Coal Evaluation Method Based on Compatibility of Coal and Pitch

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Abstract. A new evaluation method for coking coals is proposed. The distribution of optical textures of coke modified with coal tar pitch were obtained by an automatic measuring system based upon image analysis. Hydrogen donor and acceptor abilities were also estimated. Coals are evaluated in terms of the extent of the development of anisotropic textures.

Introduction

In coke manufacturing, coal tar pitch is often added in order to improve coke performance (strength, gravity, carbon dioxide reactivity, etc.) The effectiveness of this procudure changes according to the rank of the coal as well as the extent to which its anisotropic texture is developed. It is well known that there is good a correlation between coke performance and its texture. So the extent of the development of anisotropic texture provides important information for coke design.

Osaka Gas Co.,Ltd. has already developed an automatic system for measuring the optical texture of coke[1]. In this system, microscopic images of the textures are taken by TV camera and processed by a CPU, which identifies patterns of texture based on image analysis. With the support of an aotofocusing unit and an autoscanning unit, this system is operator-free. The texture distribution data is precise, reproducible and free from individual differences.

Recently it has been reported that hydrogen donor (Da) and acceptor (Aa) ability of pitch and coal are important factors governing the mesophase development in the co-carbonization of low rank coal and pitch systems[2]. This paper deals with the evaluation of coking coal in terms of the enhancing potential of anisotropic textures in co-carbonization systems with pitch.

Experimental

Nine coking coals were selected as samples, and one heat treated coal tar pitch for electrode use was used as a modifier. The elemental analysis of the coals and pitch are shown in Table 1. To observe optical texture the coals were crushed to pass through 60 Ty mesh and dried before use. The pitch contents were 0, 10, 20 and 40%. The heating rate (from 573°K to 773°K), the carbonization temperature and the period were 1.5°K/min, 1123°K and 30 min respectively. Carbonization was carried out in an inert atmosphere. Cokes were molded and polished as usual, and optical textures were examined by the automatic measuring system. Table 2 shows the classfication of textures.

The coals tested for hydrogen donor and acceptor abilities were crushed to pass through 200 Ty mesh and dried before use. Donor and acceptor ability were assessed by heating them with anthracene and 9,10-dihydroanthracene, respectively[3]. The heating rate, the heating temperature and the period were 10°K/min, 673°K and 5 min, respectively. The resulting specimen was

Table 1 Elemental analysis of Coals and Pitch

	Ultimate Analysis (wt%,daf)					
Coals & Pitch	C	H	N	S	O	Ash(wt%)
Hunter Valley	81.8	5.3	1.5	0.4	11.0	6.7
Masco	86.5	5.2	1.4	0.6	6.3	7.9
Oyubari	87.1	6.1	1.6	0.3	4.9	6.8
Luling	87.9	5.1	1.4	0.3	5.3	10.0
South Bulli	88.0	4.9	1.5	0.4	5.2	9.4
Goonyella	88.6	5.1	1.7	0.5	4.1	8.1
Peak Downs	89.9	5.0	1.9	0.6	2.6	8.0
Saraji	90.8	5.2	1.8	0.6	1.6	9.5
Slab Fork	91.7	4.6	1.2	1.0	1.5	5.3
Pitch	93.6	4.3	1.1	0.3	0.7	0.1

Table 2 Classification of Coke Textures

Name	Identifying Marks
Isotropic Texture	Uniform, flat pattern
Fine Mosaic Texture	Particle pattern under 1.5 μ
Coarse Mosaic Texture	Particle pattern from 1.5 μ to 10 μ
Fibrous Texture	Flowing pattern. Length is above 10 μ and width is under 10 μ.
Leaflet Texture	Flowing or particle pattern. Both length and width are over 10 μ.
Inert Texture	Texture derived from coal inert

dissolved in $CDCl_3$ and examined using ^1H-NMR. Aa was evaluated from the intensity of 8.4 ppm due to the 9,10 positions of anthracene. Da was estimated from the intensity of 3.9 ppm due to 9,10 positions of 9,10-DHA which are produced by the abstraction of transferable hydrogen in the sample.

