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4.5 INCH DIAMETER IPV NICKEL-HYDROGEN CELL DEVELOPMENT PROGRAM

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Summary

Interest in larger capacity $Ni-H_2$ battery cells for space applications has resulted in the initiation of a development/qualification/production program. Cell component design has been completed and component hardware fabricated and/or delivered. Finished cell design projections demonstrate favorable specific energies in the range 70 - 75 W h kg^{-1}(32 - 34 W h Lb^{-1}) for capacities of 100 - 250 A h. It is further planned during this effort to evaluate the advanced cell design technology which has evolved from the work conducted at the NASA/Lewis Research Center

Background

Cell pressure vessels (PV) of 8.89 cm (3.50 in.) dia. have successfully accommodated cell capacities ranging from 30 - 90 A h. Further growth in PV length imposes certain design and fabrication technology problems, therefore PVs of approximately 11.43 cm (4.50 in.) dia. are of interest because similar diameter-to-length relationships are maintained while accommodating larger cell capacities.

Cell designs

Figure 1 displays two PV designs to be evaluated under this program. They are primarily distinguished by the method used to effect the vessel girth or joining weld.

The design on the left accommodates an electron beam (EB) welding process. The vessel is of thin-walled, uniform construction, and the weld ring (not machined in this view) design facilitates the necessary back-supported, vessel "butt" joint. This concept is often referred to as the "Intelsat" PV design.

The design on the right accommodates an automatic, tungsten-inert-gas (TIG) welding process. The vessel is of thin-walled, multiple thickness (chem-

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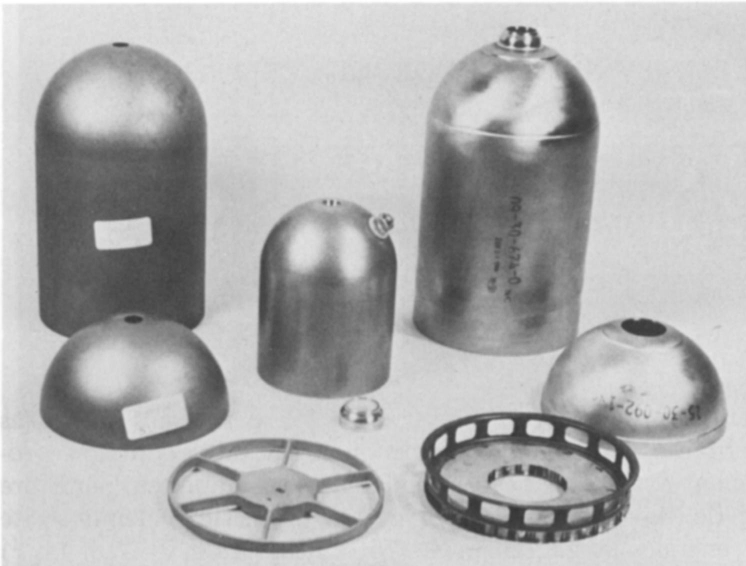

Fig 1 Photograph showing the two PV designs evaluated Left, an electron beam welded design, right, a tungsten–inert-gas welded design, centre, internal 45° offset terminal arrangement (3 5 in cell)

milled) construction and the weld ring design facilitates an unsupported, vessel "butt" joint This concept is often referred to as the "Air Force" PV design

Production designs will accommodate either "compression seal" (Intelsat) or "hydraulic seal" (Air Force) terminal assemblies. In addition, both external/internal terminal mounting either axial or 45° off-set will be accommodated. An internal, 45° off-set terminal arrangement (3.5 in cell) is shown in the center of Fig. 1

Projected cell characteristics

The characteristics or design features for four cell capacities (100, 200, 220 and 300 A h) have been projected with very favorable results. The design features for a 100 A h cell are presented in Table 1. It is noted that several listed parameters are independent of cell capacity. In Table 2 only the parameters which change are summarized for all four cell capacities. A review of these data reveal an inverse relationship between cell specific energy and cell capacity (see graph in Fig 2). This unusual relationship is primarily attributed to accelerated current conductor, cross-section growth with increased cell length.

