C&D TECHNOLOGIES

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 life.

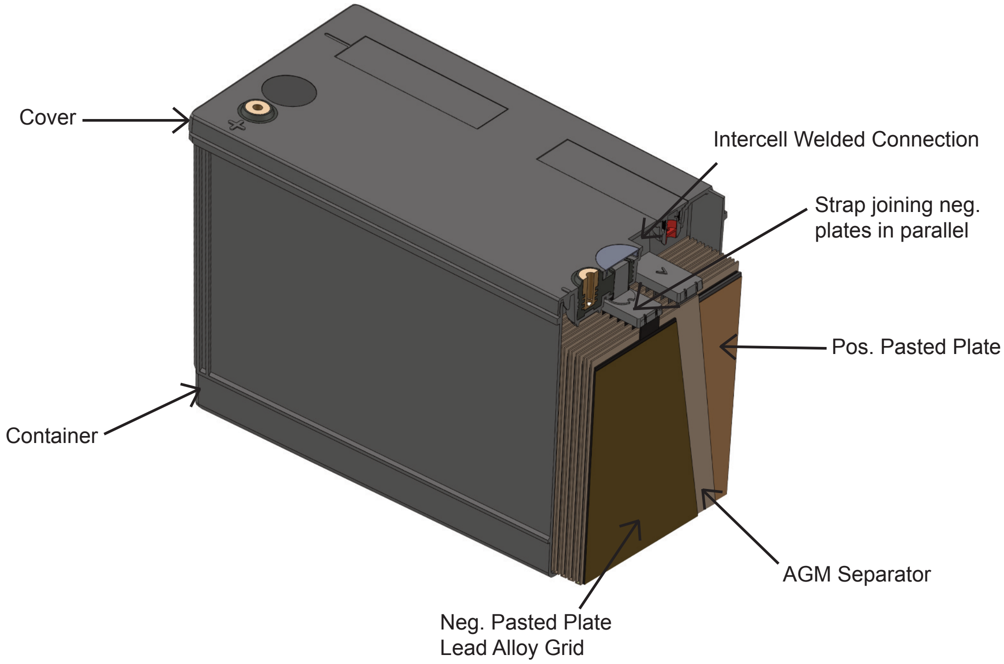
Due to these advantages of no electrolyte spillage or maintenance, minimal gas evolution, extended shelf life and improved safety, the VRLA battery has been selected for a host of critical power applications and is rapidly displacing many applications of the traditional vented or wet lead acid cell.

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 two types of AGM (absorbed glass mat) and a gelled electrolyte design.

The AGM and gelled electrolyte battery designs share many of the same components, such as container, pressure relief valves and plates. They do have a different separator system and electrolyte immobilization system which results 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' product line.

AGM VRLA Battery Construction

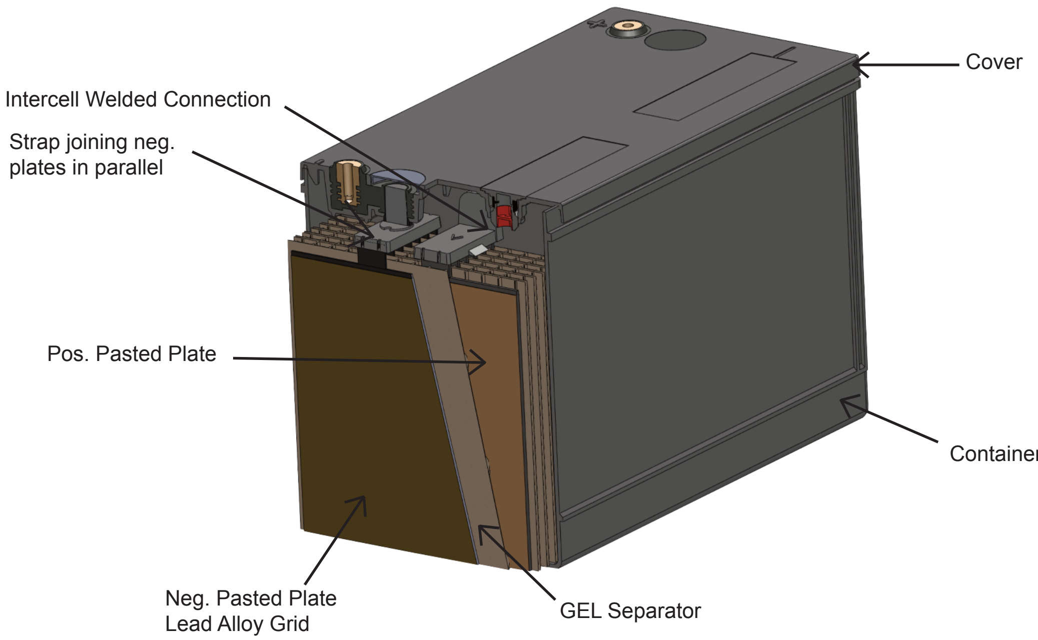
As shown in Figure 1, the AGM VRLA battery utilizes a separator of glass fibers which serves to both isolate the negative and positive plates and act as a blotter to absorb the free electrolyte within the cell. This AGM separator is somewhat fragile, highly porous and absorbent, and has very low resistance. The AGM separator is maintained under compression between the plates to assure complete contact with the plate surface since it provides the source of the electrolyte essential to the cell's electrochemical reaction. Actually, the separator is not completely saturated with electrolyte and it is the 2 to 10% void space which allows the oxygen gas generation from 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 that which the limited amount of electrolyte can fully react.



