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Sun Xtender AGM Battery Technology VS. Flooded (Wet) Solar Batteries

TECHNOLOGY COMPARISON FOR SOLAR ENERGY BATTERIES

Sun Xtender® AGM Solar Photovoltaic Battery vs. Flooded [Wet] Battery Comparison

Undertaking a comparison of Flooded Lead Acid batteries is a fairly involved procedure. There are so many types of these batteries to be considered. The technologies vary depending on usage. We'll try to keep the comparisons short.

There are several basic types of technologies employed with many variations:

- **Planté** - Pure lead.
- **Lead Antimony** - Antimony alloy additive to the lead.
- **Lead Calcium** - Calcium alloy additive to the lead.
- **Hybrids** - Using a mixture of alloys, including tin, aluminum, etc., have been added to the pure lead. [There is even a sealed lead acid battery using a cadmium alloy grid positive - not a very healthy idea.]

Some of these technologies are application specific and include:

Lead Antimony types - both high and low antimony content batteries.

- High Antimony [4 to 6 % content] batteries include those for fork lifts, golf cars, sweeper/scrubbers machines and other motive power applications.
- Low Antimony [2 to 3% content] batteries include those for telecom, switch-gear, UPS and other stand-by power systems.

Lead Calcium types - use low calcium levels, typically 0.1 to 0.2%

- The major usage of calcium batteries has been in the telecom, switchgear, UPS and stand-by systems. However, the automotive industry uses calcium grids as well.

The **pure lead** [Planté] type batteries are the oldest and have had good performance in stand-by applications. They are seldom used because pure lead is structurally weak and this limits the size of a plate that can be used.

Additionally, they do not recover well from deep discharge and cannot be used in applications where vibration or shock is experienced. In order to overcome these limitations the battery industry initially added an **alloy of antimony** to the pure lead. This increased the tensile strength and structural integrity of the battery. The high antimony content battery [4 to 6%] solved the problems of building higher capacity batteries that could withstand shock and vibration experienced in motive power [traction] applications.

However, this was not a panacea for the battery industry. The addition of this high level of antimony had its negative effects and these were not small.

Self-Discharge of this type of design is 25 to 30% per month. This means that when sizing a PV system the high self-discharge should be considered as part of the system's load.

Water Consumption on charge caused by electrolysis and evaporation is considerable. The water

consumed must be replaced regularly with water that is free of minerals and trace metals. Adding water with minerals or trace metals will significantly shorten the battery's life.

Antimony Migration - This is also known as antimony poisoning. As the battery ages the antimony in the battery actually poisons the battery. This causes the self discharge and water consumption to increase at an exponential rate and shortens the life of the battery. Self discharge can reach 50 to 75% per month when the battery gets older.

Explosive [Flammable] Hydrogen Gas levels are experienced when the battery is charged to full charge voltages. Battery explosions do occur.

Electrolyte [Sulfuric Acid/Water Mixture] can spill if the battery is tilted or when a hydrometer is used to measure specific gravity. Sulfuric acid is extremely corrosive to materials and can cause personal injury if contacted.

Electrolyte Stratification can occur causing the battery to have low specific gravity electrolyte in contact with the upper portions of the plates and high specific gravity electrolyte in contact with the lower portions of the plates. The low specific gravity will lessen the capacity of the plates on the upper portions and the high gravity will accelerate corrosion on the lower portions of the plates. This is usually caused by charging the battery at too low a voltage [an attempt to minimize out-gassing and required watering]. By charging a flooded battery at too low a voltage, the battery will not produce enough gassing to cause the electrolyte to be properly mixed. The problem becomes more severe the taller the battery.

Cycle Life is reported to be very good for some batteries but we know of no manufacturer that will supply cycle life data for a Solar PV application. The data they quote is 100% discharge to 50% of the battery's remaining capacity.

