Valve Regulated Lead Acid Battery

Dynasty VRLA Batteries and Their Application

The valve regulated lead acid (VRLA) battery utilizes a dilute sulfuric acid electrolyte which is immobilized so as to eliminate the hazards of spills and leakage and which facilitates an oxygen recombination cycle. The oxygen recombination cycle eliminates the need to add water throughout the battery's life and improves its safety of operation. The VRLA battery also contains a self resealing pressure relief valve which prevents buildup of excessive pressure in the cell and prevents entry of outside air into the cell, thus extending the battery's shelf life.

Due to these advantages of no electrolyte spillage or maintenance, minimal gas evolution, extended shelf life and improved safety, the VRLA battery has been selected for a host of critical power applications and is rapidly displacing the traditional vented or wet lead acid cell.

As with most products, no single design meets the needs of all applications. With this in mind, C&D Technologies has designed and manufactured three types of VRLA batteries to provide optimum performance in a variety of standard as well as unique applications. The VRLA battery technologies available through C&D Technologies include the AGM (absorbed glass mat) and two types of the gelled electrolyte designs.

While the AGM and gelled electrolyte battery designs share many of the same components, such as containers, pressure relief valves and plates, they have different separator systems and electrolyte immobilization systems which result in significantly different high rate performance, heat dissipation and cycle life characteristics. As a result, the technology which best meets the requirements of the application can be selected from C&D Technologies.

AGM VRLA Battery Construction

As shown in Figure 1, the AGM VRLA battery utilizes a separator of glass fibers which serves to both isolate the negative and positive plates and act as a blotter to absorb all the electrolyte within the cell. This AGM separator is somewhat fragile, highly porous and absorbent, and of very low resistance. The AGM separator is maintained under compression between the plates to assure complete contact with the plates surface since it provides the source of electrolyte essential to the cell's electrochemical reaction. Actually the separator is not completely saturated with electrolyte and it is the 5 to 10% void space that allows the oxygen gas generated at the positive plate to diffuse to the negative plate where the oxygen recombination cycle occurs. This system is also occasionally referred to as a starved electrolyte system in that there is more plate active material than what the limited amount of electrolyte can fully react.

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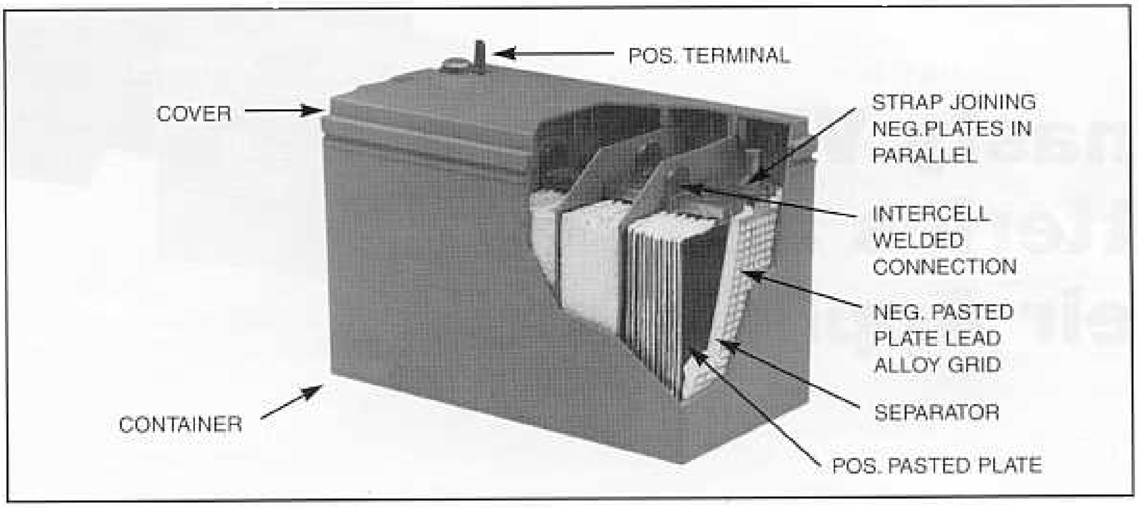
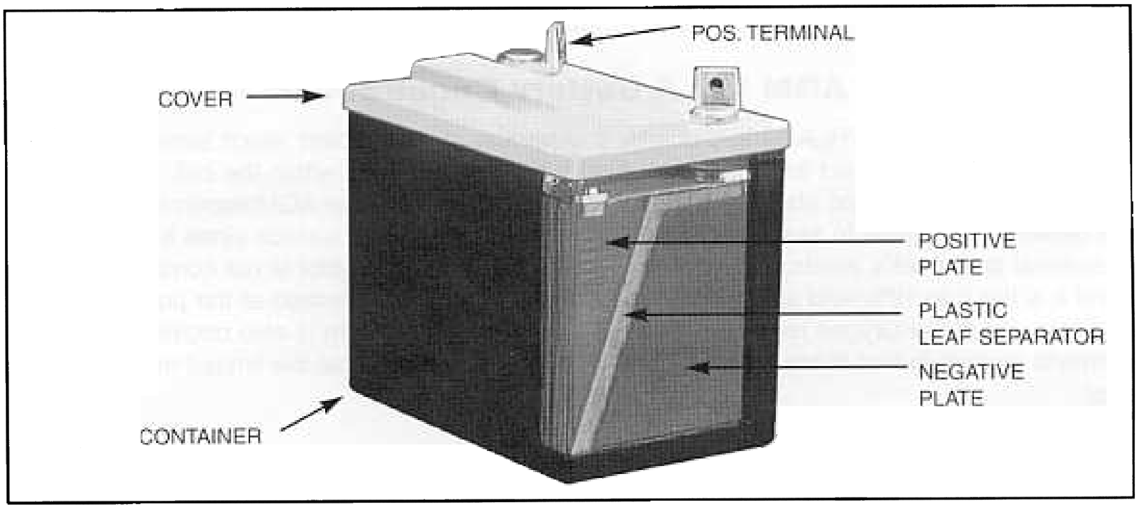


