Sunica Ni-Cd battery
Technical manual

SAFT

Contents

1. Introduction

The nickel-cadmium battery is the most reliable battery system available in the market today. Its unique features enables it to be used in applications and environments untenable for other widely available battery systems.

It is not surprising, therefore, that with the emergence of the photovoltaic (PV) market and its rigorous requirements, the nickel-cadmium battery has become an obvious first choice for users looking for a reliable, low maintenance, system.

This publication details the design and operating characteristics of the Saft Sunica battery to enable a successful battery system to be achieved. A battery which, while retaining all the advantages arising from nearly 100 years of development of the pocket plate technology, can be so worry free that its only maintenance requirement is topping up with water.

2. The photovoltaic application

The typical requirements for photovoltaic (PV) applications are ruggedness, environmental flexibility, unattended operation, ease of installation, and reliability.

Photovoltaic applications can cover many applications including:

Navigational Aids

offshore
remote lighthouses
beacons

Telecommunications

emergency telephone posts
radio repeater stations
base stations

Rail Transport

crossing guards
lighting, signalling
isolated telephone stations

Oil and Gas

cathodic protection for pipelines
emergency lighting on offshore platforms

Utilities

electrification in remote areas

A photovoltaic system is made up of three distinct parts :

The photovoltaic array which is built to give up to 20 years of service life.

Electronic components such as blocking diodes and logic circuits in power conditioners and as controllers or voltage regulators.

The battery which must assure the autonomy required by the installation.

Systems are often installed in remote areas, at sites accessible only by foot, helicopter or boat, in good weather conditions and with only limited skilled labour available.

Thus, the ideal photovoltaic power system is a reliable installation which requires only infrequent maintenance calls and, clearly, the battery plays a crucial part in this requirement.

Thus, the battery is a critical part of the system and, premature failure of the battery results in a total failure of the system.

❑ **The most important characteristics required in a battery for photovoltaic applications are:**

- Ability to withstand cycling, daily and seasonal
- Ability to withstand high and low environmental temperatures
- Ability to operate reliably, unattended and with minimal maintenance
- Ruggedness for transportation to remote sites
- Easily installed with limited handling equipment and unskilled labour
- Reliability and availability during the 20 years service life of the photovoltaic modules
- Resistance to withstand failure of electronic control systems

3. Construction features of the Sunica battery

The construction of the Saft Sunica cell is based upon the Saft pocket plate technology but with special features to enhance its use in the specialised photovoltaic application.

3.1. Plate assembly

The nickel-cadmium cell consists of two groups of plates, one containing nickel hydroxide (the positive plate) and the other containing cadmium hydroxide (the negative plate).

The active materials of the Saft Sunica pocket plate are retained in pockets formed from nickel plated steel double perforated by a patented process. These pockets are mechanically linked together, cut to the size corresponding to the plate length and compressed to the final plate dimension. This process leads to a component which is not only mechanically very strong but also retains its active material within a steel boundary which promotes conductivity and minimises electrode swelling.

These plates are then welded to a current carrying bus bar assembly which further ensures the mechanical and electrical stability of the product.

Nickel-cadmium batteries have an exceptionally good cycle life because their plates are not gradually weakened by repeated cycling as the structural component of the plate is steel. The active material of the plate is not structural, only electrical. The alkaline electrolyte does not react with steel, which means that the supporting structure of the Sunica battery stays intact and unchanged for the life of the battery. There is no corrosion and no risk of " sudden death ".

In contrast, the lead plate of a lead acid battery is both the structure and the active material and this leads to shedding of the positive plate material and eventual structural collapse.

3.2. Separation

Separation between plates is provided by injection moulded plastic separator grids, integrating both plate edge insulation and plate separation.

By providing a large spacing between the positive and negative plates and a generous quantity of electrolyte between plates, good electrolyte circulation and gas dissipation are provided and there is no risk of the stratification of electrolyte found with lead acid batteries.

3.3. Electrolyte

The electrolyte used in Sunica, which is a solution of potassium hydroxide and lithium hydroxide, is optimised to give the best combination of performance, life, energy efficiency and a wide temperature range.

The concentration is such as to allow the cell to be operated down to temperature extremes as low as – 50°C and as high as + 60°C. This allows the very high temperature fluctuations found in certain remote regions to be accommodated.

It is an important consideration of Sunica, and indeed all nickel-cadmium batteries, that the electrolyte does not change during charge and discharge. It retains its ability to transfer ions between the cell plates irrespective of the charge level.

In most applications the electrolyte will retain its effectiveness for the life of the battery and will never need replacing. However, under certain conditions, such as extended use in high temperature situations, the electrolyte can become carbonated. If this occurs the battery performance can be restored by replacing the electrolyte.

3.4. Terminal pillars

Short terminal pillars are welded to the plate bus bars using the well proven block battery construction. These posts are manufactured from steel bar, internally threaded for bolting on connectors and are nickel plated.

The terminal pillar to cover seal is provided by a compressed visco-elastic sealing surface held in place by compression lock washers. This assembly is designed to provide satisfactory sealing throughout the life of the product.

3.5. Venting system

Sunica is fitted with a special flame arresting vent to give an effective and safe venting system.

3.6. Cell container

Sunica is built up using the well proven block battery construction. The tough polypropylene containers are welded together by heat sealing and the assembly of the blocks are completed by a clip-on cover enclosing the top of the Sunica block, giving a non conducting , easy to clean, top surface.

4. Benefits of the Sunica battery

The benefits of the Saft Sunica photovoltaic battery are:

• Complete reliability

Does not suffer from the sudden death failure associated with other battery technologies.

• Long cycle life

Sunica has a long cycle life even when the charge/discharge cycle involves full discharges.

• Exceptional long life

Sunica incorporates all the design features associated with the conventional Saft twenty year life products.

• Low maintenance

With its increased electrolyte reserve, Sunica reduces the need for topping up with water and can be left in remote sites for long periods without any maintenance.

• Wide operating temperature range

Sunica has a special optimised electrolyte which allows it to have a normal operating temperature of from – 30°C to + 50°C, and accept extreme temperatures, ranging from as low as – 50°C to up to + 60°C.

• Resistance to mechanical abuse

Sunica is designed to have the mechanical strength required to withstand all the harsh treatment associated with transportation over difficult terrain.

• High resistance to electrical abuse

While the use of a voltage regulator is recommended to obtain maximum overall efficiency of the system, the failure of this component will not damage the battery. It will simply cause an overcharging of the battery and so use extra water. The Sunica battery is resistant to overcharge and over-discharge conditions.

• Low installation costs

Sunica can be used with a wide range of photovoltaic systems as it produces no corrosive vapours, uses corrosion free polypropylene containers and has a simple bolted assembly system.

• Well proven pocket plate construction

Saft has nearly 100 years of manufacturing and application experience with respect to the nickel-cadmium pocket plate product and this expertise has been built into the twenty plus years design life of the Sunica product.

5.1. Capacity

The Sunica battery capacity is rated in ampere hours (Ah) and is the quantity of electricity which it can supply for a 100 hour discharge to 1.2 volts after being fully charged. This figure was chosen as being the most useful for sizing photovoltaic applications.

