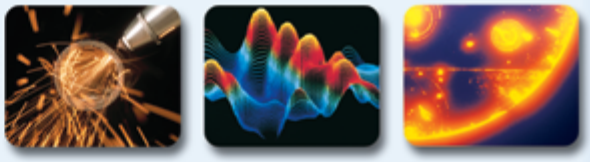
Chemistry in Action



Fuel-Cell Cars

The car of the future is quiet, has low emissions, and requires less maintenance than cars of today do. These are the promises of fuel-cell cars. The development of fuel-cell cars has been pushed by state and federal programs, legislation, and funding. There are a number of issues that need to be resolved before the large-scale manufacture of fuel-cell cars becomes feasible. These include the fuel-storage capacity of the car, and the fueling infrastructure.

The technology currently favored for automobiles is the proton-exchange membrane (PEM) fuel cell. The system works by combining hydrogen with oxygen taken from the outside air. The movement of the electrons (produced by the redox reaction) along an external route generates electricity, which is used eventually to turn the car wheels. The process is two to three times more efficient than that of the internal-combustion engine, and the only products are water and a moderate amount of energy as heat. In most cases, a traditional car battery is used to operate the car's electrical system.

In principle, fuel cells can run on any hydrogen-rich fuel. Several candidate fuels that can power fuel cells are being investigated: methanol, ethanol, natural gas, gasoline, and liquid or compressed hydrogen. If the fuel is not hydrogen gas, the engine needs to include a reformer that can convert the other fuel (such as methanol) to hydrogen.

▲*Eventually, fuel-cell cars such as this one may replace gasoline-powered cars.*

The range of fuel-cell powered cars is limited by the amount of fuel that can be stored in the storage tank. Current storage now limits the cars to around 100 miles before refueling. Researchers in this area are looking into carbon-adsorption systems, which are refrigerated and pressurized tanks that can store large amounts of hydrogen. Hydrogen is very combustible, but safe hydrogen tanks have been developed. So today, the experts do not have any more concern about the safety of hydrogen storage then they do about gasoline storage.

However, the landscape is not yet dotted with hydrogen refueling stations. Current experimental users such as governmental institutions must have their own hydrogen refueling stations. Auto companies say there needs to be a consumer infrastructure for the hydrogen fuel-cell cars before consumers will buy. On the other hand, possible developers of such hydrogen stations say that there needs to be a demand before the infrastructure can form.

The use of fuels such as methanol solves the storage and fuel infrastructure problem, because these fuels can be stored similar to the way gasoline is stored. Therefore, these fuels can be sold at current gasoline stations.

One should also consider the emissions and energy use involved in making and delivering the hydrogen fuel in addition to the emissions from the hydrogen fuel cell. Producing hydrogen fuel itself could involve substantial emissions. Even so, fuel-cell cars are still more efficient and have greater environmental benefits than the internal-combustion cars of today.

Currently, all major car companies are developing and researching fuel-cell cars. Most companies have prototype cars and some cars are in use by governmental institutions. Which type will ultimately succeed in the mass market is yet unknown. Experts agree, though, that for zero-emission cars, hydrogen is the only major fuel option that has been identified to date.

Questions

1. Fuel cells that use hydrogen as fuel produce water and moderate amounts of energy in the form of heat as the only emissions. What kinds of negative effects might cars that use hydrogen-rich fuels have on the environment?
2. In the PEB fuel cell, the hydrogen ions are produced at which electrode: the anode or cathode?