AGM VRLA Battery Construction
Figure 1

Gelled Electrolyte VRLA Battery Construction

The gelled electrolyte VRLA battery, as shown in Figure 2, utilizes a robust plastic or glass leaf separator. This leaf separator is not relied upon to absorb the electrolyte, since the electrolyte is gelled, but strictly performs the function of separating and resisting the development of shorts between the plates. In some designs, the leaf separator contains an integral glass mat retainer which lies against the positive plate active material and "retains" sloughed material and consequently improves the cell's cycle life. This durable leaf separator and the gelled electrolyte are of relatively high resistance and introduce additional voltage drop during high rate discharge. The cell is completely filled to the top of the plates with the gelled electrolyte. However, there are cracks and fissures in the gel between the plates that allow for the transport of the oxygen from the positive to the negative plate allowing for the oxygen recombination cycle.



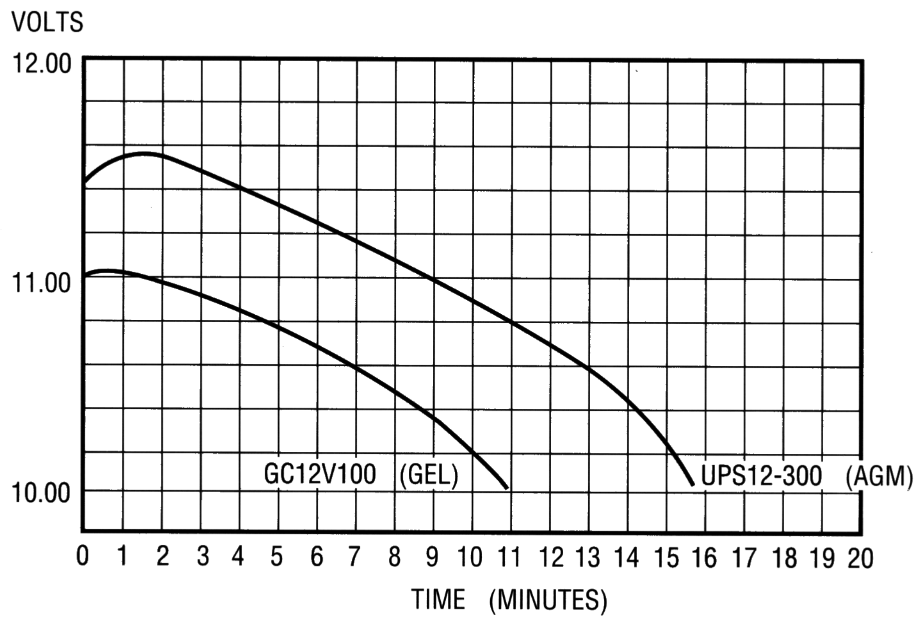
Gelled Electrolyte VRLA Battery Construction
Figure 2

VRLA Battery Capacity and Performance Characteristics

The AGM VRLA battery typically contains more electrolyte and is of slightly higher specific gravity than the comparable gelled electrolyte battery (a percentage of the electrolyte is actually displaced by the gelling agent). Consequently it will provide slightly more (approximately 7 to 10%) long duration capacity within the same container volume.

