

Microwave assisted Extraction of Coal

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Abstract: The effect of different factors on coal extraction yield, temperature, solvent, irradiation time were investigated under microwave assisted extraction (MAE). The results showed that the optimum extraction temperature for Shenfu coal using ethanol, acetone and THF were 393K, 373K and 373K respectively and the extraction yield of THF was higher than that of other two solvents used under MAE. Extraction of the 5 typical Chinese coals with several single organic solvents were conducted and result indicated that dissimilar extraction yields were achieved for similar rank coals under the same MAE conditions. Shenfu coal and its residue of THF extraction were analyzed by FT-IR.

Key words: MAE, coal, extraction yield, FT-IR analysis

CLC number: TQ531 **Document code:** A **Article ID:** 0529-6579 (2007) S1-0183-02

It is well known that less than 30% of world energy supply come from coal, and the demand for coal will inevitably increase in the next decades, especially in developing countries^[1]. Although the use of coal as energy may continue and will be indispensable, "non-fuel" use of coal is another aspect of coal utilization. Coal extraction in organic solvents is one of useful methods for "non-fuel" use of coal to produce some useful chemical products^[2-5].

This paper presents the effect of several factors on extraction yields under MAE. The MAE implies a higher extraction ratio.

1 Experimental section

5 coals (Panzhihua 87.81% C content, Tongchuan 86.21% C content, Shenfu 81.75% C content, Huating 78.45% C content, Yitai coal 72.00% C content) used were taken from China. The coals were used with granularity of coal 150 ~ 45 μm after dried under vacuum at 373 K for 2 hours. MDS6 auto frequency modulation microwave digestion/extraction oven with temperature and pressure controlling is made in China. The experiments were performed at 40 ~ 200 °C. Dry ash-free basis (daf) coals and their residues were examined by FT-IR (NICOLET-Nexus 870 FT-IR spectrometer). The extraction yield was calculated based on the weight of extracts and dry ash-free basis from the weight of coal. Extraction yield (wt%, daf) = extract

(g / coal g daf)

2 Results and discussion

2.1 Effect of temperature and solvent

Extraction results were shown in Figure 1. The extraction curve had the tendency that increased gradually until reaching a maximum value and then began to decrease with the temperature rising.

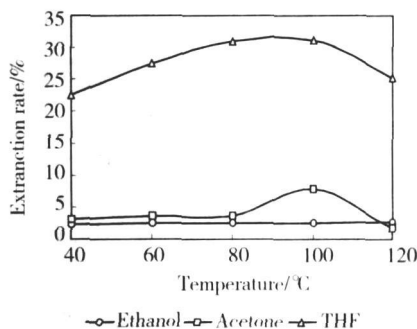


Fig 1 Effect of temperature on the extraction yield of Shenfu coal (wt%, daf)

Many researches have found that solvents with different polarity have different effect on the Soxhlet extraction, which is also true to the MAE.

2.2 Effect of irradiation time

For the optimization of extraction time 10 mL of solvent and 1 g coal was used. When prolong the irradiation time from 5 to 60 minutes, the extraction yield in

creased slightly and almost reached a maximum under MAE. There is a diverse absorbing microwave energy among different solvents and coals, so there is a different time to reach the maximal extraction yield.

2.3 Effect of rank coal

The extraction yields with acetone, THF at 373 K and ethylenediamine at 453 K for Shenfu, Tongchuan, Huating, Yitai and Panzhihua coal were tested under MAE and results were shown in Table 1. With the carbon content of raw coal increasing, extraction yield sharply increased to its maximum value and then decreased for THF, while the extraction yield of acetone gradually decreased. Extraction yield with ethylenediamine at 453 K for 15 min were over 50% regardless of rank coal under MAE. The aggregated state of coal influences its solubility in organic solvent and heat capacity, therefore extraction yields are obviously different because of the coal aggregated state changing with rank coal.

Tab 1 Effect of rank coal on extraction yields (wt%, daf)	Extraction yield /%		
	Acetone	THF	ethylenediamine
Panzhihua coal	12.48	17.42	50.01
Tongchuan coal	4.99	38.65	75.76
Shenfu coal	4.85	31.25	70.78
Huating coal	13.46	13.50	71.44
Yitai coal	10.60	20.80	53.05

Figure 2 is FT-IR spectra of Shenfu coal (daf) and its residue of THF extraction, which indicates that the macromolecular network of coal is not broken after extraction.

3 Conclusion

In the present study, the extraction results indicate that the effect of solvent and rank coal on extraction

yields is greater than that of the other factors tested. Solubility of the similar rank coals is different in the same solvents used under MAE. MAE is of high degree automation and easy to perform. It is less time consuming and requires less solvent.

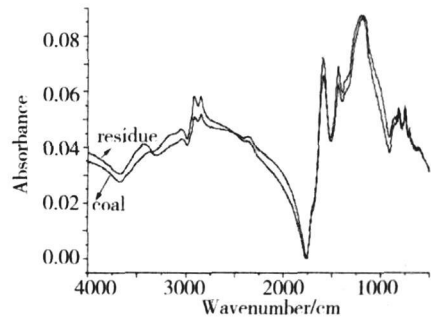


Fig 2 Spectrogram of Shenfu (daf) coal and its residue of THF

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微波辅助萃取煤的研究

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摘要: 在微波辅助下, 考察了萃取温度、溶剂种类、辐射时间对萃取率的影响。对神府煤而言, 采用乙醇、丙酮和四氢呋喃为溶剂的较佳萃取温度分别为 393 K、373 K、373 K 且四氢呋喃的萃取率高于丙酮和乙醇。采用相同的溶剂对五种不同变质程度煤的微波辅助萃取结果显示, 变质程度相似的煤在相同萃取条件下萃取率不同。对神府煤和其四氢呋喃萃取煤进行了红外分析。

关键词: 微波辅助萃取; 煤; 萃取率; 红外分析

中图分类号: TQ 531