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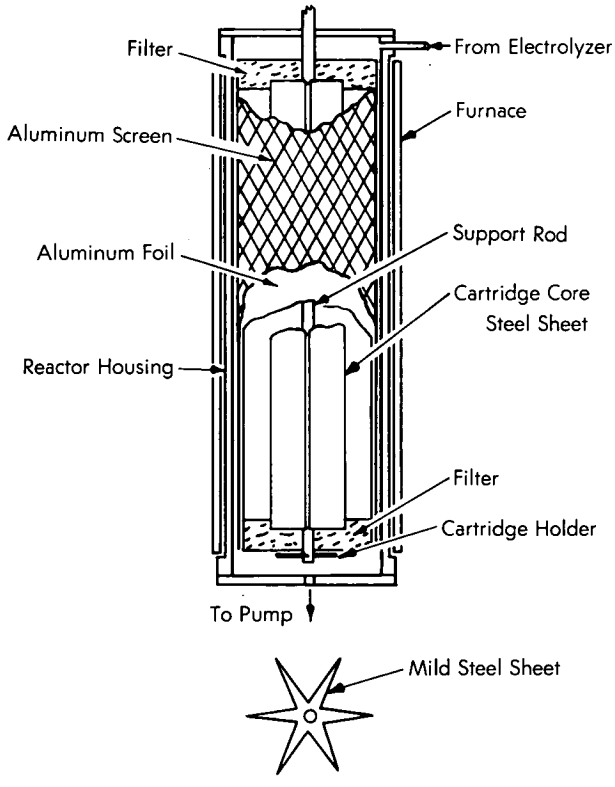
Catalytic Reactor with Disposable Cartridge

High temperature systems for the recovery of oxygen from carbon dioxide typically involve a cyclic process in which carbon dioxide is electrolyzed to form carbon monoxide and oxygen, and the carbon monoxide is disproportionated catalytically to form carbon dioxide and carbon; the net reaction is the formation of carbon and oxygen from carbon dioxide. The disproportionation step occurs optimally at 550°C in the presence of iron; ideally, the reactor in which this step takes place must contain the catalyst and provide for simple removal of deposited carbon from the system.

A novel form of catalytic reactor for the disproportionation of carbon monoxide has been developed; it consists of a disposable cartridge which encloses the iron catalyst and acts as a container for the solid carbon formed by decomposition of carbon monoxide. Deposition of carbon in other parts of the oxygen recovery system does not occur because of lack of catalytic activity; but the cartridge includes filters to trap carbon particles and prevent their being transported outside of the reaction zone.

The reactor housing may be fabricated from a 20-cm stainless steel pipe about 69 cm long; the wall thickness is reduced to 2.5 mm except for 3.8-cm lengths at each end which act as flanges for stainless steel end plates held in place by screws. The end-plate closures are rendered gas-tight by use of gold wire O-rings. The cartridge contained within the reactor housing is designed to provide a large volume for carbon deposition; it is made from a thin-walled, mild steel tube which has one end flared to aid positioning it in the reactor housing. Large, light-weight filter pads made of bulk ceramic fiber are located within each end of the tube on a central support rod; the pads are retained by suitable dimpling and tabulation of the cartridge wall. The consumable



catalyst, centered in the cartridge and held by the support rod, is 0.1-mm mild steel sheet convoluted to give a six-pointed, star-shaped cross section; it has an exposed surface area (one side only) of about

(continued overleaf)

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0.2 m^2. Because all components in the cartridge are held in place by the central support, light-weight noncatalytic materials (such as an aluminum foil–screen combination), can be used to construct the cartridge walls; the central support rod facilitates insertion and removal of the cartridge.

The active catalytic surface of iron is located substatially in the central region of the cartridge; thus, thermally insulating carbon deposits form on the catalyst surface instead of the cartridge wall. Because the walls of the cartridge are clean, thermal conduction from an outside heat source is not reduced, and so it is not necessary to increase furnace power to maintain the required reactor zone temperature as the cartridge fills with carbon.

Notes:

1. Catalytic reactors of this type might be useful in cleaning combustion gases of carbon monoxide and sulfur compounds.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP 73-10376

Patent status:

NASA has decided not to apply for a patent.

Source: Charles M. McCullough of
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