Automotive Storage Battery - Care Lead-Acid for now :)

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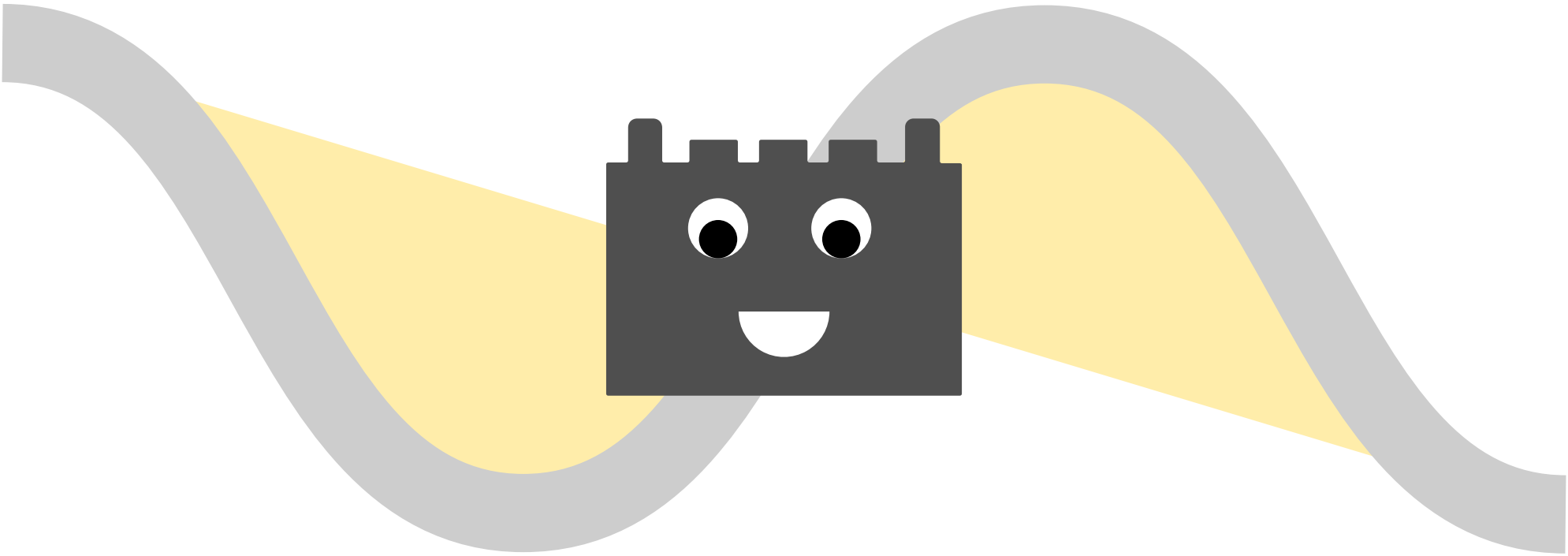
License

Overview

Let's Start ...

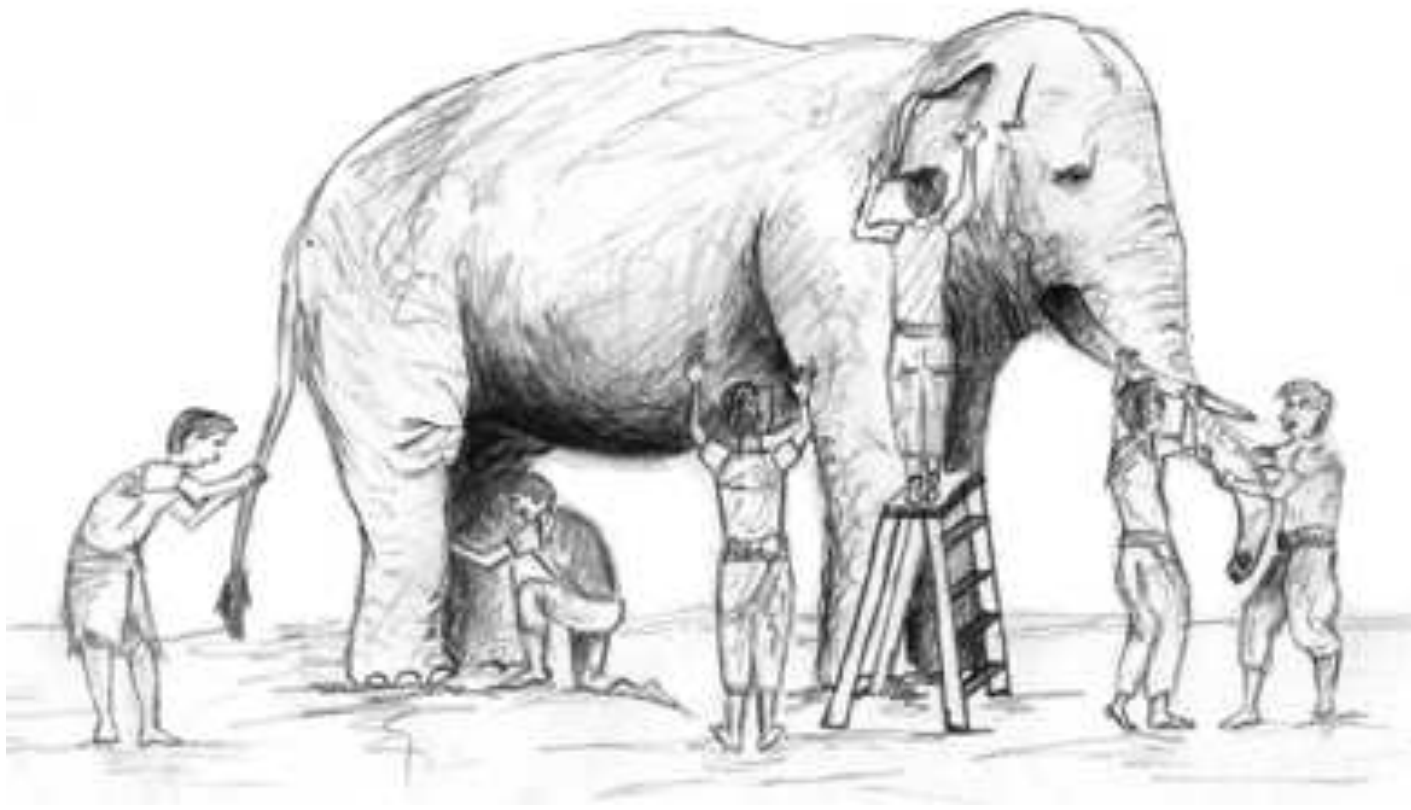


Hi there ! I am your battery

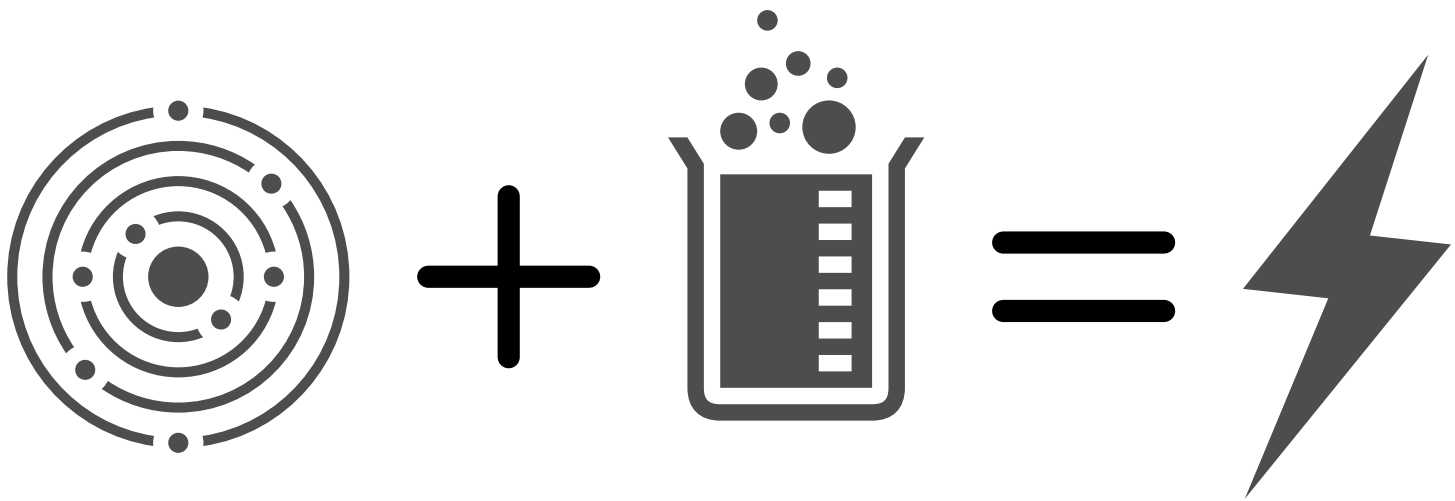
i work for automobiles mostly

i do work for gadgets :)

How people view me ?



What am I really ?



Automobile Electrical system

It constitutes the essentials of a public electricity supply system ...

- - - - - -

- **Generation** $\equiv$ Dynamo or Alternator
- **Storage** $\equiv$ Battery
- **Utilization** $\equiv$ Cranking, Ignition, Starting, lighting, etc...

Battery

Use:

- Battery serves to store electrical energy when there is little demand of current
- Acts as Standy Source

Calibre:

- Robust Construction
- Must withstand severe Vibration
- Must withstand high charging rates & heavy discharge currents

Fact:

- Not always in accessible location
- Not given proper attention

Hence, forms the **Weak Link** of the Automobile Electrical System

Principle of Operation

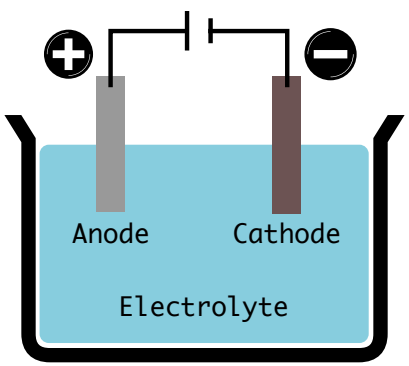
Underlying Principle: **Electrolysis**

Constituents:

- **Electrodes:** Two dissimilar metals.
- **Electrolyte:** Chemical that causes greater chemical change in one of the electrode than in other.

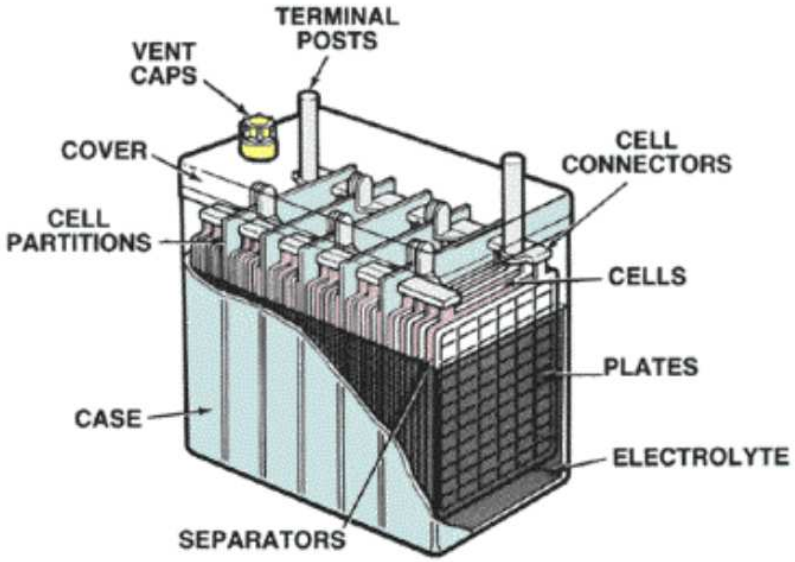
Result:

- Difference in chemical action $\propto$ Electrical pressure (*a Voltaic Cell*)
- Electrical Pressure $\equiv$ Electromotive Force
- Since the Chemical reaction is reversible, it is a Secondary cell.



