17.12: Fuel Cells

A type of galvanic cell which promises to become increasingly important in the future is the **fuel cell**. By contrast to a conventional cell, where only limited quantities of oxidizing agent and reducing agent are available, a continuous supply of both is provided to a fuel cell, and the reaction product is continually removed. A somewhat oversimplified diagram of a fuel cell in which the cell reaction is the production of water from hydrogen and oxygen is shown in Figure 17.12.1

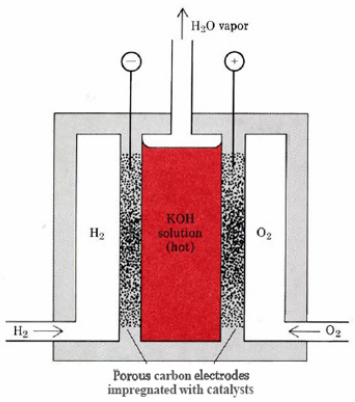

Figure 17.12.1: A hydrogen-oxygen fuel cell.

Hydrogen enters the cell through a porous carbon electrode which also contains a platinum catalyst. Oxygen is supplied to a similar electrode except that the catalyst is silver. The electrolyte is usually a warm solution of potassium hydroxide, and the two electrode reactions can be written as

$$\mathrm{H_2}(g) + 2\mathrm{OH^-}(aq) \rightarrow 2\mathrm{H_2O}(l) + 2e^-$$

and

$$\frac{1}{2}\mathrm{O_2}(g) + \mathrm{H_2O} + 2e^- \rightarrow 2\mathrm{OH^-}(aq)$$

giving the overall result

$$\mathrm{H_2}(g) + \frac{1}{2}\mathrm{O_2}(g) \rightarrow \mathrm{H_2O}$$

Unless it is removed, water produced by the reaction will gradually dilute the potassium hydroxide, rendering the cell inoperative. Hence the electrolyte is kept warm enough that water evaporates just as fast as it is produced by the cell reaction. A fuel cell like this will continue to operate and produce electrical energy as long as a supply of hydrogen and oxygen are available.

Fuel cells have an important advantage over all other devices which burn fuel to obtain useful energy: their efficiency. While an internal-combustion engine is only about 25% efficient and a steam engine about 35% efficient, the H_2–O_2 cell just described can already operate at an efficiency of 45%. The theoretically highest possible efficiency of such a cell, set by the second law of thermodynamics, is 83%. Because of this high efficiency many possible uses and developments for fuel cells have been proposed. One of these scenarios for the future envisions large nuclear power plants floating on the sea producing hydrogen gas by the decomposition of water rather than producing electrical power. This hydrogen gas could then be piped to individual homes where it could either be burned for heat or converted to electricity with the aid of a fuel cell. A second scenario involves automobiles powered by cells fueled by conventional gasoline or perhaps hydrogen. These automobiles would run virtually noiselessly without any pollution problems and deliver twice as many kilometers per liter of fuel as a conventional vehicle. Alas for such scenarios, many technological problems still intervene, but further development of fuel cells is certainly one approach to our current energy problems that should be thoroughly investigated.