

CALORIFIC VALUE

The heating value or calorific value of a substance, usually a fuel or food, is the amount of heat released during the combustion of a specified amount of it. The calorific value is a characteristic for each substance. It is measured in units of energy per unit of the substance, usually mass, such as: kcal/kg, kJ/kg, J/mol, Btu/m³. Heating value is commonly determined by use of a bomb calorimeter.

The heat of combustion for fuels is expressed as the HHV, LHV, or GHV:

The quantity known as higher heating value (HHV) (or gross calorific value or gross energy or upper heating value) is determined by bringing all the products of combustion back to the original pre-combustion temperature, and in particular condensing any vapor produced. This is the same as the thermodynamic heat of combustion since the enthalpy change for the reaction assumes a common temperature of the compounds before and after combustion, in which case the water produced by combustion is liquid.

The quantity known as lower heating value (LHV) (or net calorific value) is determined by subtracting the heat of vaporization of the water vapor from the higher heating value. This treats any H₂O formed as a vapor. The energy required to vaporize the water therefore is not realized as heat.

Gross heating value (see AR) accounts for water in the exhaust leaving as vapor, and includes liquid water in the fuel prior to combustion. This value is important for fuels like wood or coal, which will usually contain some amount of water prior to burning.

Most applications which burn fuel produce water vapor which is not used, and thus wasting its heat content. In such applications, the lower heating value is the applicable measure. This is particularly relevant for natural gas, whose high hydrogen content produces much water. The gross calorific value is relevant for gas burnt in condensing boilers which condense the water vapor produced by combustion, recovering heat which would otherwise be wasted.

Both HHV and LHV can be expressed in terms of AR (all moisture counted), MF and MAF (only water from combustion of hydrogen). AR, MF, and MAF are commonly used for indicating the heating values of coal:

AR (As Received) indicates that the fuel heating value has been measured with all moisture and ash forming minerals present.

MF (Moisture Free) or Dry indicates that the fuel heating value has been measured after the fuel has been dried of all inherent moisture but still retaining its ash forming minerals.

MAF (Moisture and Ash Free) or DAF (Dry and Ash Free) indicates that the fuel heating value has been measured in the absence of inherent moisture and ash forming minerals.

The energy value of coal

The energy value of coal, or the fuel content, is the amount of potential energy in coal that can be converted into actual heating ability. The value can be calculated and compared with different grades of coal or even other materials. Materials of different grades will produce differing amounts of heat for a given mass.

While chemistry provides methods of calculating the heating value of a certain amount of a substance, there is a difference between this theoretical value and its application to real coal. The grade of a sample of coal does not precisely define its chemical composition, so calculating the actual usefulness of coal as a fuel requires determining its proximate and ultimate analysis.

Chemical composition

Chemical composition of the coal is defined in terms of its proximate and ultimate (elemental) analyses. The parameters of proximate analysis are moisture, volatile matter, ash, and fixed carbon. Elemental or ultimate analysis encompasses the quantitative determination of

carbon, hydrogen, nitrogen, sulfur and oxygen within the coal. Additionally, specific physical and mechanical properties of coal and particular carbonization properties are also determined.

The calorific value Q of coal is the heat liberated by its complete combustion with oxygen. Q is a complex function of the elemental composition of the coal. Q can be determined experimentally using calorimeters. Dulong suggests the following approximate formula for Q when the oxygen content is less than 10%:

$$Q = 337C + 1442(H - O/8) + 93S,$$

Where C is the mass percent of carbon, H is the mass percent of hydrogen, O is the mass percent of oxygen, and S is the mass percent of sulfur in the coal. With these constants, Q is given in kilojoules per kilogram.

ALKALI

In chemistry, an alkali is a basic, ionic salt of an alkali metal or alkaline earth metal element. Alkalis are best known for being bases (compounds with pH greater than 7) that dissolve in water. The adjective alkaline is commonly used in English as a synonym for base, especially for soluble bases. This broad use of the term is likely to have come about because alkalis were the first bases known to obey the Arrhenius definition of a base and are still among the more common bases. Since Brønsted-Lowry acid-base theory, the term alkali in chemistry is normally restricted to those salts containing alkali and alkaline earth metal elements.

SLAG

Slag is the by-product of smelting ore to purify metals or the waste material left after metal has been smelted or the vitreous mass left as a residue by the smelting of metallic ore. They can be considered to be a mixture of metal oxides; however, they can contain metal sulfides (see also matte) and metal atoms in the elemental form. While slags are generally used as a waste removal mechanism in metal smelting, they can also serve other purposes, such as assisting in smelt temperature control and minimizing re-oxidation of the final liquid metal product before casting.

FOULING

Fouling refers to the accumulation of unwanted material on solid surfaces, most often in an aquatic environment. The fouling material can consist of either living organisms (biofouling) or be a non-living substance (inorganic or organic).

Other terms used in the literature to describe fouling include: deposit formation, encrustation, scaling, scale formation, crudding, and deposition. The last four terms are less inclusive than fouling; therefore, they should be used with caution.

Fouling phenomena are common and diverse, ranging from fouling of ships, natural surfaces in the marine environment (marine fouling), fouling of heat-transferring components through ingredients contained in the cooling water or gases, and even the development of plaque or calculus on teeth, or deposits on solar panels on Mars, among other examples.

In the cooling technology and other technical fields, a distinction is made between macro fouling and micro fouling. Of the two, micro fouling is the one which is usually more difficult to prevent and therefore more important.

DOLOMITE

Dolomite is the name of a sedimentary carbonate rock and a mineral, both composed of calcium magnesium carbonate $\text{CaMg}(\text{CO}_3)_2$ found in crystals.

Dolomite rock (also dolostone) is composed predominantly of the mineral dolomite. Limestone that is partially replaced by dolomite is referred to as dolomitic limestone, or in old U.S. geologic literature as magnesian limestone.