Construction of Automobile Battery

A typical automotive battery consists of the following parts:



- Plates
- Separators
- Electrolyte
- Cell connectors
- Vent plug
- Cover & Jar
- Battery Case

Plates

Automotive battery plates are formed using ***Faure Process***

Grid:

- A grid is initially made using Lead & Antimony.
  - Mechanical support for the active material.
  - Enabling the Current Conduction.
- **Positive Plate** : Grid is pasted with mix of Red Pb & other chemicals pasting, with dilute H_2SO_4
- **Negative Plate** : Grid is pasted with mix of Litharge & other chemicals pasting, with dilute H_2SO_4

Plates ...

Grid

Plate

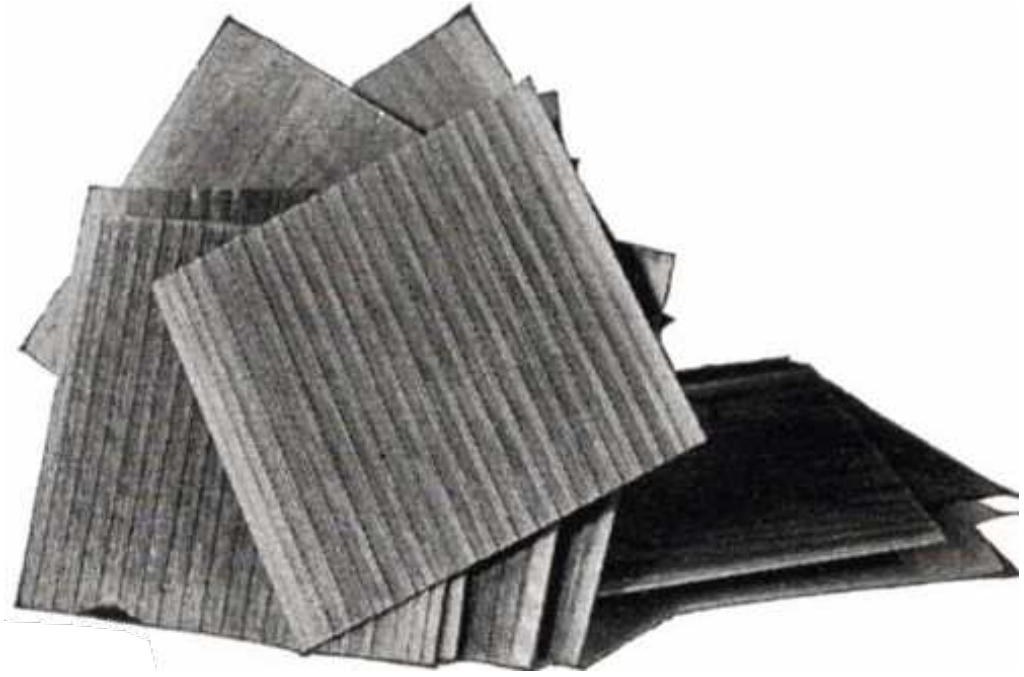
+ve Plates -ve Plates

Plates ready to form a cell

Separators

Functinolity:

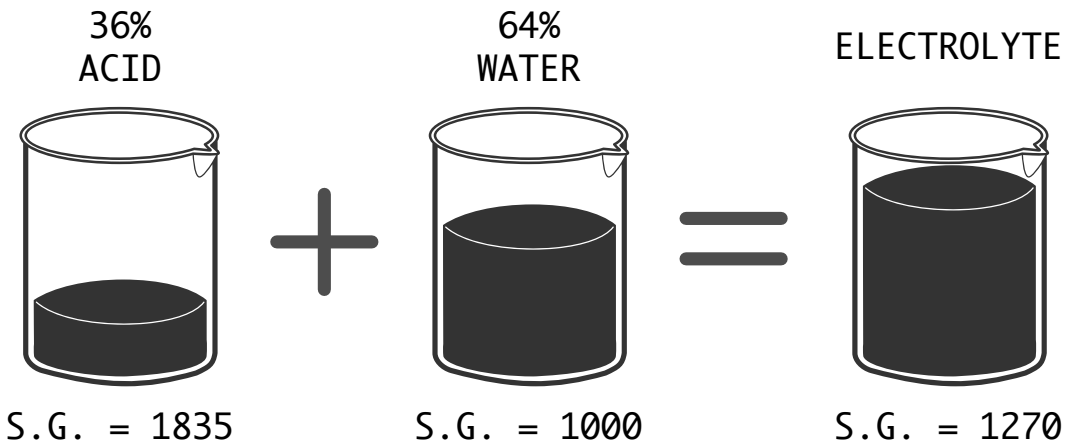
- They are the insulators that prevents short circuiting between $+ve$ & $-ve$ plates.
- They also ease the diffuse of electrolyte in the cell. It is made of PVC or Glass wool.



Electrolyte

Battery electrolyte is a mixture of 36% H_2SO_4 and 64% distilled water H_2O.
Today batteries have an electrolyte with a Specific gravity of 1270, when fully charged @ 20°C.

Specific Gravity: It is the weight of a given volume of liquid in comparison to the weight of the same volume of water. The higher the specific gravity of a liquid the denser(thicker) it is. It means ***exact weight***.

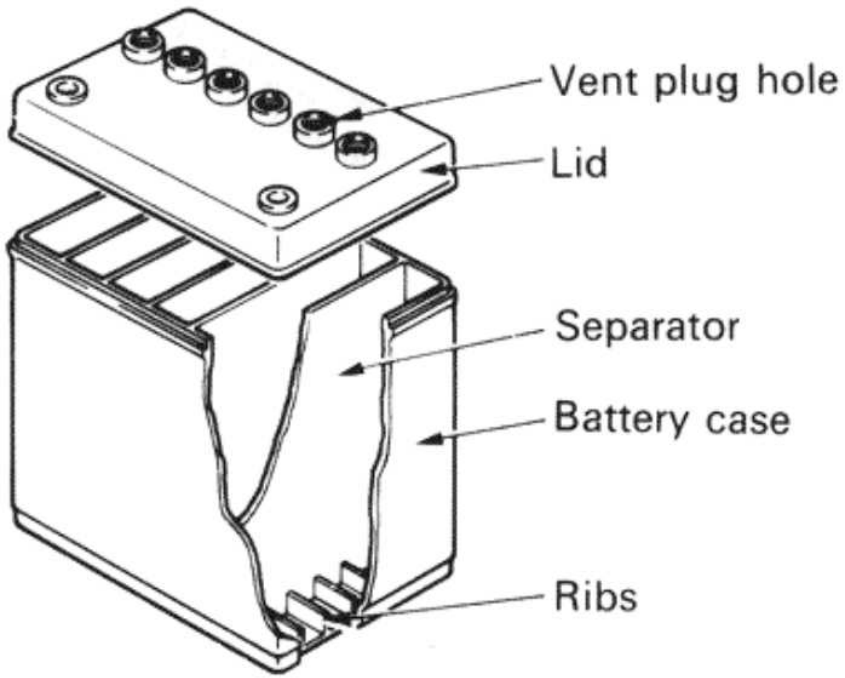


- Sulphuric Acid (H_2SO_4) is used as the electrolyte for automotive batteries.
- (H_2SO_4) ***Specific Gravity*** ranging from 1220 to 1280 is employed.
- Its concentration decides the chemical action in the cell.

Battery Case

Battery case holds the electrolyte and the individual battery cells.

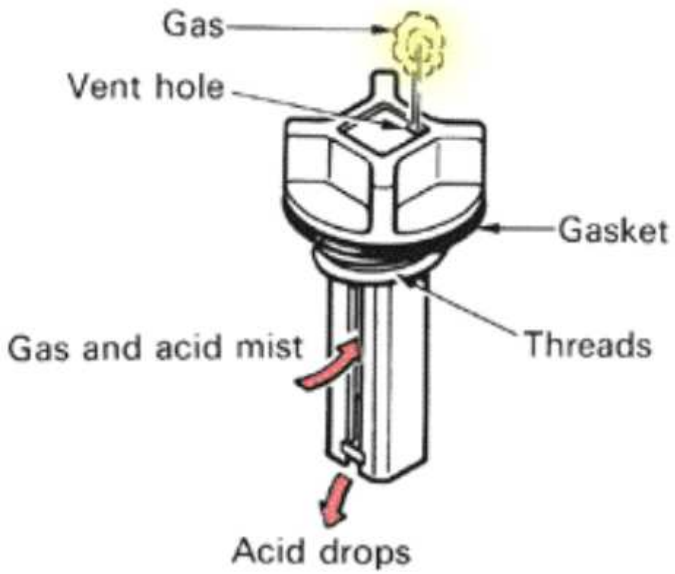
- The plates are raised up off the bottom of the case with ribs to prevent them from shorting out if any of the active materials (lead, etc.) should happen to fall from the plates.
- Usually made of polypropylene, hard rubber, plastic base materials.
- Translucent plastic cases allow checking electrolyte level without removing the vent caps - usually marked with upper & lower electrolyte level.



Vent Plugs

Vent plugs primarily cover the holes that are used for adding electrolyte.

- Designed to separate the H_2SO_4 mist & the H_2 gas that forms when the battery charges.
- Condenses H_2SO_4 mist and drop back into the battery, allowing H_2 gas to escape through the vent holes to the atmosphere.
- Translucent plastic cases allow checking electrolyte level without removing the vent caps - usually marked with upper & lower electrolyte level.



Other Parts

Cell Connectors:

- They provide electrical connection between the Cells of the battery.
- After assembling the cells in the case, they are burned to the strap posts.

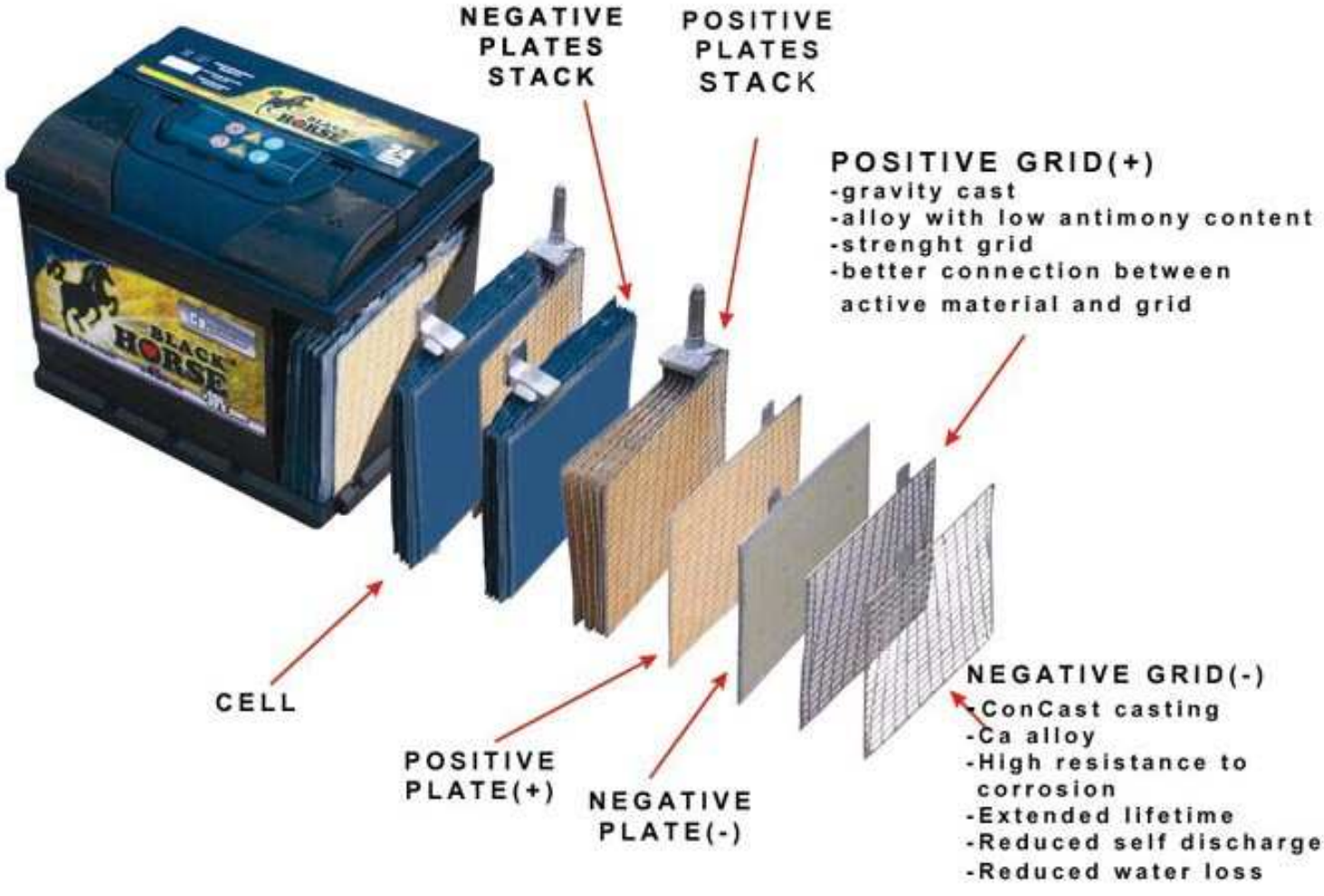
Battery Terminal:

