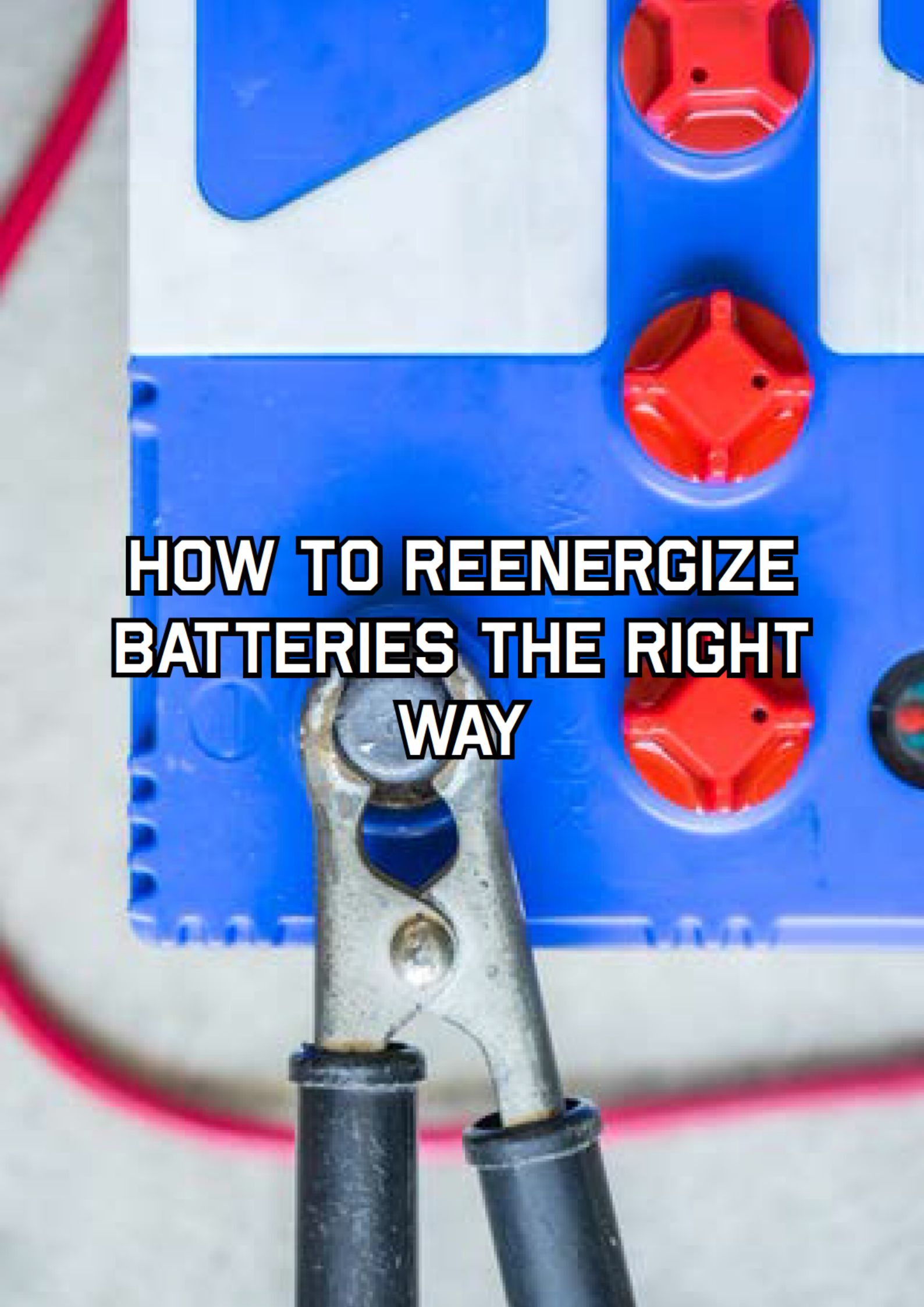




HOW TO REENERGIZE BATTERIES THE RIGHT WAY

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INTRODUCTION

The use of rechargeable batteries is widespread. Everything from cordless tools to cordless phones and cell phones, to laptop computers uses rechargeable batteries. It's pretty safe to say that life would not be the same without rechargeable batteries! The battery market is a 15-billion-dollar industry in the United States and keeps the country functioning in many ways.



The problem is that rechargeable batteries wear out so that they do not recharge as they are supposed to or run down very quickly, stranding the user without the ability to use their device or tool. Purchasing new batteries for so many devices and tools can be expensive. And there could come a time when it is

difficult or impossible to simply go out and buy another rechargeable battery. Where would you be then, when your devices and many of your tools are dependent on rechargeable batteries?

Fortunately, there is a way to recondition most batteries to extend their life and to get by when the battery fails at a terribly inopportune time. Even though most battery types can be reconditioned, in this report, you will learn all that you need to know about 12-volt lead-acid batteries, how to test them and how to recondition them. You will also learn about two specific types of batteries that you can work with. These are forklift and golf cart batteries. They are two of the most important types of batteries you can find and refurbish today.

Following the easy step-by-step guide anyone, yes anyone, can recondition batteries and save a lot of money, time, and frustration. Once you learn how to recondition batteries, you can show family members, co-workers, and friends how to recondition their batteries, too.

So let's get started so you can be "recharged" and on your way with using your tools and devices without delay!



1 ALL ABOUT LEAD-ACID BATTERIES

Rechargeable batteries are the current dominant technology for green energy for cell phones, laptops, and even electric and hybrid vehicles.



Engineers are constantly improving and refining storage capacity and performance of batteries because they are so widely used in so many ways and will continue to be so in

the future.

The original rechargeable battery was the 12-volt lead-acid battery. It is the oldest type of rechargeable battery. The battery was invented by French physicist Gaston Plante' in 1859. Plante's original model of the lead-acid battery was a very simple model that contained two sheets of lead that were separated by rubber strips that were rolled into a spiral and submerged in a solution that contained about 10% sulfuric acid. About a year after the original model, Plante' presented a more sophisticated model to the Academy of Sciences. The advanced

model included nine elements housed in a protective box with the terminals connected in a parallel pattern.

Standard, gasoline-powered transportation vehicles still use a 12-volt lead-acid battery. Most likely, it is the type of battery that you have in your car. The battery is also used in RVs, golf carts, boats and watercraft, recreational vehicles, scooters, and for alternative energy applications such as battery banks. With the surge of the tiny-home movement,

battery banks have become very common power sources for electricity for the tiny homes, and people who desire to live “off the grid” often use battery banks for storing power that can be transformed into different voltages and amperages to run refrigerators and other household appliances.

The lead-acid battery remains the most-used type of storage battery, in part, due to the fact that newer battery types are considerably more expensive. Though it is good to be aware that other rechargeable batteries such as nickel cadmium (Ni-Cd), nickel metal hydride (Ni-MH), and lithium ion (Li-ion) are also widely used in many applications on a daily basis by most

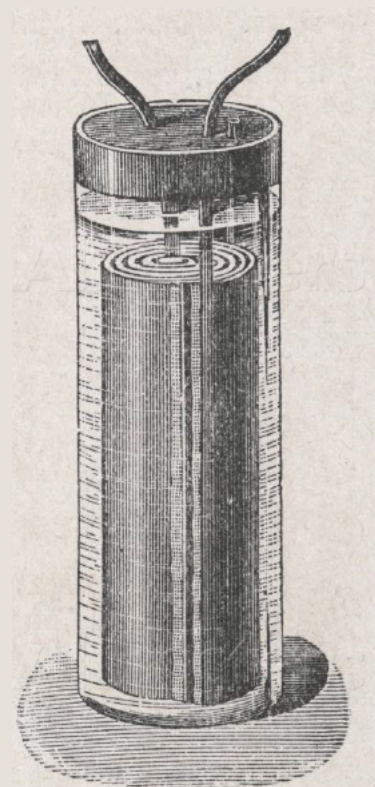


Fig 117. Plante-Accumulator.

people.

When a new lead-acid battery is purchased, it retains a charge for long periods of time and can easily power whatever it needs to power. You probably know that good feeling of having a fresh battery in your car and not having to worry about whether it will start or not! But over time, and once the battery gets older and has been thoroughly used for some time, chemical reactions take place that affects the battery's ability to retain



a charge. The battery loses the function of retaining a full-capacity charge and is not reliable for our instant and “on the go” society that expects reliable, instant power as needed. Due to its wide application, every day thousands of batteries are discarded when they fail. Many of these batteries could possibly be reconditioned and remain in service for several months lon-

ger.

The disposal of the batteries is an environmental problem because they contain toxic lead and chemicals. The batteries must be disposed of under specific conditions and at certain designated places as determined by the government of your location. In many places, it is illegal to dispose of lead-acid batteries in any way other than by the strict guide set forth by laws. Always follow the guide for your area for disposal of lead-acid batteries. Here you can find more information on disposing of lead-acid batteries here: www.EHSO.com/battery.php

With the cost of batteries as high as it is, and with the dilemma of disposing of batteries, it only makes sense to recondition the batteries, yet few people realize that it can be done and even fewer people actually know how to do it. After reading this guide, you will be one of the few people who understands lead-acid batteries and how to recondition them.

Before you get started on the steps of reconditioning a battery, it's important to discuss some safety and environmental issues regarding battery reconditioning.

SAFETY PRECAUTIONS AND POTENTIAL HAZARDS WHEN WORKING WITH LEAD ACID BATTERIES

When it comes to the correct methods of handling lead acid batteries, there is no room for poor decision-making. It is important that we utilize the appropriate facilities, tools, and methods to ensure optimal care levels at all times. The following guide indicates some of the notable hazards that may come up along with the precautions to be considered when handling lead acid batteries. Although these tools are excellent power mechanisms for various mechanical tools such as cars, some noteworthy hazards and precautions must be taken into consideration.

POTENTIAL HAZARDS

Lead acid batteries contain a significant amount of sulphuric acid. This chemical is highly hazardous, and it's often in the form of a fine mist or liquid droplets that are produced during the battery charging process. This

liquid is corrosive and harmful to one's health and may also lead to burns and skin irritation. Spilling the acid may also compromise your soil structure and even cause harm to your plant life as well. There is a chance that

sulphuric acid could leak from a battery. You must be extremely cautious when handling it.

PRECAUTIONS

You have to handle your batteries with the appropriate amount of care. In fact, you are not supposed to pour more than the stipulated amount of sulphuric acid into your battery amount since this might lead to an overflow. More so, when you are charging your lead acid batteries, ensure that you charge your batteries in an area with sufficient

ventilation mechanisms. In this way, you can easily mitigate the effects of sulphuric gas in the air, which might compromise your health.

Another notable factor to consider is that you should also use the appropriate protective clothing. For instance, ensure that you have gloves that cover your hands and reach all the way up to your elbows.



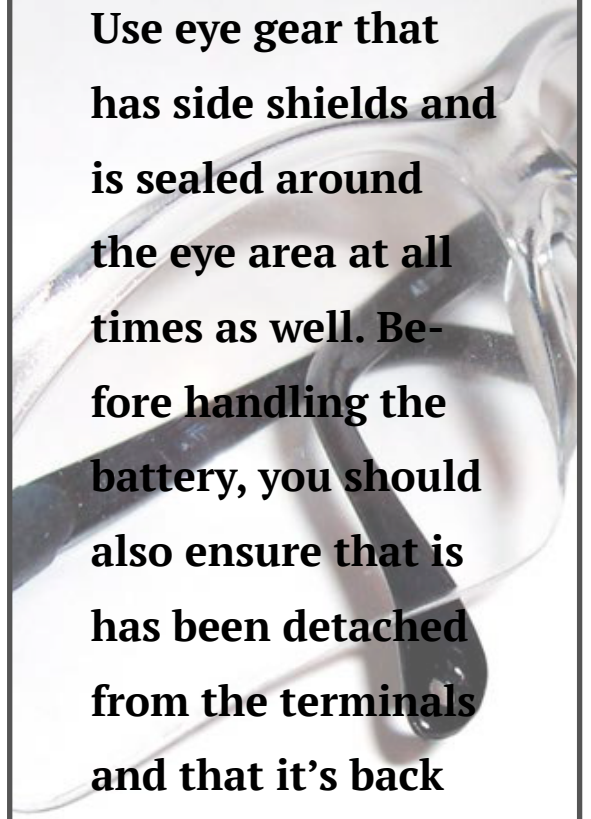
You must not smoke while working with the batteries, especially when charging them. An explosion could occur if the gas that is produced during the charging session comes into contact with the sparks or flames from a cigarette or cigar, etc.

Have a chemical spill response kit available to use in the event of a spill.

Have an eye-wash kit available in case you get acid splashed in your face or eyes.

Be extremely cautious when taking care of your batteries. You must see that they are handled properly and with enough caution in mind.

Use eye gear that has side shields and is sealed around the eye area at all times as well. Before handling the battery, you should also ensure that it has been detached from the terminals and that it's back to normal temperature levels.



KNOW THE TYPE OF BATTERY YOU ARE WORKING WITH

There is more than one type of 12-volt lead-acid battery, and it's important that you know which type you are working with so you can recondition it correctly and work safely.

Here is a list of battery types:

STARTING LIGHTING AND IGNITION (SLI)



Starting lighting and ignition batteries, otherwise known as automotive batteries, are rechargeable batteries that can be used to supply energy to an automobile. The main purpose of an SLI battery is to start the engine of a vehicle. When the engine is

successfully running, an alternator in the car supplies the power required. In most cases, the starting battery will discharge a maximum of the 3% of the battery power.

SLI batteries are perfect for releasing large amounts of current, which is often indicated as amperes while recharging with

efficiency as well. However, it is important to note that these batteries are designed for full charges. If the battery is not fully charged, the lifespan of that battery could be reduced. Aside from serving as an engine start mechanism, the SLI battery can also provide sufficient power required to operate the electrical components of the vehicle.

DEEP CYCLE BATTERIES

A deep cycle battery is a lead acid battery that is perfect for deep discharging by utilizing the overall capacity of the battery. On the contrary, the starter batteries that are found in many automobiles are perfect for providing short bursts of power for activating the car engine, which leads to a small amount of discharge.



Although deep cycle batteries are ideal for automotive power supply needs, their lower cranking current levels means that a larger battery size might be required. It is also important to note that the deep cycle batteries are made for discharging an average of 45% and 75% of the battery capacity at a given time. The specific amount that is discharged is often based on vari-

ous factors. This includes the brand manufacturer as well as the design construction of the battery. Although it is possible to cycle these batteries down to a 25% charge, it is much better to maintain the battery at an average of 45%.

DUAL PURPOSE BATTERY

The dual purpose battery is a combination of the starting battery and the deep cycle battery. It is often used to start the engine of a boat or RV and also as secondary power for the RV lights, refrigerator, etc.



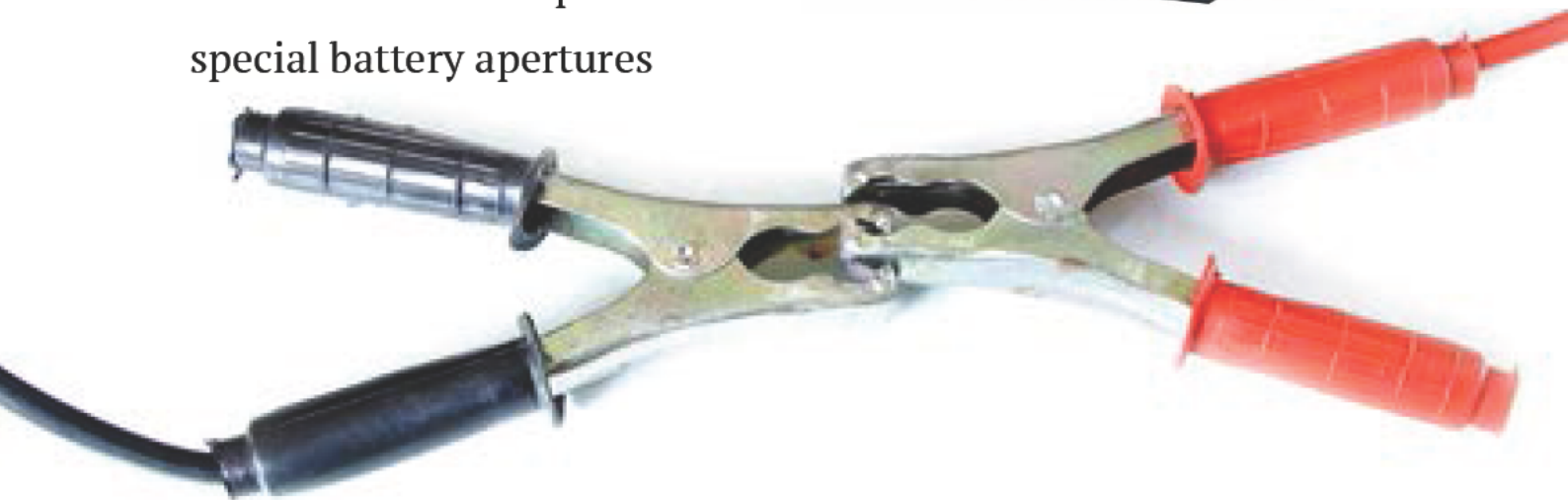
VENTED BATTERIES

The vented cell battery comes with a unique pressure release valve that will release any toxic gases produced during normal operation. Therefore, this helps to mitigate the effects of rupturing the cell casing.

There are various types of vented batteries. These batteries are referred to as flooded batteries due to their unique method of utilizing liquid electrolytes to provide power. In particular, the liquid electrolyte refers to sulphuric acid that is placed in diluted water.

Just as the name suggests, these batteries comprise of special battery apertures

which will release any hydrogen gasses continuously into the air. In most cases, the batteries are often placed in dedicated locations to reduce the likelihood of toxic gases from mixing with the normal air supply. The vented design makes them perfect for releasing the gases to ensure optimal battery capacity.



SEALED BATTERIES



Sealed lead acid batteries otherwise known as VRLA batteries are unique lead acid batteries that are both rechargeable and durable as well. This is because these batteries come with special design constructions that comprise of gel and an absorbed glass mat that can be placed at almost any angle.

Sealed batteries will still require regular functional testing and cleaning to ensure optimal functionality. These batteries are prevalent solu-

tions for portable electrical devices and off-grid devices where large amounts of electrical energy are required for an affordable cost. More so, these batteries come with unique valves that can be activated when the battery accumulates a significant amount of hydrogen gas, which is generally caused by recharging. Sealed acid batteries are by far one of the most common types of batteries available today. The process of valve activation might cause some gasses to escape, thereby decreasing the overall capacity of the given battery.

SUBCATEGORIES

There are various versions/subcategories of the lead-acid battery, including the wet cell, gel cell, and absorbed glass mat (AGM).

