guizhou is one of the coal-rich provinces in China(China National Administration of Coal Geology, 2001), where is known as "Coal-ocean in the South". You can find almost all kinds of coal in Guizhou, and most of which are bituminous coal and anthracite coal , both of the proved and the forecasting reserves are ranked fourth of China.(Tian Weijiang, 2008)

Liupanshui is located in Wumeng mountain, which combines Sichuan, Guizhou, Yunnan and Guangxi provinces. With a title of " the coal capital of southern China", it has proved reserves of 36.9 billion tons and maintained reserves of 15.6 billion tons, of which has 9.3 billion tons of coking coal (Zeng Rongshu et al.,1998). Early in the 1960's and 1970's, it was a key area of the national third-line construction and development. As an important industrial base of energy and material in southwest, rational development and utilization of coal resources is considered to be extremely significant, and apparently, investigating of the quality of coal resources is the foundation of rational exploitation and utilization. Characteristics of coal resources mainly consists of coal petrography, coal quality and coal technological identities, which determines the direction of comprehensive utilization.(Yi Tongsheng, et al.,2008). Coal quality and characteristics of the 11 coal samples that collected from this region are analyzed and discussed, and therefore, some reasonable suggestions are proposed in comprehensive utilization of coal resources.

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## 1. Coal Quality Analysis

### 1.1 Sampling and experimental methods

All those 11 coal samples, which were sampled from Shuicheng, Guizhou province, were crushed and grinded into -80 meshes before chemical analysis were carried out.

Coal industrial analysis were conducted according to GB 3715-91, by using muffle furnace(SXZ-5-12) and electric drying oven(101-4ABS). Sulfur was determined by CLS-5 computer Coulomb sulfur meter. TQ-3A multi-element analyzer was applied in element analysis of coal samples, and heat-producing capability was measured by the SD515 calorimeter. The final results were obtained after the error correction.

### 1.2 Result and Discuss

The results of industrial analysis, multi-element analysis, and heat-producing capability measurement of

coal samples, which was considered as the basic data to judge the quality of coal, were showed in Table 1

**Table 1 Basic Data of Coal Samples in Shuicheng**

| No. | Name | $A_{ad}$/% | $M_{ad}$/% | $V_{daf}$/% | $F_{Cad}$/% | $H_{daf}$/% | $S_{t,d}$/% | $Q_{gr,daf}$/ MJ·Kg$^{-1}$ | CRC | H/fixed carbon |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DD | 22.82 | 2.01 | 35.98 | 48.12 | 5.19 | 0.14 | 34.02 | 4 | 0.11 |
| 2 | BD | 35.52 | 2.57 | 21.07 | 48.87 | 4.61 | 0.17 | 33.48 | 4 | 0.09 |
| 3 | SM | 25.64 | 1.30 | 22.28 | 56.78 | 4.68 | 0.11 | 34.88 | 4 | 0.08 |
| 4 | BH | 26.44 | 3.98 | 40.71 | 41.25 | 5.33 | 0.29 | 32.50 | 3 | 0.13 |
| 5 | CM | 25.83 | 2.06 | 24.84 | 54.20 | 4.79 | 1.11 | 34.28 | 4 | 0.09 |
| 6 | SC | 10.81 | 0.95 | 26.50 | 64.86 | 4.89 | 0.18 | 35.55 | 7 | 0.08 |
| 7 | PL | 25.05 | 2.22 | 27.80 | 52.50 | 4.90 | 0.96 | 34.11 | 4 | 0.09 |
| 8 | MY | 23.09 | 1.09 | 27.17 | 55.22 | 4.88 | 1.19 | 34.81 | 6 | 0.09 |
| 9 | JL | 20.82 | 1.64 | 22.94 | 59.76 | 4.72 | 0.15 | 34.95 | 4 | 0.08 |
| 10 | JP | 11.20 | 1.50 | 18.20 | 71.41 | 4.54 | 0.62 | 35.68 | 4 | 0.06 |
| 11 | MQ | 40.66 | 1.24 | 31.23 | 39.95 | 4.99 | 0.87 | 33.28 | 4 | 0.12 |

It can be seen from table 1, MG has the highest coal ash content(40.66%) among all the samples, which belongs to high ash content coal. On the contrast, sample SC has the lowest as 10.81% and belongs to low-middle ash content coal. The other coal samples, ash content between 20%~30%, all belong to middle ash content coal.

