WorldLinks | Organic Chemistry Illuminates Humankind

In the modern world, we can summon light by simply flicking a switch or using an app on our phones. But what did humans use for light before the relatively recent inventions (developed within the past 150 years) of electricity and lightbulbs? Prior to the late 1800s, the only available light on earth was light from the sun and light produced by fire. For over 200,000 years, humans have been generating light by burning organic material. Nearly 40,000 years ago, toward the end of the Ice Age, humans created stone lamps to burn animal fats. The lamps were used to illuminate the inside of caves where we now find remnants of ancient drawings. Kerosene lamps are still used today in regions without electricity. Candles, invented at least 3,000 years ago, utilize a wick surrounded by a solid fuel source such as beef tallow, whale fat, beeswax, or paraffin. Electric lighting in the 19th and 20th centuries was made possible by the combustion of coal, natural gas, and oil. The burning of fossil fuels continues today throughout the world, but it will play a diminishing role in the future as the global population embrace more environmentally friendly options that do not contribute to climate change.

Earlier in the chapter we learned that acetylene gas is a fuel that is used in torches for welding and cutting. Perhaps acetylene could also be used in a lamp, but the challenge that comes with using a gaseous fuel is figuring out how to store it. One particularly clever solution to this problem was developed in the late 1800s with the invention of the carbide lamp. Calcium carbide (Ca_2C_2) is a dark gray solid with a garlic-like odor. When this salt comes in contact with water, the dianion is protonated and acetylene gas is produced:

A carbide lamp has two chambers that are connected by a threaded valve. Calcium carbide is added to the lower chamber, and water is added to the upper chamber. When the valve is partially opened, water from the upper chamber drips onto the calcium carbide and acetylene is produced. The generated acetylene gas is passed through a metal tube, and the stream of gas is ignited as it exits the lamp (using a match or a spark from a built-in flint striker). The size of the flame—and the corresponding brightness of the lamp—can be modified by controlling the rate of water entering the lower chamber. The portable nature of the lamp made it suitable for use as a headlight for bicycles around the turn of the 20th century and for early automobiles.

Carbide lamps were also used throughout the mining industry in the early 1900s. Compared to candles and oil-based lamps, the light from the carbide lamp was brighter, and the acetylene fuel was better because it consumed less oxygen and produced no carbon monoxide. Small lamps could be affixed to the front of a cap, and larger lamps were carried by hand. An open flame is dangerous in coal mines where pockets of flammable methane gas might be exposed at any time, so the use of carbide lamps were discontinued there when battery-powered flashlights became available.

Until the 1950s, carbide-based lighting was used in homes that had no electricity. A tank of calcium carbide was stored outside the home. As water was added, the acetylene that was produced was piped into lighting fixtures throughout the house. As might be expected when working with a highly flammable gas, such systems were prone to leaks and had the potential for explosions.

Like the *Homo sapiens* from the Ice Age, modern caving enthusiasts also needed a light source while exploring caves. Carbide lamps served this population over the past 100+ years and continues to be an option for those who are looking for an "old-school" spelunking experience

The **Safety Data Sheet (SDS)** for calcium carbide has the following label elements in accordance with the Globally Harmonized System (GHS) of Classification and Labelling of Chemicals:

Signal word: Danger

Pictograms:

Hazard Statements:

- In contact with water releases flammable gases, which may ignite spontaneously
- Causes skin irritation
- Causes serious eye damage
- May cause respiratory irritation