5.2. Cell voltage

The cell voltage of nickel-cadmium cells results from the electrochemical potentials of the nickel and the cadmium active materials in the presence of the potassium hydroxide electrolyte. The nominal voltage for this electrochemical couple is 1.2 volts.

5.3. Internal resistance

The internal resistance of a cell varies with the type of service and the state of charge and is, therefore, difficult to define and measure accurately.

The most practical value for normal applications is the discharge voltage response to a change in discharge current. The internal resistance of a Sunica cell when measured at normal temperature is approximately 140 milliohm divided by the capacity (Ah).

The above figures are for fully charged cells. For lower states of charge the values increase. For cells 50% discharged the internal resistance is about 20% higher and when 90% discharged it is about 80% higher. The internal resistance of a fully discharged cell has very little meaning. Reducing the temperature also increases the internal resistance and, at 0°C, the internal resistance is about 40% higher.

5.4. Affect of temperature on performance

Variations in ambient temperature affects the performance of Sunica and this must be allowed for in the battery engineering.

Low temperature operation has the effect of reducing the performance but the higher temperature characteristics are similar to those of normal temperatures. The effect of temperature is more marked at higher rates of discharge.

The factors which are required in sizing a battery to compensate for temperature variations are given in a graphical form in Figure 1 for operating temperatures from – 40°C to + 60°C.

5.5. Short circuit values

The typical short circuit value in amperes for a Sunica cell is approximately 15 times the ampere-hour capacity.

The Sunica battery with conventional bolted assembly connections will withstand a short circuit current of this magnitude for many minutes without damage.

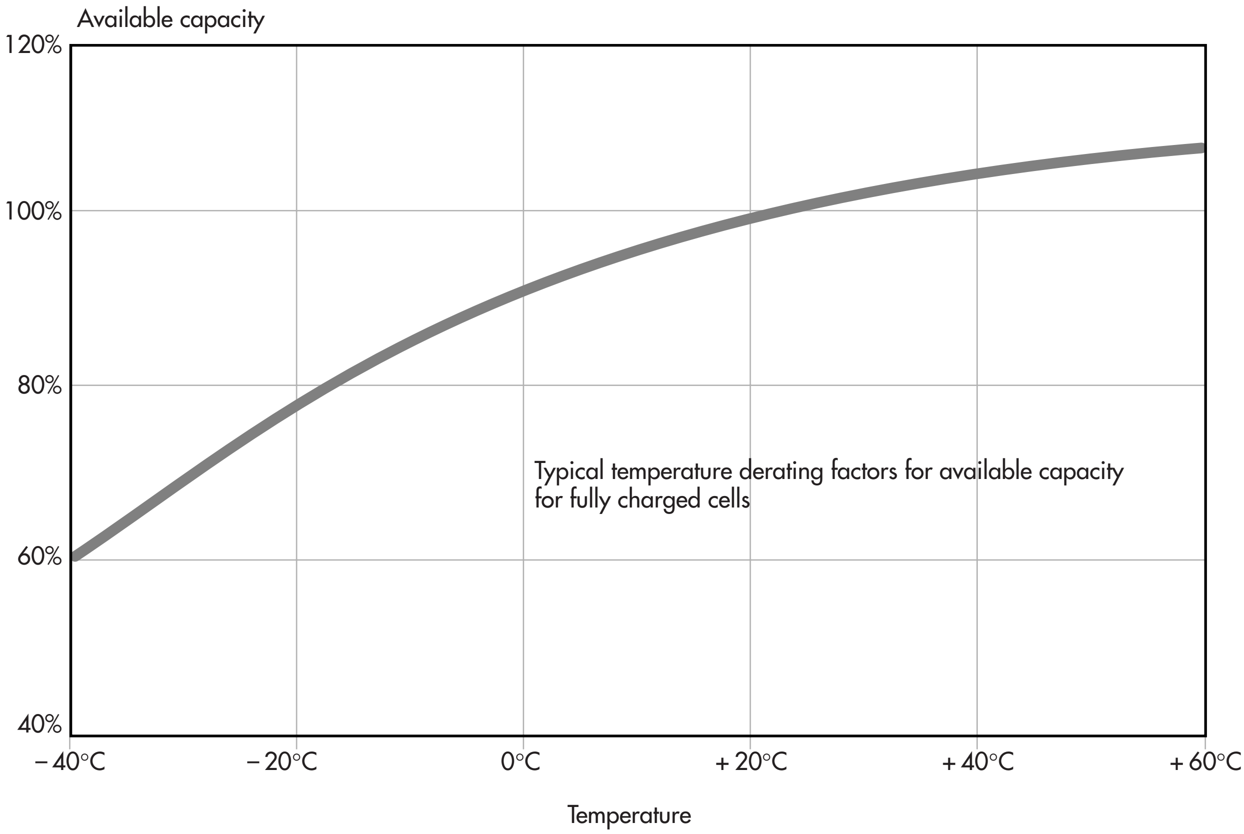


Figure 1: Typical capacity derating factors versus temperature

5.6. Open circuit loss

The state of charge of the Sunica cell on open circuit stand slowly decreases with time due to self discharge. In practice this decrease is relatively rapid during the first two weeks but then stabilises to about 2% per month at + 20°C.

The self discharge characteristics of a nickel-cadmium cell are affected by the temperature. At low temperatures the charge retention is better than at normal temperature and so the open circuit loss is reduced. However, the self discharge is significantly increased at higher temperatures.

The open circuit loss for Sunica for a range of temperatures which may be experienced in a photovoltaic application is shown in Figure 2.