In the case of volatile, sample BH is the highest(40.71%) while JP is the lowest (18.20%). Volatile of other coal samples mostly range from 20% to 30%.

The sulfur content in coal samples in this region were relatively low. The sulfur content in coal sample MG is the highest which is 1.19%; sulfur content in coal sample SM is the lowest which is 0.11%. The sulfur content in these coal samples is mostly less than 1% , which therefore belong to low sulfur coal.

Hydrogen content in coal sample BH is the highest which is 5.33%, while coal sample JP has the lowest as 4.54%. Hydrogen content in these coal samples are mostly 4.6% ~ 5.0%.

The ratios of hydrogen to fixed carbon in the coal samples are mostly close to 0.1 which illustrates that coalification degree is relatively low in this area.

## 2. Coal types Categrorization and Comprehensive Utilization

### 2.1 Characteristics and basic uses of the various coal

By comparing the results of coal chemical analysis of coal samples in Table 1 with the main indicators of different types of coal in China (see Table 2), we analysed the type of coal of each sample. As sulfur content in those coal samples are relatively low, which fit the basic standard for all types of industrial coal, so in the following analysis, sulfur content is not considered as the main basis. The main conclusions are as follows:

DD, BD, SM, CM, PL and JL are weakly caking coal, which is of weak caking property and a low to medium metamorphic degree and belongs to non-coking coal. When heated isolated from the air, it produces less gelatinous body and more powder coke. Specifically, DD and JL's ash contents are 22.82% and 20.82% respectively, those two types of coal do not need any treatment, and can be used directly in the normal pressure moving-bed gas generator. BD's ash content is 35.52%, which should be used as fuel or in power generation. In the contrary, ash content of SM,CM and PL are 25.64%,25.83% and 25.05%, respectively. Therefore, those three types of coal can be mixed with DD or JL coal as gasification coal, or they can also be used directly


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as fuel or in power generation.

BH coal is long flame coal which belongs to non-coking bituminous coal with high volatiles and the lowest metamorphic degree except lignite. It has a low burning point,net heat-producing capability is not high too. BH's ash content is 26.44%, volatile content is 40.71%, hydrogen-carbon ratio is not high. So after slightly washing, it can used as liquefaction coal, gasification coal or steamer coal, it can also be used as fuel or in power generation directly.

SC belongs to coking coal. When coking coal is coked alone, large pieces of coke with little cracks and strong wear-resistance can be obtained, but there still exists some problems, such as high expanding pressure and coke-pushing. The ash content of SC coal is 10.81%, volatile content is 26.50%. So it's suitable for coking, but should be used with other coals to achieve a better performance.

MY and MQ are fat coal. Fat coal is a kind of coking coal with medium-high volatile and strong adhesion. When coking alone, it can generate coke with good fusion property and high strength, whose wear-resistance is even better than the coke that coked from coking coal with same volatile content. However, there will be much cross-crack if coked alone. MY has a ash content of 23.09%, and volatile is 27.17%; for MQ, the ash and volatile content are 40.66% and 31.23%, respectively. Both are suitable for coking, but similarly, the result may not be good when if coked alone, therefore, a better performance can be achieved while being mixed with SC coking coal.

The JP is lean coal. Lean coal is a kind of coking coal that has the highest metamorphic degree, which is characterized by low volatile and weaker adhesion than the typical lean coal. The ash content of JP coal is 11.20% ,and the volatile content is18.20%. While coking alone, it may generate much powder coke, but with a small proportion of it can play the role of leaning. Accordingly, the JP coal can be mixed with the other kinds of coal that introduced in the front of this paper, in order to achieve their maximum degree of utilization.

