An Update of the JPL Program to Develop Li-$SOCl_2$ Cells

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JPL has been involved in a lithium thionyl chloride cell development program as I have indicated in the previous paper. It's goals are given in the first viewgraph.

Figure 1

These include 300 Wh/Kg at a 2+hour discharge rate, safely operated, with a five year storage life and a process that is well documented and controlled. This has been our goal. In this paper we will show you some of the results achieved to date.

Figure 2

We include the typical energy/power curves that one has seen before to show why lithium thionyl chloride is important to us and why we think we can meet the requirements.

Figure 3

This shows some of the applications that we are considering for space transportation, system for launch vehicles, orbiting transfer vehicles and planetary spacecraft.

Figure 4

Additional applications are given in this next viewgraph. Specific ones include the Manned Manuvering Unit (MMU), portable instruments, tools, lighting and switching among others. These are all probable applications in shuttle and space station. The main purpose in presenting this paper is to inform you of the status of the JPL Electrochemical program.

Figure 5 & 6

We are pleased to announce that we have met the goal of producing a Li-$SOCl_2$ spiral wound "D" cell. We refer to it as a First Generation Cell. Photos of the JPL lithium thionyl chloride cell are shown. We had target a goal of producing first generation cells by October 1984. We have met that goal. The cell design and electrodes, particularly the carbon cathodes were produced in-house. Also all parts were assembled, the welding performed, the electrolyte added and the cells sealed in-house.

The lithium capacity (theoretical) was 19.3 ah and that of the $SOCl_2$ in the 1.8 m $LiAlCl_4$ electrolyte, 16.4 ah (we are convinced that a greater excess of $SOCl_2$ is necessary for safe high rate operation). The electrode surface area was 452 cm^2. The carbon electrode comprised Shawinigen Black/Teflon -30 (90/10 by weight) mixture 0.020 inches thick on an expanded metal screen prepared in the JPL laboratory. There were two tab connections to the cathode. The 0.0078 inch thick lithium foil was rolled into an expanded nickel screen. The separator was Mead 934-5 figerglass material.

Figure 7

The actual results are given in this figure. As you can see we have operated at 2 amps (C/50), 1 amp (C/10), and 5 amps (C/2). The voltage curves are flat and we achieved, as you see, almost 12 amp hour at the C/50 rate over 10 amp hours at the C/10 rate, and at 5 amps (C/2) we have achieved 9 plus ampere hours. We are very pleased with these results.

Figure 8

E-I measurements were performed at 100% state-of-charge, 50% state-of-charge, and 10% state-of-charge. The power numbers are quite high, much to our pleasant surprise.

Figure 9

This is the power curve for these cells measured at different states of charge. The maximum was 48 watts at the 2C rate which is rather significant. You notice there was still almost 30 watts of power even at 90% depth-of-discharge. Another rather significant finding.

Figure 10

In summary we produced our first lithium thionyl chloride cylindrical "D" cells. The initial test results show that we were able to get up to 350 Wh/Kg at the 50 hour rate, almost 300 at the 10 hour rate, and 247 at the 2 hour rate. The power capability was 48 watts at C/2. The program and our studies on the safety are being continued in order to optimize the use of the cells. Thank you.

Lithium Thionyl Chloride Cells and Batteries Program Objectives

DESIGN, DEVELOP, AND TRANSFER TECHNOLOGY TO INDUSTRY TO MANUFACTURE FLIGHT QUALITY LITHIUM THIONYL CHLORIDE PRIMARY CELLS AND BATTERIES

- o 300 WH/KG ENERGY DENSITY
- o 2-HOUR DISCHARGE RATE
- o SAFE OPERATION
- o 5 YEAR STORAGE LIFE
- o MANUFACTURING CONTROL DOCUMENT (IDENTIFIES MATERIALS, PROCESSES, REQUIREMENTS AND QUALITY)

Figure 1.