The wet cell comes in two versions: serviceable and maintenance free. The serviceable and maintenance free are both filled with electrolyte but the serviceable is one that you can add water to and check the electrolyte and specific gravity of the electrolyte with a hydrometer. The maintenance free battery is just as implied by the name—you can't service it yourself.

The gel cell is a specialty battery, as is the AGM. The cost for these two batteries is generally about double that of the wet cell battery.



The AGM battery provides a great life span and greater cycle life than a wet cell battery. These batteries store well and don't tend to degrade or sulphate as quickly and easily as the wet

cell battery. These batteries are also about the safest lead-acid batteries available. The risk of hydrogen gas explosion is much lower.

The AGM battery is, technically, a wet cell battery, but is excellent for applications such as marine, RV, solar, or audio, as they will hold their charge better than other types, even when the equipment is not used every day. The construction of the AGM allows the electrolyte to be suspended in close proximity to the plates' active material. This is supposed to enhance the discharge and recharge efficiency.

The gel cell is very similar to the AGM battery in regard to the suspended electrolyte, but the electrolyte in a gel cell has a silica additive that causes it to stiffen (gel). The recharge voltage on the gel cell battery is lower than the other types of lead-acid batteries, and is the most sensitive cell in regard to adverse reactions to over-voltage charging. The gel batteries are best used in very deep cycle applications. It's important to use the right battery charger on the gel cell battery or the result will be poor performance or premature failure.

Most people do not realize that AGM and sealed lead-acid batteries can be reconditioned, but they can. Since the batteries are more expensive, it can be worth the effort to recondition them.

WHAT MAKES LEAD ACID BATTERIES SO POPULAR?

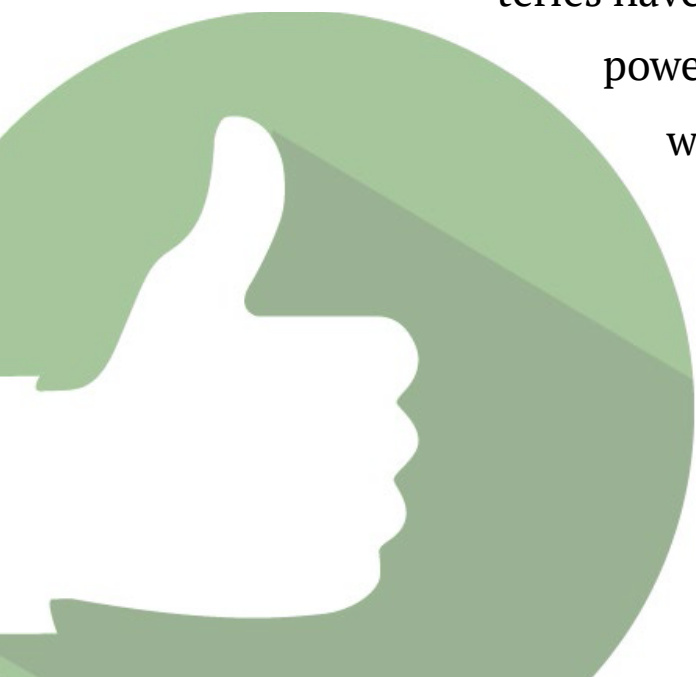
Obviously, there are advantages and disadvantages with the 12-volt lead-acid batteries. Some of the disadvantages are being addressed with technology and newer types of batteries. But the newer batteries can be cost prohibitive. Some of the advantages of the lead-acid battery are as follows:

SUPERIOR CONSTRUCTION DESIGN

Since the introduction of the first lead-acid battery, the capabilities of some of these things have been improving over the years. The liquid electrolyte that was found in the old batteries has been replaced with moistened operating materials. The battery apertures were closed on some models too.

Besides that, these batteries feature additional safety valves that provide enhanced ventilation levels, especially during the charging and discharging procedure. Nowadays, lead acid bat-

teries have become central aspects of how we power most of the mechanical tools that we own. These things have several advantages and can be used in as many different ways.



SIMPLE TO MANUFACTURE AND MAINTAIN

Another important benefit of the lead acid batteries is that they are simple and affordable to produce. In fact, there are various types of lead acid battery brand companies to choose from.

These batteries are simple to produce as when compared to the conventional forms of batteries.

More so, lead acid batteries are simple to recondition by using DIY tools such as Epsom salts and various other additives at home. These batteries have a minimal discharge rate and are therefore effective for different applications such as in automobiles.

ENVIRONMENTALLY FRIENDLY

Although the sulphuric acid and lead found in many batteries are harmful to the environment, it is important to note that well over 98 percent of lead acid batteries manufactured today are recycled. Therefore, instead of polluting the land in the form of landfills and non-recyclable materials, the lead acid batteries that exceed their life span or are perhaps ineffective are perfect for recycling procedure. Most brand manufacturers have specific collection points in vari-



ous points where individuals can collect the damaged batteries.

OTHER ADVANTAGES:

- **Lower cost than other types of batteries**
- **Reliable and proven with over 100 years of development**
- **Can deliver very high currents**
- **Sturdy and can take a lot of abuse without failing**
- **Can be stored indefinitely if electrolyte liquid is removed first**
- **Wide range of sizes, manufacturers, price ranges, and capacities available**
- **Tolerant to overcharging**
- **Power goes into the battery and out of the battery efficiently**
- **Can be reconditioned for longer life span**
- **Are recyclable**

DISADVANTAGES

Some disadvantage of the lead-acid battery includes the following:

- **Bulky and heavy**
- **Does not charge extremely quickly**
- **Has typical life span of 300-500 cycles**
- **Must be stored in a charged state after the electrolyte has been introduced in order to avoid deterioration of the active chemicals**
- **Danger of overheating during charging**
- **Coulombic charge efficiency is typically only 70% but may be as high as 85% to 90% for specially designed batteries**



THE CONSTRUCTION AND FUNCTION OF THE LEAD-ACID BATTERY

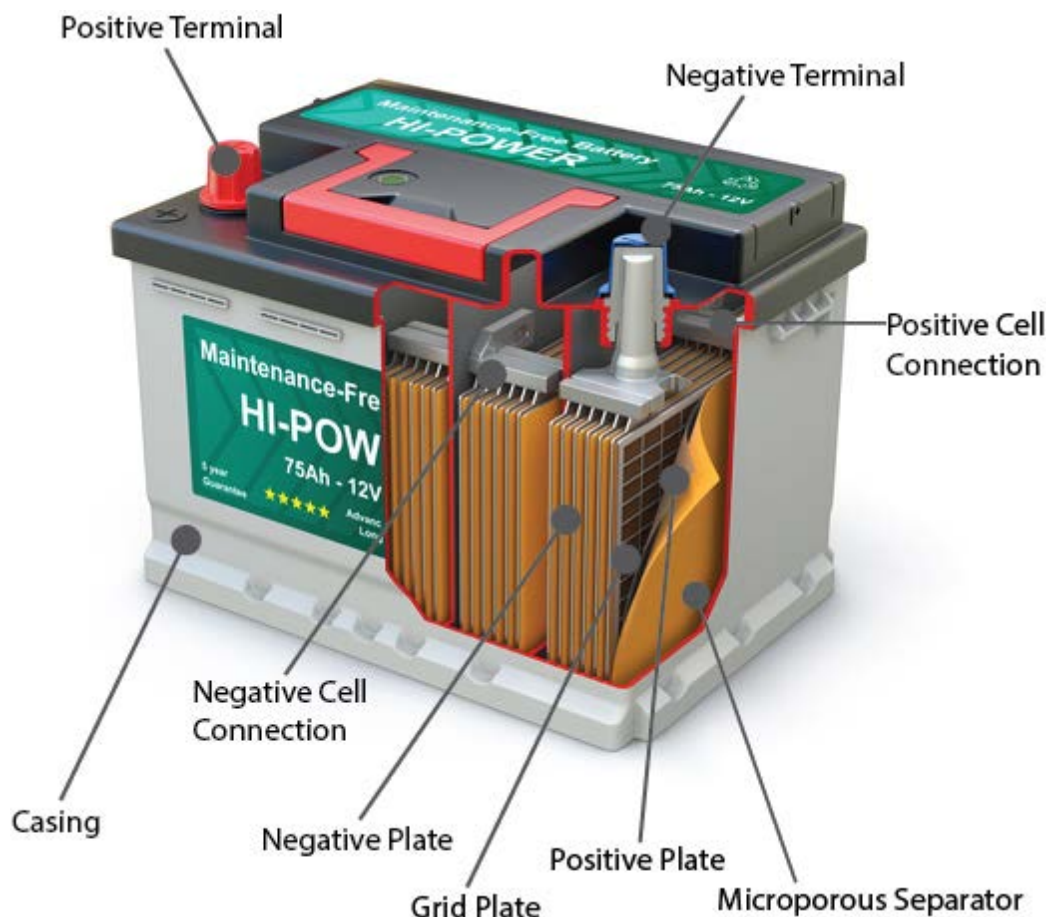
A 12-volt lead-acid battery supplies power to the starter and ignition system of your car to start the engine of the car. It is often referred to as a “starter battery.” The battery supplies the extra power that is needed when the car’s electrical load exceeds the supply from the charging system. The battery is also a voltage stabilizer in the electrical system of the car; it evens out the voltage spikes so the other components of the electrical system are not damaged.

As you read in the previous section, not all lead-acid batteries are exactly the same. But, typically, the different battery types still have the same general insides. Let’s take a look at the inside of a typical 12-volt lead-acid battery so you can be familiar with it when you get ready to test and recondition a battery.



THE BASIC DESIGN AND PARTS OF A 12-VOLT BATTERY

- The positive plate, which is covered by a paste of lead dioxide
- Negative plate that is constructed using malleable lead material
- Separator that is an insulating tool between the two plates; it allows the electrolytes and ions to enable conduction without the two plates touching
- Electrolytes that comprise of sulphuric acid and water



All these components can be found in the plastic container used to hold the battery and the electrolyte in position. The entire battery might comprise of several cells that are placed in a series to provide the desired amount of voltage. This is all with each cell being able to produce EMF forces that average 2.1 volts.

To enable the basic lead acid cell to produce sufficient voltage, the cell must first receive sufficient charge. The applied voltage must be greater than 2.1 Volts to allow the inflow of current rather than an outflow. An overcharged cell or battery will deliver sufficient charge to the external circuits, which can often function for several hours with regards to the drain caused by the battery cell.

THE THREE PHASES

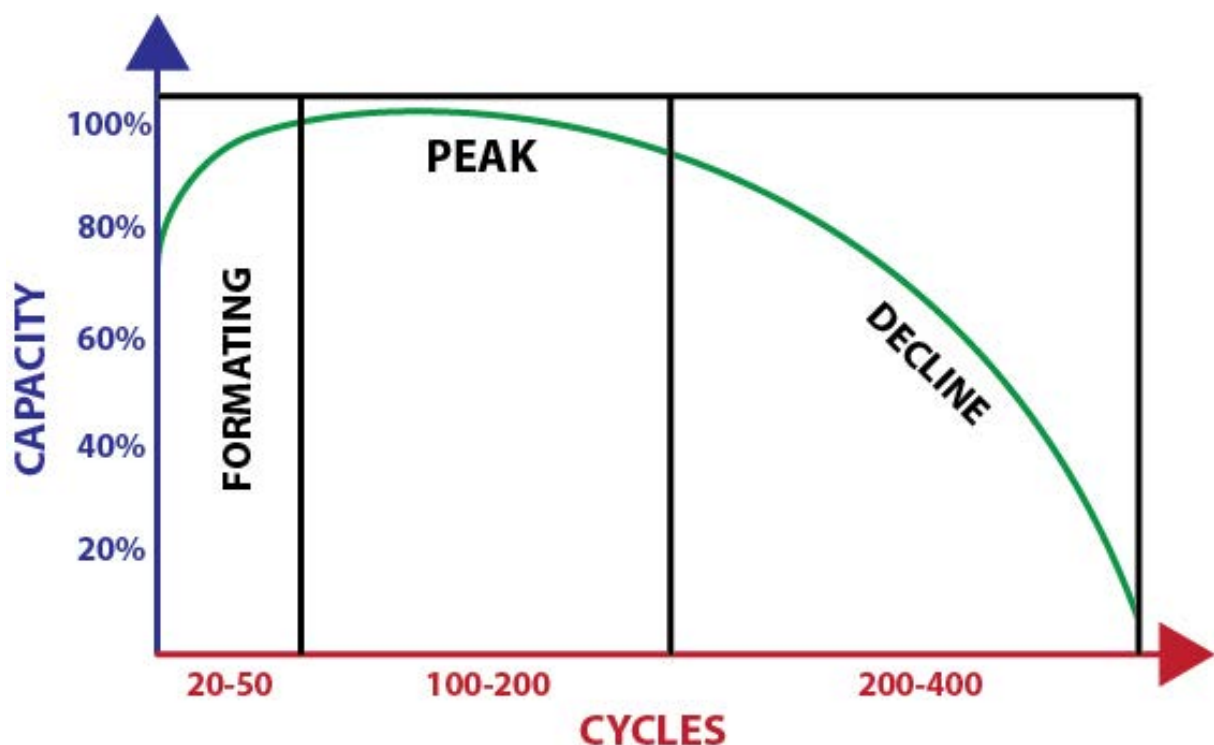
Lead-acid batteries go through three phases in their life span—formatting, peak, and decline.

During the formatting phase, also known as the charging phase, while charging the battery, the lead plates absorb the electrolyte (liquid) to coat all of the functional areas. When you charge the battery fully for the first time, it still has not reached its full capacity. Typically, a lead-acid battery needs 50 to 100 cycles (charging/discharging/recharging) before it reaches full capacity. Most deep cycle batteries only require about 20

to 50 cycles.

The second phase of the battery, peak capacity, is after your battery has been slowly broken in. This will be the time when your battery is at its peak performance. Naturally, you'll want to take good care of your battery during this time to make the battery stay in this phase, before the decline, as long as possible. During the peak capacity phase, regularly use your battery so that it doesn't sit idle for long periods of time. Even if you do not drive your car for a while, start the car and let it run for a little bit to keep the battery in good condition.

After as many cycles as your battery was manufactured to function, and depending on the way the battery was used and maintained, it will go into the decline phase. The battery will not stay charged for the same length of time that it did when it was

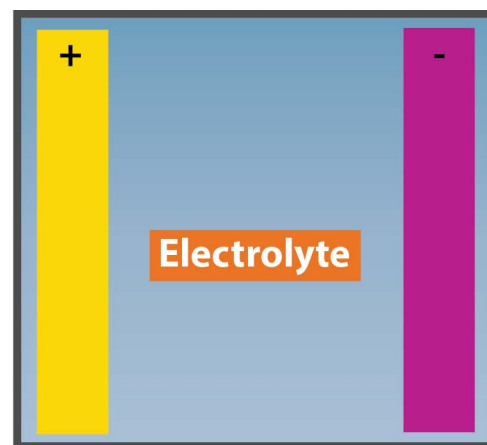


in the peak performance phase and will continue to decline as you use it.

A storage battery is somewhat like a savings account—if you keep taking money out and do not put money in, the account will eventually be empty. Today's vehicles are manufactured with a lot of electrical devices that require a reliable power source. If your battery is in the decline phase and you do not restore or replace it, you may be risking expensive electronic component failure. Today, with the increased energy demands, the average battery life has lessened. It's not common for 48-month batteries to last until the 48th month.

HOW THE 12-VOLT BATTERY WORKS

As stated above, all lead-acid batteries have two flat plates—a positive plate with lead dioxide, and a negative plate made of sponge lead. The two plates are submerged in electrolyte, which is a liquid that is about 35% sulfuric acid and 65%



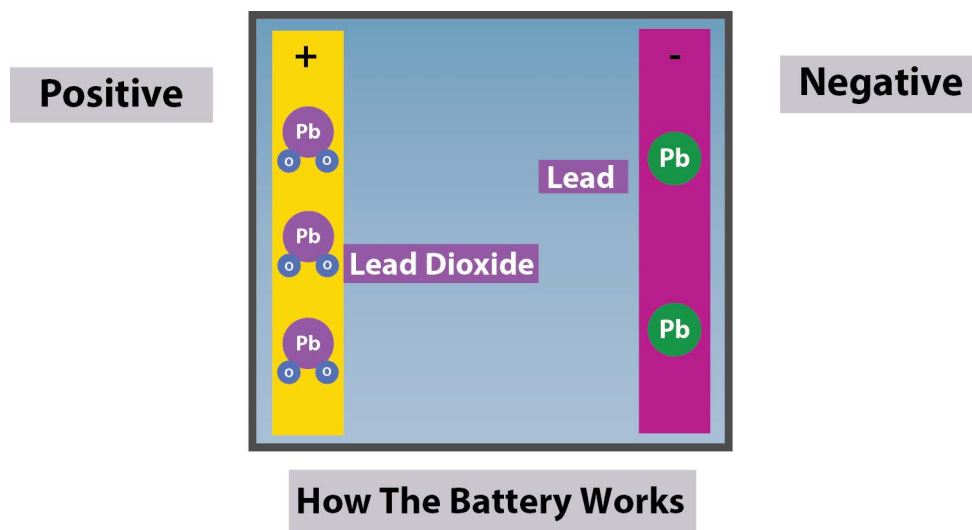
How The Battery Works

The Electrolyte inside the battery cells reacts with the two battery plates.

water.

When electrons are produced from the chemical reaction, voltage is produced. Electricity flows when there is a circuit between the positive and negative terminals. This flow

age. Lead-acid batteries are known as storage batteries and cannot generate their own voltage. Without being charged, the storage battery cannot charge. Thus, when your battery on your car goes



This chemical reaction creates electric current that powers the load.

of electricity provides power to the connecting sources.

A lead-acid cell of the battery receives a charge of at least 2.1 volts per cell from a charger and produces volt-

dead, you must have another source for recharging it, and the usual source is using battery cables hooked up to your battery and the battery of another car to charge your

battery.

The amount that a battery can depend of the bat- and the electrolyte

The storage

a lead-acid battery is referred to as the amp-hour (AH) rating of the battery. The voltage is approximately 2 volts per battery cell for a typical lead-acid battery, giving it a rating of 125 AH.

This means the battery has the ability to supply 10 amps of

current for

12.5 hours or

current for a

hours.

A battery

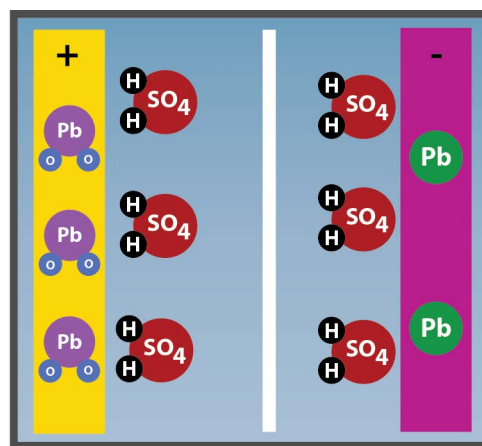
fully charged

flows into it

source, and

charges as it

er to some-



The Battery Is Fully Charged

Currently the battery is fully charged.

