Valve Regulated Lead Acid Battery

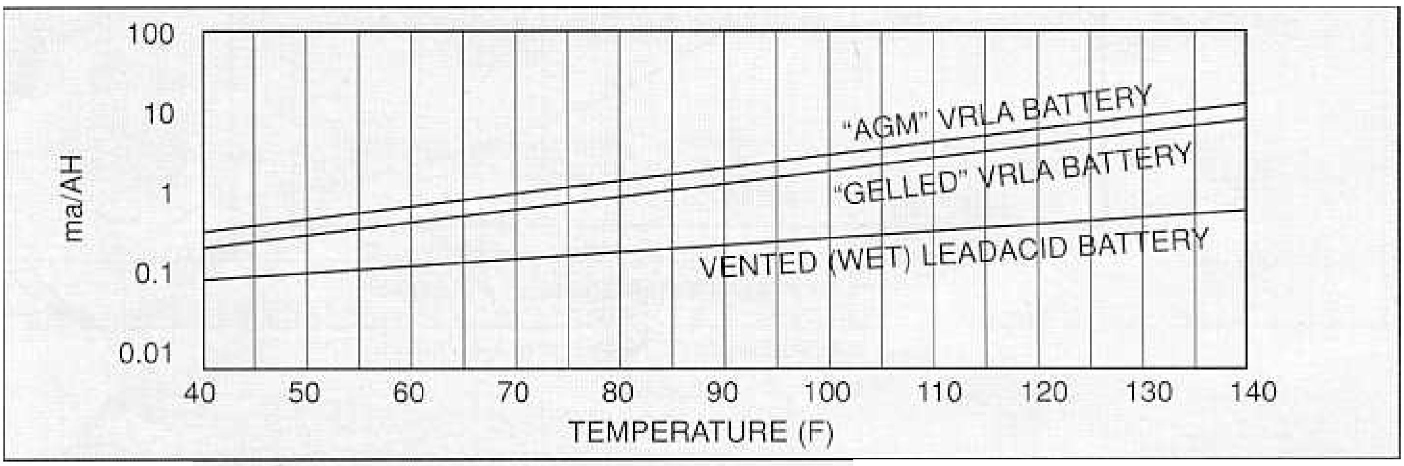
Life Expectancy and Temperature

VRLA BATTERY TYPICAL FAILURE MODE AND TEMPERATURE AFFECT

We would like to think the VRLA battery would have an infinite life — especially if it is not being "used" (cycled) and only remains on continuous charge being maintained for eventual use. However, this is not the case.

The typical VRLA battery will eventually decline in capacity and fail due to grid corrosion and drying of the electrolyte as a result of continuous overcharge. Everything else being equal, this will occur as a result of the design of the battery including plate grid thickness, oxygen recombination cycle efficiency and the quantity of reserve electrolyte. Since the grid corrosion and electrolyte drying are a direct function of the float current, it is important to control the float current to that required to maintain the cell fully charged while minimizing overcharge due to excess float current.

The VRLA batteries are rated at 77˚ F with respect to performance, life and recommended charging voltages. The gelled electrolyte and AGM VRLA batteries with an electrolyte specific gravity of 1.280 to 1.300 are typically charged at 2.25 to 2.30 volts per cell @ 77˚ F with the resulting current acceptance as noted in Figure 1. Note that



Float Current VS. Temperature at 2.3 V/C Charging Voltage
Figure 1

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as the temperature of the battery is increased, the current acceptance at the constant voltage increases – almost doubling for each 15° F increase. The life of the battery is determined by the total cumulative ampere-hours of overcharge. This increased float current at elevated temperature accelerates the accumulation of ampere-hours of overcharge. It has a significant impact on the grid corrosion rate and the gassing rate, and consequently the life of the battery. The affect can be somewhat reduced through the use of a temperature compensated charger, which reduces the charging voltage at elevated temperatures, but it cannot be entirely eliminated.

