Fast Predicting the Washability of Coal Using Digital Image Processing Method*

Zhang Ze-lin, Yang Jian-guo, Wang Yu-ling, Xia Wen-Cheng, Ling Xiang-yang, and Wang Xing-xing

China University of Mining & Technology, Key Laboratory of Coal Processing and Efficient Utilization, Ministry of Education; tech center of the State Environmental Protection clean coal and mining ecological restoration projects, Xuzhou, Jiangsu 221008, China
zhangzelin3180@163.com

Abstract. Based on the demand of real-time control and digital coal preparation, a pure new MATLAB-based image recognition system was developed to compute the coal particle density distribution through the digital image processing method, 13 of 29 image feature parameters was selected to be most representative image characteristic parameters through the analysis of statistics and graphs. Take the above parameters as the input of RBF neural network, the density level of coal particles could be estimated, combined with the cross-sectional area of coal particles and the ash content of each density level, the washability curve could be drewed. Experement show, the absolute error of the total ash is 0.545%, which meets the China standards of coal preparation(GB/T477-1998); the related coefficients of each indicator in both actual and predicted float-and-sink material are all close to 1, while the curves of $\lambda$, $\beta$, $\theta$ and $\delta$ are very similar and the deviation of $\xi$ curve is relatively large.

Keywords: digital coal preparation, image analysis, neural network, washability curve.

1 Introduction

Coal is the main part of China's energy and in quite a long time China's coal-dominated energy structure will not change. In nearly 30 years, the coal will continue to dominate the leading position in the production and consumption of primary energy sources. However, in the use of coal, there still exists low efficiency of energy and environmental pollution as well as other issues, so the only way to resolve this contradiction is to develop clean coal technology. Coal washing and processing is the preferred solution recognized internationally to realize the coal efficient and clean use and it is still one of the main content to develop clean coal technology. [1,2]

The so-called washability means the complexity of selecting products from raw materials according to the required quality indicator. The washability curve is drawn

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in accordance with the results of the float-and-sink test, which is used to reflect all the density level or any density distribution of coals and it is the necessary mean to understand the washability, evaluate, predict, and optimize the effect of gravity separation of raw coal. Besides, it can provide correct way for the coal washing and processing as well as effective way of supervision and management, so it has a pivotal position in the coal washing and processing industry. [3]

The float-and-sink experiment should not only cost a lot of manpower and resources, but also take a long time. For this, the coal preparation plant commonly conducts the comprehensive test once a month. In the daily production, they sometimes carry out a quick float every one hour to guide the production. For the quick float has an hour lag, so it cannot opportually guide the production. Besides, operators mainly operate by experience, which has large blindness and cannot automatic control accordingly. Therefore, how to rapidly predict the washability curve of raw coal has become an urgent issue. In 1996, Maixi Lu started to study the relationship between coal ash and its float-and-sink composition and also establishes the model to predict the float-and-sink composition of the raw coal [4]; In 1998, Jing Liu and Maixi Lu predict the washability of the raw coal through the total ash content [5]; in 1999, Zhenchong Wang & Maixi Lu developed a set of online system to predict coal washability curve based on the relativity between ash and density of the raw coal from some given coal preparation plants. However, this system only limited to the specific coal quality and density range and cannot achieve the industrialization [6]. This paper uses the digital image processing method to extract the surface information of coal particles in each density level, and then utilizes neural network to predict washability curve. This method doesn't limit to coal quality and density range, so it can achieve the purpose of automatic control and guiding production quickly.

In the mineral processing field, many processes should be analyzed and judged mainly by visual information, such as use the microscope to observe and utilize the image to analyze the physical dimension, shape, color, dissociation degree, intergrowth, mineral type and content of mineral particles. Use the "computer vision" replace human vision, enhance the application of digital image technology in mineral processing, and apply the latest contemporary technological achievements of digital images to promote the development of mineral processing technology, all of which have a very important guiding significance on the coal preparation industry. [7]

2 The Experimental Implementation Details

2.1 Coal Quality Characters of Experimental Coal

The coal used in this study is the coal particle with grain size of 13mm-50mm in the Taixi Coal Preparation Plant of China. When conducting the screen analysis on the raw coal of Taixi, we also carry out the lithotype proximate analysis on the raw coal in various grain sizes. (As the lithotype proximate identification for the -6mm raw coal has been quite difficult, so we only conduct the lithotype proximate analysis on +6 mm raw coal).