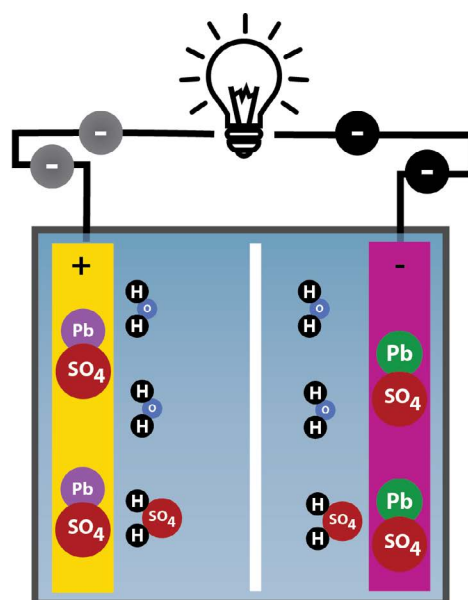
of charge lead-acid store is on the size tery plates amount of that it holds.

capacity of

a period of 20 amps of period of 6.25

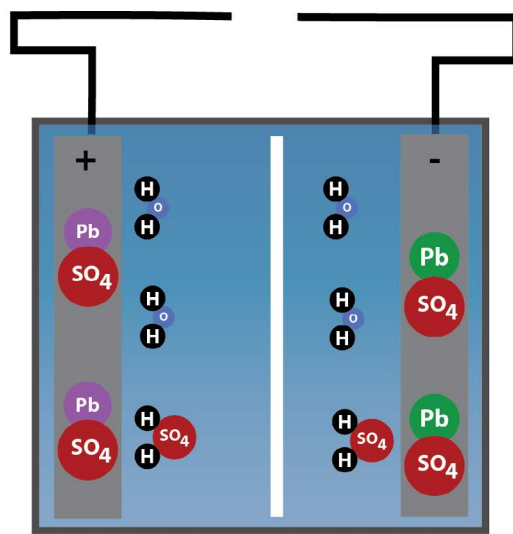
becomes when current from another then dis- supplies pow-

thing else



The Discharge Process

The sulphate crystals in the electrolyte will react with the lead plates'



The Battery Is Empty

After the chemical reaction is completed both plates are transformed into lead sulphate.

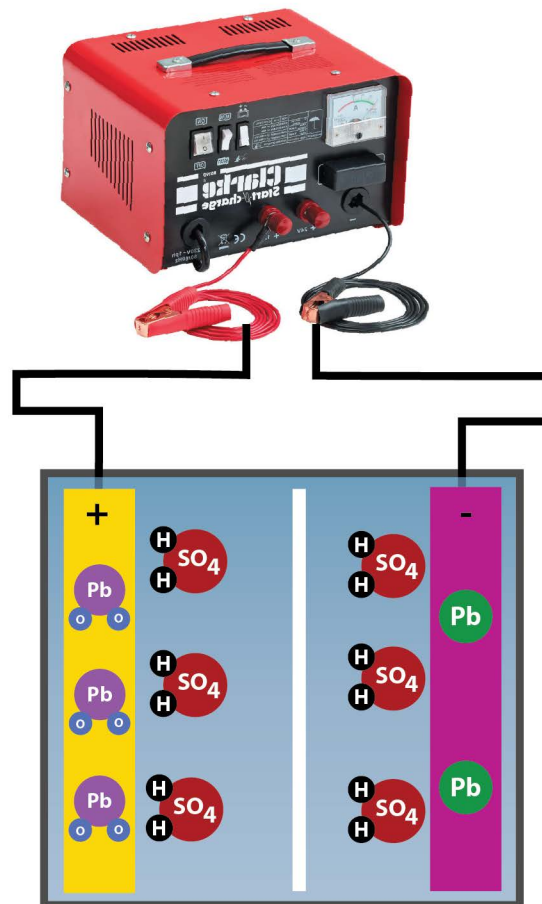
such as a car. This is a constant cycle of a battery that is in use. As this happens the acid weakens and the voltage of the battery drops.

After a time, usually within six months up to around four years, depending on

the cost of the battery and how it is used and maintained, the battery becomes discharged and loses the ability to recharge and provide enough voltage. The operating temperature of the battery significantly impacts how long the battery will last. The optimum operating temperature for the lead-acid battery is 77 degrees Fahrenheit. Higher temperatures can reduce the lifespan of the battery.

As an example, a battery that would last for ten years at 77 degrees Fahrenheit would only last for about five years if operated at 92 degrees Fahrenheit. So, now you know that it's not just a case of "bad luck" if you live in an area where the temperatures soar and your battery must be replaced yearly—and always

seems to fail you on the hottest day of the year when you need your air conditioner in the car!



Battery Charging Process

During the charging process the lead sulphate plates are slowly transformed again back into their original form of lead and lead dioxide

COMMON ISSUES OF THE LEAD-ACID BATTERY

Now that you understand how lead-acid batteries work, you understand why batteries can be reconditioned. Before you attempt to take apart a battery and recondition it, it's important that you understand the common issues that affect the lead-acid batteries.

SULPHATION AND SULFATING IN RELATION TO BATTERIES

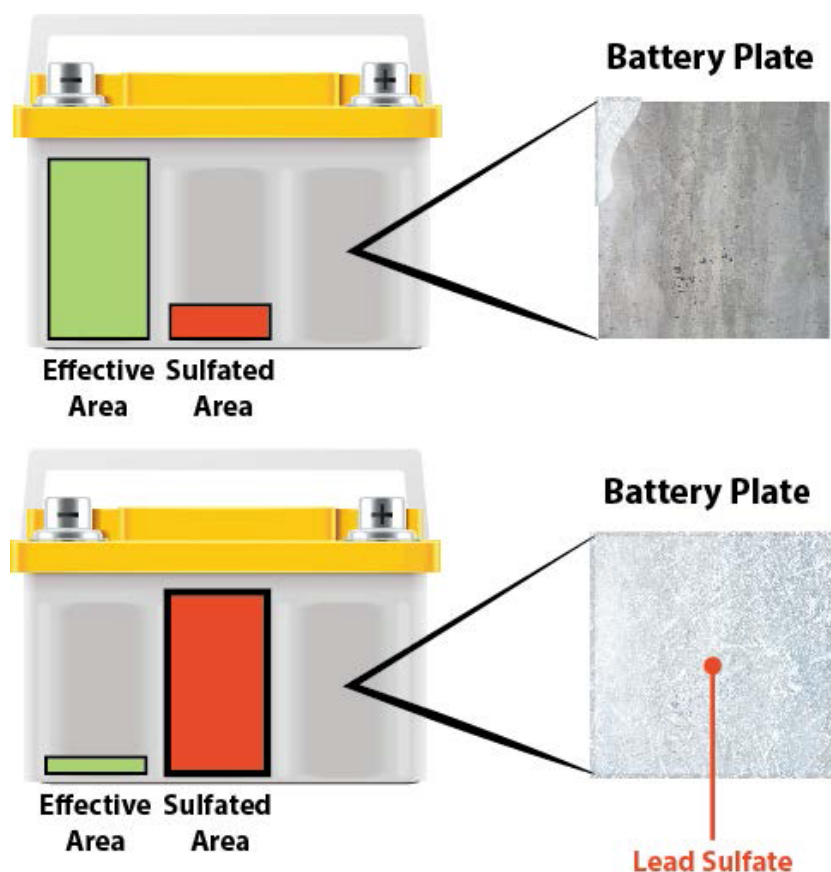
Lead-acid batteries may lose their charging capabilities, especially when discharged for a significant duration. This is due to the effects of sulfation or perhaps the crystallization of lead sulfate. These batteries will produce electrical power by using a unique double sulfate chemical process.

In this case, the active materials are found on the battery plate. The lead elements will react with the sulphuric acid. As a result, lead sulfate is produced as a fine mist that can be easily converted to lead dioxide or sulphuric acid, especially when the discharging procedure occurs.

These batteries will often go through several charging and discharging sessions before they wear out. Having said that, the

lead is not recombined into the electrolyte, and it may even convert into a crystalline form that is stable and no longer dissolves during the recharging procedure. Therefore, not all the lead in the battery is returned to the plate, and the amount of usable material that is used for active electricity production reduces as time passes. Simply put, the life of the battery will decline over time.

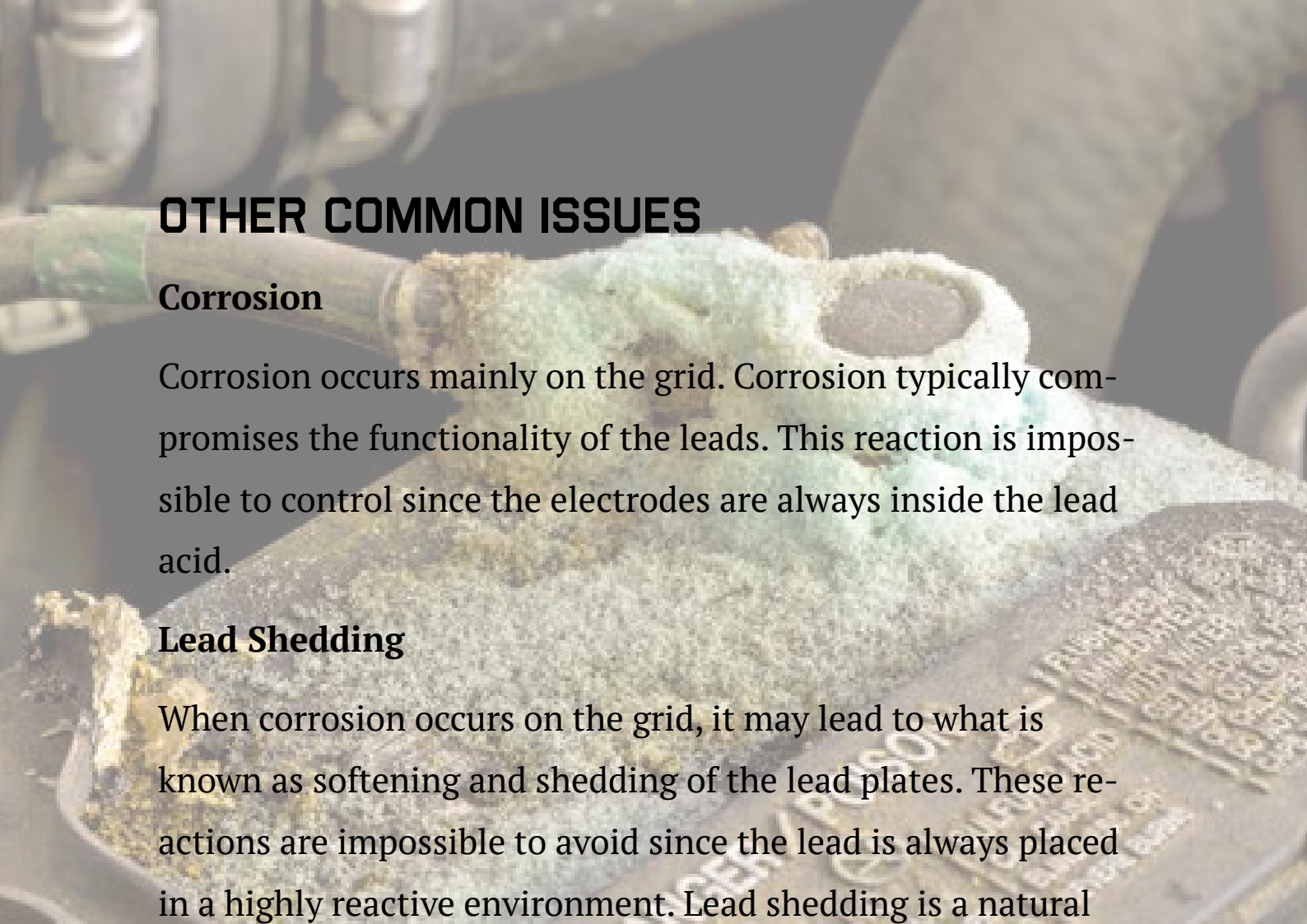
The sulfation process occurs in lead acid batteries especially when exposed to insufficient charging during normal operations. While this might compromise the recharging procedure, the sulfate deposits will finally expand and damage the plates, which can destroy the battery. Finally, a significant portion of the battery plate section will be unable to supply sufficient current such that the capacity of the battery reduces significantly.



Aside from that, the sulfate section of the lead acid batteries is not returned to the electrolyte in the form of sulphuric acid. In fact, the large crystals are known to block the electrolyte from entering the apertures that exist on the battery plates. As a result, sulfation can be controlled if the battery undergoes a full recharging procedure immediately after the discharge process is complete.

The white substance that exists on the plates may be visible in batteries with clear cases or perhaps after the dismantling of the battery. The sulfated batteries demonstrate a significant amount of resistance and provide a small amount of normal discharge current. Sulfation is also known to compromise the charging cycle, which can lead to longer charging durations and inefficient charging procedures.

SLI batteries are the most prone to such effects since the vehicles they are attached to will stay unused for long durations of time. Additionally, the motive and deep cycle power batteries will undergo constant and controlled overcharging, which will finally fail due to the effects of corrosion on the positive plates. It is important to note that there are no methods that have been shown to reduce the side effects of sulfation.



OTHER COMMON ISSUES

Corrosion

Corrosion occurs mainly on the grid. Corrosion typically compromises the functionality of the leads. This reaction is impossible to control since the electrodes are always inside the lead acid.

Lead Shedding

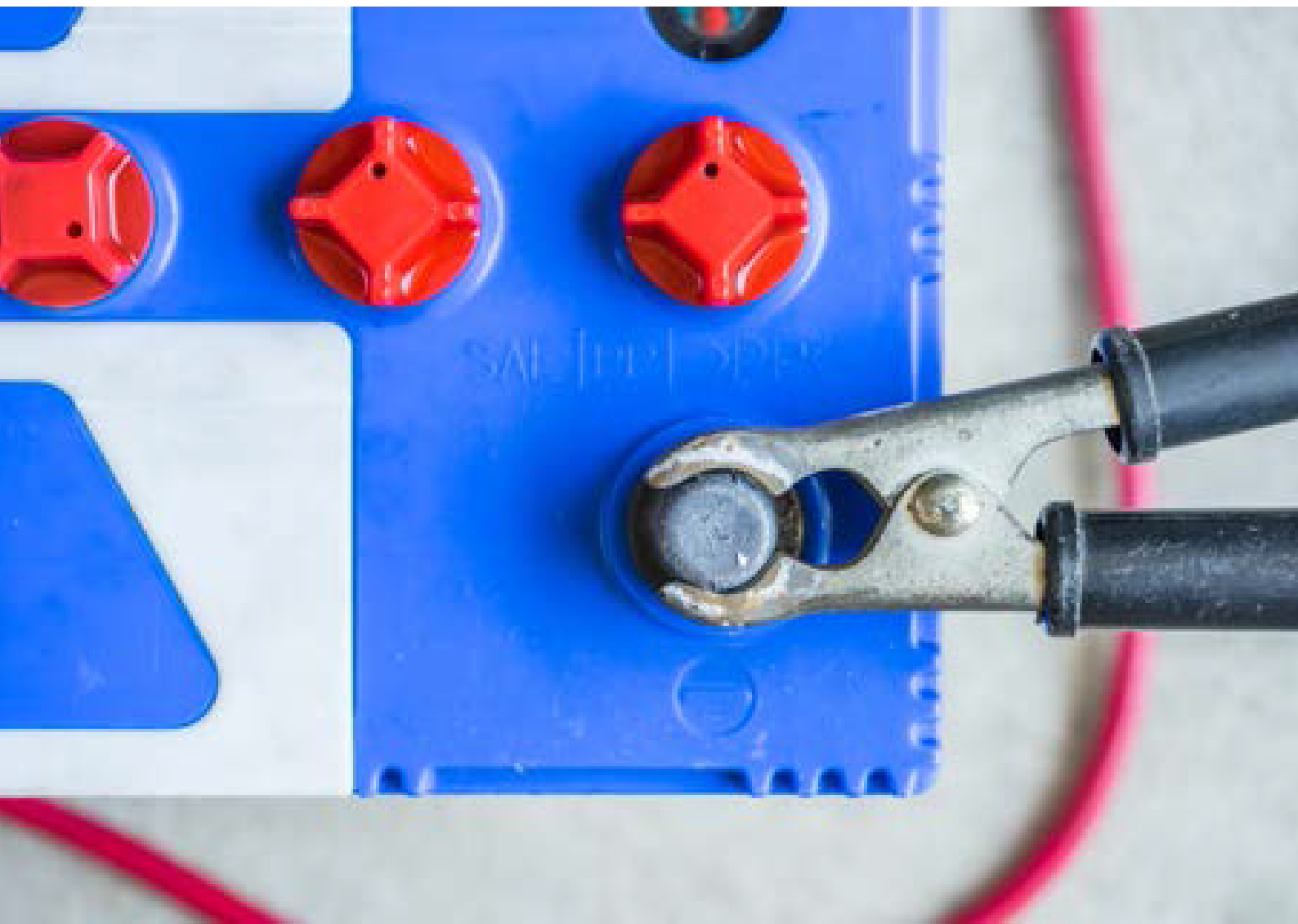
When corrosion occurs on the grid, it may lead to what is known as softening and shedding of the lead plates. These reactions are impossible to avoid since the lead is always placed in a highly reactive environment. Lead shedding is a natural process that can compromise the functionality of your battery. This can be especially dangerous given how the lead material used can be rather dangerous and harmful.

Internal Short

An electrical short is also another complication, especially with the SLI batteries that are often found in trucks. This is because as the battery sheds the leads at the bottom section of the container, a conductive substance fills the apertures that are in the sediment trap. Sometimes the conductive liquid may gain access to the plates, which might lead to an internal short. This in turn keeps the battery from being able to work well.

2 TESTING A BATTERY TO SEE IF IT CAN BE RECONDITIONED

One of the first things you will need to do before you determine to recondition a battery is to test the battery to see if it can be reconditioned. Some batteries simply cannot be reconditioned and you do not want to waste your valuable time working on them if they cannot be reconditioned. In many cases, the reason they cannot be reconditioned is that they have a bad cell and there is nothing you can do about the bad cell. You can, however, test to see if there is a bad cell in the battery before you take the time to work on the battery.



NECESSARY TOOLS

In preparing for the reconditioning process, you need to gather the tools, supplies, and equipment you'll need to keep in your work area. Having your supplies and equipment assembled ahead of time will help ensure a smooth process without any delays caused by looking for the things you need. Fortunately, the tools you need for reconditioning batteries are not expensive and are easily accessible at auto parts supply stores, at some large box discount stores, or online.