AGM VRLA Battery Construction
Figure 1

Gelled Electrolyte VRLA Battery Construction

The gelled electrolyte VRLA battery, as shown in Figure 2, utilizes a robust microporous polyethylene separator. This separator is not relied upon to absorb the electrolyte since the electrolyte is gelled, but strictly performs the function of separating the plates and resisting the development of shorts between the plates. This durable separator and the gelled electrolyte are of relatively high resistance and introduce additional voltage drop during high rate discharges. 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 the transport of the oxygen from the positive to the negative plate allowing for the oxygen recombination cycle.



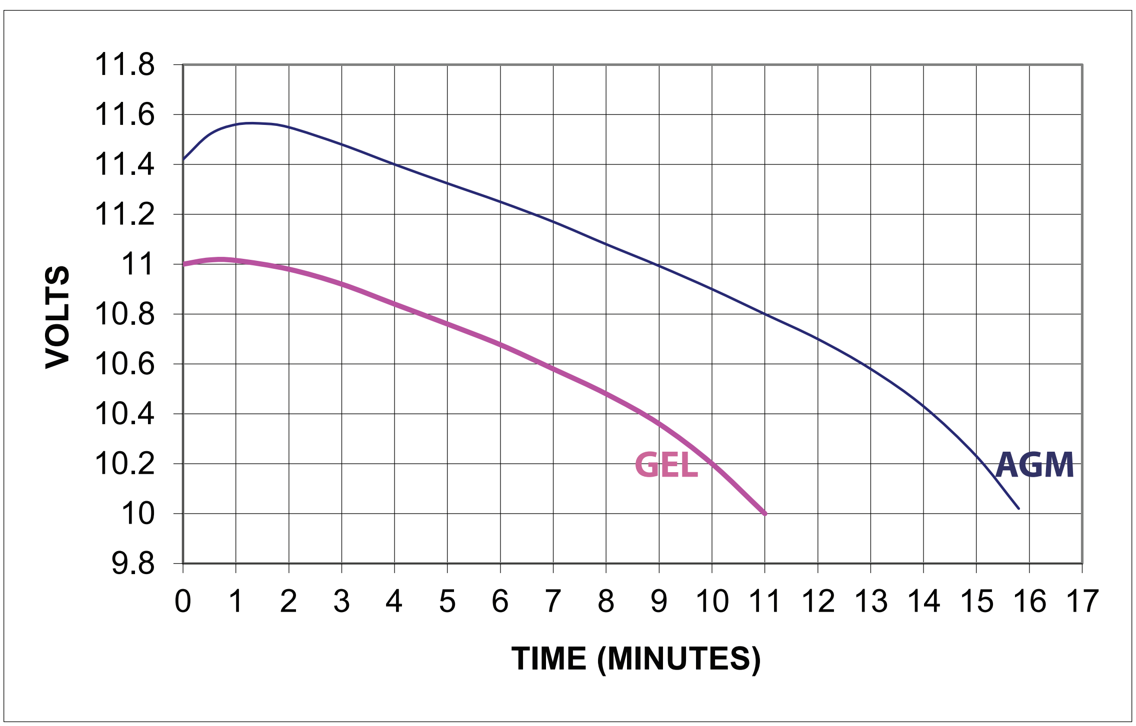
Gelled Electrolyte Battery Construction
Figure 2