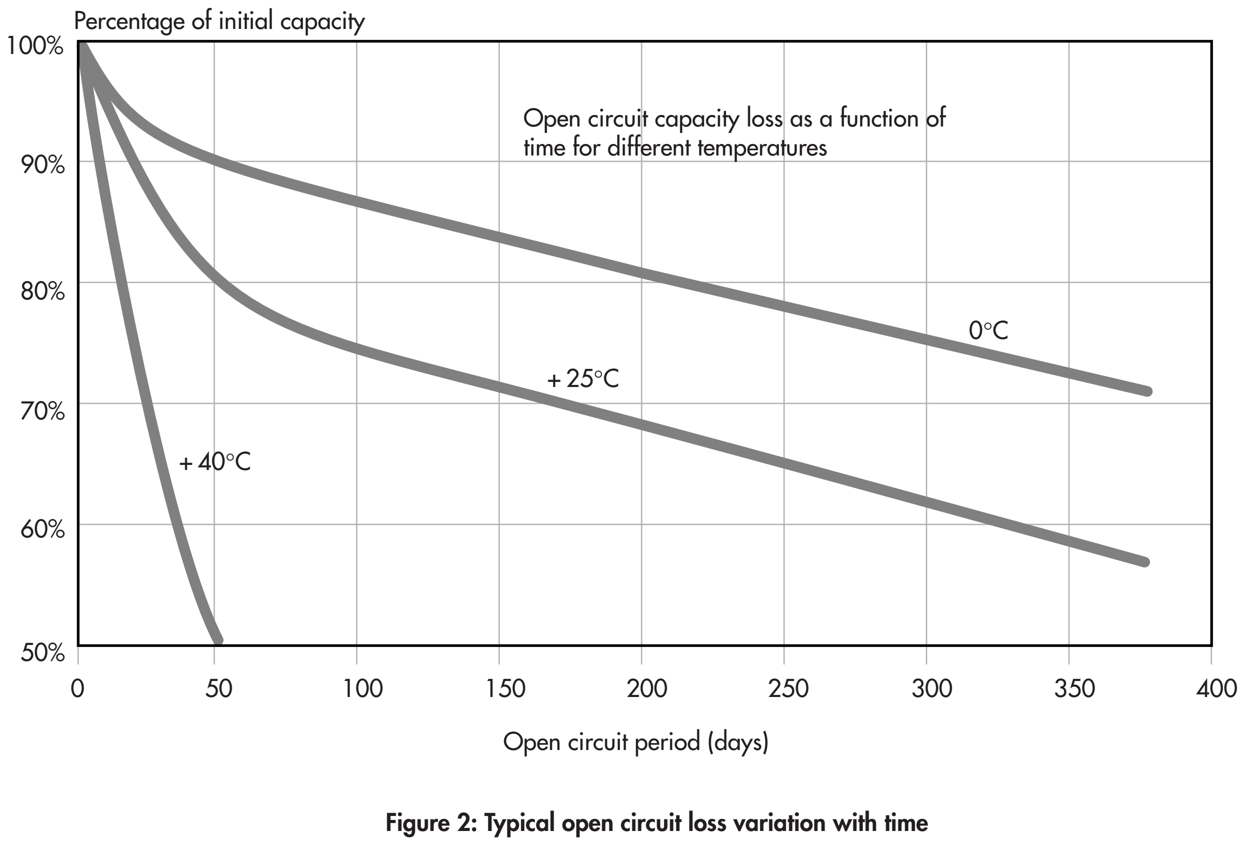


Figure 2: Typical open circuit loss variation with time

5.7. Cycling

Sunica is designed to withstand the wide range of cycling behaviour encountered in photovoltaic applications. This can vary from low depth of discharges to discharges of up to 100% and the number of cycles that the product will be able to provide will depend on the depth of discharge required.

The less deeply a battery is cycled then the greater the number of cycles it is capable of performing before it is unable to achieve the minimum design limit. A shallow cycle (say 20%) will give more than 8000 operations, whereas a deep cycle (say 80%) will give about 1000 operations.

Figure 3 gives the effect of depth of discharge on the available cycle life and, it is clear, that when sizing the battery for an application, the number and depth of cycles have an important consequence on the predicted life of the system.

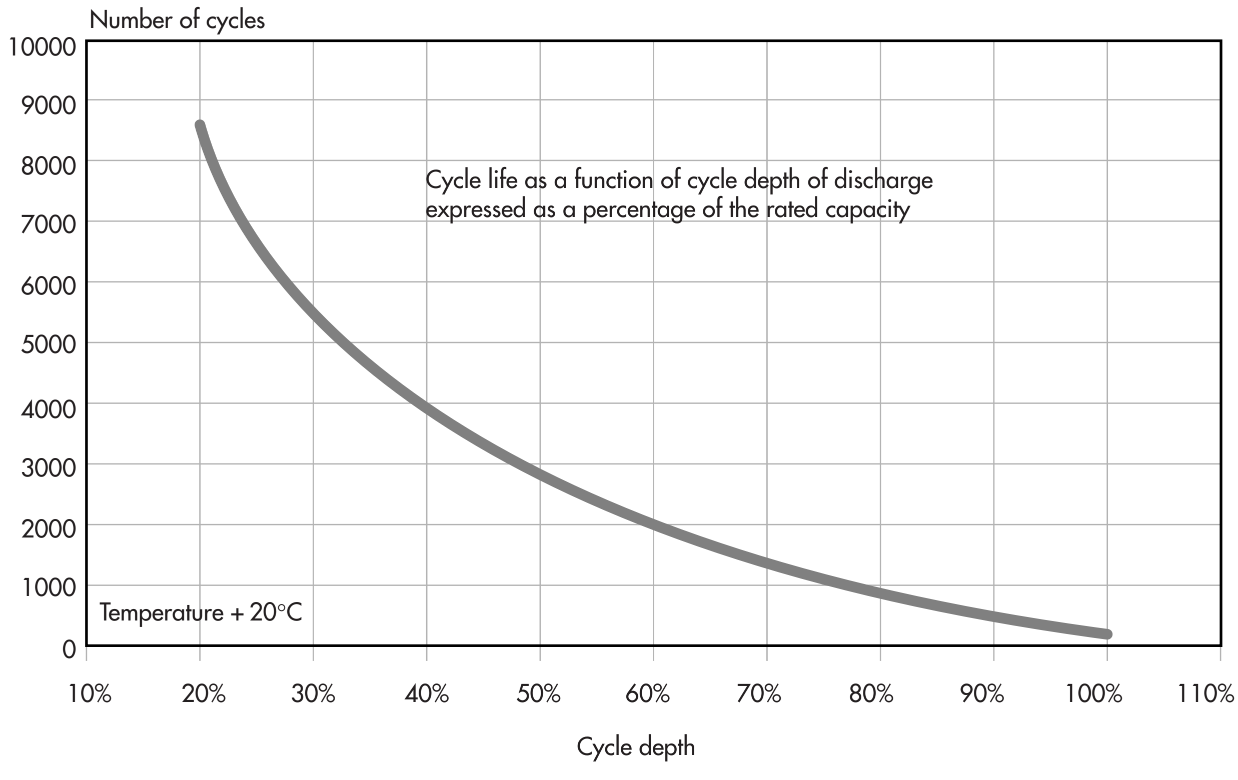


Figure 3: Typical cycle life versus depth of discharge at + 20°C

5.8. Effect of temperature on lifetime

Sunica is designed as a twenty year life product but, as with every battery system, increasing temperature reduces the expected life. However, the reduction in lifetime with increasing temperature is very much lower for the nickel-cadmium battery than the lead acid battery.

The reduction in lifetime for both the nickel-cadmium battery and, for comparison, a high quality "10 year life" lead acid battery is shown graphically in Figure 4.

In general terms for every 9°C increase in temperature over the normal operating temperature of + 25°C, the reduction in service life for a nickel-cadmium battery will be 20% and for a lead acid battery will be 50%. In high temperature situations, therefore, special consideration must be given to dimensioning the nickel-cadmium battery. Under the same conditions, the lead acid battery is not a practical proposition due to its very short lifetime.