The basic list of supplies that you'll need include the following:

THE MULTIMETER

The multimeter is a special electronic device that is used to measure several metrics within one device. In most cases, the conventional multimeter comprises of various components that can measure factors such as the current, resistance and even the voltage of a lead acid battery. The analog multimeter, which is



also known as a microammeter, uses a moving pointer to show the readings.

A digital multimeter comes with a unique numeric display and may show a graphic bar that represents the average measured value. Digital multimeters are now a common occurrence due to their high precision levels and affordability to get them.

An adequate multimeter can be purchased for around \$20 and will be a much-used tool for your battery reconditioning projects and other household tasks. A multimeter allows you to take several types of measurements including DC (direct current) voltage, AC (alternating current) voltage, electrical resistance, DC or AC current.

THE HYDROMETER

A hydrometer or aerometer is a tool to measure the specific gravity density of liquids in relation to the density of pure water. Furthermore, this tool is mainly made of unique glass and it consists of a cylindrical stem and a bulb that is filled with lead shot or mercury to enhance its buoyancy levels. Following this,



the liquid to be tested is then poured in a long container, and the hydrometer is then carefully lowered into the liquid until it achieves optimal buoyancy. The position at which the surface of the liquid is in contact with the stem of the hydrometer demonstrates the precise gravity amount.

A battery hydrometer can run anywhere from around \$10 upward to around \$30 depending on the type you purchase. The battery hydrometer is used to test the state of the charge of a battery cell. The hydrometer tests the charge by measuring the density of the electrolyte, which is accomplished by measuring the specific gravity of the electrolyte.

THE LOAD TESTER

This is an electronic tool that is used to test the state of an electric battery. In most cases, these tools are often available as basic testing devices that are perfect for DIY to advanced testers that can also determine the capacity of the battery to conserve charge and drawbacks that may be compromising the battery's per-



formance.

A battery load tester can run anywhere from around \$40 up to around \$150 depending on the type you purchase. They can be found at auto supply stores, big box stores, or online. Load testing is done to verify that the battery can meet its specified power when needed.

THE TERMINAL CLEANER

There are various tools that can be used to clean the battery terminal. If the terminal on your car battery is covered with acidic powder, you might have to clean it by putting some baking soda and water on the surface to neutralize the effects of the acid. Following this, you can then use a wire brush to clean off the effects of the acid and dirt as well.



A battery terminal cleaner is a

wire brush that is made specifically to fit the battery posts for thorough cleaning. The cleaner costs just a few dollars and is a handy tool.

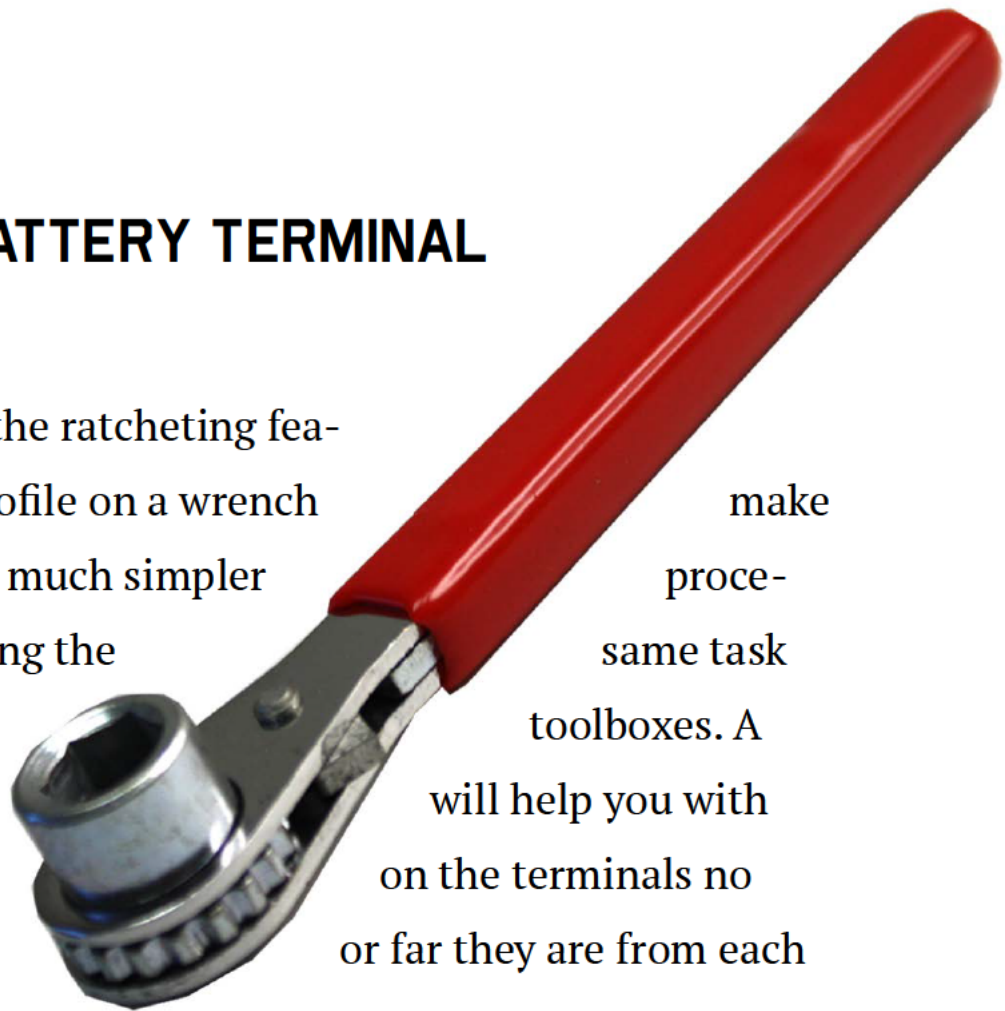
BATTERY CARRIER

A carrier is a special tool designed to carry your battery without using your hands directly. Most battery carriers are efficient since they reduce any likelihood of acid burns and they provide a secure mechanism for carrying the battery. You should still wear protective materials when handling a carrier although this should be safer and easier to work with.



SIDE POST BATTERY TERMINAL WRENCHES

Aside from safety, the ratcheting feature and a lower profile on a wrench terminal removal a much simpler procedure than attempting the using conventional terminal wrench keeping a grasp matter how close other.



make
proce-
same task
toolboxes. A
will help you with
on the terminals no
or far they are from each

OTHER TOOLS

The Smart
Charger



**Screwdriver
for removing
battery cell
caps.**



**Plastic funnel
for pouring
chemicals**



Again, keep an emergency First Aid kit available in your workspace that includes an eyewash kit and a hazardous waste kit. No matter how careful you are, accidents can happen, and you want to be prepared.



HINT: INVESTING IN A GOOD SMART CHARGER

A smart battery charger is mainly a switch mode supply unit that can communicate with your unique battery systems in order to monitor and regulate the charging procedure. This communication between the battery part system and charger is important since it determines the efficiency of the entire charging procedure. Aside from the conventional positive and negative terminals, a smart charger also comes with several terminals that can be connected to the smart battery pack system.

In most cases, the smart charger often consists of a charger case, which houses the internal components of the charger. Besides that, this unit also features large capacitors, circuit cards and transformers that might sometimes weight well over 100 pounds each. In some cases, the high-end charger might sometimes comprise of well over four transformers that can be found in the conventional chargers and diodes as well. The transformers that are found in these chargers will transform the AC electricity into DC electricity. More so, these units



also come with digital displays that indicate the vital metrics of the battery and the chosen charge cycle levels.

Some of the high-end smart chargers come with various accessories and chargers to suit various types of batteries chargers. These include the models that are used in bikes, marine vessels and vehicles as well. More so, the high-end chargers will provide a broad spectrum of functionalities and user benefits as well. Some these are fully automatic, reverse polarity controlled and spark proof as well.

The added benefit is that these tools are simple to use. Due to the patented pulse maintenance features, the range of chargers is strong enough to where they can be connected to batteries for several months without losing their functionality.

A smart battery charger will expedite various steps during the charging procedure to revive, recharge, charge and desulfate the battery. This helps to prolong the battery life and saves time and money in future. Additionally, a smart battery charger can stay in constant communication with the BMS system all throughout the entire charging procedure. In this way, users can charge to meet the needs of the battery and therefore mitigate the effects of over and under charging as well.

HOW TO TEST YOUR BATTERIES TO DETERMINE IF THEY CAN BE RE-STORED

Fortunately, most batteries can be reconditioned, but in order to know which batteries can be restored, you need to test the battery. Testing batteries is a simple process that doesn't require much time.

There are a few main tests you can conduct without any expensive equipment, and you can also conduct a test with a battery tester or analyzer if you choose to buy that equipment. If you are going to go into the business of reconditioning batteries or if you operate a lot of vehicles that use 12-volt lead-acid batteries, it can be worth the investment to buy a battery analyzer.

WHAT TO DO BEFORE YOU CONDUCT ANY BATTERY TESTS

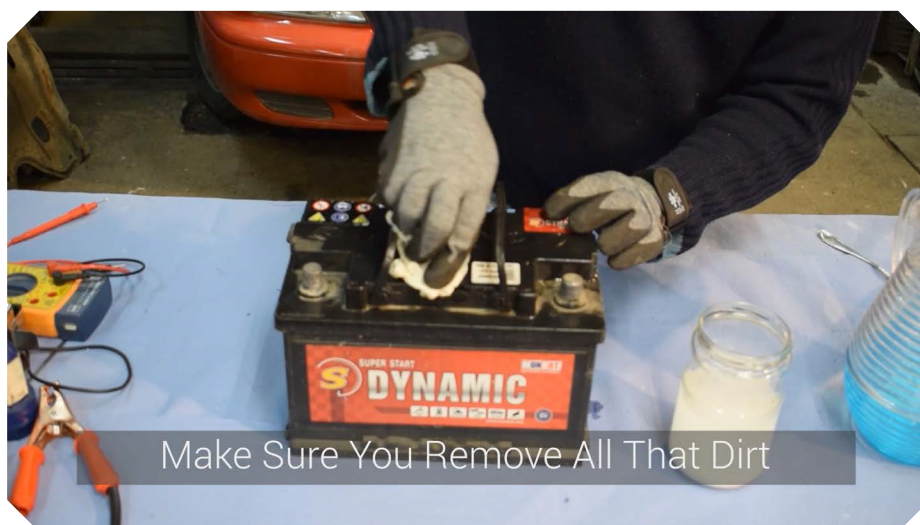
Before proceeding to handle and unpack the battery, it is important that you maintain high levels of precaution. A lead acid battery is an electrochemical tool that contains sulphuric acid and other corrosive compounds. All of these things might lead to significant injury. Therefore, the use of all lead acid batteries during normal operations might lead to the production of explosive gasses. Here are some factors that you should consider:

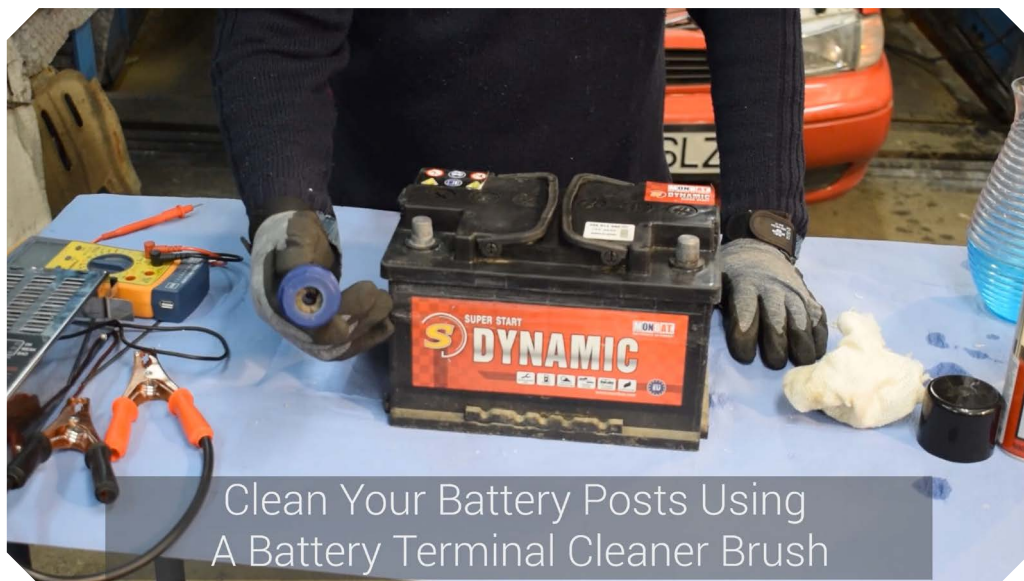
Before you can conduct any battery tests, it's imperative that you ensure you are equipped with the appropriate tools and that the battery has been disconnected. Here are some notable factors to consider before you begin any test:

- Use safety goggles and high voltage gloves when conducting the procedures with the lead acid batteries. Lead acid batteries comprise of sulphuric acid, which is highly toxic especially for your health.
- Avoid wearing your jewelry when working with lead acid batteries. The metal could react with some things.
- The negative terminal of the battery should not be connected directly to the positive terminal. This may lead to a short circuit, which might lead to a current overflow.
- Ensure that you connected the positive lead of your mechanical tools to the positive end of the battery and repeat the same for the negative terminal as well. Reversing these connections may compromise the connection on the in-

strument and result in some difficult reactions within the battery.

- Recharge your lead acid batteries in areas with sufficient ventilation.
- Remove corrosion and dirt from the battery posts using use a battery post cleaner (scrubber brush). You can also purchase liquid battery post cleaners if you prefer to use chemicals instead of the brush. Often, a combination of using the brush and chemicals or solutions works the best.
- Fully Recharge your 12-volt battery and let it “rest” for twelve hours or more after it has been charged – this will remove the “surface charge”





Clean Your Battery Posts Using
A Battery Terminal Cleaner Brush



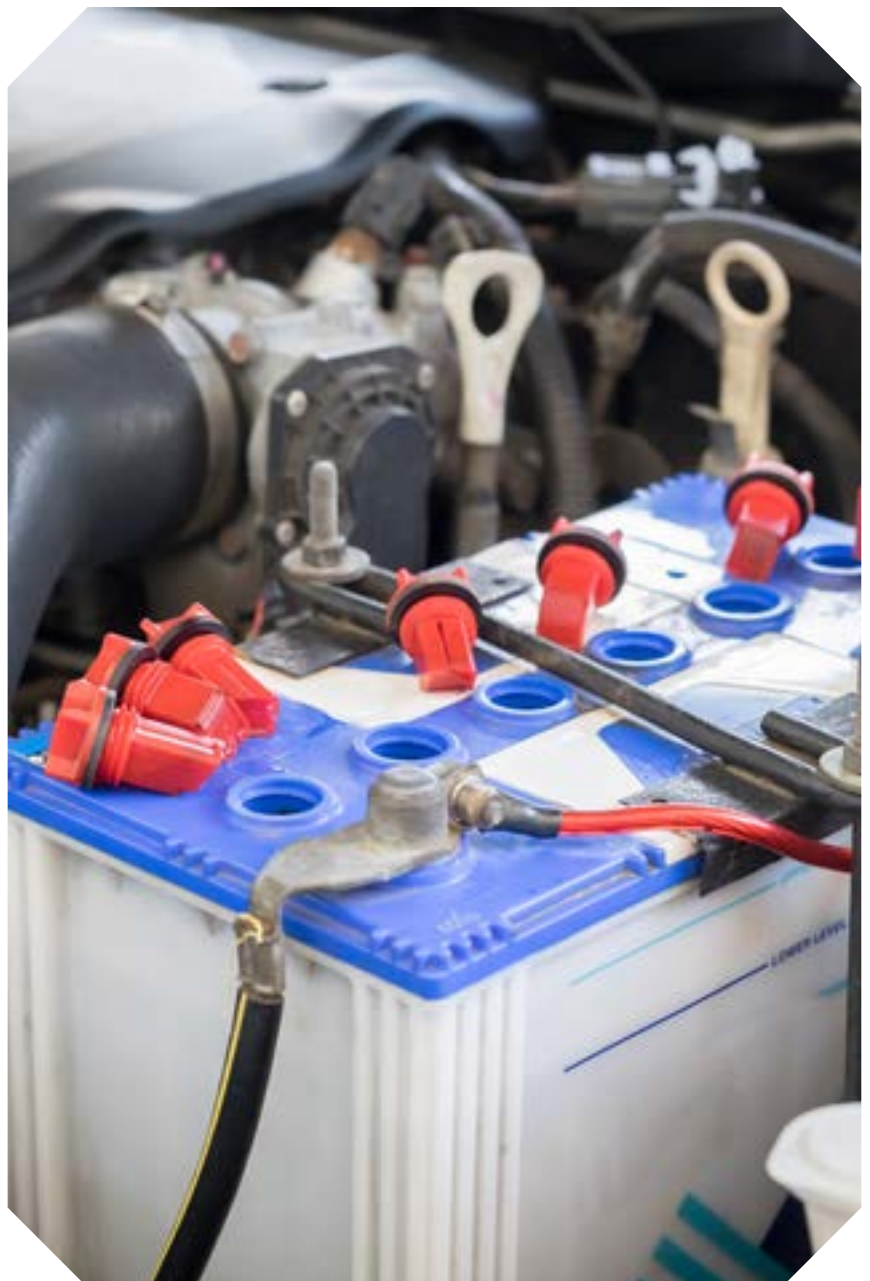
VISUAL INSPECTION

You are now ready to begin the tests that will determine if the battery can be reconditioned or not.

A visual inspection of the battery should always begin with a comprehensive evaluation of the entire structure of the battery. For instance, you might opt to check for signs of rusting

on or perhaps around the battery and any leakages on the top section of the unit. Any cracked sections or missing caps might also require replacement. You will also visually check the level of electrolyte and add the correct amount of water. On the vent cap section of the batteries, ensure that you check the electrolyte level by removing the caps.

Some batteries come with a unique fill ring which shows the average level of electrolyte in the battery. The electrolyte should be placed at an even level with the fill ring. However, if the battery lacks a filled ring, the electrolyte level should be high enough to cover even the top sections of the plates. A significant portion of the contemporary batteries comes with special electrolyte



indicator levels. This is often portrayed in the form of special color codes, which act as visual indications of the electrolyte levels.

BATTERY CHECK



When cleaning the terminals, ensure that you remove all the cables and evaluate the terminal post for any deformation. Clean the posts and interior sections of the cable clamps by using a special cleaning tool before proceeding to place new terminal posts. When measuring the average battery charge, ensure that you evaluate the condition of the electrolyte in the battery plates. This is because as the battery plates undergo

discharging, the electrolyte tends to have a higher percentage of water. As a result, the electrolytes in the discharged battery might have a lower gravity level than their fully charged counterparts. This change in gravity levels can be used to determine the average charge levels in the battery.