Rather than go through each of the flooded battery designs we have concentrated on the flooded battery most used by the Solar Photovoltaic/Wind industry in the U.S., namely the High Antimony Traction Type Lead Acid Battery.

These flooded batteries were designed and continue to be used for the Motive Power Market: Fork Lifts, Golf Carts, Sweeper Scrubbers, etc. These markets and users are used to handling the maintenance and inherent dangers in their applications. We cannot understand why the PV industry would provide such a problematic product for safe, clean PV applications.

Let's compare our Sun Xtender® Battery with a High Antimony Traction Battery. Based on the highlighted items above we have listed the Sun Xtender® Solar Energy Battery for comparison.

To begin with, the Sun Xtender® product line has been designed to the same high quality standards as our Recombinant Gas Military and Commercial Aircraft batteries. We are an AS 9100 REV. B:2004 and ISO 9001:2000 Certified and US MIL-Spec Manufacturing facility.

- **Self-Discharge** of the Sun Xtender® solar battery is 1 to 3% per month over the life of the battery.
- **Water Consumption** at any time in its life is a non-problem. No water additions are required or possible.
- **Antimony Migration** - Our AGM batteries contain no antimony. They are a Lead Calcium based design with other alloying materials.
- **Explosive Hydrogen Gas** is not a problem in Sun Xtender® Series AGM batteries. They have been tested by the US Navy to US MIL-B-8565J for hydrogen gas emission. This requires the battery to be heated to 55°C [131°F] and charged at 2.68V/cell [16.1V for a 12-volt battery]. The hydrogen gas emitted is measured. A concentration of greater than 4.1% is required to be explosive. The MIL-Spec allows a level up to 3.5% to pass. Concorde and Sun Xtender® Series AGM batteries measured 0.2% to 1.0% maximum depending on the size. All flooded antimony batteries can and have had explosion problems.
- **Electrolyte does not** spill from our solar batteries and no electrolyte specific gravity measurements are required or possible. The batteries are sealed and are Non-Spillable. Therefore,

there is no concern for personnel safety or corrosion of equipment. They may be operated in any orientation.

- **Electrolyte Stratification** does not occur in our solar batteries. The plates are snugly wrapped with the fiberglass mat material which has good wicking characteristics. The glass mat is saturated with electrolyte. This insures that the battery plates are in a balanced specific gravity solution.
- **Cycle Life** - Concorde has designed our Sun Xtender® batteries for solar energy applications. We publish cycle life data for the manner in which the batteries will be used. In a properly designed PV system we are experiencing 10+ years of life.

CONSIDERATIONS	SUN XTENDER® AGM	FLOODED TRACTION
Self Discharge	1 to 3% per month – Remains stable over life	25 to 30%per month – With age it increases exponentially
Water Additions	Never - Sealed Battery	Frequent - Also increases exponentially with age
Antimony Migration	No antimony in the battery	Poisons battery causing increase in water consumption and self-discharge
Explosive/Flammable Hydrogen Gas Emission	Does <u>not</u> occur even when in an over- charge Condition	Does occur when properly charged at recommended voltages
Electrolyte Spillage	Not possible even when turned on its side	Spills if tilted or when measuring specific gravity
Electrolyte Stratification	No stratification occurs	Stratification occurs when operated at low charging voltage or in taller batteries
Cycle Life	Very Good - Published data provides needed information	Some Very Good - Little data available for evaluation
Safety – Listed by Underwriters LaboratoriesAs an Approved Systems Component	UL Component Listing - Sealed, Valve Regulated with Flame Arresters	UL not possible due to inherent explosive/acid spill safety dangers

US MIL-SPEC QUALITY/RELIABILITY + SAFETY + "0" MAINTENANCE + LIFE
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SUN XTENDER® AGM, SEALED, VALVE REGULATED BATTERIES

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**Sun Xtender Battery Produces the Highest Quality Solar Batteries,
Renewable Energy Storage Batteries, Photovoltaic Batteries, & AGM Batteries**