Perhaps more importantly, due to the very low resistance of the AGM system, it exhibits much less internal voltage drop (IR drop) during discharge, resulting in higher terminal voltage and longer run times at high discharge rates. This is illustrated in Figure 3 where the AGM and gelled systems are discharged at the same rate and the run times are compared. The AGM VRLA battery provides approximately 40% more operating time at the 10 to 20 minute discharge rates.

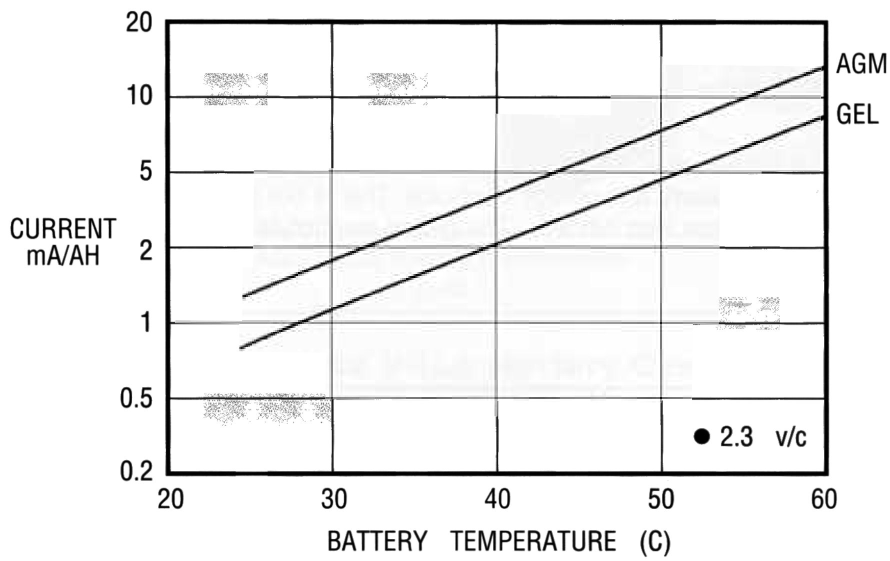
Obviously where high rate performance is the criteria, such as with uninterruptable power systems (UPS), the AGM VRLA battery would be the battery technology of choice. This is not to say the gelled electrolyte VRLA batteries cannot be used; they are just less efficient. The gelled electrolyte model might be preferred based on additional criteria.



AGM vs. Gelled Electrolyte High Rate Performance
Figure 3

VRLA Batteries and Elevated Temperature Characteristics

The AGM VRLA battery has a slightly more efficient oxygen recombination cycle and a lower resistance than the gelled electrolyte VRLA battery. As a result it will draw slightly more float current resulting in greater internal heat generation. This is shown in Figure 4 where the AGM battery draws approximately 50% more float current than the gelled electrolyte battery. Note how the float current is affected by temperature, increasing with increasing temperature. Naturally, as the float current increases, the rate of internal heat generation also increases. This has a greater impact with the AGM battery since the heating effect is proportional to the square of the current.



VRLA Battery Float Current vs. Temperature
Figure 4

To prevent premature failure and possibly catastrophic thermal runaway, it is important to operate the VRLA battery in an environment in which it can dissipate heat at a rate faster than it is internally generated. This can be accomplished by operation in a cool environment and allowing separation (0.5″ recommended) between the batteries to facilitate air flow and improved heat dissipation and/or by reducing the charging voltage and resulting float current at elevated temperatures so as to minimize the internal generation of heat.

The gelled electrolyte battery has gel in complete contact with the plates, where the heat is generated, and the walls of the battery container where it is radiated. In contrast, the AGM battery has the heat conducting electrolyte absorbed in the separator and while in good contact with the plates, it is not in complete contact with the interior walls of the container. As a result of this construction difference, the gelled electrolyte VRLA battery provides approximately 15% better heat conduction from the plates and superior heat dissipation to the environment.

VRLA Batteries' Float Service Life Characteristics

A battery is in float service when it is continually connected to the power source and the load so as to provide instant uninterrupted power in the event of failure of the primary power source. The float service life characteristics at 77° F are essentially the same for the AGM and gelled electrolyte VRLA batteries. The AGM and Type A gelled electrolyte batteries will both provide 95 to 100+% rated capacity upon initial installation and charging and all other factors being equal, will provide the same float service life. It is not the electrolyte immobilization technique that determines the float service life but the design of other components in the battery such as the electrolyte specific gravity, separators, plate grids and active materials.

