

# HYBRID AGM / GEL BATTERY TECHNOLOGY

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# Goals- Hybrid/advanced Gel

- Combine best attributes of each technology
- Gel has more thermal stability and more cycles but decreased capacity
- AGM has good capacity and very good high rate capacity but can dry out
- Hybrid Advanced Gel has good cycles and capacity and good thermal stability and resistance to dry out.

# BROADBAND HISTORY

## MCG-Series

- 2000 – Began development of the Advanced Gel Technology
  - Frank Vaccaro headed the development team of Power Battery engineers in collaboration with former Bell Lab scientist Dr. Tom O’Sullivan
- 2004 – Introduction of the Advanced Gel Technology Battery for Broadband
  - The MCG – Series
  - Patent pending



**Frank Vaccaro**

# Charging Characteristics of Advanced Hybrid Gel

- Advanced Gel has same acid concentration as AGM and can be charged as standard.
- Temperature compensation of float voltage should be employed, 1.5 to 3mV / C values are preferred to help enhance life at high T.
- Cold climates require higher float voltages.
- Simple float charging is to be preferred.

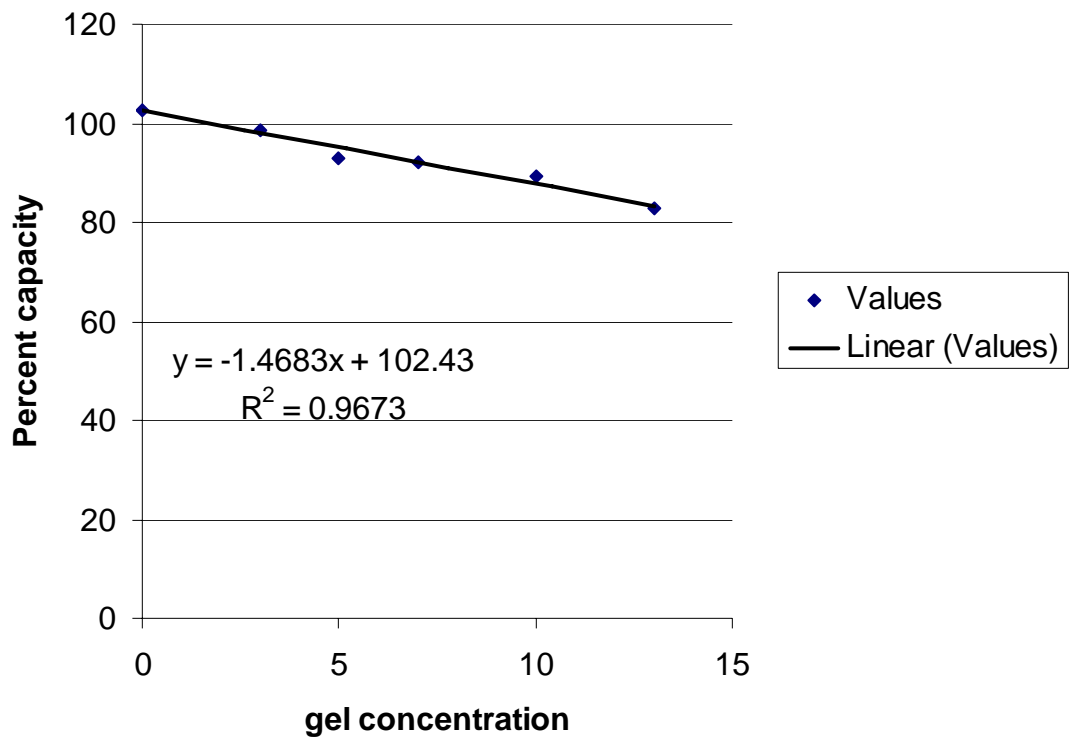
# Battery Life Expectancy

- Advanced Gel has advantage for dry-out
- Extra water provides extra life
- Oxygen recombination should be similar-  
difficult to measure-voltages indicate gel  
has lower positive polarization
- Corrosion and growth should be lower and  
extra electrolyte increases float life.

# Effect of Percent Gel on Capacity

- Advanced Gel permeates active materials—  
”dilutes acid”
- Capacity should decline as gel % increases
- Straight line equation has slope of 1.5%  
Cap/% Gel.
- 5 % gel loses 7% , 10 % loses 15%.
- Restrict percentage gel to maintain capacity.

### capacity and gel concentration



# Heat Capacity of VRLA Batteries

- POS paste-270J/K kg---2200
- NEG paste, grids-128J/K kg---3300
- Polypropylene-2100J/K kg---4500
- Separator-800J/K kg---600
- Sulfuric acid(1.300)-2900J/K kg---19000.
- GEL increases heat capacity-10,20 or 30 %
- Thermal mass of VRLA increases.