Power and Energy Characteristics of Primary Cells

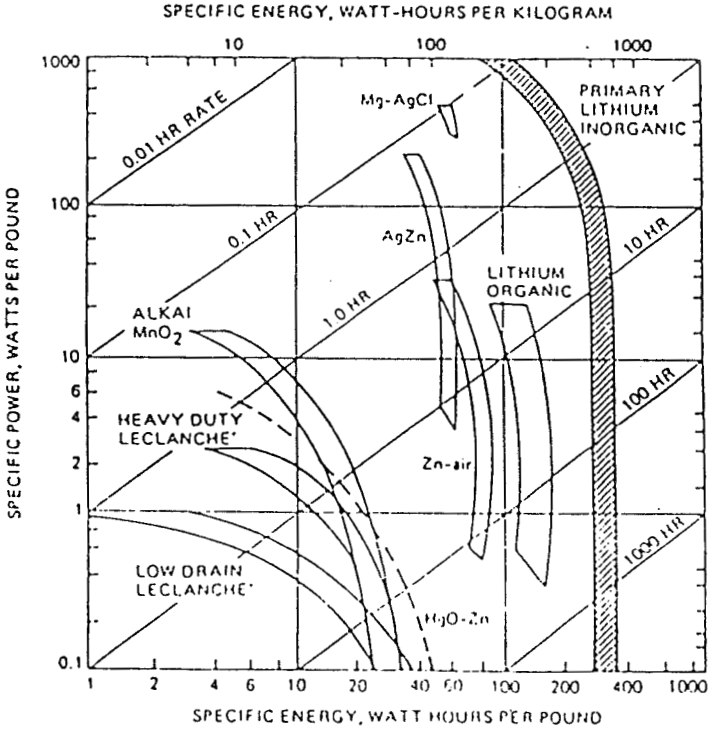

Figure 2.

Lithium Thionyl Chloride Battery Applications

- SPACE TRANSPORTATION SYSTEM (STS)
  - LIFE SUPPORT AND PROPULSION FOR ASTRONAUTS EVA
  - PORTABLE RADIOS, CAMERAS, LIGHTS, TOOLS ETC
  - DEPLOYABLE INSTRUMENTS
- LAUNCH VEHICLES
  - LOCATION AID FOR SOLID ROCKET BOOSTERS (SRB)
  - RANGE SAFETY FOR (SRB)
- ORBIT TRANSFER VEHICLES
  - POWER FOR GYROS, AVIONICS, THERMAL CONTROL, GUIDANCE, TELEMETRY, AND PROPELLENT MOTORS
- PLANETRY SPACECRAFT
  - PRIMARY POWER FOR PROBES AND LANDERS
  - PEAK POWER REQUIREMENTS FOR SPACECRAFT

Figure 3.

Lithium Thionyl Chloride Cells Applications

- MMU/EMU
- PORTABLE INSTRUMENTS
- TOOLS
- LIGHTING
- SWITCHING
- CAMERAS
- RADIO/COMMUNICATIONS EQUIPMENT
- STANDBY POWER
- STAND ALONE POWER
- DEPLOYABLE INSTRUMENTS

Figure 4.

