Research on the Influence on Briquette Characteristics by Blended Coal Preparation

Guan Duojiao*, Liu Siyu, Tang Meiling, Dong Yingnan
Shenyang Institute of Engineering, Shenyang China
guandj@sie.edu.cn

Abstract: The characteristics of briquette were not the simple superpose of the fractional coals, and its character was obviously different with the fractional coals. In this paper the research on the influence of the proportion upon volatile, ignition and heat value was done. The experiment results are of great significance to improve the mix proportion and make the mix proportion more clear and reasonable.

1. Introduction
Briquette is also known as "artificial lump coal". Its application can significantly reduce the emissions of SO2 and soot and save coal. Briquette combustion technology is one of the ten clean coal technologies in China. Popularizing and developing briquette technology is a simple and easy way to prevent and control air pollution. In order to realize efficient and clean combustion of coal in industrial and civil boilers, it is a promising direction to study the combustion of briquette.

Combustion characteristic is one of the important contents of coal combustion theory. Due to the complexity of coal genesis, composition and structure, the study of combustion characteristics is extremely complex. Briquette is composed of raw coal and additives with a certain particle size. Its properties are quite different from those of raw coal, and its particle size is also large and uniform, so its combustion characteristics may be different from those of raw coal. At present, there is no special instrument and equipment for briquette research, mainly using raw coal research methods and means to study briquette.

In this paper the research on the influence of the proportion upon volatile, ignition and heat value was done. The experiment results are of great significance to improve the mix proportion and make the mix proportion more clear and reasonable.

2. Preparation of test sample
2.1. Test equipment and raw materials
In this paper, the thermal test of single coal and briquette is carried out in a high temperature electric furnace. The high temperature electric furnace is srjx-4-13 type silicon carbide rod top heating, and the common furnace temperature is 1300 °C. The test coal sample is filled in ash pan. The ignition temperature was measured by pyros-1 TGA thermo gravimetric analyzer of Perkin Elmer company. The industrial analysis, element analysis and calorific value determination of raw coal used in the test are shown in Table 1.
Table 1 industrial analysis, element analysis and calorific value determination of raw coal

| Project     | Mar/% | Mad/% | Aad/% | Vad/% | FACd/% | Sacd/% | Nad/% | Od/% | Had/% | Cad/% | Qar,net/MJ/kg |
|-------------|-------|-------|-------|-------|-------|--------|-------|------|-------|-------|----------------|
| Jixi Coal   | 9.20  | 2.70  | 29.01 | 21.58 | 46.71 | 0.89   | 0.58  | 12.30| 3.74  | 50.78| 20.47         |
| Tuan Coal   | 6.31  | 0.51  | 32.55 | 14.59 | 52.35 | 0.85   | 0.76  | 7.03 | 2.99  | 55.31| 21.22         |
| Coke Powder | 16.95 | 0.35  | 56.23 | 2.51  | 40.91 | 0.60   | 0.07  | 0.76 | 0.53  | 41.46| 10.57         |
| Slime       | 10.12 | 0.82  | 21.82 | 16.84 | 60.52 | 0.53   | 0.81  | 7.02 | 3.52  | 65.48| 23.57         |

2.2. Preparation of briquette sample

The mass percentage of each component in the briquette provided by the briquette plant is: Jixi coal 12.08%, Tuan coal 24.43%, Coke carbon powder 24.45%, Slime 6.41%, Loess 32.64%. The calorific value of the cartridge is only 12.62 MJ / kg, which fails to reach the qualified index of briquette products. According to this situation, based on the existing ratio of raw coal and the calorific value of various raw coal, 10 groups of ratio were designed to measure the calorific value again. The results are shown in Table 2.

Table 2 Determination of various indexes of briquettes with different proportions

| #  | Jixi Coal/% | Tuan Coal/% | Coke Powder/% | Slime/% | Loess/% | Fuel ratio | t1°C | Qad,b/MJ/kg |
|----|-------------|-------------|---------------|--------|---------|------------|------|-------------|
| 1  | 11.08       | 21.43       | 24.45         | 12.41  | 30.63   | 3.21       | 475.50 | 15.114      |
| 2  | 11.08       | 21.43       | 24.45         | 18.41  | 24.63   | 3.36       | 470.40 | 16.638      |
| 3  | 12.08       | 32.43       | 20.45         | 18.41  | 16.63   | 3.23       | 458.61 | 18.713      |
| 4  | 6.08        | 32.43       | 26.45         | 24.41  | 10.63   | 3.81       | 502.30 | 19.548      |
| 5  | 12.08       | 26.43       | 26.45         | 24.41  | 10.63   | 3.42       | 491.40 | 19.378      |
| 6  | 12.08       | 26.43       | 26.45         | 24.41  | 10.63   | 3.18       | 470.40 | 19.634      |
| 7  | 6.08        | 26.43       | 26.45         | 32.41  | 8.63    | 3.61       | 480.50 | 19.776      |
| 8  | 8.08        | 26.43       | 24.45         | 32.41  | 8.63    | 2.97       | 457.07 | 19.906      |
| 9  | 10.08       | 26.43       | 26.45         | 28.41  | 8.63    | 3.02       | 475.21 | 19.616      |
| 10 | 12.08       | 26.43       | 24.45         | 28.41  | 8.63    | 2.81       | 444.71 | 19.769      |