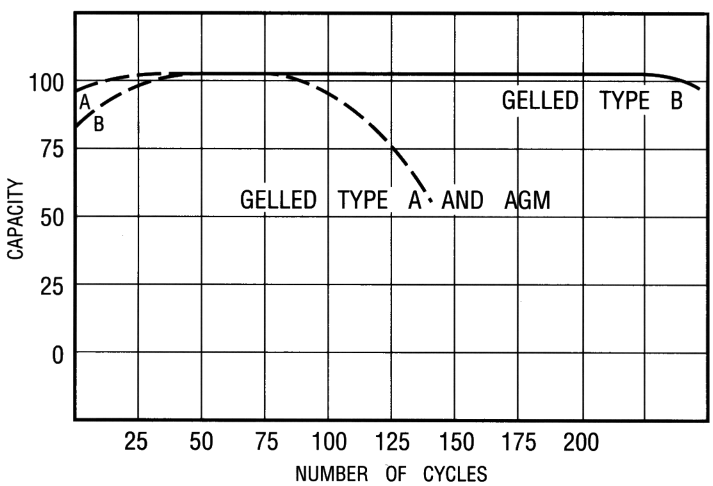
Selection of the AGM or Type A gelled electrolyte batteries for float service is determined by the high rate performance requirements vs. anticipated elevated operating temperatures.

VRLA Batteries' Cycle Service Life Characteristics

In cycle service the battery is deeply discharged as the primary power source for the application such as with wheelchairs, golf carts and photovoltaic systems. The battery is then recharged following discharge to restore its capacity for repeated use. In typical cycle service applications this cycle is repeated frequently. This repeated cycle is especially stressful on the positive plate active materials, causing them to shed from the grid. Additionally, gassing is accelerated and the grids of the positive plates suffer accelerated corrosion due to the degree of overcharge normally experienced with the higher voltage "cycle service" charging.

While the AGM and Type A gelled electrolyte batteries will provide good cycle service, the Type B gelled electrolyte battery is designed specifically to provide the longest service life in deep cycle applications. To extend the cycle life the Type B gelled electrolyte system utilizes special separators with glass mat retainers to secure the positive active material in place and a unique addition of phosphoric acid to the electrolyte. The effect of the phosphoric acid is to strengthen the positive active material, thus making it more capable of enduring the stresses of deep cycling and minimizing paste shedding. As shown in Figure 5, the net result is that a Type B gelled electrolyte battery can provide approximately double the cycle life as that provided by the Type A gelled electrolyte VRLA batteries.

However, the phosphoric acid does have the negative effect of reducing the initial capacity of the battery to approximately 90% of that provided by the Type A version and requiring up to 20 cycles or a year on float to attain the full rated capacity.



Type A vs. Type B Gelled Electrolyte VRLA Battery Cycle Life Comparison
Figure 5

VRLA Battery Applications

No one design of VRLA battery is optimum for all the various types of applications. The type of electrolyte and its specific gravity and separator systems as well as the electrolyte immobilization technique utilized greatly determine the battery's suitability to provide maximum power density, superior high rate performance, extended life at elevated temperatures and extended cycle life. Each application must be studied individually with respect to its unique requirements and an optimum choice made. Once the choice is made, it must still be remembered that the VRLA battery, while having an oxygen recombination efficiency of up to 99%, will still generate some gas during over-charge conditions and should not be charged in a sealed container.

The following table, while not all-inclusive, will provide guidance as to the recommended technology for typical applications as noted and others which are similar.

	AGM	"A" Gel	"B" Gel
Float Service – normal temperatures			
UPS Systems	X		
EPBX Systems	X		
Security Systems	X		
Emergency Lighting Systems	X		
Radio Comm. Systems	X		
Engine Starting	X		
Frequently Cycled Equipment	*		X
Float Service – elevated temperatures		X	
Cycle Service			
Wheelchairs	*		X
Chair Lift	*		X
Golf Caddie	*		X
Portable Lighting	*		X
Recreational Vehicles	*		X
Trolling Motors	*		X
Photovoltaics			X
Portable Test Equipment	*		X
Portable Communications	*		X
Portable/Mobile Tools	*		X

VRLA Battery Selection and Application Guide
Table 1

X - Standard design (BBA, BBG, GC, UPS and MPS)
* - Special design (DCS)