VRLA Battery Capacity and Performance Characteristics

The AGM VRLA battery typically contains more electrolyte than a comparable gelled battery (a percentage of the electrolyte is actually displaced by the gelling agent). Consequently the AGM battery will typically provide slightly more (approximately 7 to 8%) longer 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 system 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 and 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 battery cannot be used, they are just less efficient. The gelled electrolyte model might be preferred based on additional criteria.

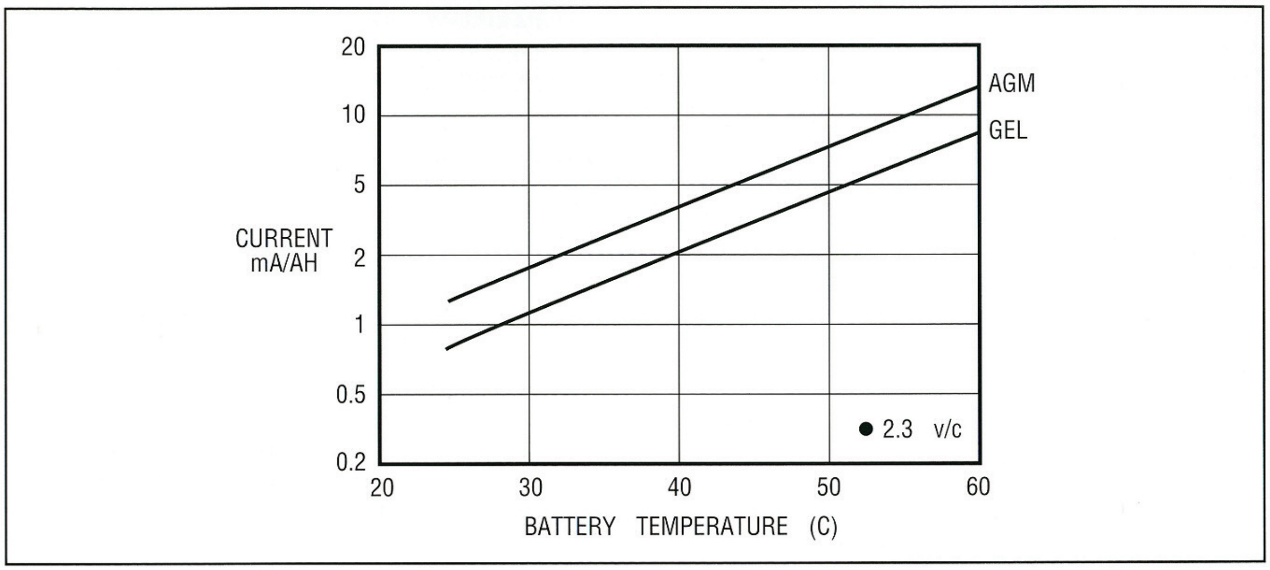


AGM vs. Gelled electrolyte High Rate Performance

Figure 3

VRLA Batteries and Elevated Temperature Characteristics

The AGM VRLA battery has a slightly more efficient oxygen recombination cycle and lower resistance than gelled electrolyte VRLA battery. As a result it will draw slightly more float current at the same float voltage 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 (1/2" recommended) between the batteries to facilitate air flow and improve 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 with 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