- Helps forming a connection to the automobile electrical circuit.
- Cables could be detachable using bolts or directly soldered to the terminal.

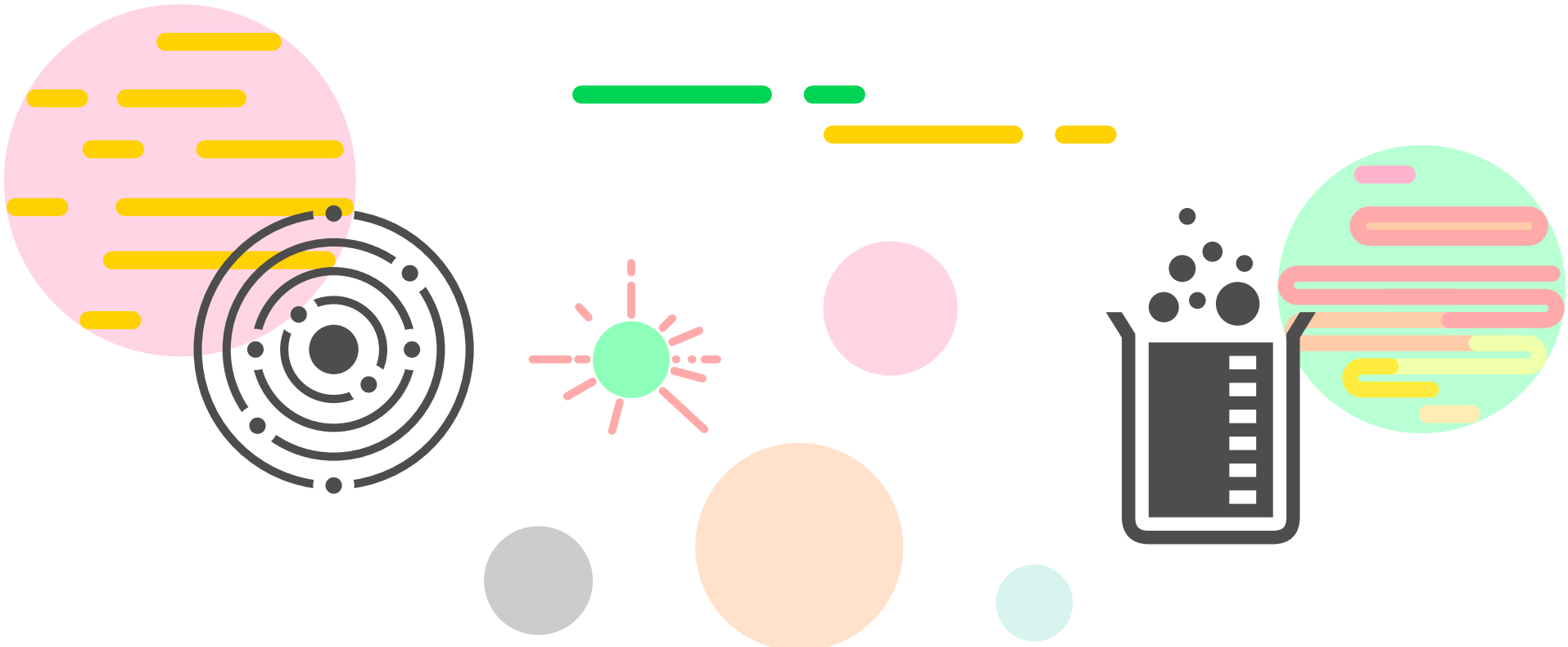
Battery Cover & Jars:

- Cover facilitates the escape of gas during charge.
- Cover provides space for expansion of electrolyte when heated.

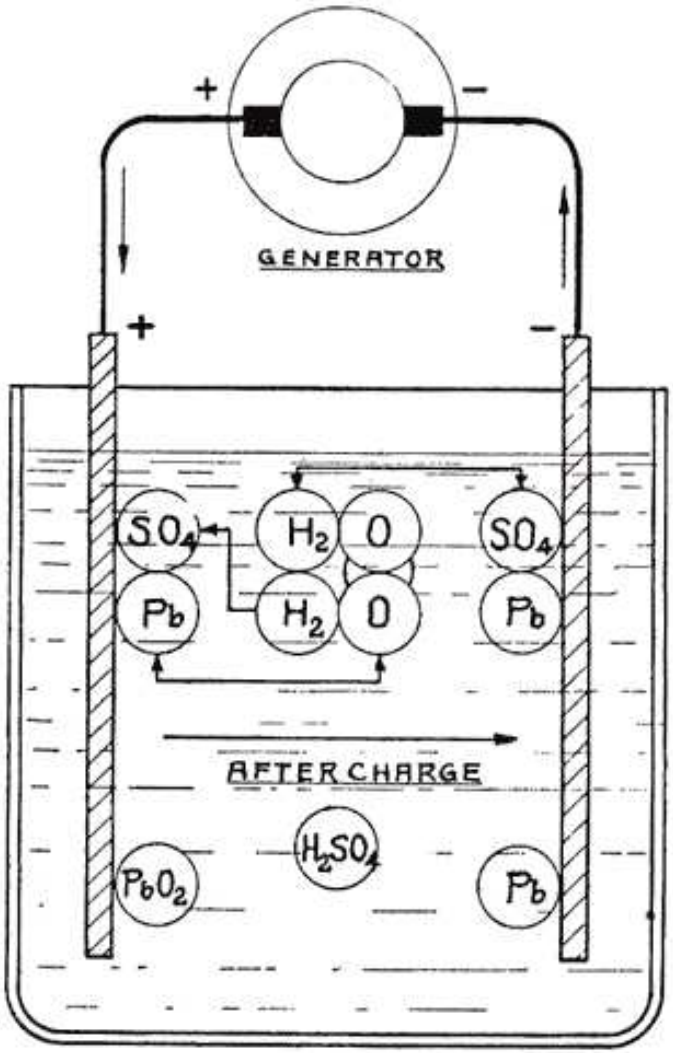
Exploded View Example ...



Chemical Action



Chemical Action During Charge



Chemical Action During Charge ...

At +Ve Plate:

$$PbSO_4 + 2H_2O \rightleftharpoons PbO_2 + H_2SO_4 + H_2 \uparrow$$

At -Ve Plate:

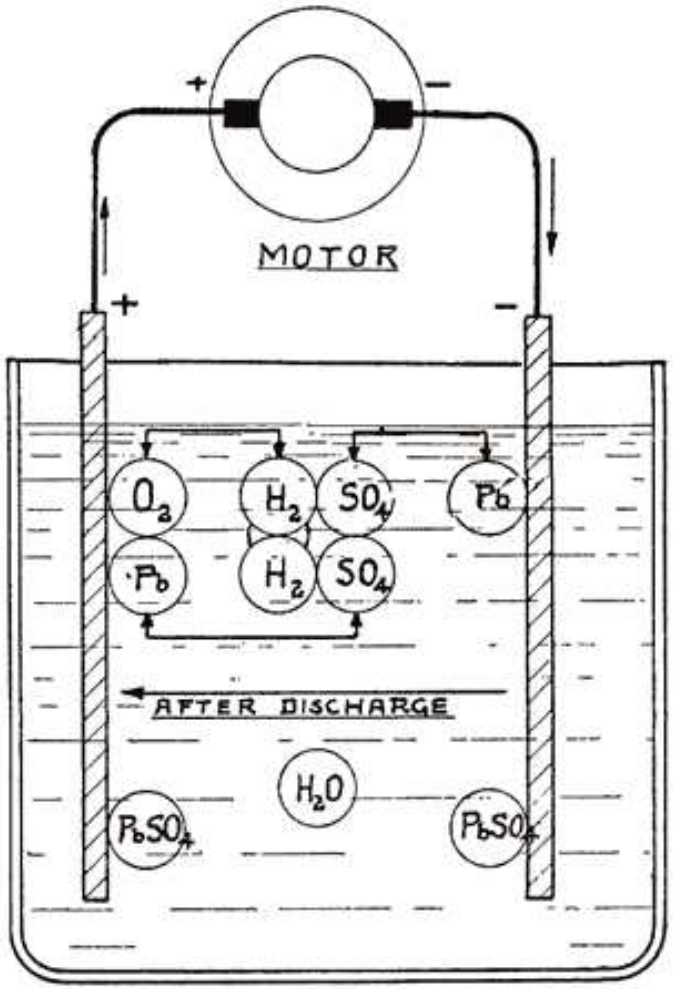
$$PbSO_4 + H_2O \rightleftharpoons Pb + H_2SO_4 + O \uparrow$$

Entire Charging Action:

$$2PbSO_4 + 2H_2O \rightleftharpoons PbO_2 + Pb + 2H_2SO_4$$

On continuous charging H_2 and O_2 rise to the surface of the electrolyte and escape from the cell. This is defined as ***gassing***, which is an indication of the cell is fully charged. **During Charge, acid is driven out of the plates.**

Chemical Action During Discharge



Chemical Action During Discharge ...

