Research Advances

A New Parameter of Cleanability to Determine the Clean Potential of Coal Resources

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Objective

This work is based on analysis on large numbers of coal data such as the latest national coal potential evaluation data and previous data published by REN Deyi, TANG Xiuyi and LU Xukun, and the evaluation methods of clean potential of coal resources proposed by predecessors. It is found that previous method rank coal is only in accordance with raw coal or washed coal, which fail to take full account of the changes in elements before and after coal washing. Some elements can be removed by washing or other methods, and others may be even enriched after the coal is washed. For this reason, this work defined a new parameter of cleanability and developed its calculation formula to determine the clean potential of coal resources. Cleanability is a comprehensive indicator based on the removal rate of each indicator harmful element in coal. The clean potential of coal is proportional to the value of cleanability. The higher the cleanability value is, the better the clean potential is, and vice versa.

Methods

After we comprehensively compared the removal rate formulas adopted by major predecessors, the value of cleanability based on the removal rate of every target harmful element in coal was obtained through adding the removal rate of different elements and considering the degree of element removal and market rules. The formula of cleanability is as follows.

$$C = \sum T_n \times R_n \quad (1)$$

In the formula (1), $R_n = \frac{W_{RC} \times \alpha_{RC} - W_{FC} \times \alpha_{FC}}{W_{RC} \times \alpha_{RC}} = \frac{W_{RC} \times \alpha_{RC} - W_{RC} \times \alpha_{FC} \times \lambda / 100}{W_{RC} \times \alpha_{RC}} = 1 - \frac{\alpha_{FC} \times \lambda / 100}{\alpha_{RC}}$;

C: cleanability; n: element; T_n: ratio determined according to the degree of element removal and market rules; R_n: theoretical removal rate of element (%); W_{RC}: quantity of raw coal; W_{FC}: quantity of flotation concentrate; a_{RC}: the content of elements in raw coal (%);a_{FC}: the content of elements in flotation concentrate (%); λ: theoretical recovery rate of flotation concentrate (%).

For the sake of simplicity, only ash and sulfur are usually considered. Thus, the formula (1) can be simplified as follows.

$$C = T_{Ad} R_{Ad} + T_S R_S \quad (2)$$

Considering the effect of removal rate of ash and sulfur on coal price and their degree of removal, T_{Ad} is given as 1 and T_S is given as 10.

$$C = R_{Ad} + 10 R_S \quad (3)$$

Results

In order to make the method of determining clean potential of coal resources by cleanability more simple and feasible and the evaluation results more intuitive, the cleanability level classification scheme was further studied. In further research, the data obtained from the latest national coal resource potential evaluation project and a lot of literatures are taken into account, and a large amount of data has been extracted from them. Some of the extracted data have been converted and calculated. Finally, 139 group sulfur data and 102 group ash data are obtained from coal resources of Anhui Province, China.

The ash and sulfur removal rates were calculated first, followed by classification of ash removal rates and sulfur removal rates respectively, based on which, cleanability was classified as shown in Appendix 1. According to this method and cleanliness classification scheme, clean potential of 36 coal field samples is evaluated and accurate results are obtained. The results are shown as shown in Appendix 2. The normal distribution curve of cleanability C value is shown in Fig. 1 .