VOLTAGE TESTING

1. First, ensure that the new battery is acclimatized to room temperature overnight to verify its Ah capacity.
2. A multimeter is needed for voltage testing. To use the multimeter, set the selector dial to the type of measurement that you want to make.
3. To get the most accurate reading, hold the probe tips, not the sides, tightly to the appropriate contact.



Avoid touching the metal part of the probes when you are making a measurement. Besides the possibility of zapping you, touching the metal part of the probes can result in an inaccurate reading.

4. Following this, determine whether the average voltage averages 12.70 volts to 13 volts maximum by using a customized digital volt tester.
5. Ensure that the test lead sockets are well cleaned using a compatible cotton bud that is dipped in cleaning fluid. Following this, you can connect the tester to the terminals to make perfect tight conditions in relation to its operational needs.
6. Calibrate the voltage tester and record the battery voltage measurements. If the voltage is above an average of 12.70 volts, you will achieve the maximum capacity. However, if the voltage surpasses the maximum amount, then you might be inclined to apply a load to mitigate the effects of overcharge.
7. After this, record the Ah reading that is available on the battery. Repeat these procedures until you are satisfied that you have the correct readings. If any fluctuations occur, evaluate the connections to both on the battery and meter terminals.

VOLTAGE TESTING COMPARISON CHART

Charge Percentage Specific Gravity Cell Voltage Voltage

100%	1.277	2.122	12.73
90%	1.258	2.103	12.62
80%	1.238	2.083	12.5
70%	1.217	2.062	12.37
60%	1.195	2.04	12.24
50%	1.172	2.017	12.1
40%	1.148	1.993	11.96
30%	1.124	1.969	11.81
20%	1.098	1.943	11.66
10%	1.073	1.918	11.51



LOAD TESTING

1. When the tester is connected to the terminals with regard to the instructions, then the Ah reading can be acquired based on various factors including temperature, voltage, and resistance of the battery.
2. When trying to determine the accuracy of the battery testers, ensure that you carefully unplug the leads from one tester to another to avoid compromising the test leads connected to the battery.
3. Ensure that you disconnect the battery from the system by removing all the connectors and cables. After this, clean the terminals and record the voltage for future references.
4. Try charging the battery by using a 12-volt charger. Just connect the charger and wait for it to attain full cycle.
5. It's important to note that if you are using an automatic or smart charger and your first reading is lower than the maximum then you might be inclined to connect the battery in parallel with another similar battery. If it is for a vehicle battery, ensure that you do not start the engine if you are using one. It is not

imperative for the charger to complete the full cycle when hooked to the battery during the testing procedure.

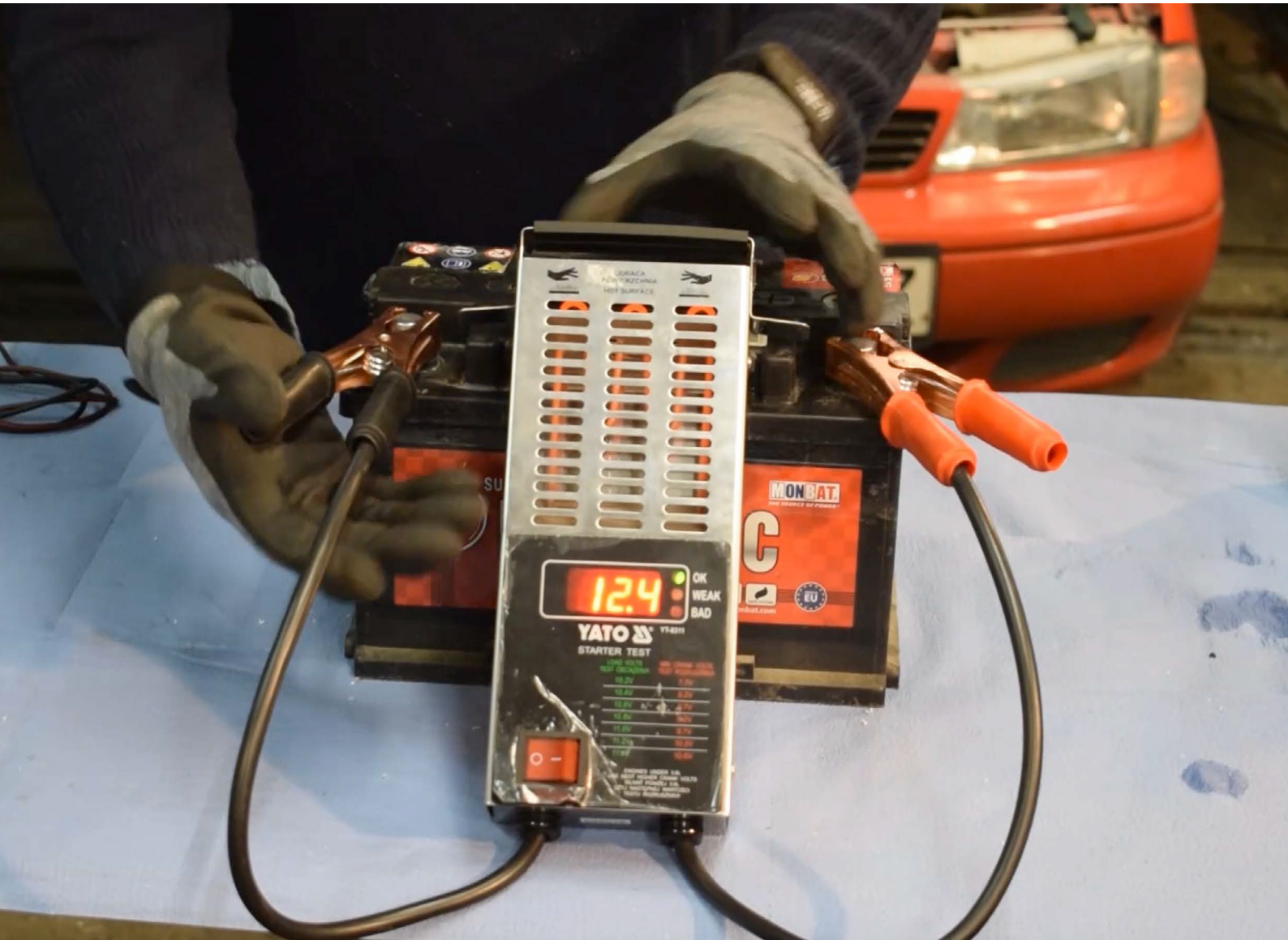
6. After the charger shows that the battery is at full charge or when it has been in the charger for well over 8 hours, you must disconnect the battery from that charger. Let this unit sit for half an hour before you proceed to record a new reading. This is to give you a more accurate readout.
7. Allow the battery to sit for several hours with no workload. Avoiding testing the battery until you know that it is dormant and therefore easier to test accurately.
8. Connect the battery to the automobile or wherever you need the lead acid battery to work at. If you are testing an SLI battery, hold the voltmeter on the battery while you try to start the motor. Record any drops in voltage and turn on as many devices as possible while the voltmeter is connected to the battery.



9. Clip the load tester's red clip to the battery's positive terminal and then clipping the tester's black clip to the battery's negative terminal. A reading will be shown indicating no load. Next, push and hold the button on your tester for a couple of seconds.
10. A reading will be shown like in the picture above.
11. Just to make sure perform another test.

Voltage On Load		
← >11V	← 6.1V - 11V	← <6.1V
		The Battery Can Be Reconditioned The Battery Can NOT Be Reconditioned

12. If you have a bad battery, you may choose to dispose of it or go ahead and conduct further testing on the battery to determine if there's a damaged cell.
13. If after the next tests it turns out that the battery has a bad cell it means that it can't be restored.



HYDROMETER TESTING

A hydrometer is a special tool that is used to measure the state of and charge capacity of a battery cell. This procedure is often achieved by measuring the density levels of the electrolyte. In particular, measuring the density of the electrolyte can be determined by measuring the gravity levels of the electrolyte. The concentration of sulphuric acid is proportional to the density of the electrolyte. Additionally, the density is also commensurate with the state of charge.

The specific gravity refers to the measurement of liquids in relation to the baseline. In most cases, the baseline is water which is classified with a unique base number level. The average temperature levels of the hydrometer reading must be customized to average 70 degrees Fahrenheit. The high-end quality hydrometers feature internal thermometers that can be used to measure the average temperature of electrolytes. If the battery has sufficient electrolyte levels in the cells and has undergone a full charging procedure, then a hydrometer can be used to determine the specific gravity of the battery. This particular measurement is essential when it comes to determining the state of

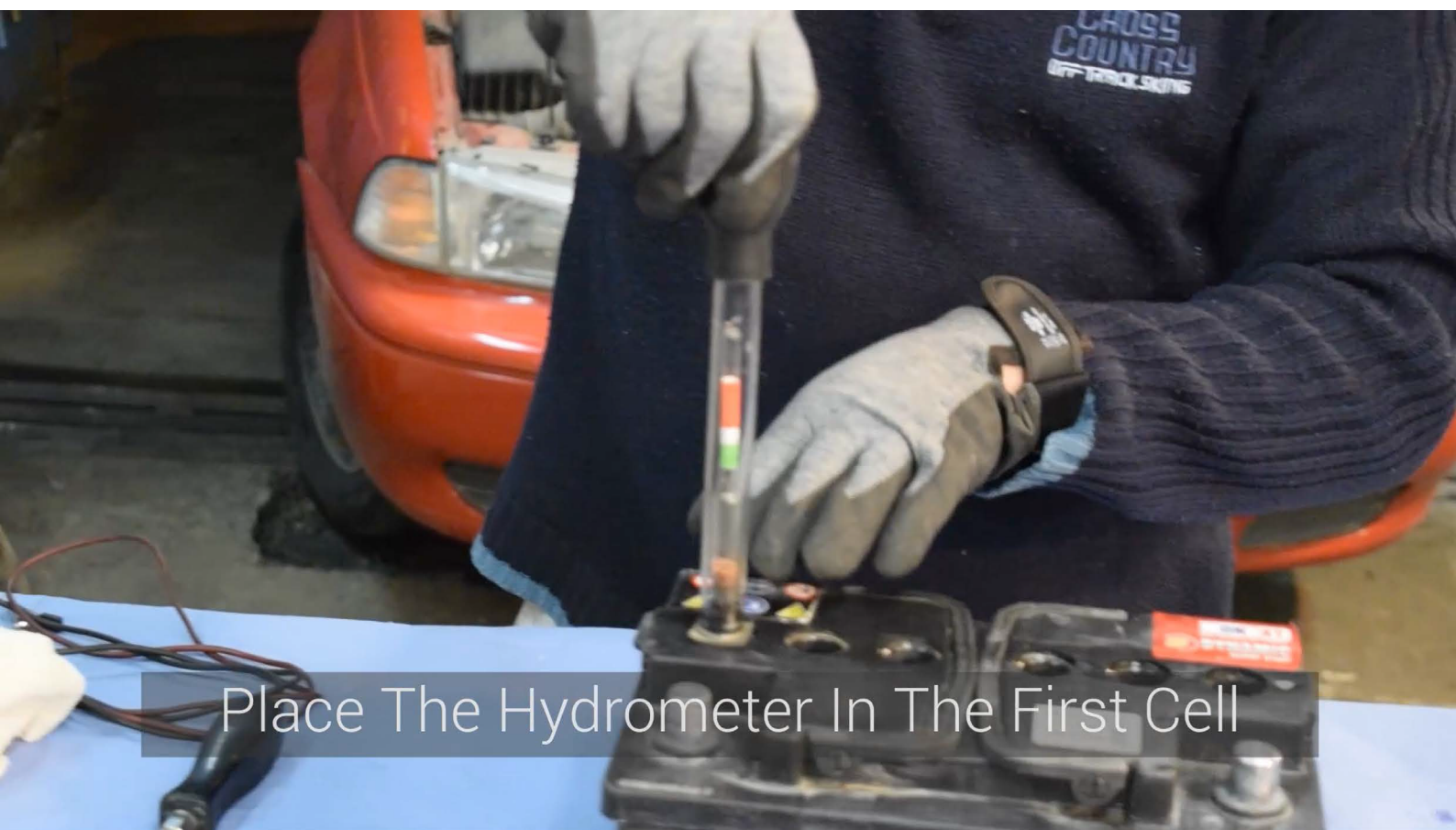


charge of the battery.

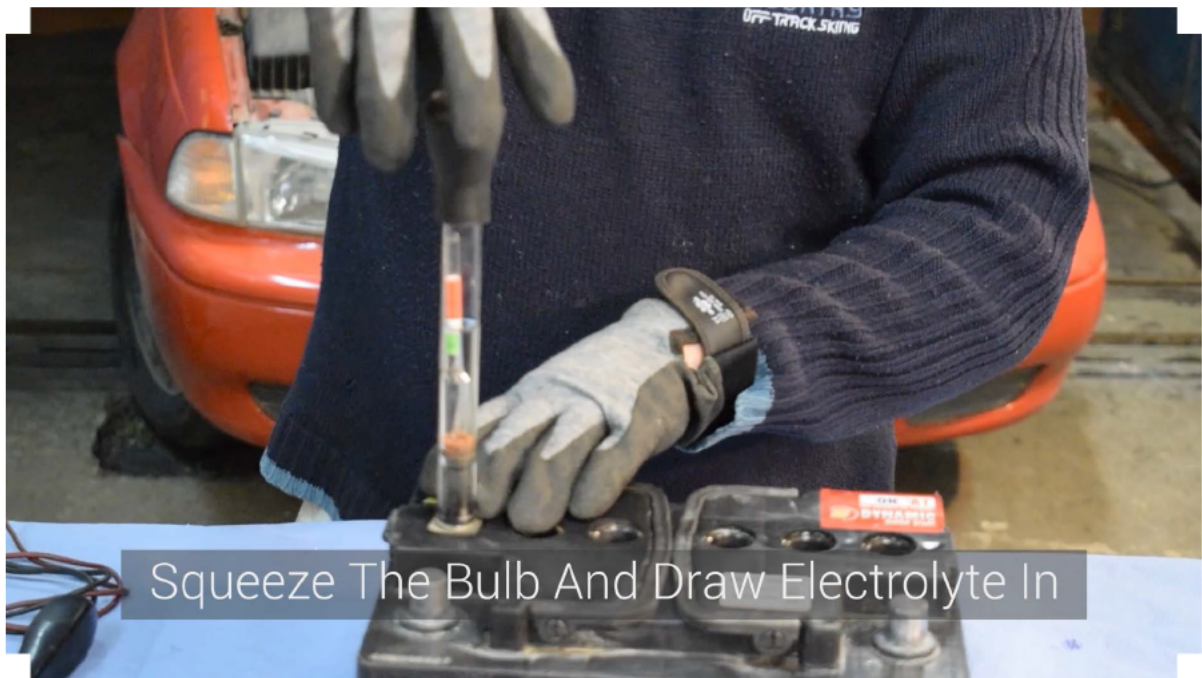
Here are the steps to use with such a testing device:

1. Add electrolytes into the hydrometer several times to allow the thermometer to acclimatize to the temperature levels and record the readings. Evaluate the color of the electrolyte and any brown or gray coloration might indicate a faulty battery.
2. Draw the minimum amount of electrolyte and add it into the hydrometer. Allow the hydrometer to float without touching the top or bottom section of the container.
3. Ensure the hydrometer is in a vertical position at eye level and record the readings where the electrolyte levels are similar to the scale on the float.
4. For every 7 degrees the temperature of the electrolyte is above 28 degrees Celsius, add or subtract five points to the measurements. Calibrate the reading to be similar to the temperature of the electrolyte.
5. Test each cell and record the readings. Any variations that occur within the two cell measurements might be a sign of poor quality battery cell.
6. As the battery ages, the specific gravity levels of the

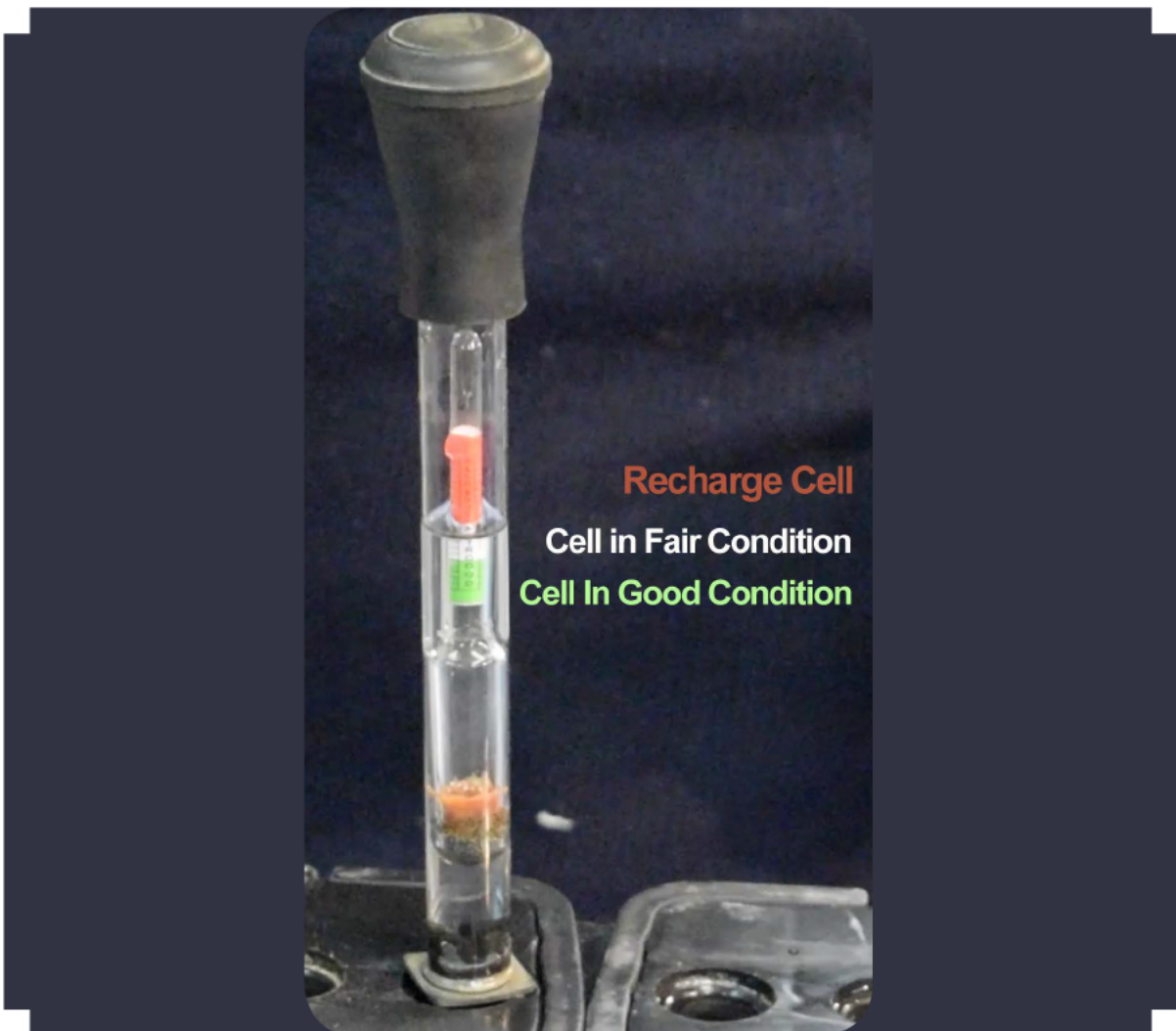
electrolyte will reduce when it is at full charge. This is because the replacing the battery cells that have slight variations is not feasible. Since the hydrometer test is used to determine the complications of mechanical tools that show performance complications, the battery should be recharged and the procedure repeated. If the results highlight a weak cell, then the batteries should be replaced with new battery cells of the same brand.