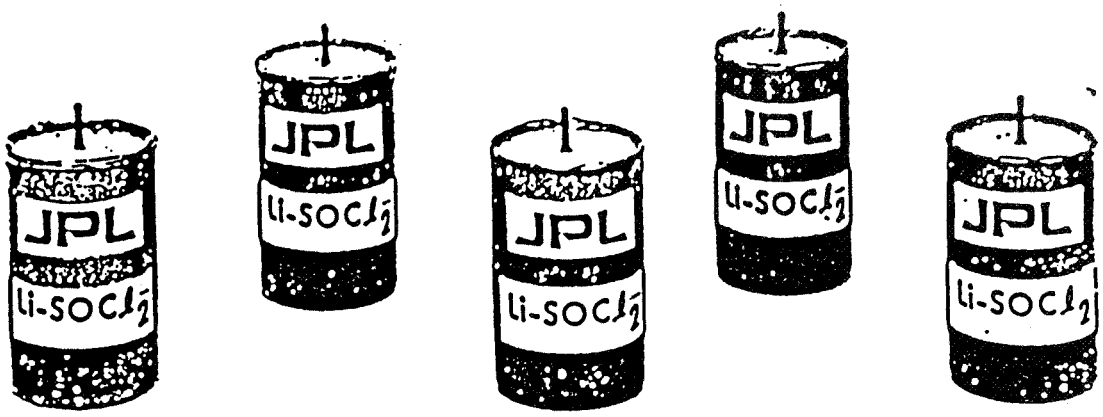

Figure 5

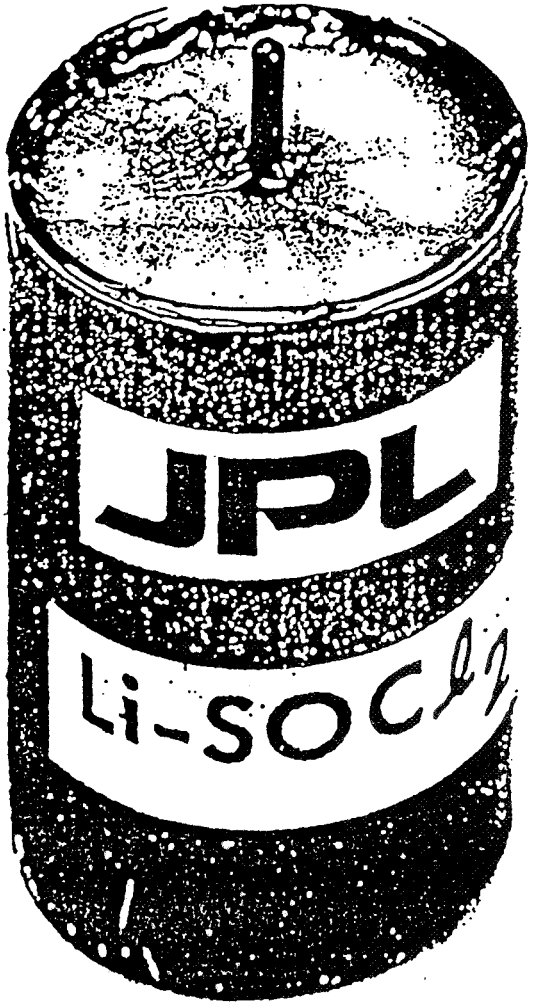

Figure 6

First Generation D-Cells: Constant Current Discharge Characteristics

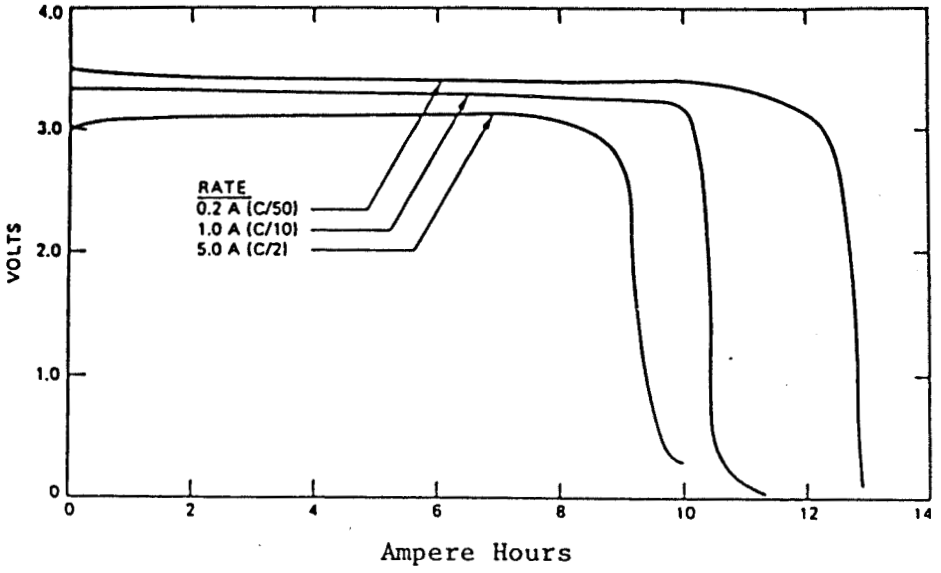

Figure 7.

First Generation D-Cells: Effect of State of Charge on Voltage-Current Characteristics

