Table 1 . . . . Typical Ultimate Analyses for Coals

Rank	Btu per Lb		Constituents, Percent						
	Moist, Mineral-matter-free[a]	Moist, as Received	Oxygen	Hydrogen	Carbon	Nitrogen	Sulfur	Ash	$O_2 + H_2 + C$
Anthracite	14,600	12,910	5.0	2.9	80.0	0.9	0.7	10.5	87.9
Semi-Anthracite	15,200	13,770	5.0	3.9	80.4	1.1	1.1	8.5	89.3
Low-Volatile Bituminous	15,350	14,340	5.0	4.7	81.7	1.4	1.2	6.0	91.4
Medium-Volatile Bituminous	15,200	13,840	5.0	5.0	79.0	1.4	1.5	8.1	89.0
High-Volatile Bituminous *A*	14,500	13,090	9.2	5.3	73.2	1.5	2.0	8.8	87.7
High-Volatile Bituminous *B*	13,500	12,130	13.8	5.5	68.0	1.4	2.1	9.2	87.3
High-Volatile Bituminous *C*	12,000	10,750	21.0	5.8	60.6	1.1	2.1	9.4	87.4
Sub Bituminous *B*	10,250	9,150	29.5	6.2	52.5	1.0	1.0	9.8	88.2
Sub Bituminous *C*	9,000	8,940	35.8	6.5	46.7	0.8	0.6	9.6	89.0
Lignite	7,500	6,900	44.0	6.9	40.1	0.7	1.0	7.3	91.0

[a] (Btu as received) × 100 ÷ (100 − 1.1 Ash)

Table 2 . . . . Classification of Coals by Rank[a]

Legend: F.C. = Fixed Carbon. V.M. = Volatile Matter. Btu = British thermal units.

Class	Group	Limits of Fixed Carbon or Btu Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracite	1. Meta-anthracite	Dry F.C., 98 percent or more (Dry V.M., 2 percent or less)	Non-agglomerating
	2. Anthracite	Dry F.C., 92 percent or more and less than 98 percent (Dry V.M., 8 percent or less and more than 2 percent)	
	3. Semi-anthracite	Dry F.C., 86 percent or more and less than 92 percent (Dry V.M., 14 percent or less and more than 8 percent)	
II. Bituminous[d]	1. Low volatile bituminous coal	Dry F.C., 78 percent or more and less than 86 percent (Dry V.M., 22 percent or less and more than 14 percent)	Either agglomerating[b] or non-weathering[f]
	2. Medium volatile bituminous coal	Dry F.C., 69 percent or more and less than 78 percent (Dry V.M., 31 percent or less and more than 22 percent)	
	3. High volatile *A* bituminous coal	Dry F.C., less than 69 percent (Dry V.M., more than 31 percent); and moist[e] Btu, 14,000[e] or more	
	4. High volatile *B* bituminous coal	Moist[e] Btu, 13,000 or more and less than 14,000[e]	
	5. High volatile *C* bituminous coal	Moist Btu, 11,000 or more and less than 13,000[e]	
III. Sub-bituminous	1. Sub-bituminous *A* coal	Moist Btu, 11,000 or more and less than 13,000[e]	Both weathering and non-agglomerating[b]
	2. Sub-bituminous *B* coal	Moist Btu, 9500 or more and less than 11,000[e]	
	3. Sub-bituminous *C* coal	Moist Btu, 8300 or more and less than 9500[e]	
IV. Lignitic	1. Lignite	Moist Btu less than 8300	Consolidated
	2. Brown coal	Moist Btu less than 8300	Unconsolidated

Adapted from *ASTM Standards*, 1937, *Supplement*, p. 145, American Society for Testing Materials.

[a] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu of the high-volatile bituminous and sub-bituminous ranks. All of these coals either contain less than 48 percent dry, mineral-matter-free fixed carbon, or have more than 15,500 moist, mineral-matter-free Btu.

[b] If agglomerating, classify in low-volatile group of the bituminous class.

[c] Moist Btu refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[d] It is recognized that there may be non-caking varieties in each group of the bituminous class.

[e] Coals having 69 percent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[f] There are three varieties of coal in the high-volatile *C* bituminous coal group, namely, Variety 1, agglomerating and non-weathering; Variety 2, agglomerating and weathering; Variety 3, non-agglomerating and non-weathering.

Table 3 . . . . Standard Anthracite Specifications[a]

Test Mesh Round

Size of Coal	Through In.	Over In.	Oversize Max %	Undersize %		Maximum Impurities %		
				Max	Min	Slate[b]	Bone[b]	or Ash[c]
Broken	4⅜	3¼ to 3	—	15	7½	1½	2	11
Egg	3¼ to 3	2 1/16	5	15	7½	1½	2	11
Stove	2 1/16	1⅜	7½	15	7½	2	3	11
Nut	1⅜	13/16	7½	15	7½	3	4	11
Pea	13/16	9/16	10	15	7½	4	5	12
Buckwheat	9/16	5/16	10	15	7½	....	....	13
Rice	5/16	3/16	10	17	7½	....	....	13
Barley	3/16	3/32	10	20	10	....	....	15
No. 4	3/32	3/64	20	30	10	....	....	15
No. 5	3/64	....	30	No limit		....	....	16

[a] Approved and adopted, effective July 23, 1947, by the Anthracite Committee (*Manual of Statistical Information*, Anthracite Institute.)