Place The Hydrometer In The First Cell



Squeeze The Bulb And Draw Electrolyte In



Recharge Cell

Cell In Fair Condition

Cell In Good Condition

TEST THE VOLTAGE IN EACH CELL

If the battery you are testing has as relatively unknown history, you will find it difficult to determine the functionalities of the cells with dilute additives. This is due to overfilling and several replacements of the acid over time. However, this complication can be controlled as when compared to the batteries that are damaged due to internal failure complications.

Some cell complications are appearance, and you can easily determine whether the battery requires additional work before it can be utilized. A cell that produces fizzing steam with a strong odor is a strong indicator of damage. The more the number of cells that are damaged, the more it might be difficult to repair the unit. Any physical damage that arises from distorted or cracked individual cell jars or cell covers within the battery might require you to consult a professional service provider.

If the battery has a sufficient amount of electrolyte visible in all cells and it has undergone the entire charging procedure since the last watering, then you might be able to use a hydrometer to evaluate the specific gravity level and determine the status of the battery as well. The two main measurements that can be used to determine the functionality of each cell includes the voltmeter and the hydrometer. The conventional DC voltmeters can be used to evaluate the voltages that can

range in between 1.75 and 2.7 volts. Having said that, ensure that open voltage readings may only give a basic idea of the cell capabilities. The voltage readings that are the most useful include the current load that should be recorded at a specific point during the charging procedure.



VOLTAGE TESTING COMPARISON CHART

Charge Percentage Specific Gravity Cell Voltage Voltage

100%	1.277	2.122	12.73
90%	1.258	2.103	12.62
80%	1.238	2.083	12.5
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30%	1.124	1.969	11.81
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10%	1.073	1.918	11.51

BATTERY ANALYZER

There are different types of battery analyzers that range from very simple to quite sophisticated. The purpose of the battery analyzer is to test the state of the battery—the charge that is present in the cells and/or voltage output. More comprehensive analyzing of the battery will also provide results that let you know the battery's capacity for performance.

In the event that, after testing, you find that you have a battery or batteries that cannot be reconditioned, don't leave them sitting around. The outer case (casing) of the battery can decay or can become brittle and cracked, creating the risk of weeping acid. This can be dangerous for pets, young children, or adults who may not realize there is acid present. It can also contaminate the ground and kill any bio-organisms that it comes into contact with or ruin surfaces.

Check with your local government (city, county, state) and find out how to responsibly and legally dispose of a battery that cannot be reconditioned. In most cases, it will be a simple matter of preparing the battery per the instructions that are given and dropping it off at



a recycling center (Again, see this website for more information on lead-acid battery disposal: www.EHSO.com/battery.php)



3 HOW TO RECONDITION YOUR 12V BATTERIES

After conducting the tests to make sure the battery doesn't have a bad cell, you can assume that the battery is probably restorable and you can move forward with the reconditioning process. Restoring the battery is not difficult. It's just a matter of following the instructions and taking safety precautions.

There are several methods for reconditioning a lead-acid 12-volt battery. Any of these methods can be used with excellent results in restoring a battery, though the first method of "equalizing a charge to the battery" may not work 100% of the time. However, it is such a simple and easy method that it's definitely worth exploring first. If the method doesn't work, all you have lost is a little time, and you can move on to the next methods.

THE "EQUALIZING CHARGE" METHOD

An equalizing charge occurs by overcharging a lead acid battery to mitigate the effects of both stratification and sulfation. Sulfation refers to the accumulation of sulfate crystals on the lead plates when the batteries are exposed to intense undercharging. Stratification refers to the accumulation of acid on the bottom section of the cell, especially when it has not been used for a long duration of time.

Both these processes will compromise the longevity and capacity of your battery. Therefore, take care of your batteries by applying an equalizing charge at both ends. Equalizing a battery can be achieved by applying a voltage that is

higher than the conventional voltage amount for the lead acid battery. By applying a significantly higher amount of charge, this will release sulfur ions into the electrolyte, which in turn triggers the desulfation process. A higher voltage also causes the accumulated acid at the bottom section of the cell to rise and combine in equal ratios with water. As a result, the stratification complication is eliminated.

Most brand manufacturers recommend that you equalize the battery every once in a while especially if it is left unused. The equalizing charge should be applied to the battery after every 20 cycles.

Equalizing a battery will often

involve the use of techniques that maximize the capabilities of the battery by using several cells in a series. This is to produce sufficient energy for use and to enhance the lifespan of the battery. A battery balancer is a unique tool that is to perform the equalization process.

These tools are often used in lead-acid batteries such as those that are found in cars. In most cases, the cells in a battery will often have varying capacities of charge, and they may be at different levels of charge. Without balancing, the cells with the least capacity may overcharge or discharge which can also compromise the charging results of other cells.

The individual cells in a battery might have varying capacities, and they may also have different levels of state of charge. The discharging procedure must stop when the lowest capacity is empty, even if this compromises the energy that can be obtained and supplied to the battery. In this case, battery balancing techniques can be used to transfer the energy from each cell such that the SOC of the cell with minimal capacity is the same as that of the battery.

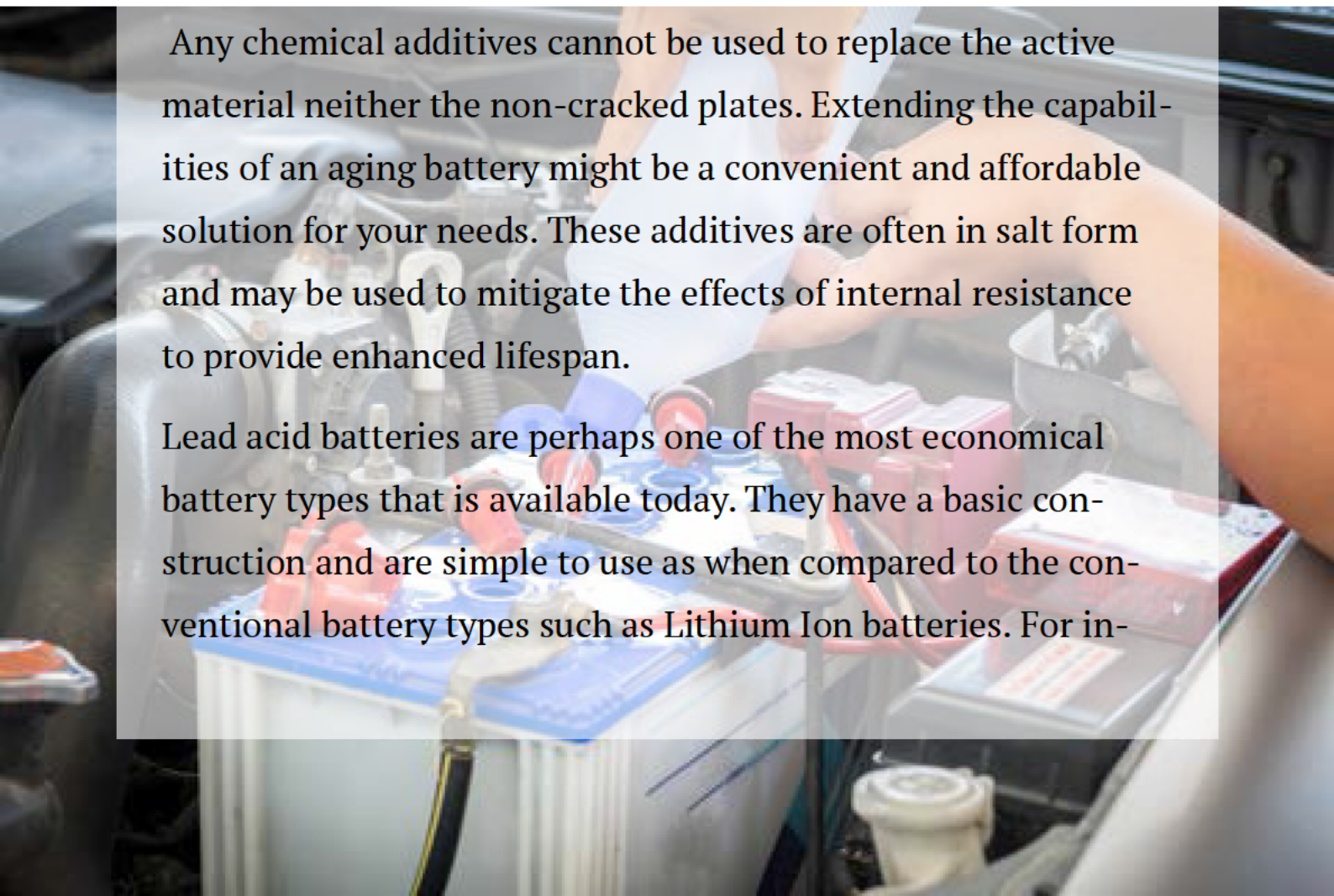
HOW TO USE CHEMICAL ADDITIVES TO RESTORE THE BATTERY - INSTRUCTIONS FOR USING EPSOM SALT TO RESTORE YOUR BATTERY

Introducing new chemicals to the electrolytes of a flooded lead acid battery can reduce the accumulation of lead acid on the battery plates, and it will, therefore, enhance the capacity of your battery. This procedure has been used since early in the 1950s, and it acts as an excellent solution for rejuvenating your dead batteries.

It's a temporary solution since the plates of the battery might have already suffered from a significant amount of damage.

Any chemical additives cannot be used to replace the active material neither the non-cracked plates. Extending the capabilities of an aging battery might be a convenient and affordable solution for your needs. These additives are often in salt form and may be used to mitigate the effects of internal resistance to provide enhanced lifespan.

Lead acid batteries are perhaps one of the most economical battery types that is available today. They have a basic construction and are simple to use as when compared to the conventional battery types such as Lithium Ion batteries. For in-



stance, when you sometimes start your mechanical tool, you will notice that it simply won't start. The main reason behind this might be that the lead in the battery is susceptible to rust which might block the flow of electricity and its ability to charge appropriately.

An excellent method to restore such a battery would be to use Epsom salts. You can easily purchase some at your local store or home depot. Four pounds of Epsom salt is more than enough for your restoration needs.

There are many steps that must be used in this process:

STEP 1 The first process is that you will require some distilled water and Epsom salt. Avoid using tap water since it may compromise the procedure. Warm the water to an average of 150 degrees and ensure that the temperature stays at that precise level.

STEP 2 Mix ten tablespoons of Epsom salt into the quart of water and stir until the entire mixture is well dissolved. Following this, pour the warm water into the solution in individual cells of the compromised battery in the same way to add water to achieve normal acid levels.

STEP 3 After this, let the battery charge the entire night. Since Epsom salt will only dissolve in water, avoid adding Ep-



som salt directly since it won't dissolve as required in the acid. A significant portion of the dead batteries will often have minimal fluid such that adding the Epsom solution will not lead to an overflow. It is recommended that you add an average of 1 quart of Epsom solution to the conventional lead acid batteries. If the battery is full of fluid, then you might have to drain some of the acids to provide some room for the Epsom solution.

STEP 4 The next step is that you need to add the solution and place the caps back on and shake the battery some more to ensure that all the chemicals mix sufficiently. Let the battery charge overnight, and if it shows improved activity levels, then you might be able to make use of it. Having said that, it might sometimes take well over ten days for the Epsom salt solution to work on your battery. Agitation is necessary and it might be difficult to ensure that the Epsom salt mixes sufficiently with your battery. One of the best mixing methods is just to drive the vehicle, and some batteries come with caps that are simple to remove to allow convenient maintenance of batteries especially when they require reconditioning.

STEP 5 A battery with low maintenance levels comes with sealed tops that help to mitigate the effects of evaporation. It allows for convenient reconditioning as well. These types of batteries can still be reconditioned, but you may have to in-

investigate for the dark marks that come on the top section of the plastic holes in the cells. First, drill some small apertures in the plastic section to gain simple access to the cells and then add some of your warm Epsom Solution. Ensure that you seal these apertures later on by using the basic plugs that are easily available at your home depot. When investing in a new battery, it is recommended that you invest in a battery that has reduced maintenance levels especially when you settle for the use of chemical additives. While using additives might work for some batteries, it may not work so well for a significant portion of some batteries. More so, this process can only be conducted a few times before the battery is completely worn out.

HOW TO USE DESULFATING EQUIPMENT TO RECONDITION A BATTERY



When it comes to desulfation, there are many tools that can be utilized during the procedure. Some notable devices on the consumer market are perfect for lead desulfation. In most cases, these tools utilize alternating pulses to break the lead sulfate loose and some contemporary chargers come with a de-sulphating

feature as well. Using a meter that is inserted into the two battery points, determine the voltage you require for your testing needs. This is usually less than 5 volts. To achieve the best results and performance, ensure that you use the sulfate to supply pulses when the voltage is close to the float voltage level.

TESTING WITH A BATTERY TESTER

Using a battery tester provides different information than using a multimeter. A battery tester is more specifically designed to measure the remaining useful charge of the battery, which is something you need to know in order to make a decision about whether you should take the time and effort to recondition the battery or not.

Battery testers measure the voltage of the battery while the load is applied. An appropriate resistance, known as a load, is applied when the battery is tested so that the battery is tested under the conditions of load. Some battery testers have the capability to test a variety of types of varieties while others will simply test the type of battery it was designed to test.

Battery testers are very simple to operate. Simply follow the manufacturer's instructions for turning on the tester and taking the reading.

TESTING WITH A BATTERY ANALYZER

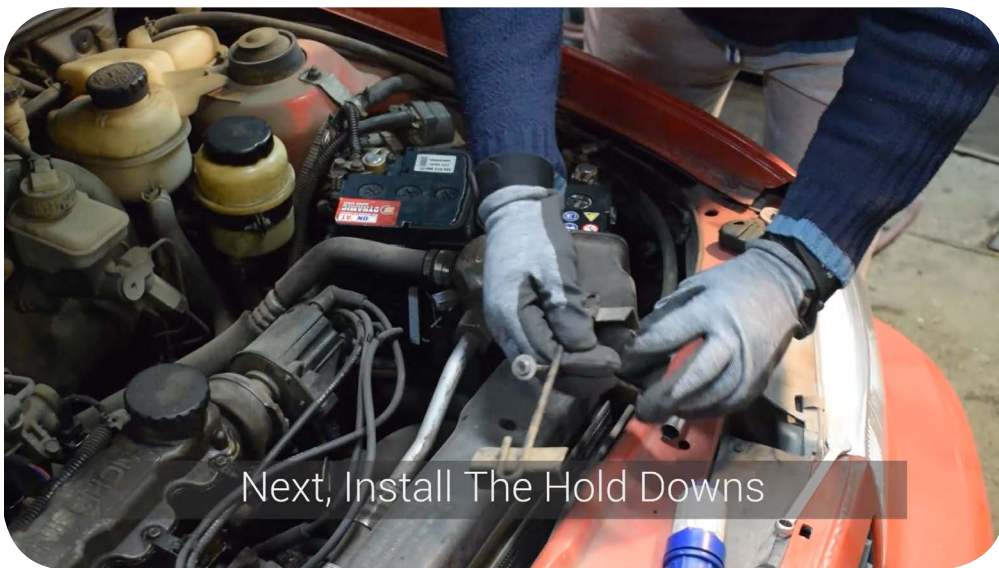
A battery analyzer provides more details and complete information than the battery tester or the multimeter. In many cases, you can take your battery to an auto parts store and test it with a battery analyzer for a small fee. If you do business with the auto parts store on a regular basis, they may even use their equipment on your battery for no fee, especially if they think they can sell you a new battery if yours has a bad cell. So keep the sales tactic in mind.

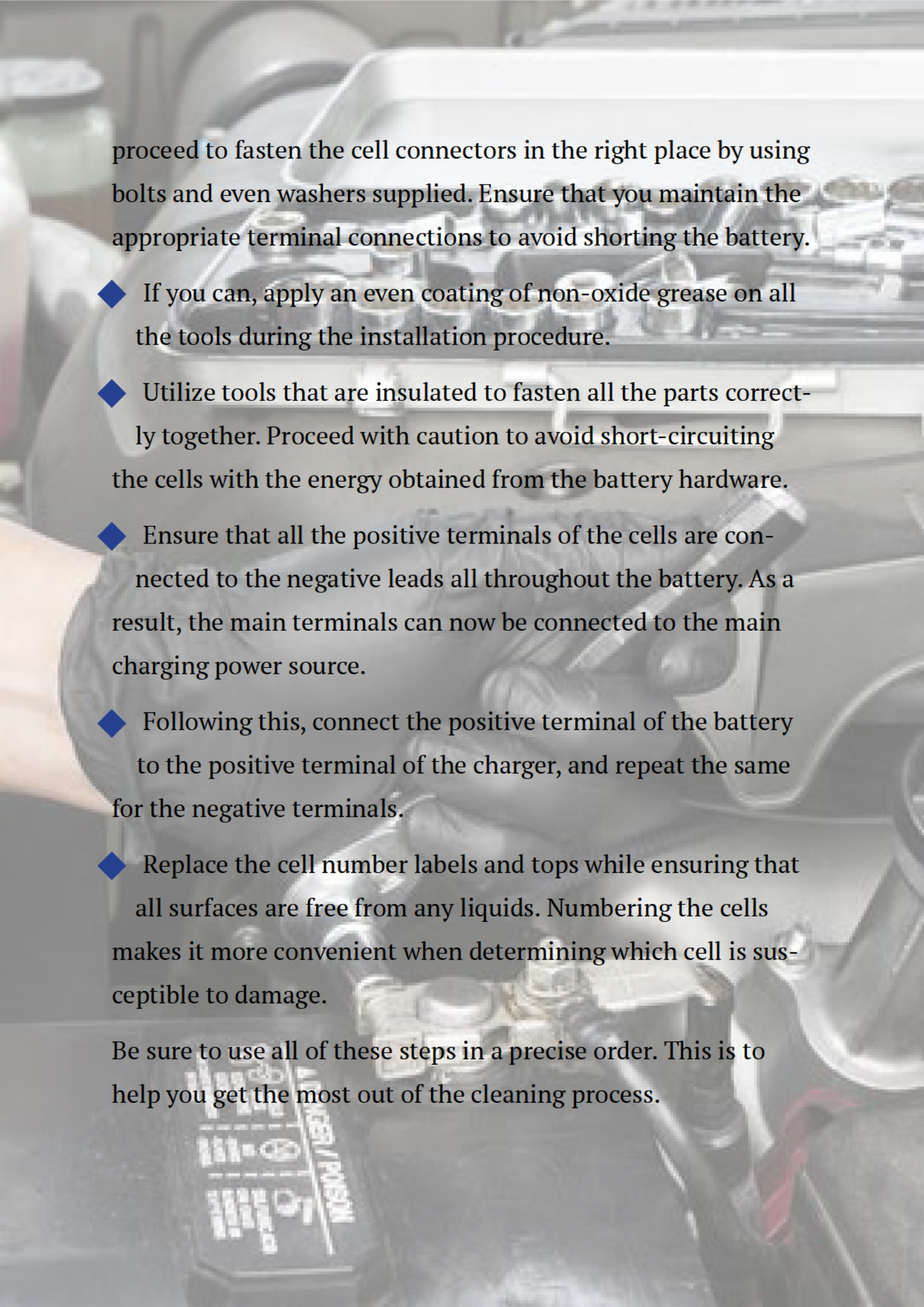
Battery analyzers come in several price ranges and with various capabilities. The price can range from around \$300 for the least expensive up to a few thousand dollars for more sophisticated models.

