

# **„Fuel Cells - Power for Tomorrow”**

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### Table of Contents

#### I SPACE-AGE POWER PLANT 9

*"A battery with a gas tank"—as space power plants—other military and civilian uses—useful by-products.*

Detailed photos and descriptions of fuel cells in space craft, small submarines and golf carts. Also shows and describes an assembly line for small fuel cells at the Union Carbide plant. Yes, in the 1960's, fuel cells on an assembly line. Something that 99% of the fuel cell companies today have NOT accomplished or succeeded in doing.

#### II HISTORY OF THE FUEL CELL 22

*From laboratory curiosity in 1839 to space age power supply*

Groves original notes and drawings on the first fuel cell are in this section in fascinating detail that you can reproduce. Also touched on, which will fascinate many, is the electrochemistry of certain metals. Grove comments, " With my apparatus every pound of zinc consumed in a Groves Battery produces a mechanical force ( friction included) equal to a weight of 331,400 lbs being lifted to the height of 1 foot." Yes, this is true, this can be done. This is the world of electrochemistry. Something few people even know about let alone study in today's college environment. Hydrogen, fuel cells, the future of energy is ALL about electrochemistry. Detailed description and a photo of the 1932 "Bacon Cell": Francis T Bacon's fuel cell.

#### III HOW FUEL CELLS WORK 38

*The nature of electricity—electromotive series—the conventional battery—the fuel cell in action—fuel, oxidants, electrodes, electrolyte, and catalysts —toward better fuel cells*

This has one of the best descriptions of EXACTLY how a fuel cell works. It starts out explaining how a BATTERY works. A standard battery. This is what a fuel cell is, its a battery with a fuel tank. Once this is understood, the fuel cell is obvious. Remember how a battery works? It is called ELECTROCHEMISTRY. Know it, love it. In plain English written for the average person ( of 1960's) Dan explains the anodic and cathodic reactions of a fuel cell as well as the different FUELS a fuel cell can run off. It can run off the hydrogen from a metal water reaction as well as straight hydrogen and oxygen as well as MANY other fuels. Dan also covers the Oxidants you can use ( not just oxygen my friend) as well as the electrodes, electrolytes and catalysts that can be used.

#### IV THE BALANCE SHEET 61

*Efficiency; simplicity; safety—the "Silent Sentry" —waste products used as fuel—electrochemistry and the fuel cell—disadvantages*

Dan shows the efficiency possibilities of the fuel cell and compares this to other forms of energy generation. Dan also explains the formula behind how an efficiency calculation is made. It is really simple, temperature in and temperature out define its efficiency. This was developed by a man whose name many fear to mention his name because they don't want to 'confuse people' The man who gave birth to modern thermodynamics is Sadi Carnot. Fuel

cells, and indeed life itself, is all about electrochemistry AND thermodynamics. Your body is an electrochemical and thermodynamic engine just like a fuel cell.

## V THE FUEL CELL GROWS UP 73

*The "dry tape" battery—the "dissolved fuel" type—high-temperature fuel cells—regenerative fuel cells*

There are lots of words and descriptions and photos in this section of Dan's book that you will not see in current day fuel cell books. The books available today that have these subjects cost over \$200 and were written so you have to have a professor explain it for us mere mortals. In here you read about dissolved fuel - fuel cells, dry tape battery / fuel cells, high temperature fuel cells, diesel / air fuel cells, methane fuel cells and one of my favorites, the REDOX Fuel Cell. REDOX stands for Oxidation and Reduction. One of my favorite areas of chemistry. Every piece of metal or mineral around you is an example of oxidation and reduction. The REDOX fuel cell he explains and diagrams is a Tin and Bromine fuel cell. It DOES use hydrogen and oxygen but Tin and Bromine are the reactants. This concept GREATLY expands the 'gas tank' ability for the "battery" In a REDOX fuel cell, you can have tanks full of reactants and do not need hydrogen or oxygen. You need hydrogen and/or oxygen LATER to regenerate what was combined and make by the fuel cell back into its original components. Also covered are regenerative fuel cells as well as liquid metal fuel cells, and solar fuel cells

## VI LIVING BATTERY-THE BIOCHEMICAL FUEL CELL 87

*The human body as a fuel cell—the biobattery the marine biocell—bacterial fuel cells—power from waste material*

In this chapter you see the basics and the diagrams of how to make a biobattery and you see photos of biobatteries running a small light bulb as well as powering a radio. yes, this is real, you CAN do this as well. Yeast, sugar and water and a whole other variety of substances can be used. I can almost any 'student' doing a science fair will win first prize if they do this experiment.

## VII FUEL CELLS IN SPACE 100

*The need for a lightweight, dependable power source—enter the fledgling fuel cell—a perfect score—Gemini . . . Apollo . . . and beyond*

Millions of dollars of NASA's work on the Gemini and Apollo fuel cells are illustrated and explained for you to learn from in this chapter. Complete operation diagrams and photos.

## VIII OTHER JOBS FOR FUEL CELLS 117

*The thirty-six-dollar power plant—in tractor . . . lift truck . . . golf cart—the one-man submarine—power for industry—the fuel-cell automobile*

## IX HOW TO MAKE A DEMONSTRATION FUEL CELL 130

*Safety rules—principles of operation—materials needed—assembly—operation*

COMPLETE instructions on how to make a METHANOL fuel cells (MFC) Methanol is available from the auto supply store.HEET Gasoline treatment is 99% methanol. This fuel cell runs on METHANOL and AIR. That's it. If you REALLY want to understand a fuel cell

more..this is the chapter for you and YES... if you want to... and wanted to learn a little more... you could scale this up to make a much larger fuel cell.

X THE FUEL CELL TOMORROW 144

*World-wide interest—the increasing need—our dwindling resources—the hazards of smog—the carbon dioxide heat trap—promise for the future*