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Ames Research Center

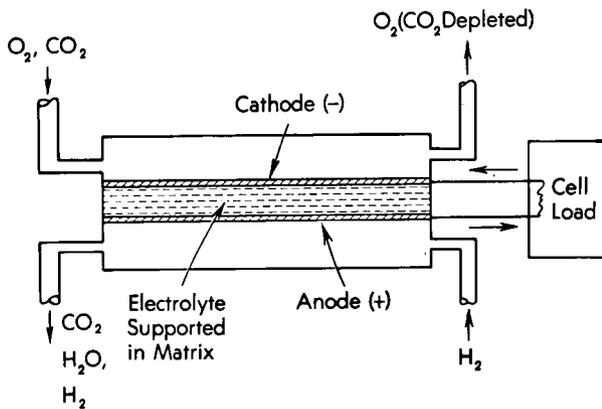


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Carbon Dioxide Concentrator

The problem:

To remove the carbon dioxide from the air exhaled by a pilot so that it may be recycled in a closed system breathing loop.



The solution:

Pass the exhaled air through an electrochemical cell which contains an aqueous solution of an alkali metal carbonate and utilizes platinumized electrodes to cause the reaction of oxygen at the cathode with the water in the electrolyte to produce hydroxyl ions which react with carbon dioxide and form carbonate ions. The reaction of hydrogen at the anode with hydroxyl ions produces water and depletes the hydroxyl ions so that carbon dioxide is given off, thus completing the transfer of carbon dioxide from the oxygen atmosphere to the hydrogen atmosphere (which is vented).

How it's done:

A single cell of the carbon dioxide concentrator (hydrogen-depolarized) is shown in the figure. Potassium carbonate electrolyte is held in a porous asbestos matrix (0.076 cm) between two, type AB-6, platinumized electrodes with active areas approximately 233 cm² (10.7 cm x 21.8 cm). Expanded silver metal (0.15-cm) is used as a spacer in both the anode and cathode gas cavities. The metal spacers are in contact with the electrodes and the respective silver current-collector plates (0.05 cm). The spacers transmit current from the electrodes to the current-collector plates, aid in heat removal, and provide physical support for the matrix.

The results of parametric studies using the potassium carbonate electrolyte indicate that cell or module performance (voltage) increases with hydrogen flow rate and operating temperature but is independent of oxygen flow rate changes over the range evaluated. Carbon dioxide transfer increases with increasing cathode carbon dioxide concentration and is relatively unaffected by operating temperature and oxygen flow rate over the ranges evaluated.

In a hydrogen-depolarized, carbon dioxide-concentrator, an equilibrium exists between carbonate and bicarbonate ions; this equilibrium is dependent on carbon dioxide concentration, operating temperature, and electrolyte concentration. When potassium carbonate is used, potassium carbonate is in equilibrium with potassium bicarbonate which has a limited solubility. If the electrolyte becomes too concentrated as a result of water imbalance, a precipitate can form at the anode of the cell and reduce cell performance.

Cesium carbonate has also been examined as an electrolyte; in this instance, bipolar plates of titanium-

(continued overleaf)

clad copper can be substituted for the silver current-collector plates. Platinum or platinum screen electrodes can be substituted for anodes; expanded titanium can be used for gas cavity spacers.

The module employing cesium carbonate as electrolyte was not as susceptible to moisture imbalance problems as that with potassium carbonate; as the module operating temperature increased (37.8° to 54.4°C), stack voltage increased as expected. Because cesium carbonate and cesium bicarbonate have higher solubilities than the corresponding potassium salts, they provide a wider tolerance to electrolyte water imbalance. Thus, cesium carbonate electrolyte appears to be much more desirable in the carbon dioxide-concentrator application.

Notes:

1. The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price \$3.00
(or microfiche \$0.95)

Reference:

NASA CR-73397 (N71-11204),
Aircrew Oxygen System Development-
Carbon Dioxide Concentrator Subsystem
Report

2. The system has application for aircraft, spacecraft, and submarines.
3. Requests for additional information may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: TSP 72-10194

Patent status:

No patent action is contemplated by NASA.

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