TABLE 1

100 A h 4.5 in dia. Ni–H_2 cell design features

Nominal capacity (to 1 00 V)	109 A h
Diameter	11 76 cm (4 63 in)
Length	18 29 cm (7.20 in)
Operating pressure	61 atm (900 psi)
Safety factor	2 5 1
Terminals	Internal, 45° off-set
Mass	1783 g (3 92 lb)
Specific energy	74 6 W h kg^{-1} (33.9 W h lb^{-1})

TABLE 2

4 5 in dia Ni–H_2 cell design features

	Ampere hours			
	100	200	220	300
Features				
Nominal capacity (A h)	109	218	243	333
Length (cm)	18 29	32 26	35 81	46 99
Mass (g)	1783	3676	4164	6055
Spec en. (W h kg^{-1})	74.6	72 4	71 2	67 1
Common features				
Diameter	11 76 cm (4 63 in)			
Operating pressure	61 atm (900 psi)			
Safety factor	2 5 1			
Terminals	Internal, 45° off-set			

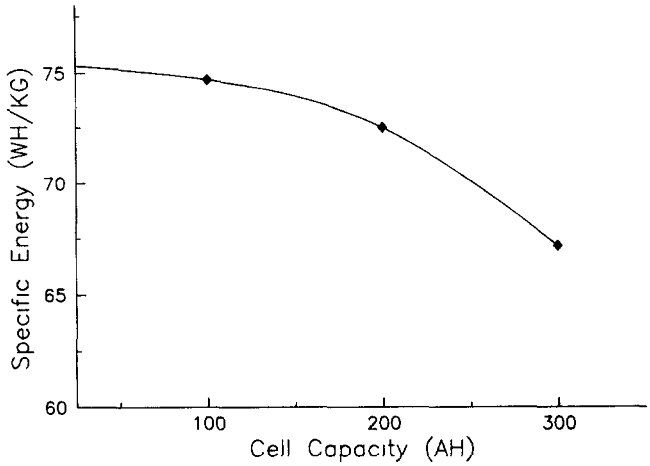

Fig 2 Relationship between cell specific energy and cell capacity for a 4 5 in dia Ni–H_2 cell design

Advanced cell design technology

Advanced $Ni–H_2$ cell design technology has been reported by researchers at the NASA/Lewis Research Center. Technical details were most recently presented at the 1984 GSFC Battery Workshop [1] and the 20th Intersociety Energy Conversion Engineering Conference [2].

Portions of this technology will be evaluated under this program to assess their potential benefit The enhanced thermal/oxygen/electrolyte management characteristics offered by the catalyzed wall wick/reservoir concept may be well suited to the larger diameter cell configuration, particularly in LEO applications Each of these parameters becomes more difficult to manage as cell cross-section increases

Conclusion

A development/qualification/production program is proceeding on schedule to introduce 4 5 in. dia. $Ni–H_2$ cell technology. Production tooling has been completed and cell hardware fabricated or delivered. Cell assembly will soon be initiated for design qualification and user industry evaluation.

Large capacity $Ni–H_2$ cells (100 - 250 A h) exhibiting specific energies of 70 - 75 W h kg^{-1} (32 - 34 W h Lb^{-1}) and offering improved operational characteristics will be available for the most demanding space missions on a near term basis.

References

1 L H Thaller, Nickel–hydrogen technology, *1984 Goddard Space Flight Center Battery Workshop, Publication 2382*, Greenbelt, MD, Nov , 1984
2 L H Thaller *et al* , Design principles for nickel–hydrogen cells and batteries, *Proc 20th Intersoc Energy Conv Eng Conf , SAE P-164*, Miami Beach, FL, Aug , 1985