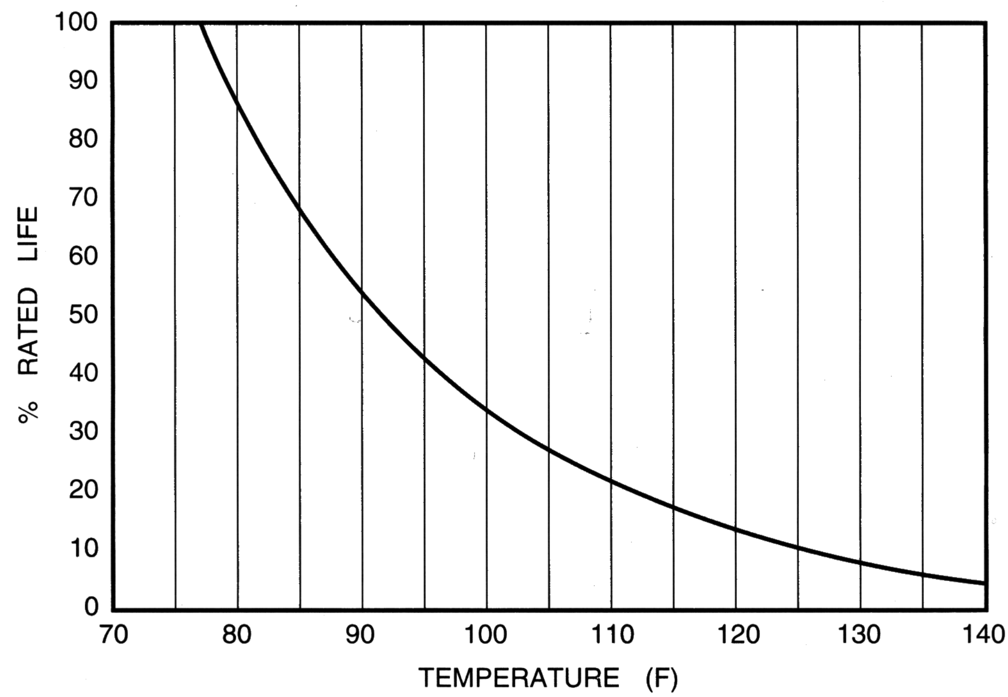
Elevated operating temperature is one of the most frequent causes of not attaining the design life of a VRLA battery.

Figure 2 illustrates the impact of elevated temperature operation on the life of the typical VRLA battery. Note that a constant float charging voltage, for each 15° F increase in the battery operating temperature, the battery will experience a 50% loss in life (e.g., a battery designed for a 10 year life will provide only 5 years to 80% rated capacity).

CALCULATING EXPECTED LIFE AT ELEVATED TEMPERATURE

To determine the expected life of a VRLA battery operating at a constant elevated temperature, the calculation is:

Actual life expected (L_A) = derating factor at operating temperature (D_T) x design life (L_D)



Lead Acid Battery % Life (D_T) VS. Temperature

Figure 2

For example, a battery with a 10 year design life (L_D) operating at 85° F would have an actual life (L_A) of 6.9 years (6.9 years = 69% x 10 years).

When the battery is operated at a constant non-temperature compensated voltage and in an uncontrolled environment, for example when the ambient temperature varies with the seasons, the expected life can be calculated considering the cumulative affect of each of the average operating temperatures and the time for which it exists during the year.

The actual life (L_A) to be obtained would be calculated as follows:

$$L_A \text{ (years)} = \frac{L_D \text{ (months)}}{\frac{\text{Time @ T1}}{DT_1} + \frac{\text{Time @ T2}}{DT_2} + \frac{\text{Time @ T3}}{DT_3} + \frac{\text{Time @ T4}}{DT_4}}$$

The following is an example of the calculation of the actual life (L_A) of a battery operated under elevated temperature conditions that had a design life (L_D) of 10 years at 77° F.

	F Temperature	Months	% Life @ Temp.
Operating Conditions:	77	1	100
	80	2	89
	85	4	69
	95	5	43

$$L_A = \frac{120 \text{ months}}{\frac{1 \text{ month}}{1.00} + \frac{2 \text{ months}}{0.89} + \frac{4 \text{ months}}{0.69} + \frac{5 \text{ months}}{0.43}}$$

$$L_A = \frac{120 \text{ months}}{1 \text{ month} + 2.25 \text{ months} + 5.8 \text{ months} + 11.63 \text{ months}}$$

$$L_A = 5.8 \text{ years}$$

As can be seen, the affect of elevated temperature upon the life of the battery is dramatic and the desirability of a temperature compensated charger and/or cooler environment is evident.

RECOMMENDATIONS FOR ELEVATED TEMPERATURE OPERATION

When operation of VRLA batteries is anticipated in an elevated temperature environment the following recommendation should be followed to minimize the affects:

1. Use temperature compensated charging techniques.
2. Protect batteries from direct heat sources.
3. Install batteries with 1/2″ or greater spacing to allow for free air circulation.
4. Incorporate effective active or passive ventilation of the enclosure.
5. Increase the frequency of periodic maintenance and capacity testing activities.