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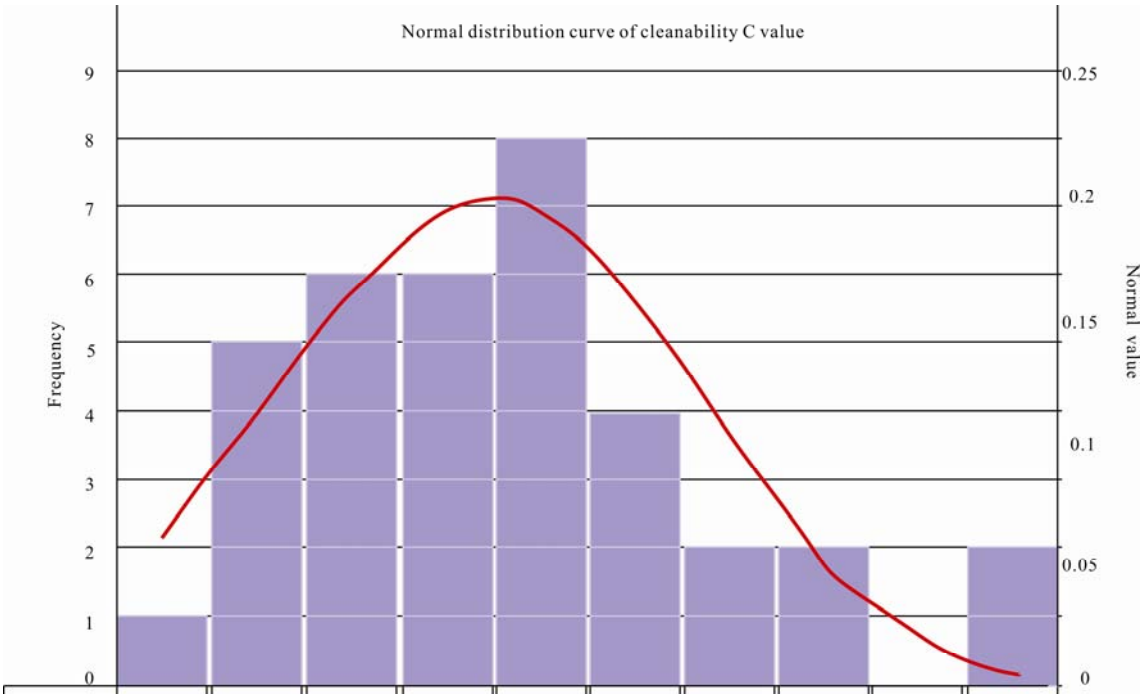

Interval	1.6	2.58	3. 57	4. 55	5. 54	6. 52	7. 51	8. 49	9. 48	10. 46
Frequency	1	5	6	6	8	4	2	2	0	2
Normal value	0.060843	0.110446	0.159556	0.193671	0.194359	0.157416	0.101039	0.050513	0.018907	0.00521

Fig. 1. Normal distribution curve of cleanability *C* value.

Conclusions

(1) The method of determining clean potential of coal resources by cleanability and cleanability classification are proposed in this paper, and they are applied in evaluating some coal resources.

(2) Limited by coal data, this experimental evaluation failed to evaluate a greater number of coal samples. Henceforth, the relevant experimental data are going to be collected according to the calculated cleanability value. Then the evaluation results are graded by using of mathematical statistics. In addition, the method of determining clean potential of coal resources will be improved and optimized continuously, which provide scientific basis for production practice.

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Appendix 1 Cleanability classification scheme

Classification	Cleanability	Remark
Worse		$R_{Ad} < 0$ or $R_S < 0$
Poor	$0 \le C < 3.0$	$R_{Ad} \ge 0$& $R_S = 0$, or $0 \le R_{Ad} < 50\%$&$0 \le R_S < 25\%$
Fair	$3.0 \le C < 5.7$	$R_{Ad} \ge 50\%$& $0 \le R_S < 25\%$, or $R_{Ad} < 70\%$ &$25\% \le R_S < 50\%$
Good	$5.7 \le C < 8.4$	$R_{Ad} \ge 70\%$&$25\% \le R_S < 50\%$, or $R_{Ad} < 90\%$& $25\% \le R_S < 75\%$
Proficient	$C \ge 8.4$	$R_{Ad} \ge 90\%$&$25\% \le R_S < 75\%$, or $R_{Ad} \ge 0$& $R_S \ge 75\%$

Appendix 2 Evaluation results

Classification	Poor	Fair	Good	Proficient
Cleanability	$0 \le C < 3.0$	$3.0 \le C < 5.7$	$5.7 \le C < 8.4$	$C \ge 8.4$
Samples	8	18	7	3
Percentage	22.22%	50.00%	19.44%	8.34%