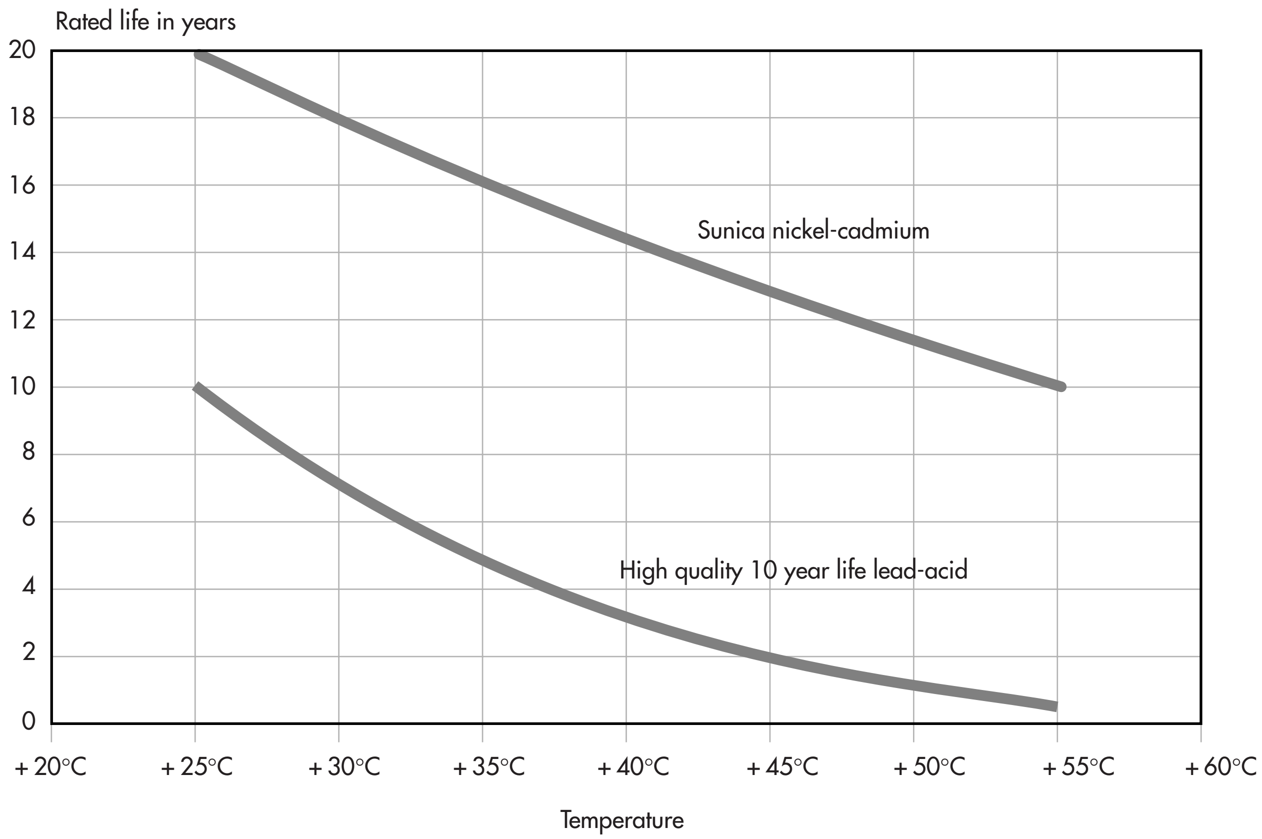


Figure 4: Typical battery life expectancy at high temperatures

5.9. Water consumption and gas evolution

During charging, more ampere-hours is supplied to the battery than the capacity available for discharge. These additional ampere-hours must be provided to return the battery to the fully charged state and, since they are not all retained by the cell and do not all contribute directly to the chemical changes to the active materials in the plates, they must be dissipated in some way.
This surplus charge, or overcharge, breaks down the water content of the electrolyte into oxygen and hydrogen, and pure distilled water has to be added to replace this loss.

Water loss is associated with the current used for overcharging.

A battery which is constantly cycled, i.e. is charged and discharged on a regular basis, will consume more water than a battery on standby operation.

In theory, the quantity of water used can be found by the Faradic equation that each ampere hour of overcharge breaks down 0.366 cc of water. However, in practice, the water usage will be less than this as the overcharge current is also needed to support self discharge of the electrodes.

The overcharge current is a function of both voltage and temperature and so both have an influence on the consummation of water.

Figure 5 gives typical water consumption values over a range of voltages and temperature.

The gas evolution is a function of the amount of water electrolysed into hydrogen and oxygen and are predominately given off at the end of the charging period. The battery gives off no gas during discharge.

The electrolysis of 1 cc of water produces about 2000 cc of gas mixture and this gas mixture is in the proportion of 2/3 hydrogen and 1/3 oxygen. Thus the electrolysis of 1 cc of water produces about 1300 cc of hydrogen.

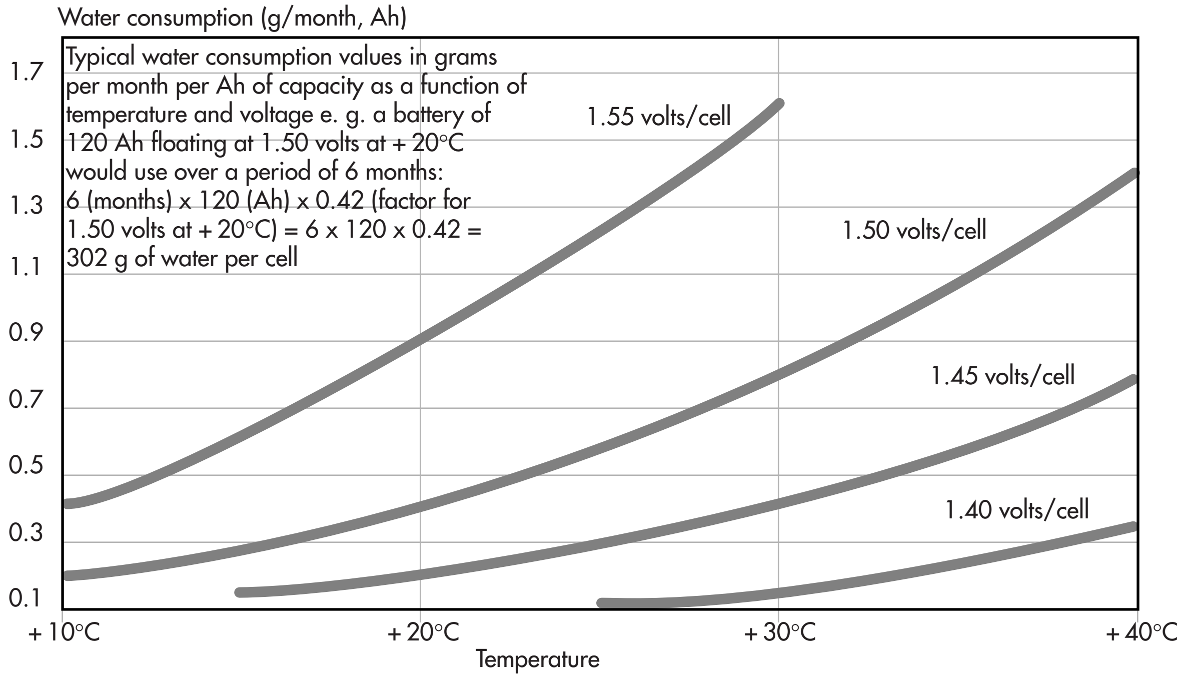


Figure 5: Typical water consumption values

6. Battery charging

6.1. Charging generalities

The photovoltaic array converts solar irradiance into dc electrical power at a predetermined range of voltages whenever sufficient solar radiation is available. Unlike a mains connected system the output from a photovoltaic array is variable and, to obtain the best efficiency from the system, it is quite normal to have some form of charge control.