[b] When slate content in the sizes from Broken to Nut inclusive is less than above standards, bone content may be increased by one and one-half times the decrease in the slate content under the allowable limits, but slate content specified above shall not be exceeded in any event.

[c] Ash determinations are on a dry basis and include bone and ash.

A tolerance of 1 percent is allowed on the maximum percentage of undersize and the maximum percentage of ash content. The maximum percentage of undersize is appliesble only to anthracite as it is produced at the preparation plant.

Slate is defined as any material which has less than 40 percent of fixed carbon.

Bone is defined as any material which has 40 percent or more, but less than 75 percent of fixed carbon.

soot are possible, if improperly fired, especially at low rates of burning.

Sub-bituminous coals occur in the western states; they are high in moisture when mined and tend to break up as they dry or when exposed to the weather; they are liable to ignite spontaneously when piled or stored. They ignite easily and quickly, and have a medium length flame; are non-caking and free-burning; the lumps tend to break into small pieces if poked; very little smoke and soot are formed.

Lignite is of woody structure, very high in moisture as mined, and of low heating value; it is clean to handle. It has a greater tendency than the sub-bituminous coals to disintegrate as it dries, and it also is more liable to spontaneous ignition. Freshly mined lignite, because of its high moisture, ignites slowly. It is non-caking. The char left after the moisture and volatile matter are driven off burns very easily, like charcoal. The lumps tend to break up in the fuel bed, and pieces of char falling into the ashpit continue to burn. Very little smoke or soot is formed.

Classification of Cokes

Coke is produced by the distillation of the volatile matter from coal. The type of coke depends on the coal or mixture of coals used, on the temperatures and time of distillation and, to some extent, on the type of retort or oven. *Petroleum coke* is produced as a residue from the destructive distillation of oil.

COMBUSTION OF SOLID FUELS

Firing Methods for Anthracite

An anthracite fire should never be poked or disturbed, as this serves to bring ash to the surface of the fuel bed, where it may melt into clinker.

Egg size is suitable for large fire-pots (grates 24 in. and over) if the fuel can be fired at least 16 in. deep. For best results this coal should be fired deeply.

Stove is the proper size of anthracite for many boilers and furnaces. It burns well on grates at least 16 in. in diameter, on which it is fired about 12 in. deep. The fuel should be fired deeply and uniformly.

Chestnut size coal is in demand for fire-pots up to 20 in. in diameter, and is usually fired to a depth of from 10 to 15 in.

Pea size coal is often an economical fuel to burn. When fired carefully, pea coal can be burned on standard grates. Care should be taken to shake the grates only until the first bright coals begin to fall through the grates. The fuel bed, after a new fire has been built, should be increased in thickness by the addition of small charges until it is at least level with the sill of the fire-door. A satisfactory method of firing pea coal consists of drawing the red coals toward the front end, and piling fresh fuel toward the back of the firebox.

Pea size coal requires a strong draft, and therefore the best results generally will be obtained by keeping the choke damper open, and regulating solely by means of the cold-air check and the air-inlet damper.

Buckwheat size coal, for best results, requires more attention than pea size coal, and in addition the smaller size of the fuel makes it more difficult to burn on ordinary grates. Greater care must be taken in shaking the grates than with the pea coal to prevent fuel from falling through the grate. In house heating furnaces, the coal should be fired lightly and more frequently than pea coal. When banking a buckwheat coal fire, it is advisable after coaling to expose a small spot of hot fire by putting a straight poker down through the bed of fresh coal. This will serve to ignite the gas that will be distilled from the fresh coal and prevent delayed ignition which, in some cases, depending upon the thickness of the bed of fresh coal, is severe enough to blow open the doors and dampers of the furnace. Where frequent attention can be given and care is exercised in manipulation of the grates, this fuel can be burned satisfactorily without the aid of any special equipment, except small mesh grates.

In general, it will be found more satisfactory with buckwheat coal to maintain a uniform heat output and, consequently, to keep the system warm all the time, rather than to allow the system to cool off at times and then to attempt to burn the fuel at a high rate while warming up. A uniform low fire will minimize the clinker formation and keep any clinker formed in an easily broken up condition so that it readily can be shaken through the grate. Forced draft and small mesh grates or, for greater convenience, domestic stokers are frequently used.

Buckwheat anthracite No. 2, or rice size, is used principally in stokers of the domestic, commercial and industrial type. No. 3 buckwheat anthracite, or barley, has no application in domestic heating.

Firing Methods for Bituminous Coal

A commonly recommended procedure for firing domestic heating units, called the side-bank method, requires the movement of live coals to one side or the back of the grate, and placing the fresh fuel charge on the opposite side. The results are a more uniform release of volatile gases, and the subjection of these gases to the high temperature of the red coals. If the fresh charge is covered with a layer of fine coal, still better results may be obtained because of slower release of volatile matter.

Bituminous coal should never be fired over the entire