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

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 | 4½ | 3½–3 | — | 15 | 7½ | 1½ | 2 | 11 |
| Egg | 3½–3 | 2⅞ | 5 | 15 | 7½ | 1½ | 2 | 11 |
| Stove | 2⅞ | 1½ | 7½ | 15 | 7½ | 2 | 3 | 11 |
| Nut | 1½ | ¾ | 7½ | 15 | 7½ | 3 | 4 | 11 |
| Pea | ¾ | ⅜ | 10 | 15 | 7½ | 4 | 5 | 12 |
| Buckwheat | ⅜ | ⅜ | 10 | 15 | 7½ | ..... | ..... | 13 |
| Rice | ⅜ | ⅜ | 10 | 17 | 7½ | ..... | ..... | 13 |
| Barley | ⅜ | ⅜ | 10 | 20 | 10 | ..... | ..... | 15 |
| No. 4 | ⅜ | ⅜ | 20 | 30 | 16 | ..... | ..... | 15 |
| No. 5 | ⅜ | ..... | 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.

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

*Slate* is defined as any material which has less than 40 per cent of fixed carbon.

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

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.

## DUSTLESS TREATMENT OF COAL

In order to allay the dust the more friable coals are sometimes sprayed with various petroleum products, a solution of calcium chloride or a mixture of calcium and magnesium chlorides.

The coal is usually treated at the mine, but sometimes by the local distributor just before delivery. The salt solutions are sprayed under high pressure, using from 2 to 4 gal or from 5 to 10 lb of the salt per ton of coal, depending on its friability and size. Oil for the dustless treatment of coal is also applied under high pressure, in concentrations of 1 to 8 qt per ton of coal, depending upon the characteristics of the coal and oil.

Dustless treatments, which are of such a corrosive nature that they may damage coal handling or burning equipment, should not be used.

## 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, the temperatures and time of distillation and, to some extent, on the type of retort or oven; coke is also produced as a residue from the destructive distillation of oil.



*High-temperature cokes.* Coke, as usually available, is of the high-temperature type, and contains between 1 and 2 per cent volatile matter. High-temperature cokes are subdivided into *beehive coke* of which comparatively little is now sold for domestic use, *by-product coke*, which covers the greater part of the coke sold, and *gas-house coke*. The differences among these three cokes are relatively small; their denseness and hardness decrease and friability increases in the order named. In general, the lighter and more friable cokes ignite and burn more readily.

*Low-temperature cokes* are produced at low coking temperatures, and only a portion of the volatile matter is distilled off. Cokes, as made by various processes under development, have contained from 10 to 15 per cent volatile matter. In general, these cokes ignite and burn more readily than high-temperature cokes. The properties of various low-temperature cokes may differ more than those of the various high-temperature cokes because of the differences in the quantities of volatile matter, and because some may be light and others briquetted.

*Petroleum cokes*, which are obtained by coking the residue left from the distillation of petroleum, vary in the amount of volatile matter they contain, but all have the common property of a very low ash content, which necessitates the use of refractory pieces to protect the grates from being burned.

## CLASSIFICATION OF FUEL OILS

Fuel oils are produced by distillation from crude petroleum after gasoline, naphtha, and other lighter products have been removed. Fuel oil is composed chemically of about 85 per cent carbon and 12½ per cent hydrogen with small amounts of oxygen, nitrogen, and sulfur. Oils are classified according to their specific gravity, but specific gravity alone is not a sufficient index of the properties that are important for heating purposes. Other characteristics that must be considered in the choice of a fuel oil are the flash point, pour point, water and sediment content, carbon residue, ash, sulfur content, distillation temperatures, and viscosity.

The flash point and distillation characteristics are important relative to easy ignition and complete gasification of the oil in a burner. A low pour point and low water content are of interest in connection with the storage of the fuel in outdoor tanks, while a low viscosity permits easy passage through a small orifice. The sediment, carbon residue, and ash content should be low to prevent clogging of strainers and accumulation of unburned material in the burner. The sulfur content may be of importance because of the corrosive effect of sulfur compounds in the burner and heating appliance, or in special commercial processes.

The Commercial Standard Specifications for Fuel Oils (CS 12-48) of the *U. S. Department of Commerce* are given in Table 4. These specifications conform to *American Society for Testing Materials* Tentative Specifications for Fuel Oils D 396–48T.

The relationship between the *A.P.I.* gravity of fuel oils and their calorific value is given in Table 5. Fuel oil grades No. 1 and No. 2 only, are used in domestic heating equipment. Grades No. 5 and No. 6 are used in commercial and industrial burners, and usually require preheating.

## CLASSIFICATION OF GASES

Typical fuel gases used in the United States fall into three broad classifications, natural, manufactured and liquefied petroleum. Natural gas is a mechanical mixture of several combustible and inert gases obtained from