Selecting 6 # and 9 # briquettes with high calorific value from table 2, and the corresponding data in these two groups of proportioning are not the same, an orthogonal experimental table L8 (25) with 5 factors and 2 levels can be established. Through the direct optimization method of orthogonal experiment, three groups of ratios were obtained, as shown in Table 3.
Table 3 Determination of various indexes of briquette proportioned by orthogonal experiment method

|   | Jixi Coal | Tuan Coal | Coke Powder | Slime | Loess | Fuel ratio FC/Vad | t1/°C | Qad,b/MJ/kg |
|---|-----------|-----------|-------------|-------|-------|-------------------|-------|--------------|
| Group 1 | 10.99 | 29.48 | 29.50 | 22.19 | 7.85 | 2.93 | 465.6 | 20.029 |
| Group 2 | 7.63 | 30.59 | 30.61 | 23.02 | 8.15 | 2.89 | 458.2 | 20.017 |
| Group 3 | 10.79 | 28.95 | 28.97 | 23.58 | 7.71 | 3.01 | 464.9 | 19.928 |

3. Influence of briquette made of multi coal on its characteristics

3.1. Variation of volatile matter in briquette

In the test, the industrial analysis of test coal and its component coal was carried out (see Table 1), and then the weighted average volatile v'ad was calculated according to the coal blending proportion with the data of single coal volatile, and the relationship curve between the measured value and the calculated value was shown in Figure 2. It was found that there was a certain difference between the calculated value and the measured value, but there was a good linear relationship. Through regression calculation, the linear relationship is as follows:
The volatile content of coal directly affects the ignition and combustion stability of coal. It can be seen from Figure 2 and linear relationship (1) that when the volatile content of briquette is less than 15% ($V_{ad}$ of briquette prepared in this experiment is all lower than this value), the actual volatile content will be greater than that calculated according to the weighted average of single coal, that is, the briquette prepared with multiple coal types is conducive to the improvement of actual volatile content, indicating that the superior coal type in briquette promotes the precipitation of volatile content of other coal types. For example, in Table 2, briquette composed of 6.08% Jixi coal, 32.43% Tuan coal, 26.45% Coke powder, 24.41% slime and 10.63% loess, according to the weighted average, the calculated volatile $v_{ad}=10.82\%$, while the measured volatile $V_{ad}=11.61\%$, an increase of 0.79 percentage points was received. Briquette, which is composed of 12.08% Jixi coal, 32.43% Tuan coal, 20.45% Coke powder, 24.41% Slime and 10.63% Loess, the calculated volatilization $v_{ad}$ is 11.96%, while the measured volatilization $V_{ad}$ is 13.74%, an increase of 1.78% was received. In addition, it can be seen that the higher the proportion of low volatile coal is, the less the actual volatile content of briquette increases. In other words, improper coal blending will reduce the increase of the actual volatile content of briquette. Even if the coal with high volatile content is added, the effect of increasing the volatile content of briquette is not obvious, resulting in unnecessary waste of energy and economy.

3.2. Variation of calorific value of briquette

The calorific value of test coal and its component coal is measured (see Table 1, table 2 and table 3), and then the weighted average calorific value $Q_{adb}$ is calculated by the calorific value analysis data of single coal according to the proportion of coal blending. The relationship curve between the measured value and the calculated value is shown in Figure 2-2. It is found that there is a certain difference between the calculated value and the measured value, but there is a good linear relationship. Through regression calculation, the linear relationship is as follows:

$$Q_{adb}=0.8478Q_{adb}^0+3.4182 (R=0.9795)$$

(2)

The calorific value of coal is the most important performance index of coal. It can be seen from Figure 3 and linear relationship (2) that when different coal qualities are mixed in various proportions, the measured low calorific value of air drying basis is larger than that calculated by weighted average, and its increase value decreases with the increase of calorific value of briquette. For example, in Table 2, Briquette composed of 6.08% Jixi coal, 26.43% Tuan coal, 26.45% Coke powder, 32.41% slime and 8.63% loess is 19.621mj/kg according to the weighted average calculation, while the measured calorific value is 19.776mj/kg, an increase of 0.155mj/kg was received. Briquette, which is composed of 8.08% Jixi coal, 26.43% Tuan coal, 24.45% coke powder, 32.41% slime and 8.63% Loess, is 19.797mj/kg based on weighted average, while the measured calorific value is 19.906mj/kg, an
increase of 0.109mj/kg. This shows that the combustion of briquette can improve the burn out rate (the influence of pollutant emission and slagging characteristics are not considered here), so as to achieve the effect of energy saving. The reason is that after mixing different kinds of coal, they have complementary advantages, which is similar to the effect of catalytic combustion. The combustion zone of better coal improves the burn out rate of inferior coal, and makes the reaction more complete under the same combustion conditions, so the heat released increases.

4. conclusion
The actual volatile content of briquette will be greater than that calculated by weighted average of single coal, and the higher the proportion of coal with low volatile content is, the less the actual volatile content of briquette will increase.

The actual calorific value of briquette is larger than the weighted average value calculated by single coal type, and the increased value increases with the decrease of calorific value, that is, the burn out rate of briquette combustion can be improved, so it has the effect of energy saving.

The ignition temperature of briquette increases linearly with the increase of fuel ratio. It can be seen that the ignition of briquette composed of coal with large fuel ratio and great difference becomes more and more difficult with the increase of blending amount of coal with large fuel ratio. Therefore, only from the point of view of ignition, the amount of coal with high fuel ratio should not be too large.

The various characteristics of briquette are not the simple superposition of various coal characteristics. Due to the different composition and characteristics of different kinds of coal, the coal particles of different coal quality will affect and restrict each other in the combustion process after mixed briquetting. Therefore, reasonable briquette preparation can give full play to the advantages of each component coal, learn from each other's strong points to make up for its weak points, and have a good impact on combustion safety and economy. If the briquette is not properly prepared, the operation level of combustion equipment will be reduced, the ignition will be difficult, the combustion will be unstable, and the efficiency will be reduced.

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