**Table 2 The main indicators of different types of coal in China**

| Coal category | Proximate analysis | | | | Element analysis | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mad/% | Vdaf/% | CRC | St,d/% | Qgr,daf/ MJ·Kg$^{-1}$ | $C_{daf}$/% | $Hd_{af}$/% | $N_{daf}$/% | $O_{daf}$/% |
| lignite | 3~28 | 38~62 | 1 | 0.1~5.0 | 25~30.5 | 61.5~76 | 4.5~6.9 | 0.6~3.5 | 14~28 |
| long flame coal | 1~18 | >37~53 | 1~4 | 0.2~5.0 | 29~33.5 | 72~81 | 4.5~6.8 | 0.6~2.8 | 8~19 |
| non caking coal | 1~14 | >20~37 | 1~4 | 0.1~2.5 | 28~35.5 | 74~86 | 3.5~5.2 | 0.6~1.5 | 7~16 |
| weakly caking coal | 0.6~5 | >20~37 | 3~6 | 0.1~3.0 | 32.6~36.2 | 81~89 | 4.5~5.5 | 0.6~1.65 | 6~11 |
| gas coal | 0.5~6 | >28~49 | 4~8 | 0.2~9.0 | 32.6~36.6 | 77~87 | 4.7~6.7 | 0.7~2.4 | 7~13 |
| 1/3 coking coal | 0.4~4 | >28~37 | 4~8 | 0.1~5.0 | 33.5~36.7 | 80~89.5 | 4.7~6.0 | 0.8~2.0 | 3~10 |
| gas-fat coal | 0.3~3 | >37~59.5 | 5~8 | 1.0~12.0 | 33.9~36.6 | 77~87 | 5.4~7.2 | 0.7~1.9 | 2.5~7.5 |
| fat coal | 0.2~2.0 | >20~37 | 6~8 | 0.3~10.0 | 34.5~37.2 | 83~90 | 4.7~6.3 | 0.7~1.9 | 3~6.5 |
| coking coal | 0.1~2.0 | >15~28 | 5~8 | 0.1~8.0 | 34.5~37.2 | 85~91.5 | 4.5~5.5 | 0.5~2.0 | 2~5.0 |
| lean coal | 0.3~2.0 | >13~20 | 3~6 | 0.2~7.0 | 34.5~36.6 | 86~92.5 | 4.2~4.9 | 0.6~1.85 | 1~4.2 |
| meager lean coal | 0.3~2.0 | 11.5~20 | 3~5 | 0.2~7.5 | 34.0~34.5 | 86~92.5 | 4.0~4.8 | 0.5~1.85 | 0.9~4.0 |
| lean coal | 0.4~2.5 | >10~20 | 1~3 | 0.2~12.0 | 33.5~34.5 | 87~92.5 | 3.7~4.8 | 0.5~1.80 | 0.8~4.0 |
| anthracite coal | 0.5~9.0 | >1.5~10 | 1~2 | 0.1~8.0 | 31.5~34.5 | 87~98 | 0.5~4.2 | 0.2~1.80 | 0.1~5.0 |

## 3. Conclusions

（1）These coal samples are of relative low sulfur content, middle ash content, higher volatile matter and high heat-producing capability. The coalification degree of the coal samples is higher than lignite and lower than anthracite coal.

（2）There are 4 samples belong to coking coal, they are coal sample SC, coal sample MY, coal sample MQ and coal sample JP, and the ash content should be removed by washing. Because of their different characteristics, when mixed the coal samples according to a certain proportion, better coking performance can be obtained. There are 7 coal samples which belong to noncoking

coal, of which coal sample BD, PL, CM, SM and BH are suitable for steam coal and fuel coal while coal sample DD and coal sample JL can be used in normal pressure moving-bed gas generator.

（3）Reasonable coal blending should be considered in the process of coal resources utilization. Therefore, coal resources can be used rationally and efficiently.

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