At +Ve Plate:

$$PbO_2 + H_2SO_4 \rightleftharpoons PbSO_4 + H_2O + O \uparrow$$

At -Ve Plate:

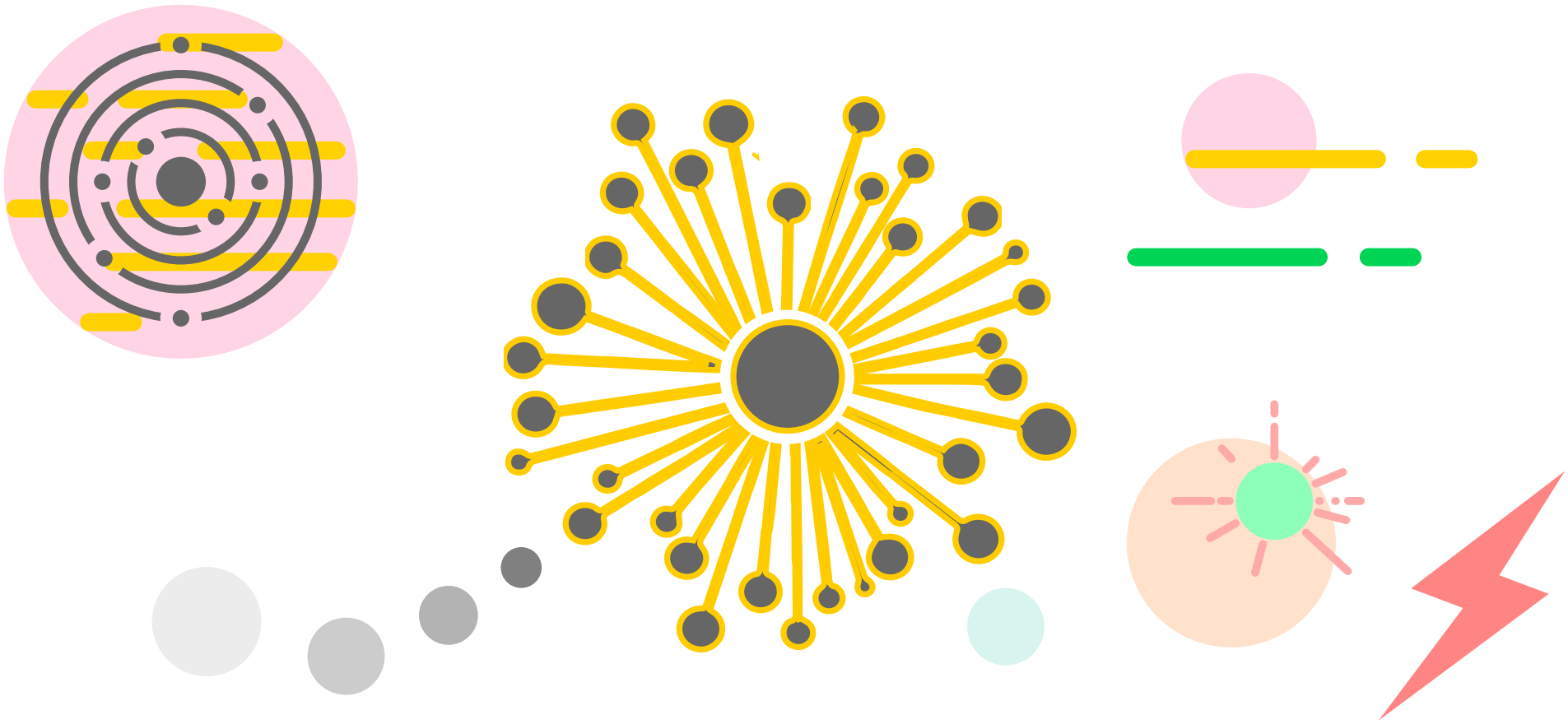
$$Pb + H_2SO_4 \rightleftharpoons PbSO_4 + H_2 \uparrow$$

Entire Charging Action:

$$PbO_2 + Pb + 2H_2SO_4 \rightleftharpoons 2PbSO_4 + 2H_2O$$

Chemically discharging consists of changing the spongy lead and lead peroxide into lead sulphate and the abstraction of the acid from the electrolyte. **During discharge the acid goes into the plates.**

Electrical Action

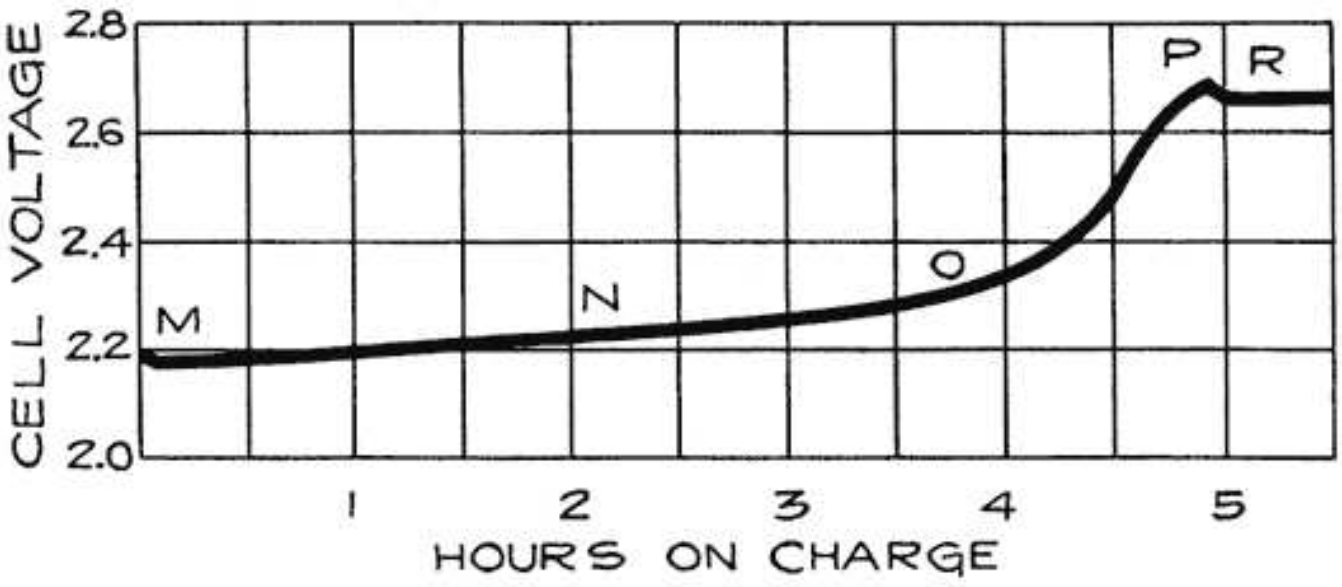


Interaction

Considered electrically, the changes are more complex. The following parameters and interaction between them must be considered:

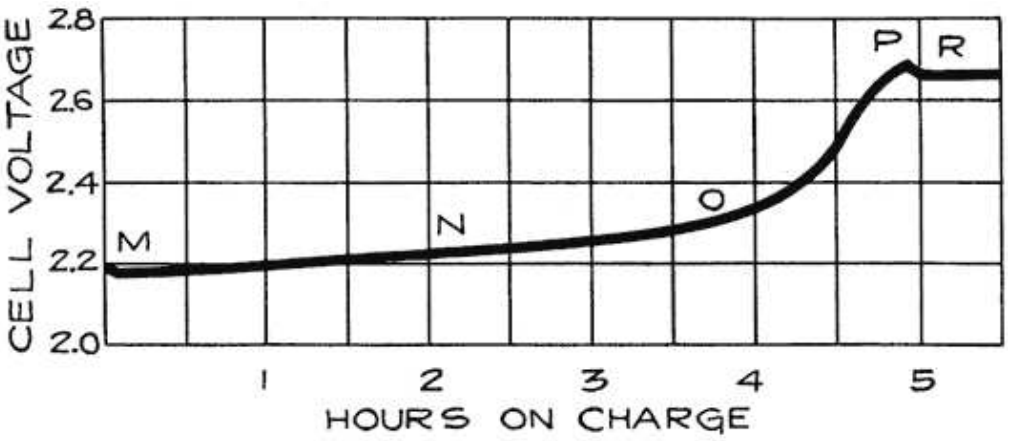
- Voltage
- Internal resistance
- Rate of discharge
- Capacity

Electrical Action During Charge



Voltage rises rapidly for a fraction of the first minute of the charge, & drops rapidly to a normal value and thereafter begins to raise steadily to the end of the charge.

Process...

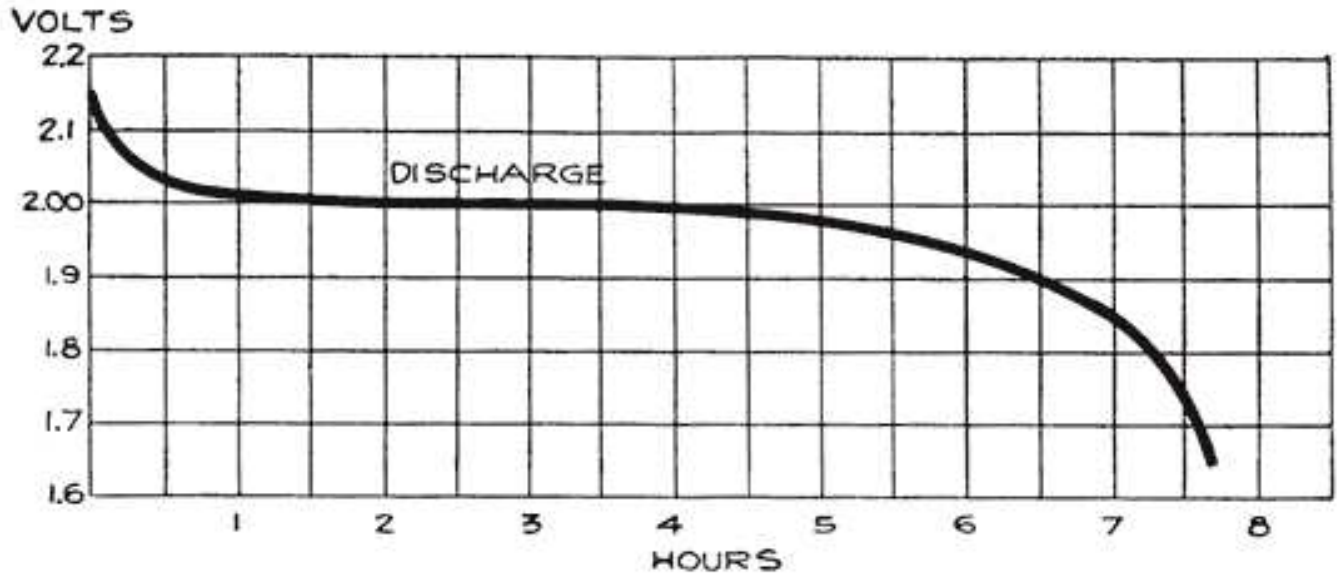


- At point **O** the voltage begins to rise very rapidly due to the $PbSO_4$ in the plate decreasing. Bubbles of gas rises throughout the electrolyte.
- At point **P** the last portion of $PbSO_4$ are removed and acid is no longer formed. H_2 & O_2 gases are formed rapidly.
- Voltage becomes constant at **R** $\approx$ 15 to 16 Volts.

Density

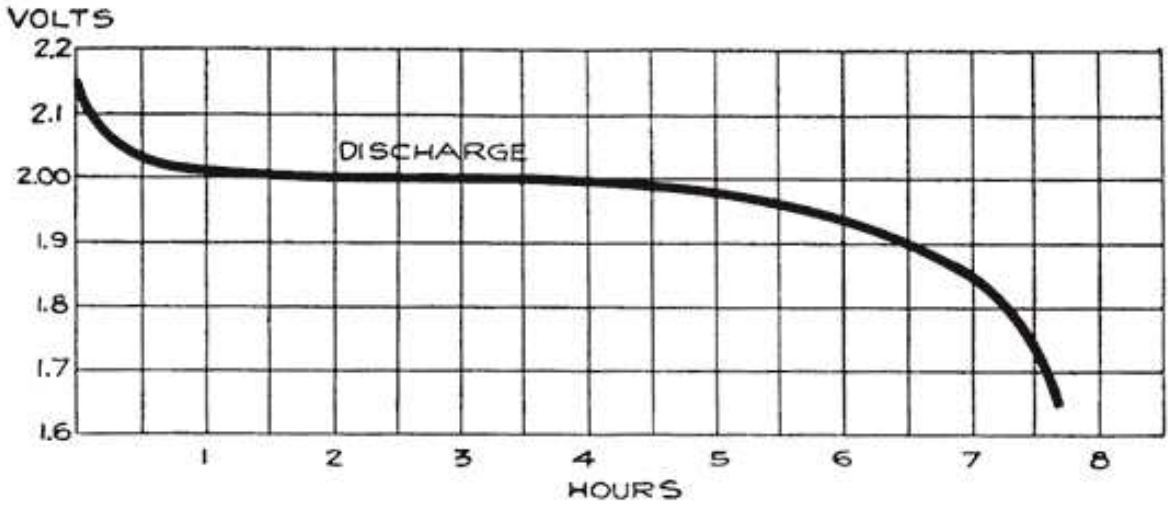
Progress of the Charge is generally determined the density/Specific Gravity of the electrolye in the range 1220 to 1280 measured at 23°C.