Two techniques for charging nickel-cadmium batteries used in photovoltaic systems are as follows:

6.1.1. Voltage limit with charge current limited by array

In this system, the battery is charged at a current which is determined by the array capability. When the battery has reached a predetermined voltage limit, the charge current tapers off. Ideally, to obtain the best efficiency from the system, the voltage limit should be temperature compensated. The battery will continue to charge until the photovoltaic power available is less than that required to charge it.

The upper voltage limit for the nickel-cadmium battery is usually chosen in the range of 1.55 to 1.65 volts/cell depending on the system requirements.

6.1.2. Two step charging

This differs from the above method by allowing the battery to charge up to a high preset voltage and then dropping to a lower maintenance level voltage to reduce the water consumption of the battery. This second low level "floating" voltage should be in the range 1.42 to 1.45 volts to ensure that the battery will still continue to accept a small level of charge. Again, as the previous method, it is recommended that temperature compensation should be used to reduce water consumption of the battery.

6.2. Charge efficiency

The charge efficiency of Sunica is dependent on the state of charge of the battery and the temperature.
For much of its charge profile it is recharged at a high level of efficiency.

Figure 6 shows the charging efficiency for batteries 50%, 70% and 90% charged for a wide range of temperatures and, it should be noted that, although the charging efficiency is at it lowest at +40°C it still remains at above 75% for a battery already 70% charged.

In general, at states of charge less than 80% the charge efficiency remains high but as
the battery approaches a fully charged condition, its the charging efficiency falls off.
This is illustrated graphically in Figure 7.

In practice, a photovoltaic system's battery normally has a state of charge between 20% and 80% and so the charging efficiency of Sunica remains high.

The charging efficiency of Sunica is not reduced with time and so this does not have to be taken into account in battery sizing.

