Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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for design and scaleup, and a mechanistic understanding of the controlling phenomena is essential for efficient progress toward full realization of the potential advantages.

12.2.2 Coal Composition

12.2.2.1 *Coal Petrography*

The organic material in coal is a heterogeneous mixture of "organic minerals" known as macerals. Coal petrographers have identified numerous types of maceral components by microscopic analysis with reflected and transmitted light.[19] The precise chemical nature of the macerals is not well established, but their botanical origins seem to be rather well understood.[20]

For ease of discussion, the various types of maceral component are often combined into three principal groups: vitrinite, exinite, and inertinite. With regard to physical and chemical properties, exinite is characterized by the highest hydrogen content, volatile matter content, and heating value: inertinite has the least. Inertinite has the highest density and the greatest degree of aromaticity, whereas exinite is the lowest in both these properties. Thus vitrinite, by far the most abundant of the three maceral groups as can be seen in Table 12.2, usually exhibts chem-

[19] W. Spackman, "The Nature of Coal and Coal Seams," in *Short Course in Coal Characteristics and Coal Conversion Processes*, Pennsylvania State University, University Park, May 19–23, 1975.

[20] D. W. Van Krevelen, *Coal*, Elsevier Publishing Company, Amsterdam, 1961.

[21] H. Gan, S. P. Nandi, and P. L. Walker, Jr., "Nature of the Porosity in American Coals," in *Short Course on Characterization and Characteristics of U.S. Coals for Practical Use*, Pennsylvania State University, University Park, October 25–28, 1971.

Table 12.2 Composition of Some American Coals[21]

Number[a]	Location	ASTM Rank	Ultimate Analysis (wt %, maf) C	H	N	S	O[b]	Vitrinite Content (vol %)[c]
85	Pennsylvania	Anthracite	91.2	3.8	0.60	1.1	3.1	97.5
80	Pennsylvania	Anthracite	90.8	2.6	0.75	0.64	5.1	96.3
130	West Virginia	lvb	90.5	4.3	1.1	0.55	3.4	72.7
127	Pennsylvania	lvb	89.5	5.0	1.0	0.83	3.6	77.7
135	Alabama	mvb	88.3	4.9	0.25	0.65	5.7	83.1
142	Oklahoma	mvb	88.2	4.5	0.20	1.0	6.4	—
4	Kentucky	hvAb	83.8	5.7	1.5	0.88	7.9	67.3
95	Washington	hvAb	81.6	6.0	1.0	1.7	9.4	89.6
105A	Indiana	hvBb	81.3	5.7	1.0	1.8	9.9	62.5
24	Illinois	hvCb	80.0	5.5	1.0	4.5	8.8	88.1
213	Kentucky	hvCb	78.8	5.6	1.7	4.2	9.4	73.4
22	Illinois	hvCb	78.7	5.8	1.5	2.8	11.0	88.3
26	Illinois	hvCb	77.2	5.6	1.1	7.4	8.3	88.5
197	Pennsylvania	hvBb	76.5	5.6	1.2	4.5	12.2	85.3
64	Missouri	hvBb	76.4	4.2	1.2	7.3	11.4	—
190	Illinois	hvCb	75.5	5.3	1.0	3.3	14.6	88.9
97	Wyoming	Subbituminous	75.0	5.5	0.58	1.3	17.5	86.7
138	Texas	Lignite	74.3	4.9	0.37	0.75	19.6	75.1
100	Wyoming	Subbituminous	72.0	5.2	0.81	0.55	21.2	86.0
141	Texas	Lignite	71.7	5.2	1.3	0.90	20.8	75.3
90	Montana	Lignite	71.5	4.8	0.83	0.50	22.2	60.9
89	North Dakota	Lignite	63.3	4.6	0.47	1.5	29.9	70.3

[a] PSOC numbers employed in Pennsylvania State University–Office of Coal Research (now ERDA) coal characterization study.
[b] Determined by difference.
[c] Mineral-matter-containing basis.

ical and physical properties bet
the other two.[22]

The different maceral groups
edly different behaviors under
ditions,[2] and the same woul
hold for hydropyrolysis. As mi
ed from the order of volatile m
the total yield of volatiles is
order exinite > vitrinite > in
are also compositional differen
products. For example, liquid
have been characterized as pri
oils, but those from vitrinite ter
and more phenolic.

The discussion of petrogra
ents points up the approximat
available descriptions of pyroly
pyrolysis that treat coal as a s
If extensive rate and yield dat
ent maceral groups eventually
able, it should be possible t
behavior of different coals in
petrographic compositions a
rameters evaluated for each n

12.2.2.2 *Coal Chemistry*

The organic matter in coal con
of carbon, hydrogen, oxygen,
sulfur, although trace quantitie
ments are also found. Typica
so-called ultimate analyses of s

[22] I. G. C. Dryden, "Chemical C
Reactions of Coal," in *Chemistry*
zation, Supplementary Volume,
Ed., John Wiley and Sons, New
232–295.

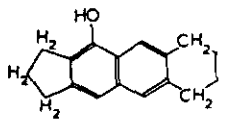

Figure 12.1 The Given model for n