Electrical Action During Discharge



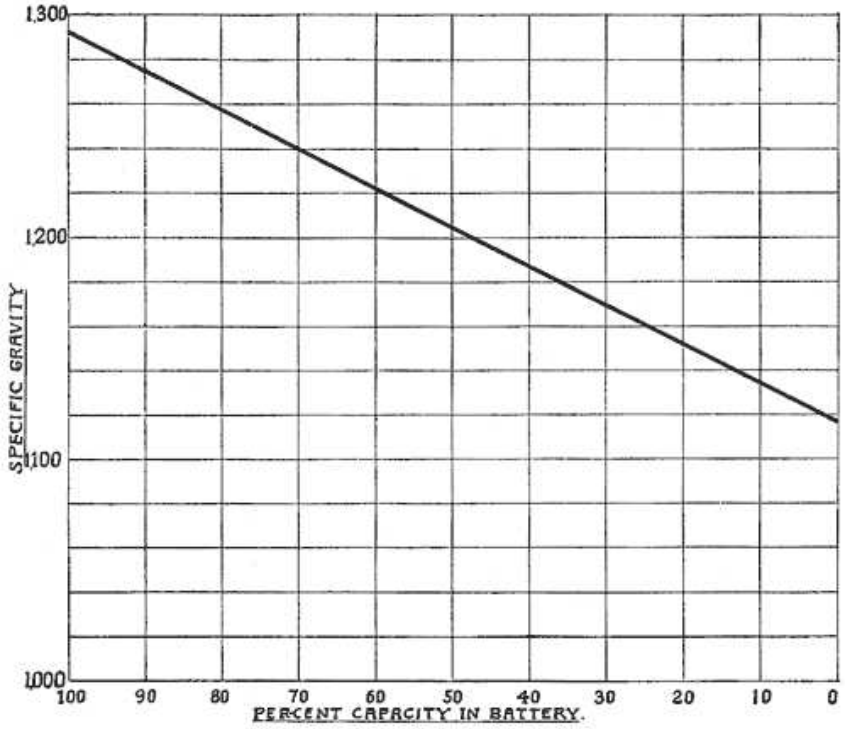
As soon as charging circuit is opened the cell voltage drops rapidly to about 2.1V, within 3 or 4 minutes due to the formation of thick layer of $PbSO_4$ on the surface of -Ve plate & between lead peroxide and the metal of the +Ve plate.

Process...



- When current is being drawn from the battery the sudden drop is due to the **internal resistance of the cell**, formation of more sulphate and the abstraction of the acid from the electrolyte which fills the pores of the plate.
- The limiting value of 1.75V/cell applies to a continuous discharge at a moderate rate. During cranking it may be permitted to a lesser voltage.
- Voltage does not depend upon the area of the plate surface but upon the nature of active material and electrolyte.

Density



The discharge process may be continued upto a Specific Gravity of 1150 at normal temperature due to the fact that further discharge will reduce the life of the battery and battery capacity cannot be expected below 1150 as shown above.

Capacity of automotive battery

What is it ?

- Capacity is the product of Current($\boldsymbol{I}$) drawn from the battery & no. of Hours($\boldsymbol{T}$) the current flows, measued in **Ampere Hour.**
- Leading health indicator of a battery.

Limit:

- In practice we do not discharge the battery to a voltage less than 1.75V/cell, except when the rate of discharge is high, like during cranking.

So ?

- Thus capacity is measured by the no. of hours it can furnish before its voltage drops below 1.75V/cell.

Capacity Ratings

What is it ?: Several Battery capacity ratings have been established by Battery Council International (BCI) that helps to determine the current capacity of a battery. It is an indication of battery's ability to develop and deliver high amperage current to the starter and provide reserve power to the electrical system.

- **Cold Cranking Amps (CCA) rating:** Indicates the ability to deliver specified current @ low temperatures - of a fully charged battery for 30 sec. @ 0degF (-17.8°C) with terminal voltage not less than 7.2V.
- **Cranking Amps (CA) rating:** Indicates the ability to deliver a cranking current at 32degF.
- **Reserve Capacity rating:** It is the time in minutes a vehicle can be driven **after the charging system fails**. It is the length of time a fully charged battery can supply 25A, before the terminal voltage falls below 10.5V @ 26.7°C.
- **Ampere Hour rating:** It is the amount of current a fully charged battery could supply for 20 hrs. without having the terminal voltage below 10.5V, @ 26.7°C.

Capacity Factors ...

Based on Design & Construction:

- Area of plate surface.
- Quantity, arrangement & porosity of active material.
- Quantity & Strength of electrolyte.
- Circulation of electrolyte.

Based on Conditions of Operation:

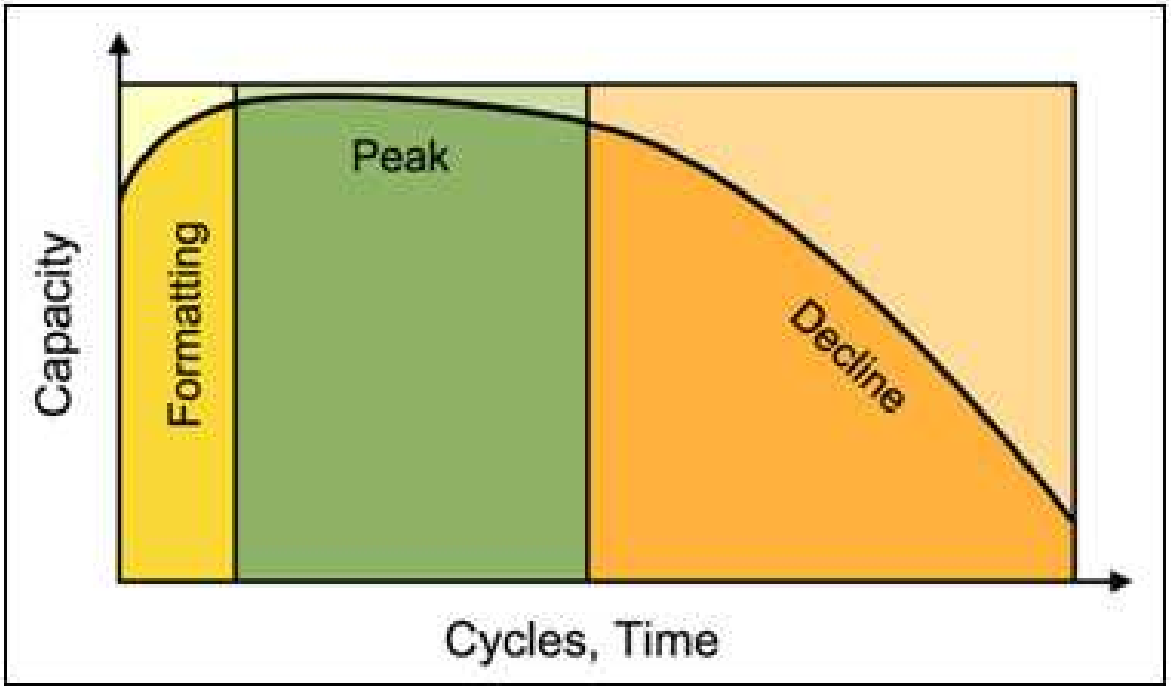
- Rate of discharge
- Temperature

Aging profile of a Battery & its Capacity

Average life of Lead Acid Battery goes through 3 phases:

- **Formatting**
  - the plates are in spongy condition surrounded by liquid electrolyte
  - capacity gradually increases with activation of electrodes
- **Peak**
- **Decline**

Aging profile of a Battery & its Capacity



Courtesy : *Battery University*

Internal Resistance of automotive battery

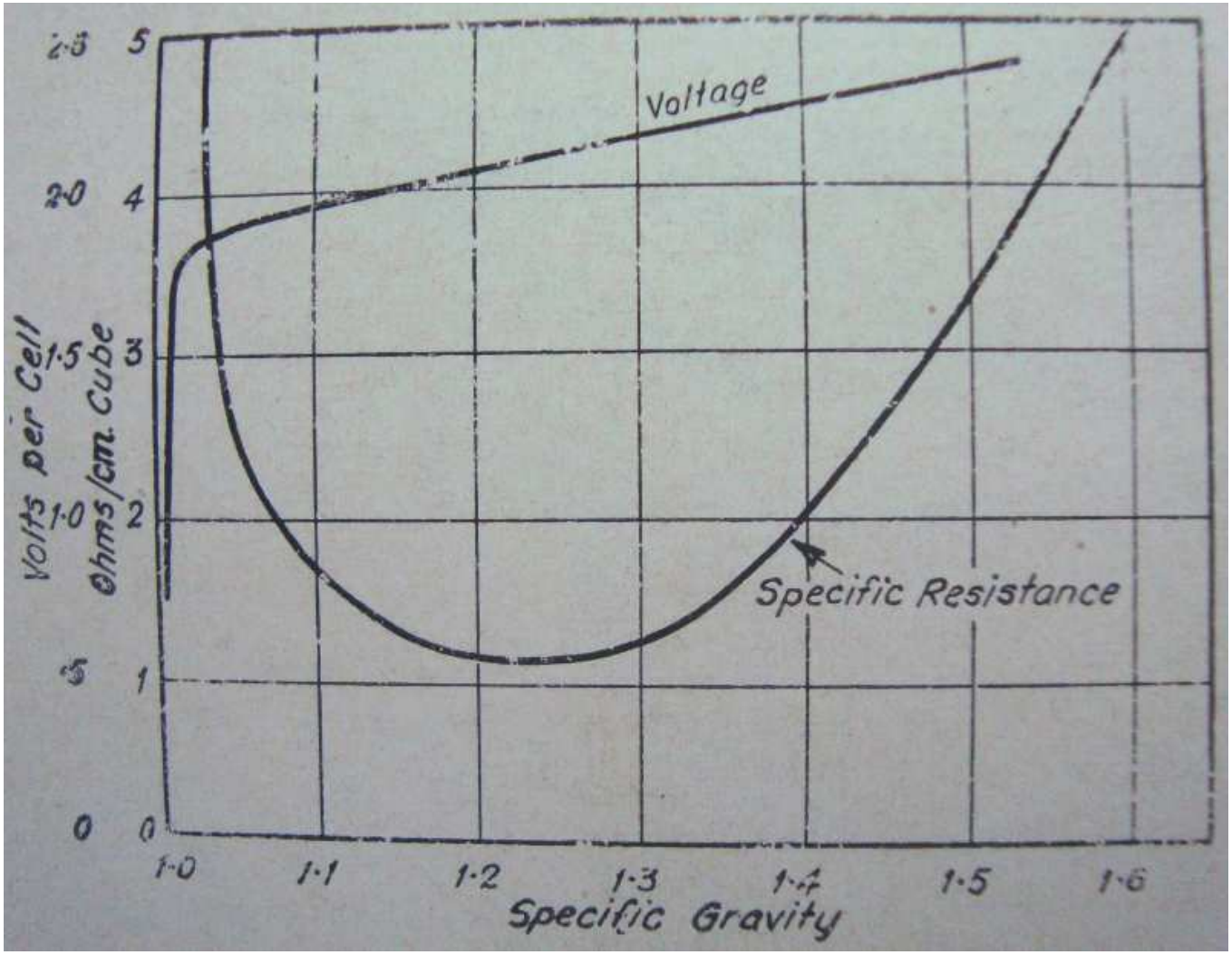
What is it ?