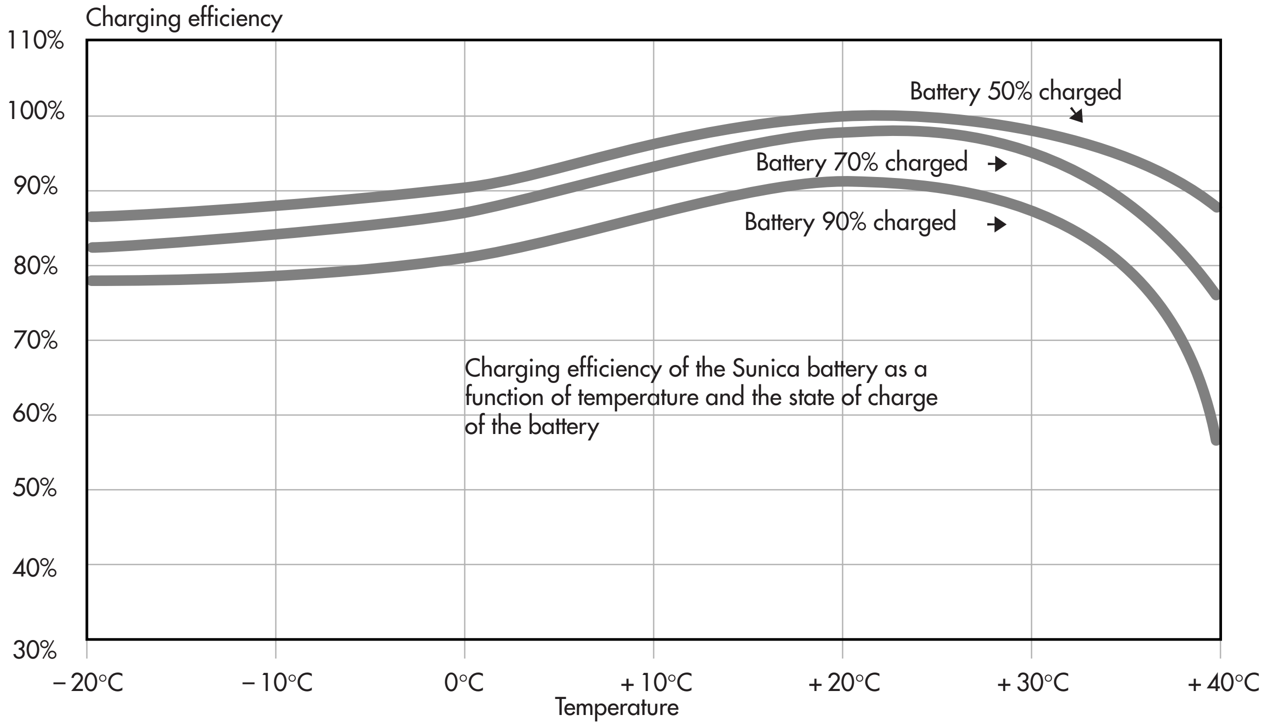


Figure 6: Charging efficiency as a function of temperature

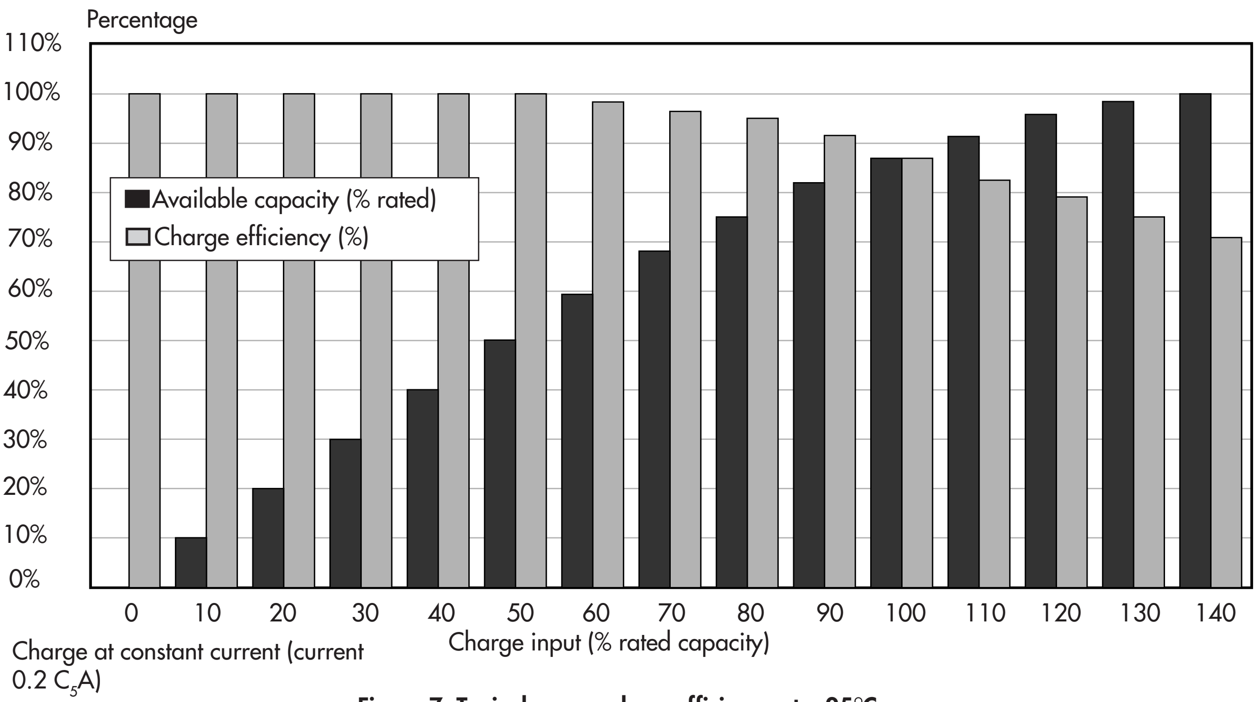


Figure 7: Typical ampere-hour efficiency at + 25°C

6.3. Temperature effects

As the temperature increases, then the electrochemical behaviour becomes more active and so, for the same floating voltage, the current increases. As the temperature is reduced, then the reverse occurs. Increasing the current, increases the water loss and reducing the current creates the risk that the cell will not be sufficiently charged.

Thus, as it is clearly advantageous to maintain the same current through the cell, it is necessary to modify the floating voltage as the temperature changes.
The change in voltage required, or "temperature compensation", is given in Figure 8.

If these values cannot be exactly met with a particular system then temperature compensation values of between −2 mV/°C and −3.5 mV/°C are acceptable.

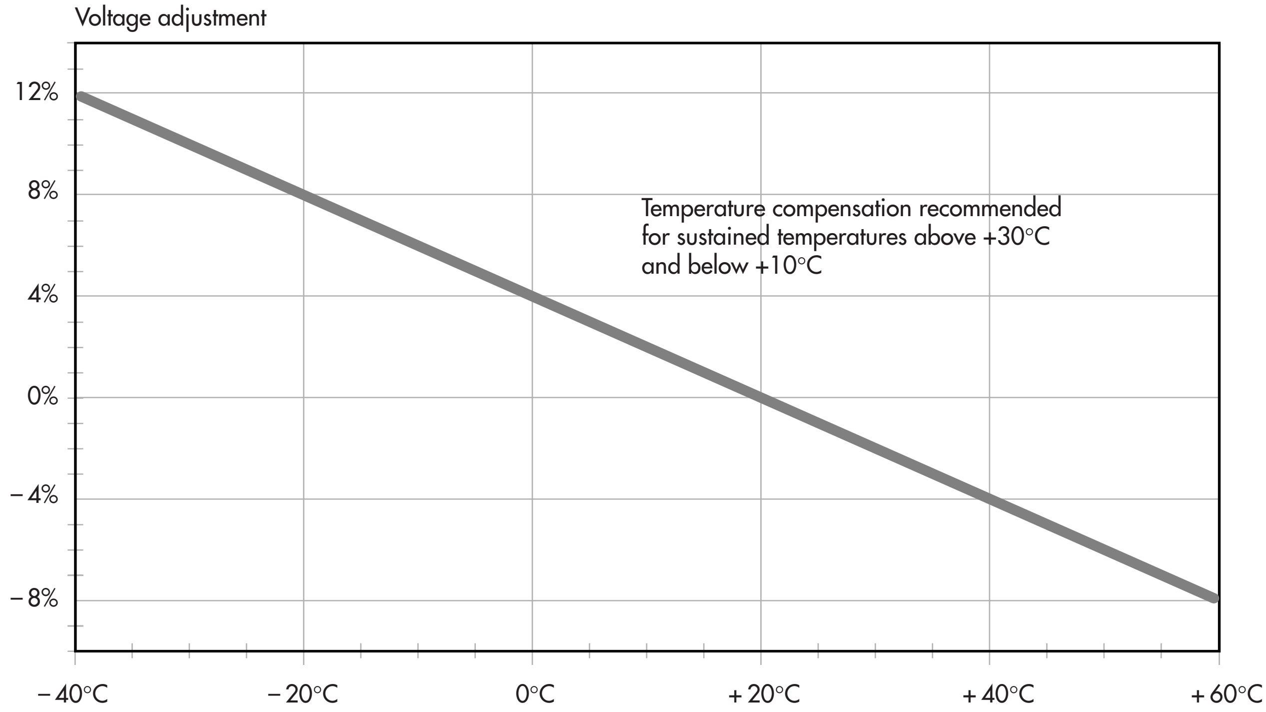


Figure 8: Charging voltage adjustment for sustained temperatures

6.4. Commissioning requirements

It is recommended that a good first charge should be given to the battery.

This is particularly true for discharged and empty cells which have been filled as they will be in a totally discharged state.

A constant current first charge is preferable and this should be such as to supply 300% of the rated capacity of the cell.
Thus, a 250 Ah cell will require 750 ampere hours input
e.g. 50 amperes for 15 hours.

In cases where it is not possible to provide constant current charging, it is possible to achieve this with a constant voltage by using a high voltage level. e.g. 1.65 voltage limit may be used for 20 to 30 hours if the current limit is approximately equivalent to the 5 hour charge current (cell rated capacity ÷ 5).
If the current rating is lower then the charge time should be increased accordingly.

When the charger maximum voltage setting is too low to supply constant current charging, divide the battery into two parts to be charged individually at a high voltage.

In the case of remote areas, where the only charger available is the photovoltaic array, charging may be possible.
The battery should be connected to the system with no connected load and no voltage limit.
The battery should then be charged, in good sunshine conditions, for approximately three times the calculated full charge capability of the solar array.

7. Special operating factors

7.1. Electrical abuse

7.1.1. Ripple effects

The nickel-cadmium battery is tolerant to high ripple and the only effect is that of increased water usage. In general, any commercially available charger or generator can be used for commissioning or maintenance charging of Sunica.

7.1.2. Over-discharge

If more than the designed capacity is taken out of a battery then it becomes over-discharged.
This is considered to be an abuse situation for a battery and should be avoided.

In the case of lead acid batteries this will lead to failure of the battery and is unacceptable.

The Sunica battery is designed to make recovery from this situation possible.

7.1.3. Overcharge

In the case of Sunica, with its generous electrolyte reserve, a small degree of overcharge will not significantly alter the maintenance period. In the case of excessive overcharge, water replenishment is required but there will be no significant effect on the life of the battery.

7.2. Mechanical abuse

7.2.1. Shock loads

The Sunica block battery concept has been tested to both IEC 68-2-29 (bump tests at 5 g, 10 g and 25 g) and IEC 77 (shock test 3 g).

7.2.2. Vibration resistance

The Sunica block battery concept has been tested to IEC 77 for 2 hours at 1 g.

