TABLE 1. GENERAL DATA OF COMBUSTIBLE ELEMENTS AND COMPOUNDS

Substance	Molecular Symbol	Chemical Reaction of Combustion	Ignition Temperature[a] Deg F	Calorific Value: Btu per pound, Higher	Calorific Value: Btu per pound, Lower	Calorific Value: Btu per Cubic Foot, Higher	Theoretical Oxygen and Air Requirements: Lb per Lb, O_2	Lb per Lb, Air	Cubic Ft per Cubic Ft, O_2	Cubic Ft per Cubic Ft, Air
Carbon (to CO)	—	$2C + O_2 = 2CO$	—	4380	—	—	1.333	5.76	—	—
Carbon (to CO_2)	—	$2C + 2O_2 = 2CO_2$	—	14540	—	—	2.667	11.52	—	—
Sulphur	S_2	—	—	—	—	—	1.000	4.32	—	—
Sulphur (to SO_2)	—	$S + O_2 = SO_2$	—	4050	—	—	—	—	—	—
Sulphur (to SO_3)	—	$2S + 3O_2 = 2SO_3$	—	5940	—	—	—	—	—	—
Carbon monoxide	CO	$2CO + O_2 = 2CO_2$	1166-1319	4380	—	342	0.572	2.46	0.5	2.391
Methane	CH_4	$CH_4 + 2O_2 = CO_2 + 2H_2O$	1202-1346	23850	21670	1073	4.000	17.28	2.0	9.564
Acetylene	C_2H_2	$2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O$	763-824	21460	21020	1590	3.077	13.29	2.5	11.955
Ethylene	C_2H_4	$C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$	986-1123	21450	20420	1675	3.429	14.81	3.0	14.346
Ethane	C_2H_6	$2C_2H_6 + 7O_2 = 4CO_2 + 6H_2O$	986-1123	22230	20500	1883	3.733	16.13	3.5	16.737
Hydrogen	H_2	$2H_2 + O_2 = 2H_2O$	1063-1166	62000	52920	348	8.000	34.56	0.5	2.391
Hydrogen sulphide	H_2S	$2H_2S + 3O_2 = 2H_2O + 2SO_2$	599-608	—	—	—	1.412	6.10	1.5	7.173

[a]From International Critical Tables, 1927.

ignition temperature before it will unite in chemical combination with oxygen to produce combustion. The ignition temperatures for several of the combustible constituents of fuels are presented in Table 1.

HEAT OF COMBUSTION

As previously stated, the process of combustion results in the evolution of heat. The *heat of combustion*, or calorific value, of a fuel is the amount of heat generated by the complete combustion of a unit of the fuel and is constant for a given combination of combustible elements and compounds. The heat of combustion of the several fuel elements and compounds in their *pure* state is given in Table 1.

The reaction of the carbon in the fuel with oxygen may result in the formation of carbon monoxide or carbon dioxide. In burning to carbon monoxide, the carbon is not completely oxidized and, as shown by the data, the heat produced is considerably less than if it were completely oxidized. This fact is of greatest importance in considering the efficiency of combustion.

The calorific value of a fuel is determined by direct measurement of the heat evolved during combustion in a calorimeter. As the calorific value, on a *moisture and ash free* basis, of coal from a given district or mine remains substantially constant the calculation of the calorific value of a particular lot of coal can be made if the lot is analyzed for moisture and ash. From a known reliable calorific value for coal from the same mine or district the calorific value on a *moisture and ash free* basis, often called the H value, is calculated from Formula (1).

$$\text{Calorific value, moisture and ash free} = \frac{100 \times \text{Calorific value (as received)}}{100 - (\text{Moisture} + \text{Ash})} \quad (1)$$

If a *dry* or *moisture free* analysis is used it is necessary to correct for *ash only* to reduce to moisture and ash free basis. From the value obtained by Formula (1) the calorific value for the sample under consideration can be calculated as follows:

$$\text{Calorific value} = \frac{\text{Calorific value (moisture and ash free)} \times [100 - (\text{Moisture} + \text{Ash})]}{100} \quad (2)$$

In the above formulae moisture and ash are expressed in per cent.

The H values for Illinois coals are published[1] and it is to be expected that more data on H values for other coals will be available in the future.

As practically all fuels contain hydrogen they produce a certain amount of water vapor as one of the products of combustion. The amount of water vapor produced increases as the hydrogen content of the fuel increases. When the calorific value of a fuel is determined in a calorimeter the water vapor is condensed and the latent heat of vaporization that is given up during the condensation is reported as a portion of the heat value of the fuel. The heat value so determined is termed the *gross* or *higher* heat value and this is what is ordinarily meant when the heat value of a fuel is specified. In burning the fuel, however, the products of

[1]*State Geological Survey Bulletin*, No. 62, Classification and Selection of Illinois Coals.