- Resistance offered by the battery to the low of the current through it results in a loss of voltage & heating. Usually it is measured about 0.05Ω, between the terminals of the cell/battery.

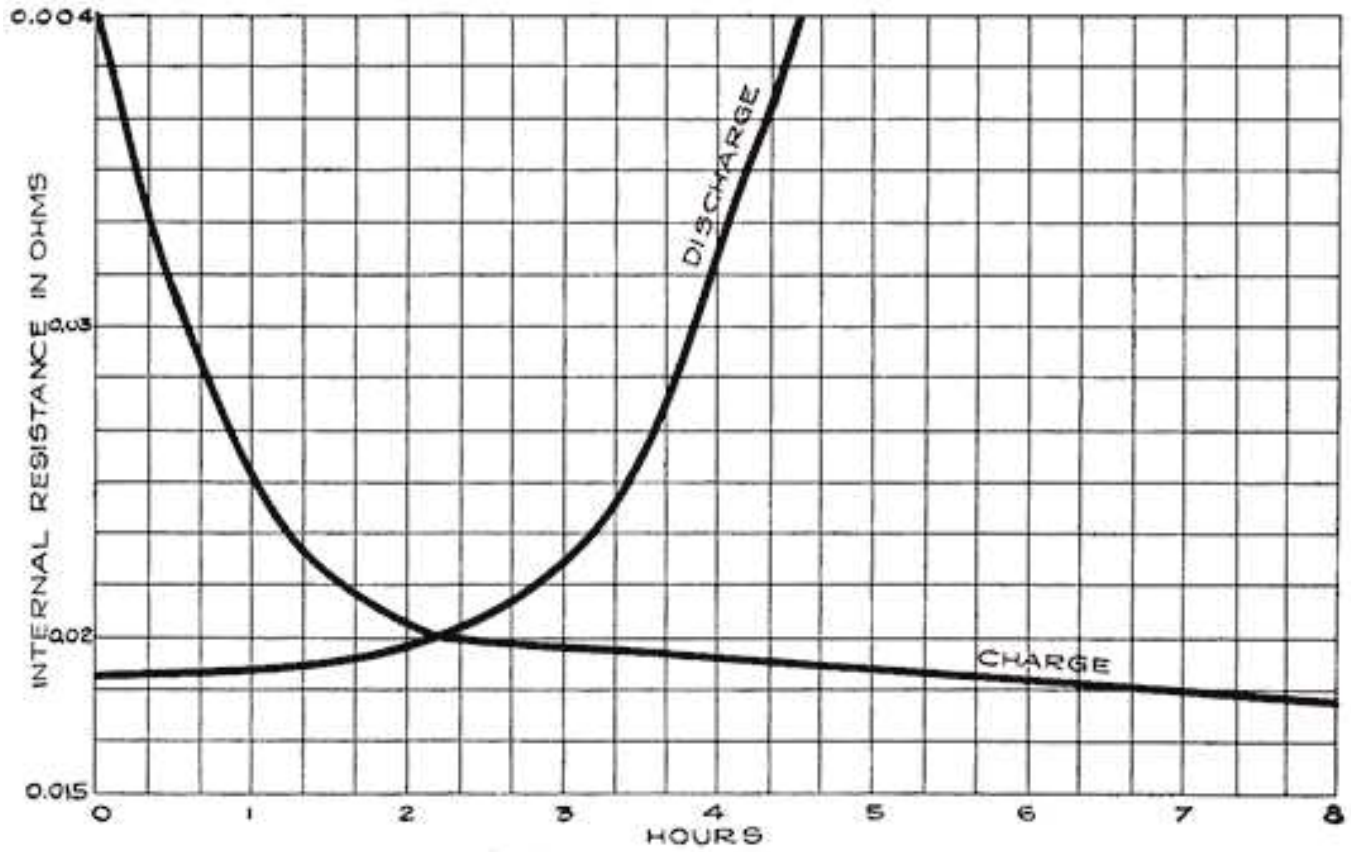
Why is it there ?

- Due to grids including terminals, connecting links & framework upon which active materials are paster, that vary as the temperature of the grid varies.
- Electrolyte - main cause of internal resistance, can be reduced to optimum value by maintaining the Specific Gravity of 1150 to 1280.
- Active material - includes its own resistance & electrolyte in the pores of the active material that varies during charging and discharging.

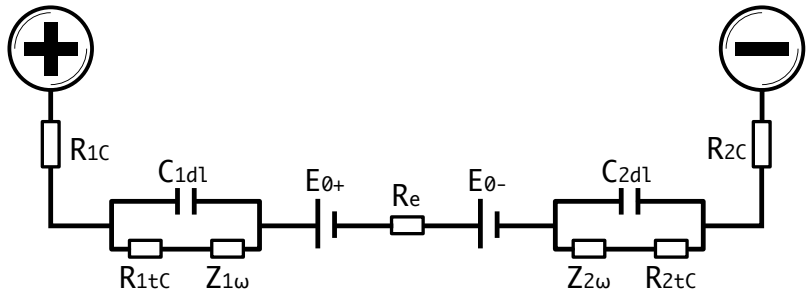
Internal Resistance & Specific Gravity of Electrolyte



Internal Resistance during Charging & Discharging



Electrical equivalent of the Electrochemical phenomemena



The total equilibrium potential of the battery is the difference between the potentials of the two electrodes:

$$E_{eq} = E_{0+} - E_{0-}$$

Internal resistance of the battery results in the sum of various connector resistances & electrolyte resistance:

$$R_{\omega} = R_{1c} + R_{2c} + R_e$$

C_{1dl} & C_{2dl} represent the double layer capacitane on each electrode, caused by the charge distribution between the electrode & electrolyte.

R_{1tc}&R_{2tc} represents the phenomenon of chage transfer resistance between the electrode and electrolyte. This causes an over voltage of charge transfer η_{tc}.

$Z_{1\omega}$&$Z_{2\omega}$ represents the phenomenon of diffusion, caused by grade of concentration of electrolyte near electrode. It again causes a second over voltage of concentration η_{diff}. This is called as ***warburg impedance***.

▸ Goto Analysis

Battery Caring

Battery Care in Vehicles

In General:

- Keep interior of battery box clean & dry.
- Put nothing but battery in battery box.
- Keep battery clean and dry to avoid leakage of current.
- Firm fixation.
- Sufficient slack in cables connected to the battery.
- Inspect the battery twice a month in winter & every week in summer.

Battery Care in Vehicles ...

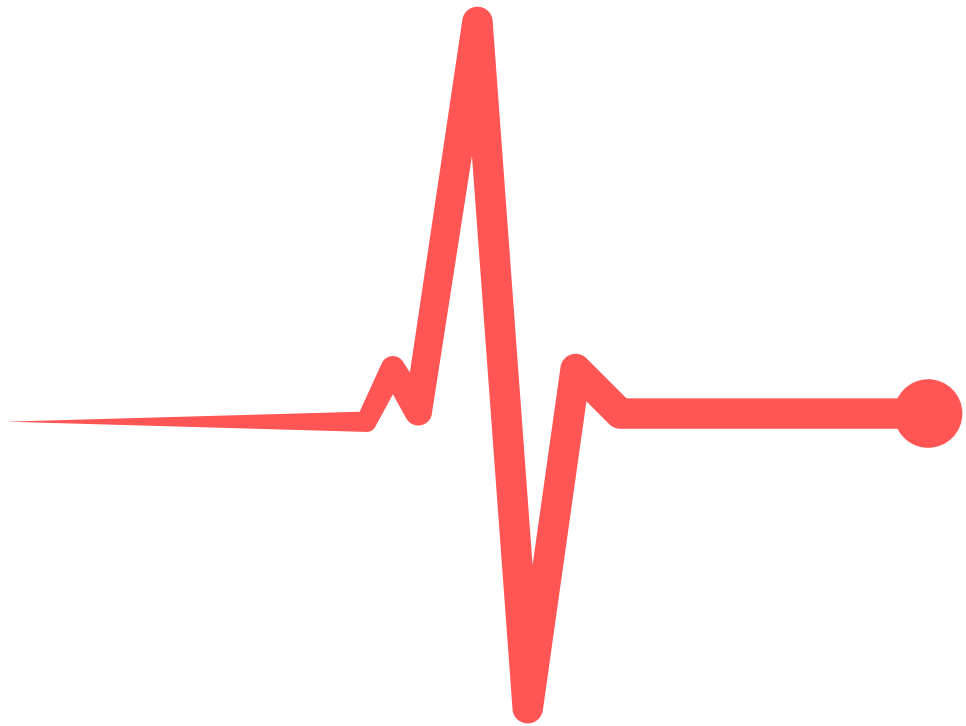
Specific Gravity:

- Specific Gravity (Sp.gr.) of the electrolyte measured periodically are recorded permanently for future reference.
- Electrolyte must not spill over while testing the electrolyte.
- Electrolyte must be retured to same cell during testing.
- Sp.gr. of all cells should rise and fall together.
- If Sp.gr of one cell is lower than the other cells in series, it has internal trouble(may be short circuit).
- If entire battery shows a Sp.gr below 1200, then the battery is not receiving enough charge.

During Idle/Not in Use:

- Filled with distilled water & given a complete charge.
- After every 6 to 8 weeks, battery is given a freshening charge without rising the temperature.

Troubles



What are the Troubles ?

When there is slackness in caring the battery, it becomes subjective to a number of ***preventable*** diseases that leads to inefficiency.

- - - - - -

Most battery diseases are contagious and if one part fails, eventually other related parts also affected.

Major troubles are with:

- Plates
- Separators
- Jars
- Container
- Cell connectors & Terminals
- Electrolyte

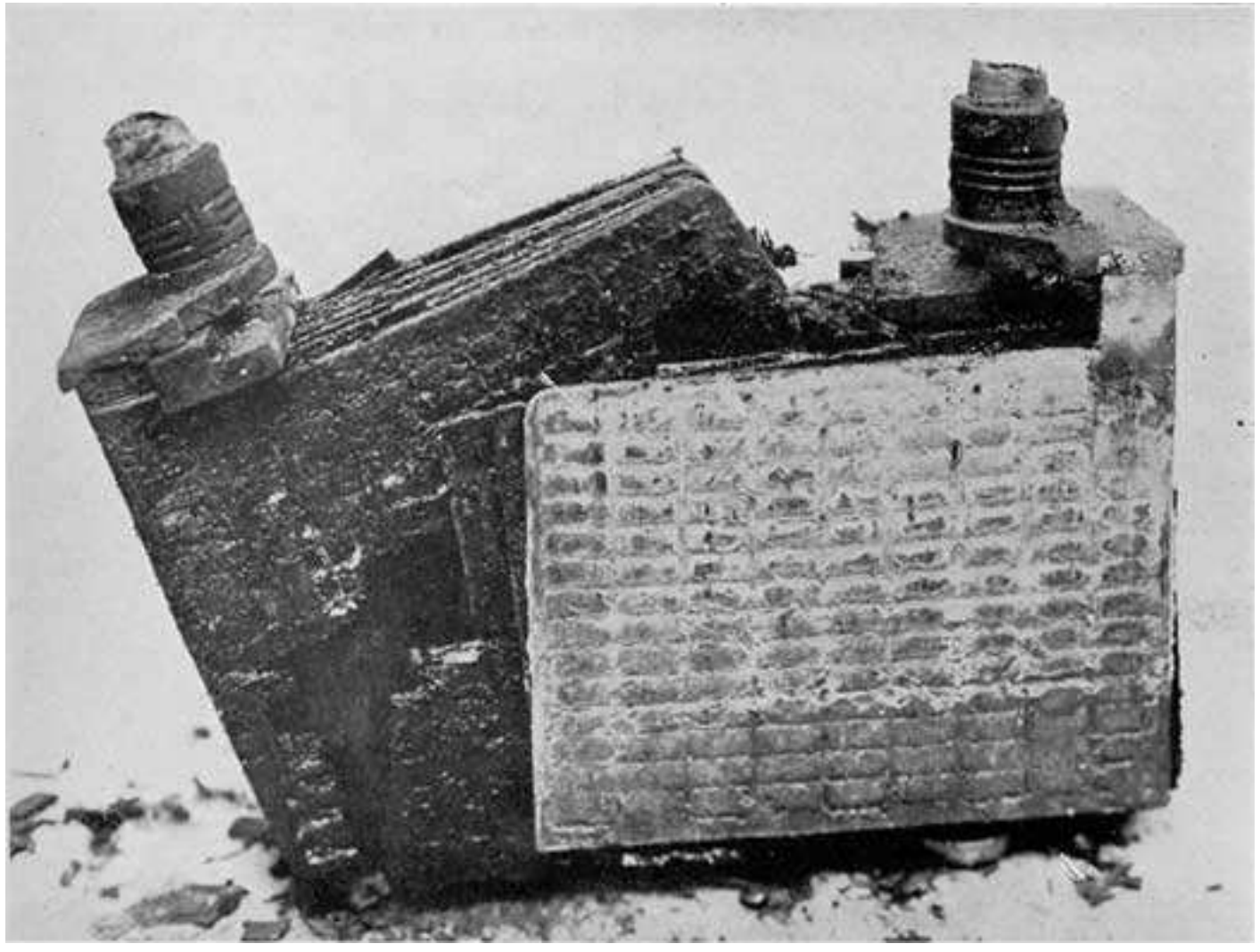
Plate Troubles

Plates are the ***vitals*** of the battery that affect life of the battery than other parts.