Typically, a battery analyzer is utilized to run the battery through the discharge cycle and measures the capacity as the total amount of useful current that the battery can deliver in amp-hours or milli-amp-hours (mAh). As an example, if a battery is capable of delivering a total of 400 mAh, then it can provide 400 mAh of current for one hour, or 100 mAh for four hours, or any combination of current and time that multiplies to 400

4 HOW TO INSTALL A BATTERY

- ◆ Ensure that all the cell jars and covers are well cleaned and dry before you can start the procedure. If there is any evidence of acid spillage, then ensure that you clean the posts should be clean with a toothbrush that has been dipped in baking soda or any other alkali solution.
- ◆ Wipe the leads of the battery to remove any surface oxidation by using a fine grit abrasive paper or cloth.
- ◆ If the battery is heavy, then ensure you lift it using an appropriate mechanism such as the spreader plate. Separate the instructions for using these items for a hassle free procedure.
- ◆ Always use lifting straps that come with the battery to reduce any likelihood of injury or damage to the battery cells. Position the cells or blocks in a unique position on the rack and with an appropriate spacing which is compatible with the intercell connectors that come with the battery.
- ◆ A significant portion of batteries come with a basic series arrangement such that the cells can be arranged to withstand any form of configuration in the terminals.
- ◆ When all the cells have been placed on the rack, you can





proceed to fasten the cell connectors in the right place by using bolts and even washers supplied. Ensure that you maintain the appropriate terminal connections to avoid shorting the battery.

- ◆ If you can, apply an even coating of non-oxide grease on all the tools during the installation procedure.
- ◆ Utilize tools that are insulated to fasten all the parts correctly together. Proceed with caution to avoid short-circuiting the cells with the energy obtained from the battery hardware.
- ◆ Ensure that all the positive terminals of the cells are connected to the negative leads all throughout the battery. As a result, the main terminals can now be connected to the main charging power source.
- ◆ Following this, connect the positive terminal of the battery to the positive terminal of the charger, and repeat the same for the negative terminals.
- ◆ Replace the cell number labels and tops while ensuring that all surfaces are free from any liquids. Numbering the cells makes it more convenient when determining which cell is susceptible to damage.

Be sure to use all of these steps in a precise order. This is to help you get the most out of the cleaning process.

5 RESTORING/RECONDITIONING AGM AND SLA BATTERIES

FOR AGM

Perhaps the best strategy for restoring the capacity of a deeply discharged AGM battery is that you may have to invest in a contemporary charger for your needs. A significant portion of these chargers comes with specific settings that are perfect for the desulfation procedure. More so, some feature supplementary terminals that will attach easily to the battery leads to allow for convenient charging. Another method for testing AGM batteries is to hook up a good battery and a deeply discharged battery in parallel format.



- 1.** Remove the battery from its compartment in the vehicle. Clean the corrosion from the leads of your battery. Mix a solution of baking soda and some water. Using a toothbrush, apply the solution to the leads of the battery.
- 2.** Inspect the battery for any signs of damage including cracks, holes or even leakages. Remove the caps that cover the cells of the batteries. Check for any cells that have the plates exposed and distilled water.
- 3.** Following this, hook the battery to the charger and turn it on. After charging for an average of one hour, confirm to determine if the AGM battery is warm. Batteries will become warm during the charging process, but excessive heat might indicate that its functionality has been compromised.
- 4.** Using a voltage meter, measure to evaluate whether the AGM battery has acquired sufficient charge averaging at 11 volts and above. If the desired voltage is achieved, disconnect the charger and remove the battery from the charger. After this, you will only connect the discharged battery and the AGM to the charger until it reaches its full potential.
- 5.** Charge the battery overnight with a three-phase charger that is set at an average of 2.3 to 2.5 volts. Evaluate the charger in the morning. If the batteries are full charged, then it might be time for you to detach the battery from the charger.

6. If the battery has not charged back to optimal capacity, then open the tops and tilt it to the side to remove the battery acid. Mix some distilled water with some Epsom salts and pour it into the battery. If the battery still does not accept any charger after this step, then is unlikely that you may be able to salvage it at all.

TESTING THE SLA



- Remove the lid and evaluate for any signs of tampering. Insert your screwdriver into the small slots and open the lid carefully to break all the seals.

- Ensure that you have gloves on since any acid that escapes through might compromise your health. Wipe the wet section using a cloth and discard it after use. Evaluate the caps to determine whether they are damaged, which is often a sign of internal damage. By using a hemostat, hold the sides of the battery and you will hear a hissing sound as the pressure balances.
- Using a flashlight or lamp, aim into the holes and determine whether you can come across any dried white material. However, if you see only wet and shiny materials then your cell is not dried, and you can continue the procedure.
- Using a syringe and needle, draw some small amount of water and when the battery is over 7ah. Then you can add some water until the glass mat is no longer absorbent. However, if the cell does not fill up, then evaluate the level of added water and give the mat as well as filling the other cells. Release the caps and place the lid while using a voltmeter to power up to an average of 2 volts.
- Place the power supply on the battery with the current limit set low such that you can open it up to achieve steady voltage results. Your battery should now draw zero mA and give the battery acid time to mix with the water while distributing in the mat. After this, the charging voltage will gradual-

ly rise and it will finally reach an average current level. Increase the current limit by calibration and allow the battery to charge. The current in the large batteries might at some point increase to allow optimal charging results and to ensure that the battery does not overheat. Evaluate for any increase in temperature, bubbling or hissing sounds since this might reduce the voltage. An increase in temperature does not necessarily mean that the battery is compromised.

- You may notice that the battery will sometimes discharges for no apparent reason down to zero and it may fail to hold sufficient charge. In this case, maybe at least one cell plate has gotten into constant shedding and the battery current draw has increased significantly. If your battery shows such characteristic, then you might consider disposing it off.
- You may also notice the cells that have undergone a significant amount sulfation might cause the battery to warm up excessively. If this is the case then you might probably have to use a regulator to regulate the charge by using a trickle charger.
- Ensure that the battery has sufficient charge and that you have tested to determine if it provides sufficient current. In this case, seal the lid and place some adhesive to ensure optimal durability and to mitigate the effects of venting gasses.

6 HOW TO RECONDITION BATTERIES FOR FORKLIFTS

ABOUT FORKLIFT BATTERIES

The forklift is unique unlike the conventional batteries since it acts as a power source and it provides a massive counterweight mechanism to aid in lifting the forklift. The conventional forklift batteries often comprise of various components including:

- Battery case - The battery case is used to encasing the individual cells in the battery. In most cases, the average cell number can range from as little as 6 to as much as thirty-six. The voltage, on the other hand, can reach volts of as much as 48volts.
- Battery cells - The battery cells are simply small and self-contained batteries that comprise of several cells that are tightly stacked lead plates filled with sulphuric acid.
- Battery bars - The battery bars are typically large lead bars that can be used to link each cell to create a complete circuit for the flow of electric current.

- Battery cables - Cables that vary in size ranging from the four gauge wire, which is on average the length of a diameter pencil to as much as 4/0 cables that can have radiuses of as much as 0.5 inches. Such cables might require stout wiring to be able to withstand the high currents that some batteries are capable of producing. In fact, some batteries can produce well over 1,200 amps.

If the forklift perhaps shows a significant decrease in its overall performance levels especially when attempting heavy tasks, then it might be time to investigate the battery. In fact, any battery that averages well over five years is likely to show signs of reduced capacity levels. At this point, ensure that you replace the battery ahead of time to avoid any compromised situations. Failures in forklift batteries may occur at any time,

and this might be due to factors such as improper charging or even watering.



SAFETY GUIDELINES

Similar to charging activities, the main factor to consider is that you require sufficient training and handling equipment as well to ensure safe operation results. Various fleets might necessitate the use of forklift battery chargers and calibrate the equipment to suit your mechanical tools as well as the battery. Using battery lifting beams and hosts are essential for the battery-handling feature. A good recommendation for you would be to adhere to your brand manufacturer's recommendations.



Since forklift batteries are rather heavy, you should consider the following to reduce any likelihood of injury or perhaps damage to your equipment:

- Never attempt to lift the batteries without using the correct tools.
- Ensure the lift truck is positioned appropriately with regards to the battery charger position.
- Before altering the functionality, ensure the forklift is stable by applying the brakes.
- Tools such as chains or hooks may damage the

battery. Therefore, use a battery extractor system to perform the procedure.

When moving the forklift battery, ensure that you use a battery transfer cart to ensure optimal safety levels. The transfer cart should come with a roller surface that allows for convenient battery load movement and wheel locks to ensure the cart does not move on its own. With sufficient training, you might even use a gantry crane to perform the lifting and positioning procedures of the battery.

When using the forklift battery chargers or any other similar tools, you should ensure that you adhere to all the safety stipulations and rules. In fact, you might in some cases require some special training to ensure that all programs are up to date with regards to correct practices of battery management.

By and large, here are some of the general considerations for you to take into account for your routine:

- Wear the correct protective tools including face shields, safety goggles, and neoprene gloves.
- Avoid wearing any metallic jewelry including earrings that must be kept away from the uncovered batteries to mitigate the effects of any sparking.

- Take precautions when working with flammable materials and never allow flames, sparks or electric current to get in contact with your battery.

- Evaluate the electrolyte and water levels before you can kickstart the charging procedure. Having said that, ensure that you don't add any water since this should only be done after the charging procedure completes.

- During the mixing procedure, ensure that you pour acid into the water since doing it opposite may compromise the entire procedure. Ensure that you turn off the charger and detach all the clamp connections.

- Batteries that come with sealed vents should not surpass an average of 25 amps of current.

- When attaching the clamps, ensure that you first connect the positive clamp to the positive terminal, and repeat the same for the negative terminals.

- If the battery heats up, ensure that the vents are not leaking. Proceed to turn the charger off

and restart the procedure with a lower charge rate.

- Maintain the indicated water levels and only add water after the recharge procedure completes.
- The above recommendations and recommendations are not all-inclusive, and users should make informed choices when handling lead acid batteries. It is also important to note that poor disposal methods may compromise ecosystems due to the toxic nature of lead and sulphuric acid.

SUPPLIES AND EQUIPMENT

There are various supplies and equipment that might be required for restoring the forklift battery. For instance, you need various measuring equipment such as the voltmeter and the hydrometer. Besides that, you also require unique handling mechanisms since most forklift batteries tend to be rather heavy. Some of the other supplies that you may require for the procedure include:

- Safety gear- Handling lead acid batteries is a delicate procedure and you, therefore, need to

protect yourself from the toxic acids.

- Additives such as Epsom salt- You will need to open the caps on the top of the battery section and empty the battery. Following this, mix some battery water with the salt for the charging procedure.
- Smart charger- The smart charger is perfect since it functions in tandem with the BMS system to regulate the effects of undercharging and overcharging as well.

STEPS FOR RECONDITIONING THE FORKLIFT BATTERY

Servicing a forklift battery is a procedure that is similar to servicing a conventional 12-volt battery. These tests can be conducted on a regular basis if you want to enhance the overall battery lifespan for your needs. However, you need to be careful when handling the battery since any slight damage might hamper its overall capacity.

STEP 1 Once you have identified the battery that requires reconditioning, the first step is that you should determine the average voltage of the battery. For instance, you may achieve this by counting the cell water caps and multiplying this number by 2.



STEP 2 Following this, ensure that you use a DC voltmeter that is customized for a particular voltage and records the current from the positive to the negative terminal.

STEP 3 The current should be equal to the average voltage of the battery or higher if you perhaps just disconnected it from the charger. If the average voltage measures lower than the stipulated voltage, then you may be having some damaged battery cells. Each battery cell should average 2.1 to 2.5 volts. Having said that, if it reads lower than 2 volts, then this might compromise the overall charge capacity of the battery.

STEP 4 The next procedure is that you have to evaluate the voltages of each cell in the given battery. You might need a DC

voltmeter along with some metal probes to achieve results with this procedure.

STEP 5 Ensure that you maintain the ideal polarity levels when using the test probes. For instance, you may start the procedure by cleaning the top section of the positive terminal as well as the metal probes.

STEP 6 By using the probes that are clipped on to voltmeter cables, position the positive probe on the clean, positive terminal and place the negative probe into the first cell of the battery.

STEP 7 Record the readings on the voltmeter and ensure that you are making sufficient contact with the positive end of the battery terminal. Note the voltage on the pad, test sheet, and the voltage as well. The voltage should average at 2 volts. The added benefit is those forklift batteries are well marked like the conventional batteries.

STEP 8 Insert the probes into each cell and record the voltages. The voltage should average 2.1 to 2.5 volts.

STEP 9 The next step is that you have to use a hydrometer to determine the specific gravity of each cell. You can use this to read the totals on each of them to see what needs to be charged properly.

STEP 10 After recording the hydrometer and voltage levels, ensure that you decide whether you can recondition the battery or dispose of it.

STEP 11 If the hydrometer float reading is rather low especially in the white or red section of the float, then this might indicate that sulfation has compromised the capacity of your battery.

STEP 12 If the cell test reading is lower than two volts, then you may still stand a chance at recovering the battery. The batteries are often expensive to replace, and you might be forced to settle for DIY reconditioning methods if you hope to salvage its capacity.

STEP 13 If the cell test readings are under two volts each, it is more of a gamble that the battery will come back at all.

STEP 14 After determining whether can be rescued, you can then add the chemicals and ensure that each cell in the battery distils above the plates by at least .25 inches. Never fill the battery to the brim as you may risk overfilling it improperly.

STEP 15 You can then add the special additives for rescuing your battery. Whether its Epsom salt or another chemical, ensure that you add It appropriately.

STEP 16 After adding the battery additives to all the cells,

ensure that you replace all the filler caps and watering hoses as well. Position the forklift rear section of the battery charger for long and steady charging results.

STEP 17 You will soon note that each time you charge the battery, its overall charge capacity improves. After two weeks of steady charging and reconditioning, you should achieve the desired results for your needs.

MAINTAIN YOUR FORKLIFT BATTERY

There are various factors to consider when it comes to forklift battery care.

CHARGING METHODS

Charging is important since it plays a role in the lifespan and overall capacity of your battery. Consider the following:

- Ensure that you utilize the battery up to the point the battery achieves 80% depth discharge levels in the red zone by using a conventional voltmeter.
- Forklifts are different from the conventional forms of batteries since they have a longer lifespan and recharging them every once in a while ensures optimal functionality.

- Using a voltmeter, measure the readings on your battery every once in a while. If you come across any inconsistencies, then you might have to recondition your car battery.
- An automatic charger that comes with special processing unit will provide long lasting charging capabilities for your needs. Using a smart charger that comes with an equalization phase and auto switching to floating charging would be an affordable option for enhancing the lifespan of your battery. This will help to mitigate the effects of overcharging and discharging as well.

FLUID LEVELS

- Since a battery that is running dry may be prone to damage, ensure that you evaluate the water levels in your battery after every charging session. Evaluate the water level and determine whether it is sufficient to cover the plates with-



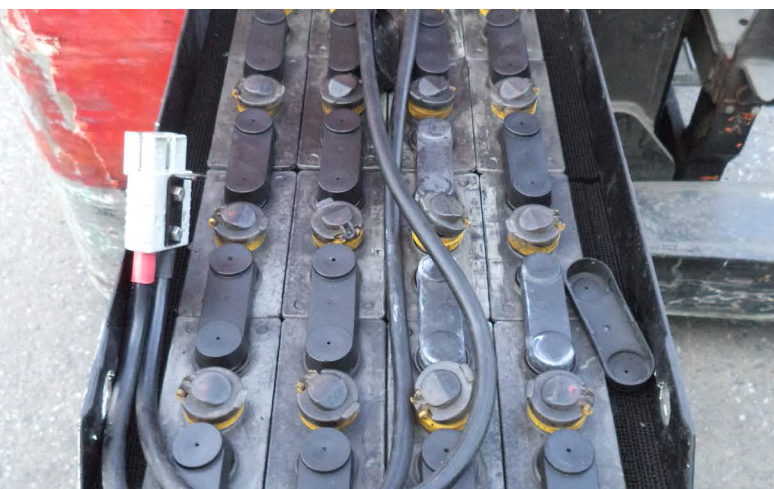
in the battery. Furthermore, ensure that you use pure or distilled water when going through the refilling procedure.

- Using superior quality charging additives may help reduce the average charging time needed to recondition your battery.
- Never fill your battery over the recommended level since additional space is required for gas expansion especially at the final stage.

CLEANING

- Ensure that you rinse off any overflows from your battery immediately with generous amounts of water and baking soda. This procedure will help to mitigate the effects of corrosion on the top and bottom sections of the battery. Ensure that you use sufficient water to remove the overflow and clean any corrosion or build on a regular basis. If this does not succeed, then the battery could undergo a discharge when not in use, which might lead to excessive heat production during the recharge procedure.