7.2.3. External corrosion

Sunica nickel-cadmium cells are manufactured in durable polypropylene, all external metal components are nickel plated and these components are protected by a rigid plastic cover.

8. Battery sizing principles

The type of use of the PV system and the required reliability is of paramount importance in sizing the system.
Professional applications (emergency systems, sea-lights, radio beacons etc.) have to be oversized according to their importance and it is necessary to take into account the working conditions of the system.

It is not the purpose of this manual to give sizing methods for complete photovoltaic systems. However, this is an application with specific performance requirements and it is useful to discuss the different factors which can effect the design of the system and the battery sizing.

The array and battery size are related since the photovoltaic system must have array and battery sizes which are sufficient for the load to operate at all the required times throughout the year. The system could have a small array and a large battery or vice versa. However, there are limits to these sizes as, while the minimum array size is that which can deliver the annual daily load in the average daily insolation, the minimum battery size is that which can supply the overnight load.

The final choice of a particular combination of array size and battery size is related to the relative costs of each, their respective maintenance costs and their respective replacement frequencies.

❑ **The following factors have a major influence when sizing a photovoltaic system:**

- Insolation
- Photovoltaic array tilt angle
- Load size and profile
- Ambient temperature
- Maximum permissible depth of discharge of the battery
- System availability (autonomy)

❑ **Numerous other factors have a lesser but still significant effect:**

- Battery charging efficiency
- Battery charging current
- Ageing of array
- Safety margin
- Rate of self discharge of batteries
- Water consumption

The importance of each factor is discussed below and it is important that a battery manufacturer should supply such information where required.

The insolation is very important and the annual variation in average daily insolation is required. This is often available as average monthly insolation values and should be preferable averages over several years. For some types of sizing programs the number of consecutive days of low insolation is required.

The size and angle of tilt of the photovoltaic array affects the quantity of insolation which is converted into usable electricity. This is also influenced by the ambient temperature.

The load characteristics have a major effect on battery size. If the load demand is mostly during the middle of the day then the battery size will be smaller than if the load is during the night.

If it is possible to discharge the battery fully, then the battery size required will be smaller than if the batteries may only be discharged to a predetermined value. In deciding the maximum discharge depth, consideration must be given to its effect on battery life (section 5.7) e.g. if the battery size is halved by doubling the depth of discharge but the life of the battery is reduced four-fold then perhaps it may be better to restrict the depth of discharge and use a larger battery. Again, the ambient temperature affects the total available battery capacity (section 5.4).

The charging efficiency is the ratio of the energy supplied to the energy stored in the battery. This is dependent both on the ambient temperature and the state of charge of the battery.
It is important to allow for different charging efficiencies at extremes of ambient temperature and depth of discharge (section 6.2).

The charging current has an influence on charging efficiency and, as in photovoltaic applications the charging current is very variable, values used should be typical for low charging currents and it should take into account the ambient temperature (section 6.3).

The water consumption, has an indirect effect on the sizing of the battery as, if reduced maintenance visits to the site are required, it may be necessary to oversize the battery.
Correct choice of battery type and charging voltages can reduce considerably the water consumption (section 5.9).

Over the life of the photovoltaic system, due to ageing effects, the array output will decease slightly and the fully charged capacity of the battery will also decrease.
In addition, high ambient temperatures will have an affect on the lifetime of the battery.
Thus an over-sizing of the battery is required to allow for this (section 5.8).

In some applications where there may be periods of several weeks or more when the system is neither charged or discharged, the self discharge, or open circuit loss, of the batteries should also be considered (section 5.6).

Thus the battery information required for sizing a photovoltaic application is generally more extensive than that required for conventional systems.

Sizing methods

With regard to photovoltaic system sizing, there are fundamentally two different methods used. One method calculates the array size for a stated system availability and a range of battery sizes, the other uses the number of days of autonomy required for the system (based upon the maximum expected number of low insolation days) which determines the battery size and then calculates the array size. The former method is often known as "availability sizing", the latter as "autonomy sizing".

Autonomy sizing

Autonomy sizing is generally applicable where the insolation is fairly constant during the year, typically in the tropics, but it can be extended to any situation where a non-sunny period can be expected. Thus, it relies on a statistical analysis of consecutive non-sunny days and depends on an optimisation between cost and system availability.

For the battery sizing, it is fairly simple to carry out.

If the battery is assumed to be fully charged every day the following formula can be used:

Capacity = A x L x kt x kd x ka
where:
A = required autonomy (hours)
L = daily load
kt = temperature compensation factor (see Figure 1)
kd = compensation factor for maximum allowable depth of discharge (see Figure 3)
ka = compensation factor for ageing (see Figure 4)

Thus, as an example, we will take an application which requires an autonomy of 3 days (72 hours), but is usually only discharged to its design limit once every 2 weeks, has a normal ambient temperature of + 30°C and has a normal average daily load of 100 watts/48 volts. (see example below).

Autonomy sizing can be of two distinct types. The inter-seasonal storage type, where the array size (small) is chosen to produce enough energy to match the yearly load and the battery (large) is required to store sufficient energy produced in summer to supply the energy deficit in winter, or, the short term storage type, where the array size is chosen to cover the load demand in the worst sunlight period, and the battery size is chosen to supply energy over a prescribed number of days autonomy.

Availability sizing

Where the insolation data is not constant enough throughout the year to use autonomy sizing, then availability sizing must be used. This method of sizing requires meteorological data (e.g. Typical Reference Year for Europe or Typical Meteorological Year for US to give insolation and daytime temperatures) to be available and, for a particular tilt angle, the load and battery type are entered. The minimum array size is calculated from the array parameters such that it will supply just enough electrical energy in the year to meet the annual load. Using this minimum array size, the array size to meet the worst month for different battery sizes can then be calculated.
Once the array/battery size is found the battery life may be found from the number and depth of discharge and the optimum system produced.

Clearly, this iterative method requires many different parameters and is time consuming. Computer programs which carry out such an analysis are used by all major systems manufacturers and are beyond the scope of this manual. It is recommend that system sizing should be referred to such suppliers but if you do have difficulty to obtaining the information you need or finding a suitable system supplier do not hesitate to contact your Saft representative.

Autonomy = 3 x 24 = ... 72 hours
Daily load = 100/48 = ...2.1 A
Temperature compensation factor (Figure 1) = 1/1.04 = ... 0.96
Maximum allowable depth of discharge is calculated from life requirement (20 years) and number of cycles (26 per year) =........... 520
so discharge depth allowable (Figure 3) = ...90%
and so factor = 1/0.9 = ... 1.11
Compensation factor for aging at + 30°C (figure 4) = 20/18 = ... 1.11
So battery capacity = 72 x 2.1 x 0.96 x 1.11 x 1.11 = ... 178.8 Ah
Number of cells required = 48/1.2 = ... 40

and so the battery will be 8 blocks of Sunica type SUN 17-5.

9. Installation and storage

9.1. Emplacement

The battery should be installed in a dry and clean location away from direct sunlight, strong daylight and heat.