They are also very difficult to diagonise the troubles associated.

Sulphation: Formation of lead sulphate ($PbSO_4$) on plates.

- Over discharge
- Keeping idle
- Starvation
- Electrolyte below the top of plates
- Impurities
- Adding acid instead of distilled water
- Over heating



Types of Sulphation

There are 2 types

- **Soft Sulphation (*Reversible*)**

  - can be corrected by overcharging a fully charged battery.

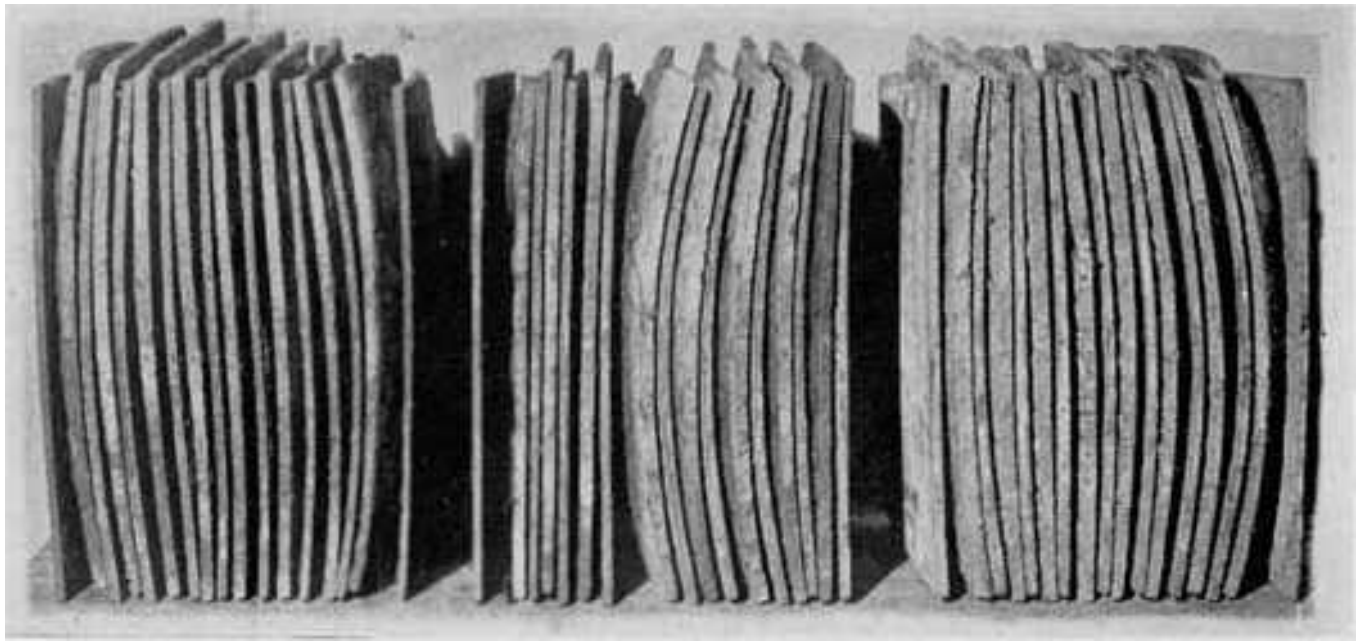
  (*immediately after service to a terminal Voltage for 15V to 16V & increasing battery temp. 50 to 60 deg.**C** to dissolve the crystals*)

- **Hard Sulphation (*Permanent*)**

  - due to battery kept in a low state of charge for weeks or months which cannot be restored

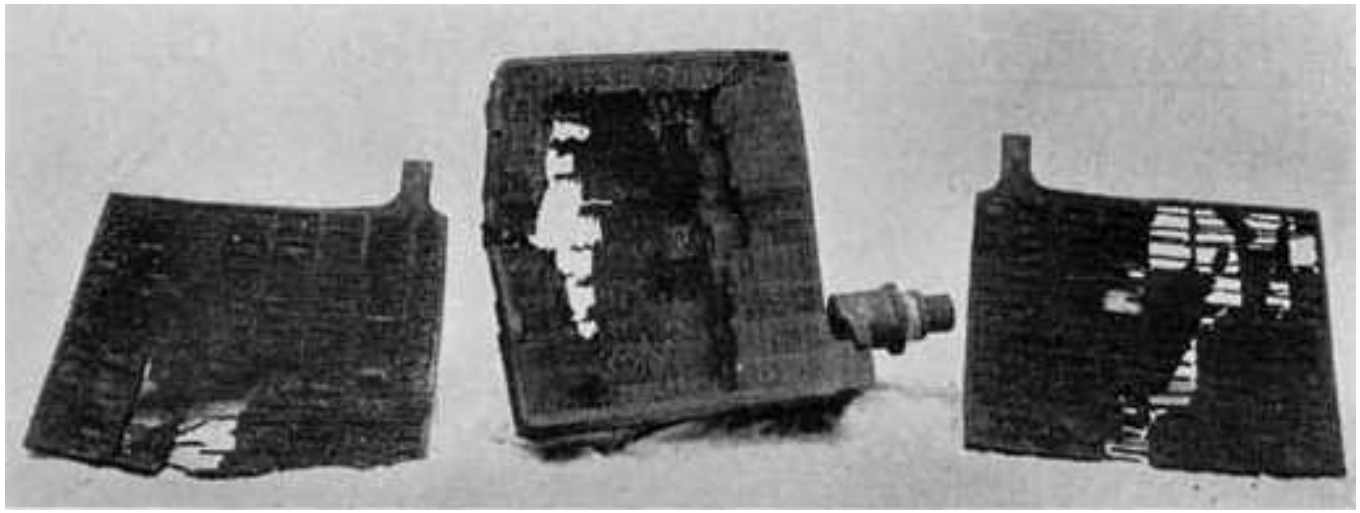
Buckling: Bending & Twisting of plates due to unequal expansion of different parts of the plates due to:

- Over discharge
- Continued operation in discharged condition
- Charging at high rates
- Non-Uniform distribution of currents over the plates
- Defective grid alloy



Shedding/Loss of Active Material: Loosening of lead peroxide of +ve plate which reduces the capacity of the plates due to:

- Normal Shedding
- Over charging/Excessive charging rate
- Charging sulphated plates at too high rate
- Charging only **part** of the plate
- Freezing



Loose Active Material: Active material are no longer in contact with the grid, may be one of the cause of chemical action on grids shifted from active material to the grid itself, due to:

- Over discharge
- Buckling

Impurities:

- That attack the plates due to the acids other than H_2SO_4 which dissolve the lead grids – disintegrating plates into pieces.
- That do not attack grid/separators, but cause internal self discharge due to methods other than lead causing hydrogen bubbles giving electrolyte a milky appearance.

Corroded grids: Thin, weak & corroded due to the chemical action of electrolyte over the grid

- Impurities other than H_2SO_4
- High temperature
- Aging

Separator Troubles

Separators are the weakest part, performing important duty for the battery.

Troubles are:

- Not properly expanded before installation.
- Improper inspection (cracked separator).
- ***Treeing*** between plates, causing short circuit.
- Improperly treated separators will cause battery to show low voltage at high rates of discharge, particularly in cold weather.
- Rotted/Carbonized, due to overage, over heating or high gravity electrolyte.
- Pores clogged due to dust, impurities from impure water & $PbSO_4$.
- Edges chiseled off – buckling plate cut through lower edges of separator.

Container Troubles

Eventhough modern day batteries are made with polypropylene/high grade components, to reduce the weight, still troubles occur due to:

- Rough handling.
- Battery not properly fitted.
- Any weight placed on top of the battery.
- Freezing.
- Defective Jars.
- Expansion in cell.

Cell Connectors & Terminal Troubles

This is a common trouble which should be guarded very carefully.

Corrosion: Indicated by the presence of greenish substance on the battery terminals (especially +ve) due to:

- Too much water added to cells.
- Battery not fastened firmly.
- Battery poorly sealed.
- Vent cap loose.
- Electrolyte spilled on top of cover while measuring Sp.gr.
- Battery cables damaged or loose.
- Attaching bare wires on battery terminals.
- Loose connections in the terminals.

Electrolyte Troubles

- Low gravity due to addition of distilled water.
- High gravity due to addition of acid instead of distilled water.
- Low level due to improper topup maintenance of battery.
- No rise in Sp.gr. due to plates not taking full charge or water is used to replace the spilled electrolyte.
- **Stratification** of electrolyte due to starvation of charge.
- **Milky electrolyte:** mixing of $PbSO_4$ in battery acid or gassing or impurities.

Electrolyte Troubles...

Normal Battery:

The acid is equally distributed from the top to the bottom of the battery, providing good overall performance.

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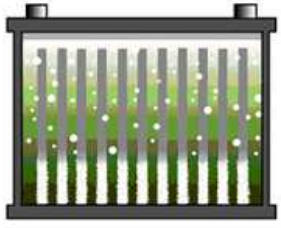
Stratified Battery:



The acid concentration is light on top and heavy on the bottom. This raises the open circuit voltage and the battery appears fully charged. Excessive acid concentration induces sulfation on the lower half of the plates.

Courtesy : *Battery University + Cadex*

Other General Troubles ...

Open Circuit:

- Poor burning of connectors to posts.
- Terminals broken off.
- Acid on soldered joints.
- Defective posts.
- Plates improperly burned.

Battery Discharged:

- Due to excessive use of starting motor.
- Failure of generator.
- Defective switches.
- Defective regulator.
- Addition of accessories or use of too large lamps.
- Defective wiring.
- Insufficient charging rates.
- Batteries allowed to remain idle.

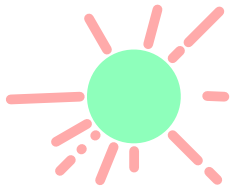
Dead cells:

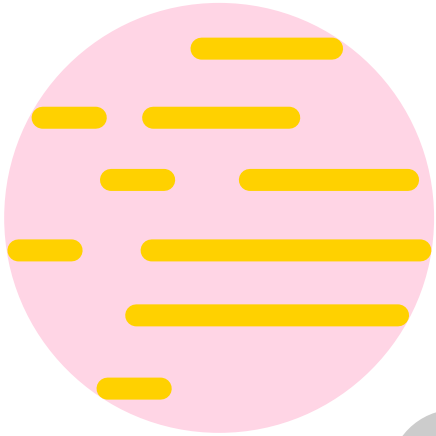
- Worn out separators.
- Foreign material.
- Accumulation of sediments.
- Badly sulphated plates & separators.
- Impurities which attack the plates.

