The problem: In hydrogen–oxygen fuel cells, more water is formed at the hydrogen fuel electrode than is needed for cell reactions. If not removed as rapidly as formed, this excess water causes electrode flooding, a decrease in cell output, and ultimate cell failure. In the past, many arrangements of pumps and condensers have been used to remove this water with varying results. Such equipment requires sufficient power to seriously penalize the high efficiency of the fuel cell.

The solution: A system that uses a portion of the heat inherent in the fuel cell current generation reaction to transform excess water into water vapor and cause it to be exhausted from the cell by means of a porous vapor transport membrane adjoining a vapor removal cavity maintained at low pressure.

How it's done: As an electrical load is applied to the fuel cell, oxygen enters the oxygen cavity and...
hydrogen enters the hydrogen cavity and come in con-
tact with the electrolyte in the electrolyte membrane
through the oxidant and fuel electrodes, respectively.
The gases have relatively free access to the electrolyte
membrane for production of the required chemical
reaction. The oxygen at the oxidant electrode reacts
with the electrolyte (an aqueous solution of potassium
hydroxide) and is electrochemically reduced to hy-
droxyl ions. The hydrogen reacts with the hydroxyl
ions and is electrochemically oxidized to water, re-
leasing electrons to the load circuit. For every unit of
hydrogen oxidized, two units of water are formed at
the fuel electrode. One unit of this water migrates into
the electrolyte membrane to replenish the water used
in the oxygen reduction. The other unit of water is
waste product and must be removed from the cell.

In both of these reactions, heat is produced. Some
of this heat is absorbed by the product water formed
at the fuel electrode and transforms the water to a
vapor. This vapor diffuses into and through the vapor
transport membrane where heat of the cell causes
evaporation of the water from the vapor transport
membrane into the vapor removal cavity. The vapor
removal cavity, through the water exhaust line, is
maintained at a suitable low pressure so that the
water is removed from the cell structure at a rate con-
sistent with its generation at the fuel electrode.

Notes:
1. The requirement for fins or other cooling media on
   the cell is minimized by use of some of the gener-
eted heat in removal of the waste water.
2. This invention provides a compact fuel cell having
   high energy-to-weight and energy-to-volume ratios
   and requiring a minimum of auxiliary equipment.

Patent status: Title to this invention has been
waived under the provisions of the National Aero-
nautics and Space Act (42 U.S.C. 2457 (f)), to the
Allis-Chalmers Manufacturing Company, Box 512,
Milwaukee, Wisconsin, 53201.

Source: John L. Platner of
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