Sunica batteries can be fitted onto stands, can be floor mounted or can be fitted into cabinets.

Local Standard or Codes normally define the mounting arrangements of batteries, and these must be followed if applicable.
However, if this is not the case, the following comments should be used as a guide.

When the battery is housed in a cubicle or enclosed compartment it is necessary to provide adequate ventilation.

A typical figure for room ventilation is about 2.5 air changes per hour and under such conditions it is satisfactory to install 700 watt hours of battery capacity per cubic meter if the final charge current is at 0.1 C_5 amperes.

Note that special codes for ventilation may be applicable in your area and/or battery application. In case of doubt, please contact Saft for advice.

When mounting Sunica it is desirable to maintain an easy access to all blocks and they should be situated in a readily available position.
Distances between stands, and between stands and walls, should be sufficient to give good access to the battery.

The overall weight of the battery must be considered and the load bearing on the floor taken into account in the selection of the battery accommodation. In case of doubt, please contact Saft for advice.

When mounting the battery ensure that the cells are correctly interconnected with the appropriate polarity. The battery connection to load should be with nickel plated cable lugs.

The connectors and terminal screws should be corrosion-protected by coating with a thin layer of neutral vaseline or anti-corrosion oil.

Recommended torque for connecting screws are:

- M 6 = 11 ± 1.1 N.m
- M 8 = 20 ± 2 N.m
- M10 = 30 ± 3 N.m

To avoid accelerated ageing of the plastic due to UV-light, batteries with plastic cell containers should not be exposed to direct sunlight or strong daylight for a prolonged period.

9.2. Electrical

Batteries may be supplied charged and filled or discharged and empty.

9.2.1. Batteries supplied charged and filled

When the battery is received remove immediately the plastic transport seals. The battery is ready for installation.

A filled battery can be stored for a maximum of 1 year and should be given a commissioning charge as described in section 6.4 before putting into service.

Cells delivered filled have already the cell oil in place.

9.2.2. Batteries supplied discharged and empty

When the battery is received do not remove the plastic transport seals until ready to fill the battery with electrolyte.

A fully discharged, empty battery with its transport seal can be stored for many years.

When filling the cells refer to the "Electrolyte Instructions" data sheet supplied with the electrolyte.

The electrolyte type to be used for the first filling is: E30.

The cell oil must be added to reduce water loss due to evaporation and self discharge. Add the oil with a syringe, according to the quantity indicated in the Installation and operating instruction sheet.

After filling with electrolyte the battery should be given a full charge discharge cycle (300% charge, discharge to 1.0 volt/cell) before passing to the normal commissioning charge described in section 6.4.

10. Maintenance of Sunica batteries in service

In a correctly designed standby application Sunica requires the minimum of attention.

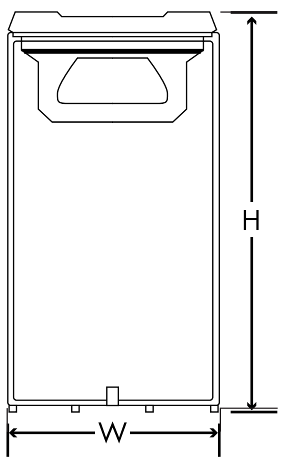
However, it is good practice with any system to carry out an inspection of the system once per year or at the recommended topping up interval period to ensure that the charger, the battery and the ancillary electronics are all functioning correctly.

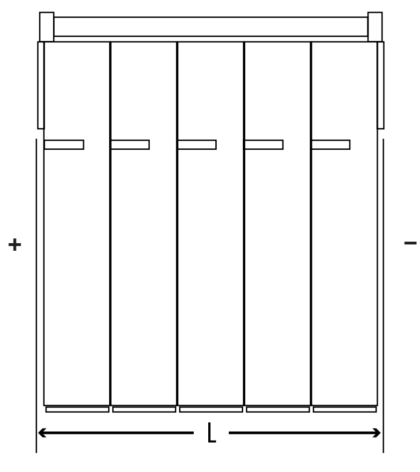
When this system service is carried out it is recommended that the Sunica cell electrolyte levels should be checked visually to ensure that the level is above the minimum and if necessary the cells should be topped up.

The batteries should also be checked for external cleanliness, and if necessary cleaned with a damp cloth and the cover should be removed to check that the connections are tight, that the protective grease on the terminals remains intact and that the vents are clean.

11. Sunica battery range

Type	Voltage (V)	Capacity (Ah) 100 h to 1.2 V	Dimensions (mm) L	W	H	Weight (kg)	Electrolyte (l) Total	Reserve
SUN 3-2	2.4	35	63	195	349	5	0.74	0.22
SUN 3-3	3.6	35	88	195	349	8	0.74	0.22
SUN 3-5	6.0	35	137	195	349	13	0.74	0.22
SUN 7-2	2.4	70	85	195	349	8	1.08	0.35
SUN 7-3	3.6	70	121	195	349	12	1.08	0.35
SUN 7-5	6.0	70	192	195	349	21	1.08	0.35
SUN 10-2	2.4	105	109	195	349	11	1.31	0.48
SUN 10-3	3.6	105	157	195	349	17	1.31	0.48
SUN 10-5	6.0	105	252	195	349	28	1.31	0.48
SUN 14-2	2.4	143	133	195	349	14	1.84	0.61
SUN 14-3	3.6	143	193	195	349	21	1.84	0.61
SUN 14-5	6.0	143	312	195	349	37.5	1.84	0.61
SUN 17-2	2.4	178	165	195	349	17	2.17	0.75
SUN 17-3	3.6	178	238	195	349	25.5	2.17	0.75
SUN 17-5	6.0	178	377	195	349	42.5	2.17	0.75
SUN 21-2	2.4	214	189	195	349	19	2.60	0.88
SUN 21-3	3.6	214	274	195	349	29	2.60	0.88
SUN 21-5	6.0	214	437	195	349	48	2.60	0.88
SUN 24-2	2.4	251	228	195	349	24	3.25	1.10
SUN 24-3	3.6	251	336	195	349	36	3.25	1.10
SUN 28-2	2.4	286	252	195	349	27	3.78	1.20
SUN 28-3	3.6	286	372	195	349	40.5	3.78	1.20
SUN 31-2	2.4	322	278	195	349	31	4.00	1.35
SUN 31-3	3.6	322	411	195	349	46.5	4.00	1.35
SUN 35-2	2.4	358	304	195	349	32	4.24	1.50
SUN 35-3	3.6	358	450	195	349	48	4.24	1.50
SUN 38-1	1.2	393	171	195	349	18	4.77	1.65
SUN 42-1	1.2	429	183	195	349	19	5.20	1.75
SUN 52-1	1.2	537	232	195	349	25.5	6.40	2.25
SUN 63-1	1.2	645	268	195	349	29	7.80	2.65
SUN 70-1	1.2	717	304	195	349	34	8.60	3.00
SUN 84-1	1.2	860	352	195	349	38.5	10.40	3.50
SUN 87-1	1.2	896	377	195	349	42.5	10.60	3.75
SUN 104-1	1.2	1070	437	195	349	48	13.00	4.40





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