DISTRIBUTION OF MACERALS IN THE PRODUCTS OF VARIOUS COAL CLEANING PROCESSES

Shiou-chaun Sun and S. M. Cohen

Pennsylvania State University
University Park, Pennsylvania

Coal is comprised of several petrographic constituents, which are called macerals[13] in analogy with the minerals in a rock. These macerals, differing from each other in their physical and chemical properties, govern the technological properties of coal. For example, in the case of coking coal, the carbon-rich "carbinite" macerals such as fusinite, semi-fusinite, and micrinite are inert on heating, and consequently reduce the caking index. The hydrogen-rich "hydrinite" macerals like exinite, resinite, and alginite decompose on heating into plastic melt and tar. In contrast, the maceral vitrinite constitutes the actual coking principle.

For the sake of more efficient utilization, numerous attempts have been made in research laboratories for separating coal macerals by means of controlled crushing and sizing[1,5,8,9], heavy liquid separation[2,4,10], and flotation[6,7,11], but no similar study has been made in commercial coal preparation plants. The object of this work was to determine the effects of various concentration methods on the distribution of macerals in the products of two Pennsylvania bituminous coal cleaning plants. Also determined were the sulfur and ash contents of the fractionized maceral concentrates.

Experimental.

Each coal sample was first crushed and pulverized to minus 100-mesh and then ground to minus 10-micron. About 5 grams of the ground sample was mixed with 200 ml. of an aqueous zinc chloride solution in a glass bottle, and agitated for 14 hours. The resulting suspension was separated into five different "maceral concentrates" according to the float-and-sink method of Figure 1. A centrifuge was used to aid the separation. The concentrates thus obtained were washed, dried, weighed, analyzed chemically for their ash and sulfur content, and examined microscopically for their petrographic composition.

The procedure of microscopic examination consisted of mounting each maceral concentrate with paraplex. The mounted sample was polished, and then examined under a Leitz, Panphot microscope with 750X resultant magnification and arc illumination. A series of traverses, one millimeter apart, were completed on each block until a total of 300 entities had been identified and counted. The results, as given in Table I, were used as a basis for calculating the distribution of macerals in the products of various coal cleaning processes.

Results and Discussion.

Figure 2 shows that the percentage recovery of macerals in the two Pennsylvania coal cleaning plants decreases in the order of exinite, vitrinite, micrinite, fusinite, and mineral matter, irrespective of the employed concentration method. This is caused, in the case of gravity concentration, by the increase of the density of the macerals in the same order. The reason for the different floatabilities of the macerals lies in the variation of their chemical composition, as indicated partly in Figure 3. A detailed explanation has been given in a previous publication.[12]

Figure 2 shows also that the relative effectiveness of the various concentration methods for separating the desired macerals vitrinite, exinite, and micrinite from the undesired maceral fusinite and mineral matter decreases generally in the order of heavy media, Rheolaveur, tabling, and flotation. This is due, as shown in Table 2, chiefly to the decrease of the particle size of coals treated by these processes in the same order. Fine coal particles, having a tendency of indiscriminate flocculation, are more difficult to clean than coarse ones. Comparing with particle size, the influence exerted by the petrographic composition of the tested coals is relatively insignificant, because of limited variation. The summation curves[3] show that vitrinite is more selectively upgraded by all the tested concentration methods than the rest of macerals.

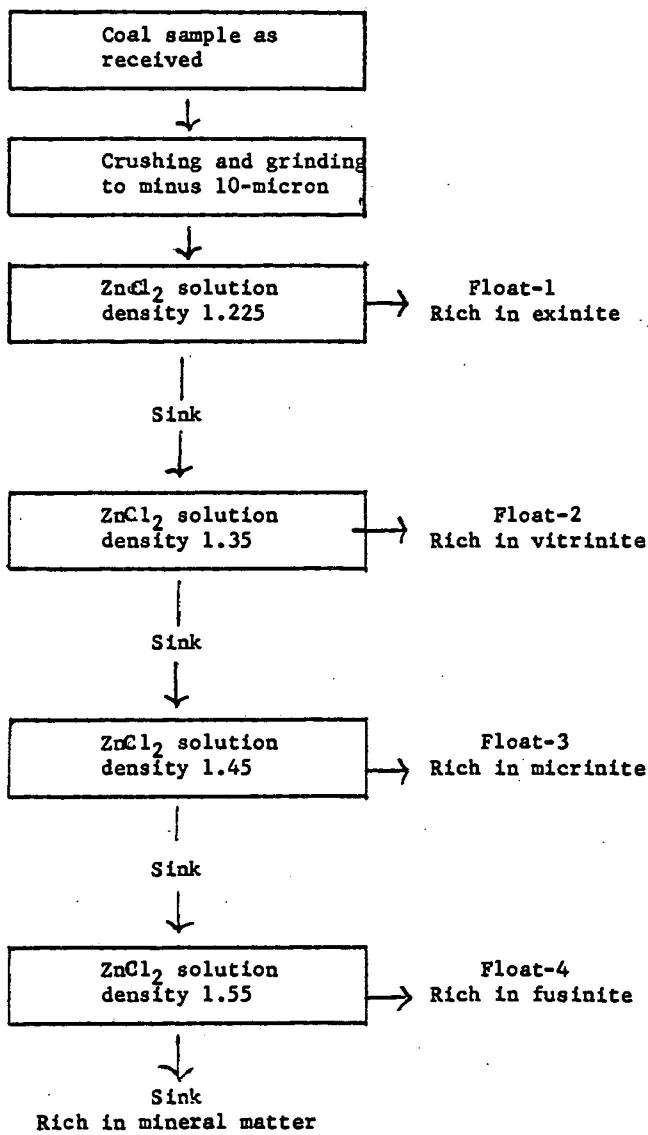

Figure 1. The Float-and-Sink Method Used for Fractionizing Coal Macerals.