# Thermal Advantages of Advanced Hybrid Gel Battery

- Outdoor Applications fluctuate in Temperature seasonally and daily
- Arrhenius equation shows that higher temperatures are more harmful than colder ones are beneficial—12 hrs @35 and 12 hrs @ 15C are 45% more harmful than 24h@25
- Higher heat capacity lessens excursions—18-32C provides 22% increase not 45%.

# Temperature Coefficient of Capacity

- Advanced Gel has slightly lower coefficient than AGM
- Flooded Batteries have about twice the variation of VRLA or Advanced Gel
- Advanced Gel batteries can be smaller than flooded or AGM in cold climates—extra electrolyte helps freezing problems.

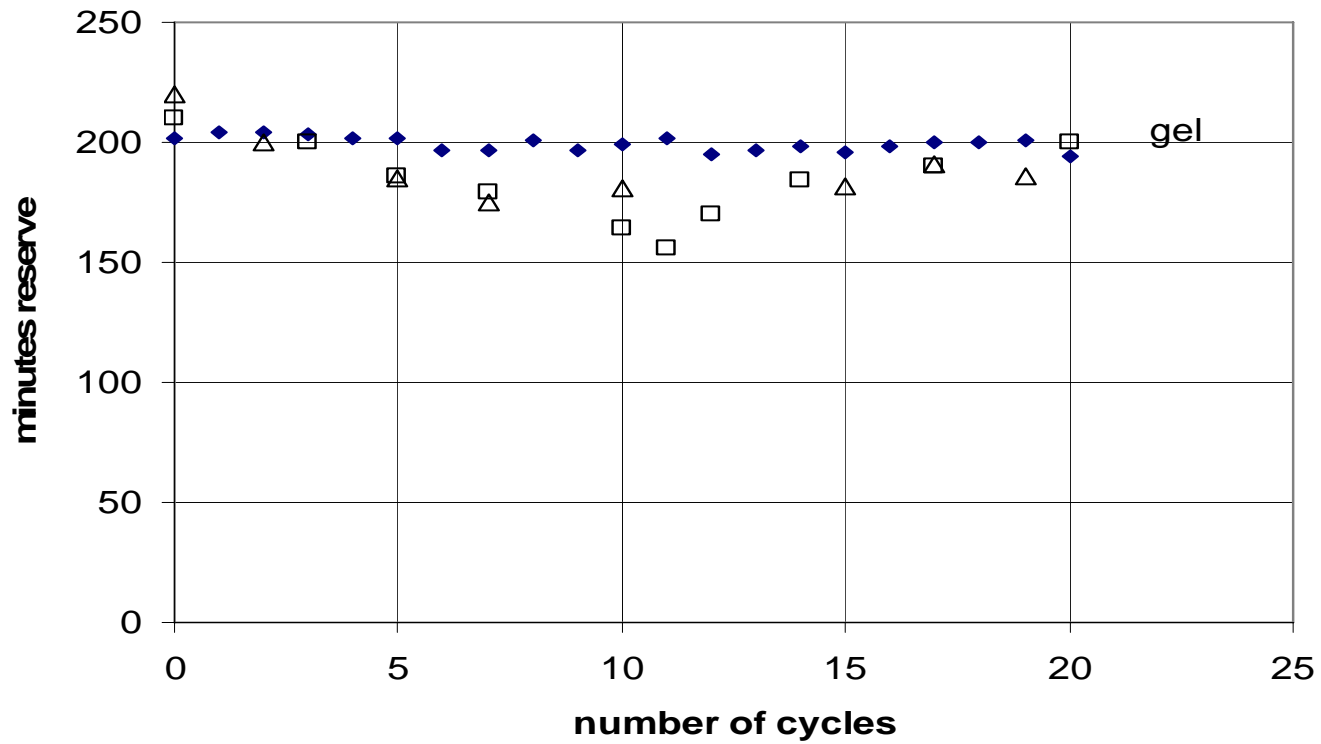
# Colloidal Silica Gelling Times

- Colloidal silica is available in several particle sizes (4-20 nanometers—40 Å)
- Particle size and concentration determine gelling times in acids at temperatures.
- Gel hardness depends on concentration—but higher also gels faster.
- Advanced Gel has selected material that gels very slowly—at end of formation.
- Additional quick gelling layers may also be used.

# Cyclic Advantages of Advanced Hybrid Gel Battery

- Slow gelling allows diffusion throughout
- Gel forms inside pores of  $\text{PbO}_2$  and Pb
- Gel forms throughout glass mat separator
- Gel behaves as very fine separator ( $.1\mu$ ) and minimizes stratification.
- Advanced Gel has been successfully applied in wheelchairs. Solar is new application.

**Capacity(minutes reserve) and cycles**  
**open ---AGM**  
**Closed---Gel**



# Second Gel Layer Parameters

- Second gel layer adds extra water
- S-Gel will surround cell core--conduct heat
- S-Gel will increase heat capacity of battery.
- S-Gel will crack- facilitating recombination
- Second gel is more concentrated-gels faster
- Second Gel components addition can be final manufacturing step.