



Fuels and Propellants

Materials that are burned to provide heat or to power movement

HIGHLIGHTS

- Most fuels react with oxygen in a process called combustion.
- The main fuels in use now are fossil fuels, which are the compressed remains of organisms that died millions of years ago.
- Propellants are burned to generate hot gases rather than to produce heat.

A fuel is a material that is a good source of heat. Most fuels produce heat from a process called combustion (burning). Combustion can be started with a spark, by tightly squeezing a fuel-air mixture, or by adding an already burning material. Common fuels react with oxygen in the air, but some fuels do not need air to combust. Nuclear fuels produce heat from radioactivity rather than combustion.

The most commonly used fuels are so-called fossil fuels, such as coal, oil, and natural gas. These fuels derive from the remains of plants and animals that lived millions of years ago.

Energy

Combustion is the release of energy caused by a chemical reaction. When a reaction occurs, the atoms in one molecule split apart and join up with atoms from another molecule to make a new, different substance. Because it takes energy to break the bonds in a molecule, heat is often needed to start a reaction. As new bonds form, energy may be released. In combustion reactions, the formation of new bonds releases more energy than required to break up more fuel molecules, so the combustion process sustains itself, and the extra energy is released as heat and sometimes as light. The heat may make any gases released in the reaction glow. These glowing gases are flames.

LOOK CLOSER

Calorific value

The amount of energy produced by a given weight of fuel is called its calorific (kal-uh-RIF-ik) value. Calorific values can be worked out using a machine called a calorimeter. A calorimeter is a metal cylinder with thick sides. A small amount

of the fuel is placed inside, and the cylinder is sealed. The exact amount of oxygen needed for the fuel to burn up completely is pumped into the calorimeter. The calorimeter is then put in a tank of water. The fuel is ignited by an electric spark, and heat from the fuel passes into the water, causing its temperature to rise. Scientists can figure out exactly how much heat was produced by the rise in water temperature.

Coal

Coal is a solid fossil fuel. There are several types of coal. Lignite, or brown coal, is wood that is still in the process of being turned into a harder coal. It has less carbon than other coals but more sulfur. Lignite produces several damaging pollutants when burned. Other coals are harder than lignite and are found deeper underground.

Anthracite (AN-thruh-syt) is the hardest coal and has the most carbon in it. Most anthracite in the United States comes from Pennsylvania.

In the 18th century, coal powered a great expansion of industry, the Industrial Revolution. Iron workers discovered that heating coal removed many of its impurities, leaving almost pure carbon. Coal treated in this way is called coke. Coke burns hot enough to make steel, a tough mixture of iron and carbon.

Liquid heat

Crude oil is a thick black liquid that contains many important chemicals, most of which are used for fuel. Liquid fossil fuels, such as gasoline and diesel, are produced in a number of ways. Diesel is extracted directly from crude oil, while gasoline is made by breaking long chains of molecules into smaller ones.

Liquid fuels were little used until the invention of the internal combustion engine in 1876. The internal combustion engine runs on liquid fuels and powers cars, trucks, and buses. As the numbers of these vehicles increased, so did the demand for liquid fuels. The jet engines of aircraft use a liquid fuel called kerosene.

Gas fuels

Gas fuel has been used for around 150 years. Coal gas, a mixture of poisonous gases produced by heating coal, was pumped to homes for heating water and for cooking. This gas has now been largely replaced by natural gas, another type of fossil fuel. Natural gas has become the chief source of energy of some nations. The United States and Canada account for about one-half of the world's production.

Gas power stations are efficient since the gas can be used to power generators before it is burned to produce heat. Natural gas is cleaner than other fossil fuels, because it produces no

ash and less carbon dioxide. Gases released from petroleum are used to make liquefied petroleum gas (LPG). The gases are cooled into liquid and, along with alcohol, are a possible cleaner alternative to gasoline as automobile fuel.

Propellants

Propellants power rockets. A fuel is burned to release heat and light, but a propellant is burned to produce a large amount of hot gas. Fuels need air to burn, while most propellants do not. Propellants either have the necessary oxygen inside them, or they burn in a different way.

Solid propellants are basically explosives. Gunpowder, the first rocket propellant, was used in fireworks in China more than 1,000 years ago. A solid propellant is packed carefully inside a rocket so it burns evenly. If it burns unevenly, the rocket will not fly straight. Solid propellants, such as those that launch the space shuttle, burn completely once they are ignited. Rockets powered by liquid propellants are easier to control, because they can be turned on and off. Liquid propellants usually need to be mixed with a second liquid for them to burn. This second liquid is called an oxidant. For example, the main engines on a space shuttle are powered by liquid hydrogen (the propellant) and liquid oxygen (the oxidant). When the two liquids mix together, they combine into very hot steam and release a huge amount of energy.

INTO THE FUTURE

Biofuels

Millions of years ago, forests laid down layers of dead leaves and wood that were eventually buried underground and became fossil fuels, such as coal. Using sunlight and water, plants turn carbon dioxide gas in the air into more complicated chemicals. By burning fossil fuels, the carbon dioxide trapped by those plants long ago is returned to the air. Because large amounts of carbon dioxide in the atmosphere increase global warming, people are looking for new fuels that do not increase the level of this gas.

Biofuels use the same source of energy as fossil fuels—plants. However, instead of being produced over millions of years, biofuels are produced from plants grown now. When these plants are cut down, new ones are planted in their place. The same amount of carbon dioxide released from burning biofuel is taken in by the growing plants.

A simple biofuel is wood. Countries with large forests have power plants that burn wood. The wood is taken from plantations of fast-growing trees, such as birch or fir, and is cut into small chips that are dried before being burned. Trees cut down for fuel are replaced by new ones. Alcohol is a biofuel obtained from plant material. In Brazil, alcohol is made from sugarcane and mixed with gasoline to power automobiles. However, alcohol is still more expensive to produce than gasoline.

See also: [COAL](#); [ELECTRICITY](#); [GAS INDUSTRY](#); [OIL AND NATURAL GAS](#); [OIL REFINING](#).

Citation:

"Fuels and Propellants." *Exploring Technology*. Marshall Cavendish Digital. 2009. 21 July 2009
<<http://www.marshallcavendishdigital.com/articledisplay/32/7042/71682>>.

Copyright © 2006 Marshall Cavendish Corporation. All rights reserved.