Results and Discussion

Fig.1 shows the texture distribution of Saraji coking coal co-carbonized with coal tar pitch. The X axis is defined as the pitch content and Y axis is defined as the distribution of optical textures observed after co-carbonization with that amount of pitch. Coarse mosaic texture and leaflet texture increase and inert texture decreases as the pitch content increases. As pitch itself has leaflet, that above the dashed line can be attributed to pitch while that under the line should be attributed to coal. In addition to Saraji, Slab Fork and Peak Downs showed a similar pattern. Fig. 2 shows the distribution for Masco coal. In this case the borderline between coarse mosaic and leaflet is above the dotted line, that is, Masco shows more coarse mosaic than can be expected from the proportion of pitch. Luling and Hunter Valley showed a similar pattern. In South Bulli, Goonyela and Oyubari, the borderline between coarse mosaic and leaflet was on the dotted line. These coals can be classified as an intermediate group.

In order to define the extent of hydrogen transfer in the co-carbonization system, we have introduced a D/A parameter. This is defined by formula (1). Fig. 3 shows the major anisotropic texture and

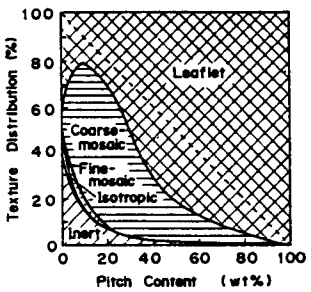

Fig.1 Texture Distribution Chart of Saraji with Pitch Content

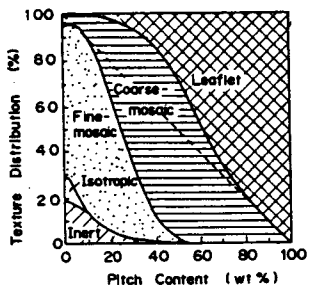

Fig.2 Texture Distribution Chart of Masco with Pitch Content

$$D/A = \frac{(m1/m2(Da)pitch) + (Da)coal}{(Aa)coal} \quad (1)$$

m1/m2 is the blending ratio of pitch to coal (by weight)

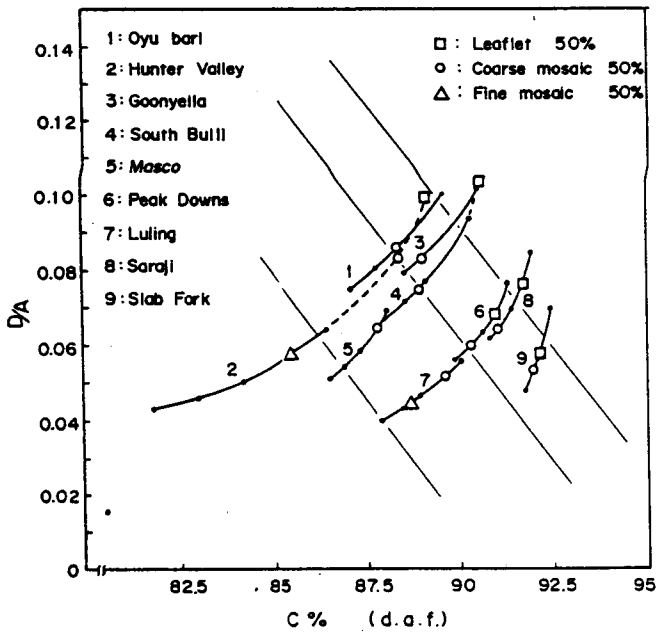

Fig3 Observed Major Anisotropic Textures and Relationship between D/A Parameter and C%

the relationship between D/A and C% for each coal and pitch system. Open circles indicate the point where coarse mosaic reaches 50%. Squares indicate leaflet 50%. Triangles, fine mosaic 50%. Though the extent of the development of anisotropic texture for the same pitch content differs from coal to coal, there is fairly good correlation between D/A and C% where the dominant anisotropic texture (50%) is observed.

In any blend system of coking coal and pitch, the distribution of optical textures can be estimated from hydrogen donor and acceptor abilities, and C%.

References

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(3) Yokono, T., Obara, T., Iyama, S., Yamada, J., and Sanada, Y., J. Fuel Soc. Japan, 1984, 63, 239