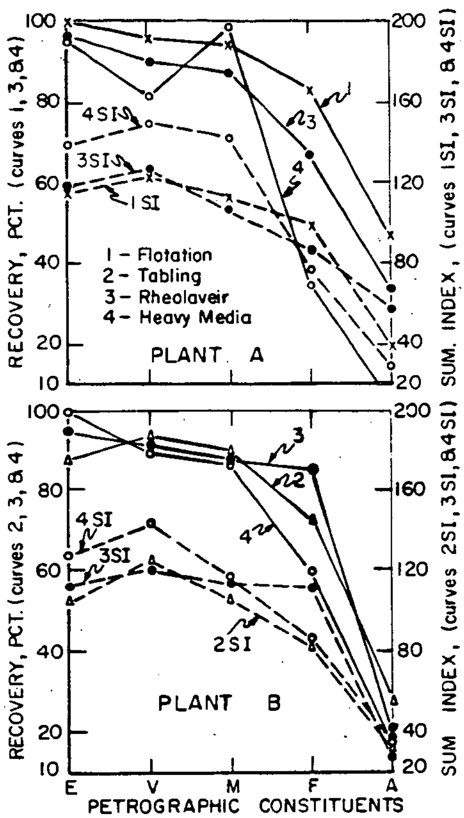

Figure 2. The Upgrading of Macerals With Various Concentration Methods in Two Pennsylvania Bituminous Coal Cleaning Plants.

Petrographic constituents: E, exinite; V, vitrinite; M, micrinite; F, fusinite; A, mineral matter.

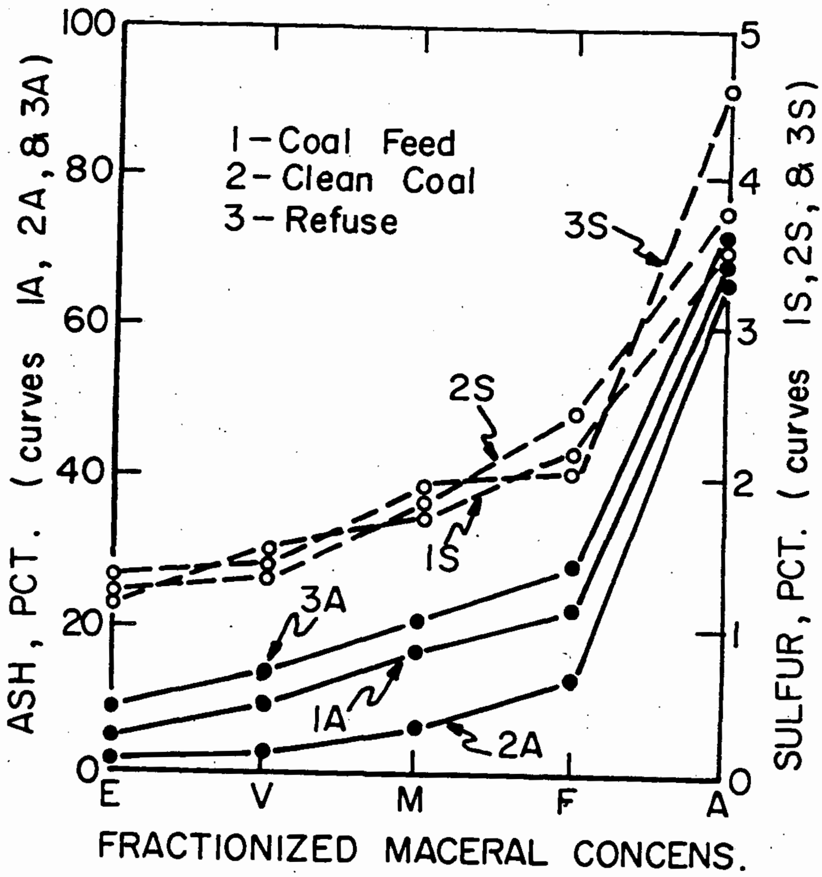

Figure 3. The Ash and Sulfur Content of Fractionized Coal Maceral Concentrates.

Table 1. The Petrographic Composition of Fractionized Maceral Concentrates, as Determined by Microscopic Examination.

Fractionized maceral concentrate	Volume Percentage of petrographic constituent						
	Exinite	Resinite	Vitrinite	Micrinite	Fusinite	Mineral matter	Intended constituent
Exinite	5	5	67	4	18	1	10*
Vitrinite	1	10	79	6	3	1	79
Micrinite	4	1	72	12	10	1	12
Mineral matter	Trace	Trace	16	2	12	70	70

* Including resinite.

Table 2. The Particle Size and Petrographic Composition of Feeds for the Various Concentration Processes of Two Pennsylvania Coal Cleaning Plants. (Volume %)

Particle size and petrographic composition of feed	Plant A			Plant B		
	Heavy media	Rheola-veur	Flotation	Heavy media	Rheola-veur	Tabling
Particle size	3/8" x 6"	3/8" x 0	-48 mesh	1/4" x 8"	1/4" x 0	1/8" x 0
Exinite	6.26	7.50	5.30	6.95	8.59	9.57
Vitrinite	53.60	64.07	60.52	57.56	62.18	65.61
Micrinite	4.20	5.72	6.64	4.79	4.22	4.99
Fusinite	9.81	8.38	11.21	8.17	14.31	7.65
Mineral matter	26.21	14.34	16.36	22.52	10.69	12.22

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