- It is recommended that you rinse your battery every once in a while or more to remove the accumulated acid and residue from the leads.
- Evaluate the top section of the battery including the connector and the cables as well. Eliminate any corroded products that have accumulated on the battery while it is disconnected from the charger and the forklift as well. Evaluate the connections carefully by tugging and flexing the cables. Any loose cables are a direct sign of damage.
- If the cables have any damage, then it might be time to perform a replacement. Damaged connectors and leads are also other complications that users must address. For instance, insufficient contact by the spring loaded connector tips may reduce the transmission of power acquired from the battery to the forklift. Evaluate the connectors on the charger cables with dexterity.





7 HOW TO RECONDITION GOLF CART BATTERIES

Golf cart batteries are somewhat similar to conventional batteries, and it is therefore simple to restore them as well. By using the standard methods of using additives and smart chargers, you can not only recharge your battery, but you may also enhance its overall lifespan. Sulfation is perhaps the leading cause of battery failures, and it can be easily reversed through the use of electronic pulses.

A good pulse charger removes sulfation with excellent results to ensure long lasting performance result for our needs. The sulfation process occurs when sulfur accumulates on the lead plates, and it might play an important role in restoring the battery. Here are some factors you should consider when replacing

the lead acid battery:

- ★ If the battery can no longer start the golf cart engine then you should get it replaced.
- ★ It must also be replaced if the battery is impossible to restore. This could be the case if it has suffered major physical damage such as holes and detached terminals.
- ★ Most cart batteries will last an average of four to five years. If the battery is hitting this age gap, then you should consider performing a reconditioning procedure to restore its performance.
- ★ Evaluate the voltage of the battery several times by using a voltmeter and when the charge drops below an average of 11.5 volts. This is because the effects of sulfation have likely compromised its overall functionality.

TIME AND SUPPLIES NEEDED

The average amount of time required to test and recondition the battery is similar to that of most batteries. In fact, once you prepare the battery for the charging procedure, you will have to let it sit on the charger for several hours before proceeding to evaluate the average voltage levels. Furthermore, you will also need the conventional hydrometer and voltmeter as well. To be specific, the voltmeter will be used to determine whether the battery has achieved an optimal charge capacity levels.

In most cases, this often averages at 11.7 volts and a maximum of 13 volts. However, if you are unsure of the reading acquired from the voltmeter, then you might be inclined to use the hydrometer to determine the specific gravity reading levels.

Many people might be surprised that restoring a battery is a rather simple procedure and it involves more than just crossing some electric wires by using jumper cables. The materials required to restore the functionality of your battery are simple. Some of them include:

- ★ Tools such as hydrometer and voltmeter
- ★ Crescent wrench
- ★ Automatic and smart chargers

- ★ Epsom salt
- ★ Baking soda
- ★ Pure water

SAFETY GUIDE

- ★ Put on the appropriate gear including gloves, goggles and an apron when handling the batteries. This is because most batteries tend to be rather heavy and it might lead to an injury when handled incorrectly. Besides that, putting on gloves helps decrease the likelihood of your skin being exposed to the acids.
- ★ Avoid smoking when working with the batteries. Ensure that any sparks or flames of all kinds are far from your working area. The gases produced during the charging and discharging procedure are flammable especially in rooms that are not well ventilated.
- ★ Never place metal tools on the top section of the cell since this might lead to sparks and shorting on the cell terminals. You must be aware that a lead acid battery is an electrical tool that and placing metal items might lead to

an electrical shock or even internal shorting.

- ★ During the production of electrolyte, always pour acid into water. This is because pouring the water into the acid will compromise the potency of the electrolyte especially when it comes to the charging procedure.
- ★ Ensure that you replace all the caps on the cells before you attempt to install the battery back into your mechanical tools. In this way, you reduce the chances of spillages and negligent care that may damage the overall capacity of your battery.
- ★ If the electrolyte comes into contact perhaps with your skin or clothing, ensure that you wash adequately with water and neutralize the solution by using baking soda or water. If the electrolyte comes into contact with your eyes, rinse and wash rapidly and rush to a medical practice.



STEPS TO RESTORE THE BATTERY

Ensure optimal safety levels before kick starting the procedure by putting on the appropriate gear such as goggles and gloves. The lead acid is a very corrosive and it might lead to chemical burns. More so, ensure that you work area is well ventilated as well. After you get everything prepared properly, you must use the following steps to make it all work:



STEP 1 Using a crescent wrench, disconnect the battery cables and remove the battery from the golf cart. Detach all the cell covers and tilt the battery sideways to remove all the acid into a plastic container. Neutralize the effects of the acid by adding some alkali compounds such as baking soda until this liquid stops producing a fizzing sound. Throw away the fluid by allowing water to run through it for a couple of minutes.

STEP 2 Introduce your additive solution. The best is Epsom salt, and an average of 50z mixed with distilled water is sufficient for your needs. It is important that you use distilled water since tap water contains chemicals that may compromise the capacity of the battery. Ensure that you fill each cell to the brim with the solution and cover the tops.

STEP 3 Use a three-phase charger to rejuvenate your battery. The three-phase chargers are perfect for lead acid batteries since they will regulate the charging procedure thereby avoiding the effects of overcharging. Ensure that you turn off the charger and then connect the terminals correctly. After this, let the battery charger overnight.

STEP 4 Turn off the charger when the golf cart battery receives sufficient amount of charge. You may start off this procedure by disconnecting the charger leads and replacing them with unique cell caps. Replace the battery in the golf cart and ensure that the battery cables are well fastened.



DIFFERENT BATTERY CONFIGURATIONS

When it comes to purchasing the perfect battery for your golf cart, there are various configurations that you should take into consideration. The standard battery voltage for most golf carts averages at 48 volts. The procedure of creating a multi-bank battery system for your mechanical tool is a rather basic procedure.

There are several reasons for using several battery configurations including cost savings, enhanced voltage/ capacity, and efficiency a well. Furthermore, the two methods of connecting the batteries include the series and the parallel modes.



6-VOLT BATTERY CONFIGURATION

The six-volt configuration comprises of eight 6-volt batteries. This configuration involves connection the batteries in series and parallel to achieve the ideal amp levels. The main drawback of this particular configuration is that it comprises of several batteries which can be difficult to install or perhaps recondition.

8V BATTERY CONFIGURATION

The eight-volt battery configuration comprises of six 8-volt batteries. The six and 8-volt batteries provide better discharge capabilities, especially when used for a longer duration of time. The 8-volt batteries provide the best of both worlds when it comes to battery configurations of golf carts.

12V BATTERY CONFIGURATION

The 12-volt battery configuration comprises of 4 batteries. Although the 12-volt battery system is the most simple to set up, this configuration tends to have poor discharge rates as when compared to the 6 and 12-volt batteries.

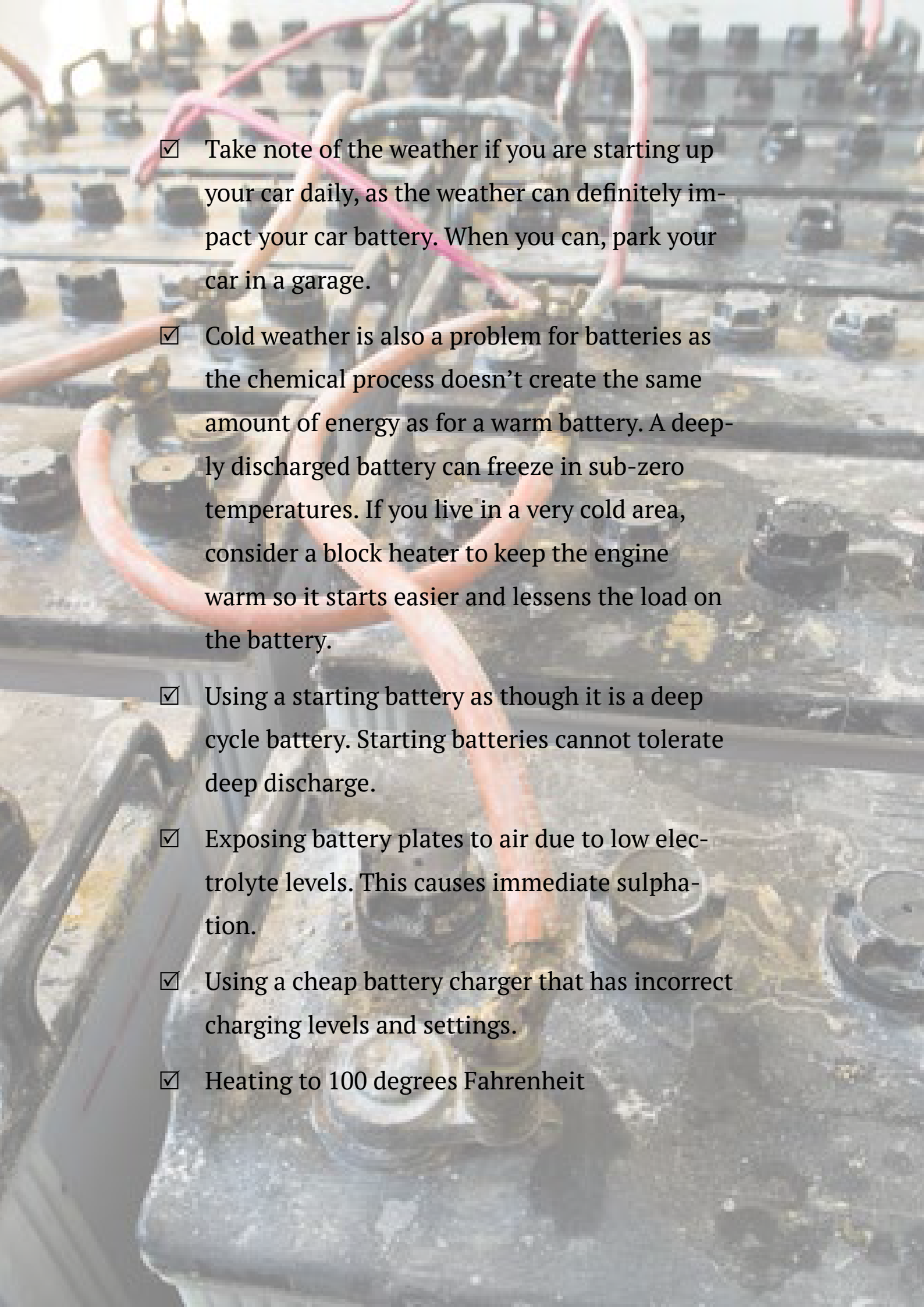


8 BATTERY CARE & MAINTENANCE

When it comes to the best practices for maintaining the functionality of your battery, it is important that you avoid discharging them and leave them to sit unused for an extended duration of time. Whenever the discharge occurs, the chemical change that occurs in the positive plates of the battery can change the lead oxide into sulfate when the discharge procedure occurs. If the battery stays discharged for a significant duration, then plenty of positive plates might be converted into lead sulfate. The sections of the plates that are affected by the sulfation can no longer store sufficient energy.

Sulphation can take place for several reasons. If you know the things that can cause sulphation, you'll be able to take the necessary actions to avoid it and your battery (new or reconditioned) will last longer. Here are some of the things that can cause sulphation:

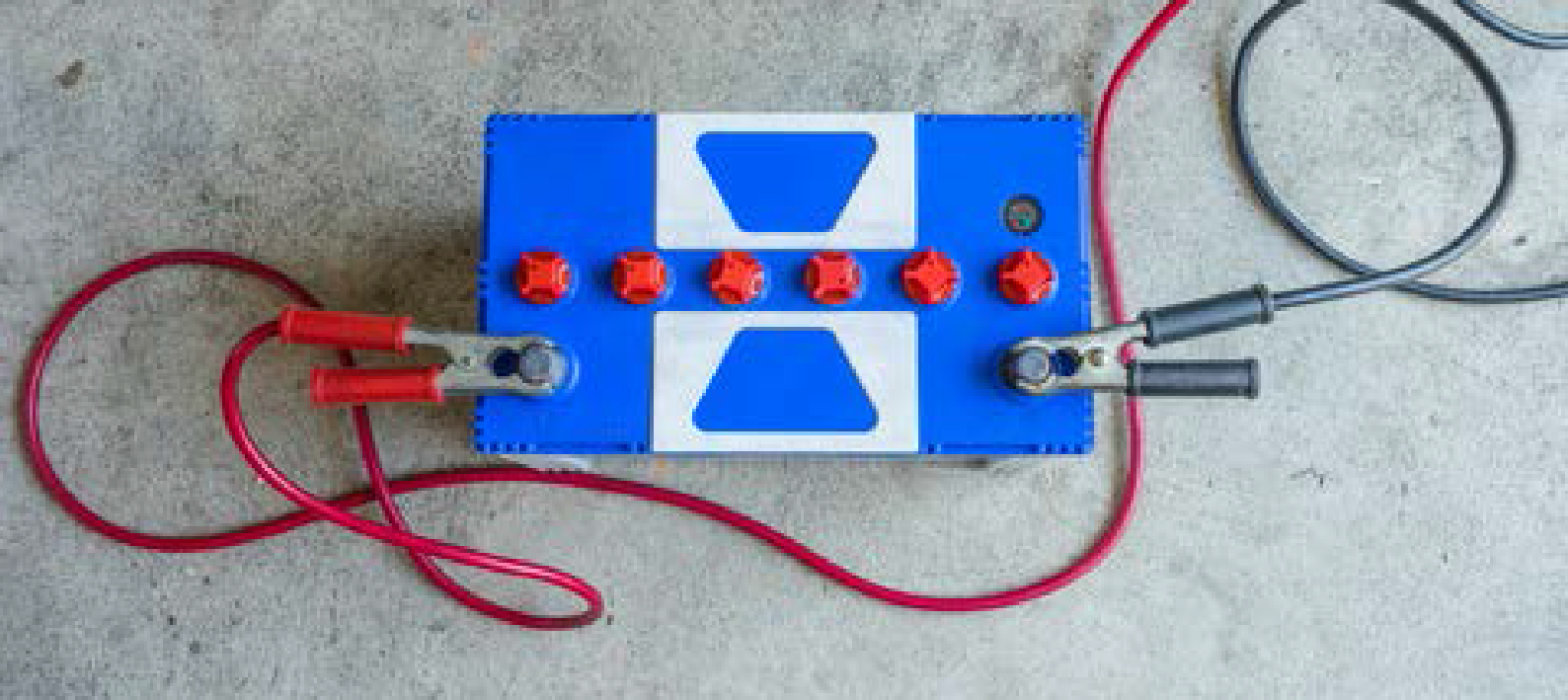
- ☑ The battery is stored without some type of energy input.
- ☑ The battery sits idle for too long between charges.

- 
- ☑ Take note of the weather if you are starting up your car daily, as the weather can definitely impact your car battery. When you can, park your car in a garage.
 - ☑ Cold weather is also a problem for batteries as the chemical process doesn't create the same amount of energy as for a warm battery. A deeply discharged battery can freeze in sub-zero temperatures. If you live in a very cold area, consider a block heater to keep the engine warm so it starts easier and lessens the load on the battery.
 - ☑ Using a starting battery as though it is a deep cycle battery. Starting batteries cannot tolerate deep discharge.
 - ☑ Exposing battery plates to air due to low electrolyte levels. This causes immediate sulphation.
 - ☑ Using a cheap battery charger that has incorrect charging levels and settings.
 - ☑ Heating to 100 degrees Fahrenheit

The batteries that are deeply discharged and partially discharged can fail in as little as 12 months. Evaluate your battery on a regular basis to ensure that its received sufficient charge. Implement the use of a hydrometer to determine the particular gravity levels of the lead acid batteries. It is important to note that if the batteries undergo deep cycles, then they might quickly recharge.

The particular gravity reading might be smaller than it should be since the electrolyte at the top of the battery might not have mixed appropriately with the charged electrolyte, which can hamper the capacity of the battery. Also, evaluate the electrolyte level in wet cell batteries several times during the year and top each cell off with some pure water. Avoid adding water to the discharged batteries since the electrolyte might be absorbed when the batteries discharge.

If you add any water at this time, you will be inclined to recharge the battery, and the electrolyte overflow might lead to a mess. There are several other things that you can do to maintain the condition of batteries, new or reconditioned, and to enhance their overall lifespan as well. Here is a handy checklist to use to make certain that you are doing all the right things to keep your battery charging and providing the power you need for as long as possible.



- ☑ Keep the terminals clean and free of corrosion.
- ☑ Clean the batteries using special solutions that may be mixed with baking soda and some small amount of water. To control the effects of corrosion of the cable connectors and the leads, place a small silicone bead to act as a sealing mechanism at the base of the post. Following this, place a felt battery washer over the post and embellish the washer with hot grease. When placing the connector back on the lead, ensure that you place it securely.
- ☑ Maintain the correct electrolyte level-This is only applicable for the vented batteries. Therefore, ensure that you add distilled water as required to ensure the plates are well covered. It may be difficult to add water at this point

- ☑ Avoid High temperatures for your Batteries
-Temperatures that average 100 degrees Fahrenheit might increase the level of internal discharge which might lead to sulfation, therefore avoid leaving the batteries in a position that has a high temperature. Avoid deep cycling your sealed battery since automobile batteries can control the effects of the discharge. They should therefore not be used to perform discharge tasks.
- ☑ Avoid long times in between charges- A battery that sits for a significant duration in between charges may fail to function since this leads to gradual discharging.
- ☑ Avoid undercharging- Charging your batteries past the stipulated capacity might lead to sulfation.
- ☑ Use a smart charger- If your battery is functioning properly, then the alternator might keep your car battery at full power.
- ☑ However, a deep cycle battery is required for appropriate charging especially after the discharge cycle. A good smart charger for lead acid

batteries should comprise of either three or four step to suit your unique needs. The three steps are perfect for initiating the bulk charging where the battery can achieve as much of 80% of its capacity at the maximum voltage.

- ☑ Ensure the tops of the battery are clean at all times and that the cables are tight. Avoid tightening or removing the cables during the charging or discharging procedure since any spark on the batteries might lead to a hydrogen explosion in the interior section, ruin the cell structure or even hamper your health.
- ☑ You may have to use equalizing charges when some of the cells demonstrate even a small difference in their specific gravity measurements. This might show a long and steady overcharge which causes the battery to produce a hissing or sucking sound. Avoid equalization of the gel or sealed batteries.
- ☑ With the sufficient amount of care, the lead acid batteries can provide long lasting performance and work well with almost any power systems as well.

9 CONCLUSION

Remember when working with lead acid batteries that you watch for how well you are taking care of them and to see that you won't put yourself at risk when handling them. The process of using such great batteries can be impressive and important but you must watch out for how they are made and what you are doing with them.

Good luck with your plans for taking care of these batteries. You will be amazed at what you can get out of your batteries if you look at how well you are handling them and using them to your advantage.