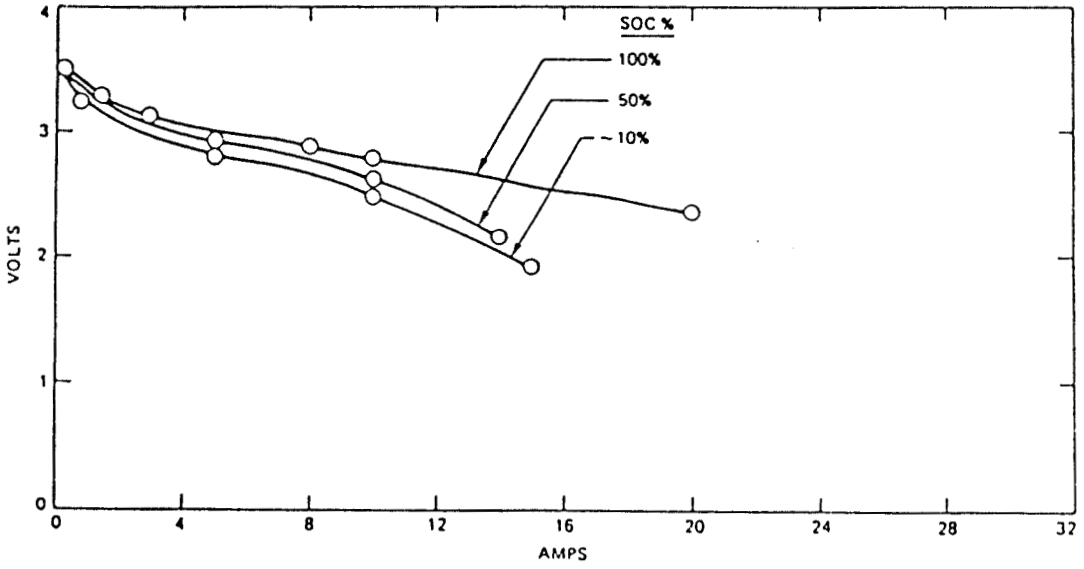

Figure 8.

First Generation D-Cells: Power Output Characteristics

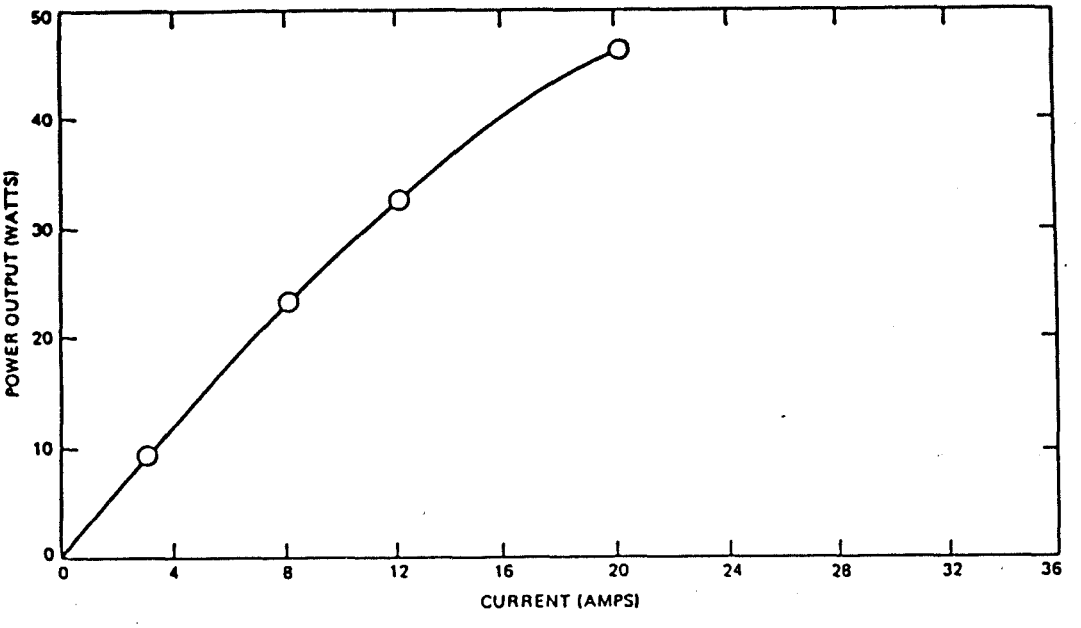

Figure 9.

Summary

- o FIRST GENERATION $Li-SOCl_2$ "D" CELLS ASSEMBLED
- o INITIAL TEST RESULTS - INDICATE TARGETS ARE WITHIN REACH

  12.6 AH AT C/50 = 350 WH/Kg
  10.4 AH AT C/10 = 299 WH/Kg
  9.2 AH AT C/2 = 247 WH/Kg

- o POWER CAPABILITY HIGHER THAN ANTICIPATED
  48 WATTS AT 2C RATE

- o DEVELOPMENT CONTINUING WITH SAFETY THE PRIMARY GOAL

Figure 10.