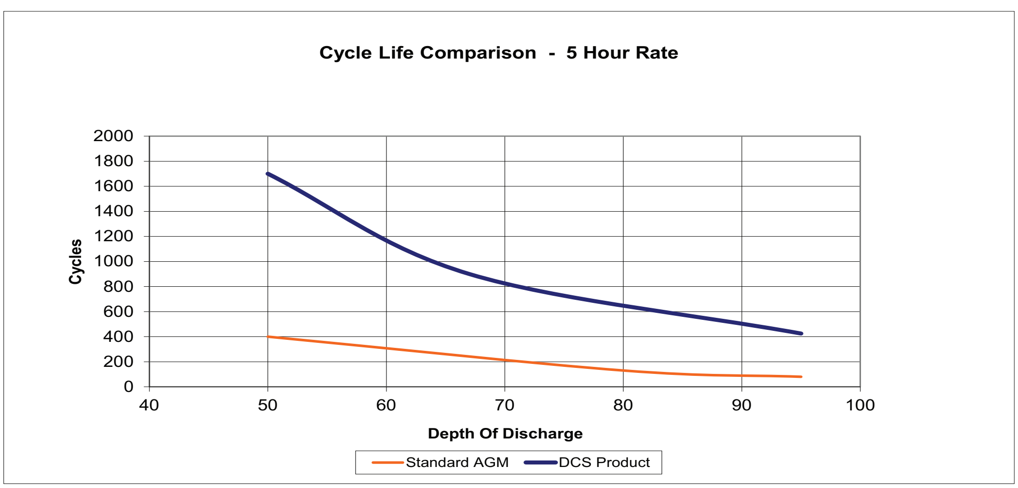
A battery is in float service when it is continually connected to the power supply and the load so as to provide instant uninterrupted power in the event of failure of the primary power source. The float service life characteristics at 77 deg F (25 deg C) are essentially the same for AGM and gelled electrolyte VRLA batteries. The AGM and gelled electrolyte batteries will both provide 95 to 100+% of 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, separator, plates, grids and active materials.

VRLA Batteries Cycle Service Life Characteristics

In cycle service, the battery is deeply discharged as the primary power source for the application such as Solar, wheelchairs/scooters, golfcarts, Marine trolling motors, UPS in poor power areas, etc. The battery is then recharged following discharge to restore its capacity for repeated use. In the typical cycle service application, this cycle is repeated frequently. This repeated cycle is especially stressful on the positive plate active material, causing the paste to shed from the grid. Additionally, gassing is accelerated and the grid of the positive plate will suffer accelerated corrosion due to the charge normally experienced with the higher voltage cycle service recharge.

For these applications, C&D has developed the DCS, or deep cycle service battery. This is an AGM battery designed specifically to provide the longest service life in deep and frequent cycle applications. To extend the cycle life, the DCS design contains a positive paste formula developed specifically to address the stresses that develop during the structural changes occurring in the discharge/charge cycle. The DCS paste maintains the structure of the active material during this severe application. The grid alloy has been developed to reduce grid corrosion and the resulting grid growth that can separate the active material from the grid structure. The combination of the positive paste formula and grid alloy provides the durability essential for long service life in severe cycling applications.

There are trade offs for this cycling capability. The DCS product line does not achieve the equivalent ampere-hour ratings and watt per cell ratings of the UPS and Telecom products. The design efficiency and therefore the ratings are lower than the UPS and Telecom product in same block sizes. Initial capacity of the DCS batteries is typically between 90 and 95% of rating. Reaching full rated capacities requires up to 20 cycles with extended float time between discharges or about a year in float.



Cycle life comparison of Standar AGM battery to the Deep Cycle Series product designed for repeated cycle application

Figure 5

VRLA Battery Applications

No one design of VRLA battery is optimum for all various type of applications. The type of electrolyte and its specific gravity, plate chemistry, and separator system as well as the electrolyte immobilization technique utilized greatly determines the battery's suitability to provide maximum power density, superior high rate performance, extended life at elevated temperature 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 overcharge 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 application as noted and others which are similar.

	UPS & MR	Tel	Gel	DCS
Float Service – normal temperatures				
UPS Systems	X			
EPBX Systems	X			
Security Systems	X	X		
Emergency Lighting Systems	X	X		
Radio Comm. Systems	X	X		
Engine Starting	X			
Telephone back up power		X		
Cell Phone Towers back up power		X		
Float Service – elevated temperatures			X	
Cycle Service				
Solar/Photovoltaic				X
Poor Power Quality areas				X
Wheelchairs				X
Frequently Cycled Equipment				X
Golf Carts/Caddie				X
Portable Lighting				X
Recreational Vehicles				X
Trolling Motors				X
Portable Test Equipment				X
Portable Communication				X
Portable/Mobile Tools				X

VRLA Battery Selection and Application Guide
Table 1
X - Standard Design (UPS/MR, GEL and DCS)

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