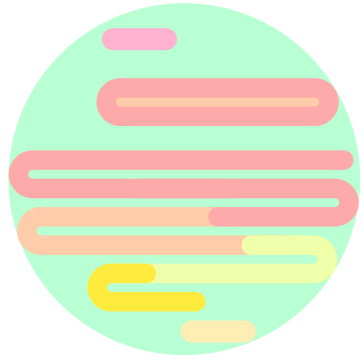
Loss of capacity:

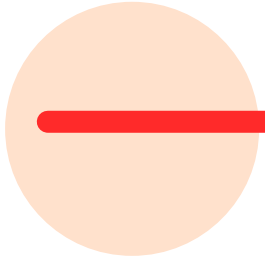
- Impurities in the electrolyte.
- Sulphation.
- Loose active material.
- Incorrect Sp.gr. of electrolyte.
- Separators clogged.
- Shedding.
- Low level of electrolyte.
- Reversal of plates.
- Effect of age.

Analysis of Degradation







Analysis Tools:

Tools such as **causal tree and fault tree analysis** offer an inductive & deductive analysis to evaluate safety & reliability of a complex system such as lead acid battery.

The analysis of the causality chain of lead-acid battery is based on two stages:

- 1st stage interested in development of causal tree presenting possible combination of events generated by **physicochemical** phenomena.
- 2nd stage completes causality chain with fault tree analysis(FTA) with **electrical equivalent circuit** & experimental determination of **parameters** in the circuit, according to each mode of degradation.

What Causes Degradation ?

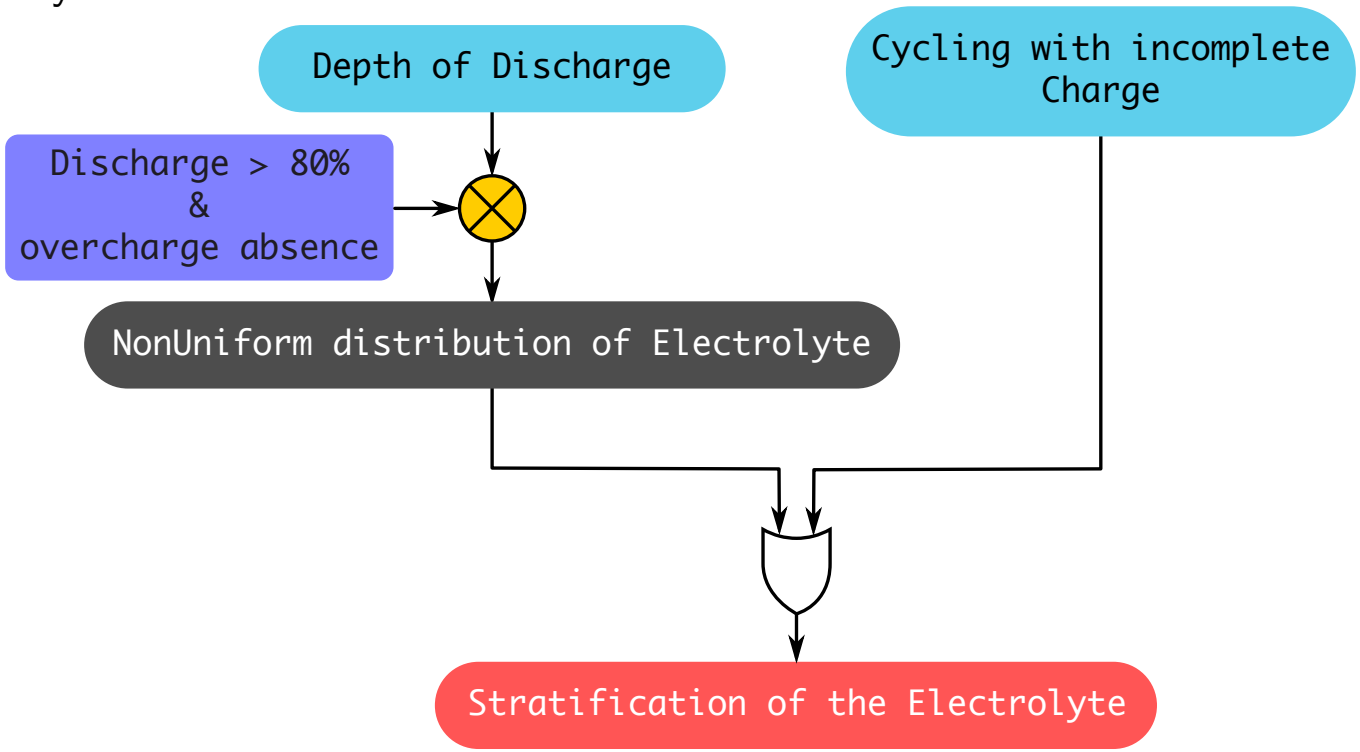
The aging mechanisms of batteries are the actual chemical & mechanical events that cause its degradation, depending on the condition which it is operated. All the types of lead acid batteries suffer from same damage mechanisms but with different degrees.

Major aging process are:

- Stratification of electrolyte.
- Sulfating of the electrodes.
- Corrosion of the electrodes.
- Non cohesion of the active mass.

Causality - Stratification of Electrolyte

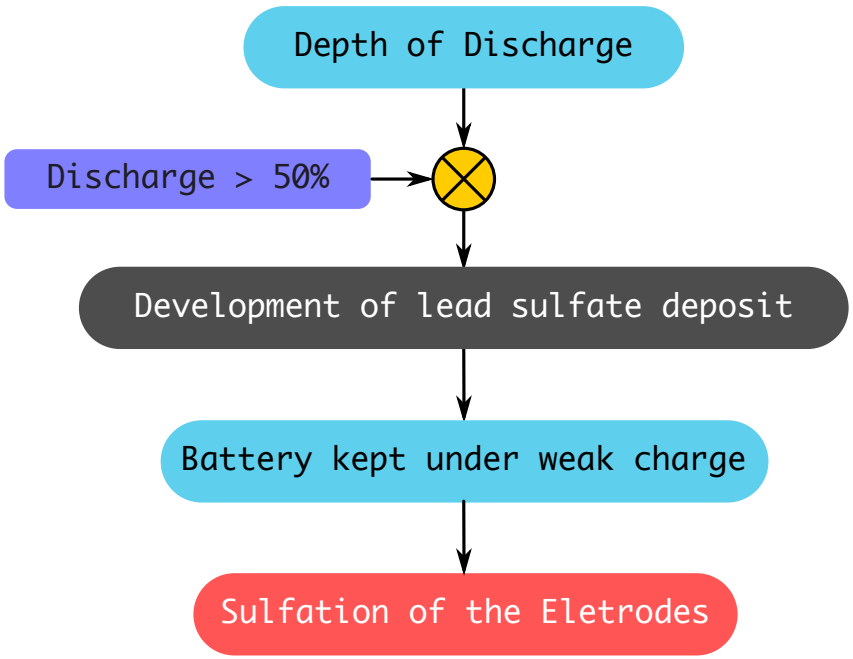
Battery tends to stratify if it did not recieve a complete charge or kept under weak charge. With such conditions, distribution of electrolyte is not uniform with charge & discharge cycles.



The ions heavier than water tend to accumulate at the bottom of the battery, creating a **stratification of electrolyte**. Leads to reduced battery capacity by concentrating chemical reaction to specific parts of electrodes.

Causality - Sulfating of Electrodes

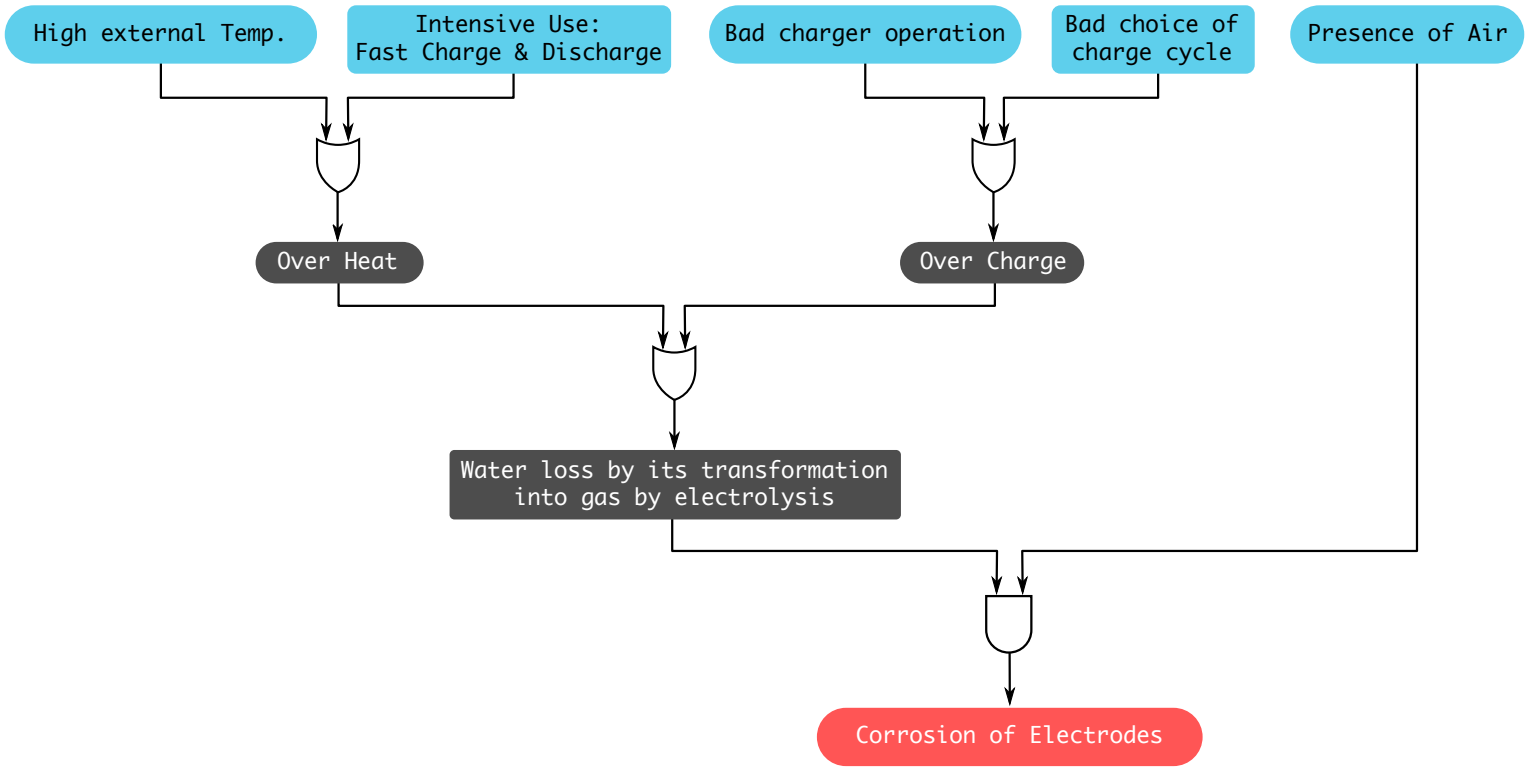
When battery is discharged, sulfate cyrstals are formed at both the electrodes. When charged, the sulface crystals dissolve and form PbO_2 & Pb respectively on +ve and -ve electrode respectively. If left at a low state of charge for longer period of time, sulfate crystals and do not dissolve easily when charged. This leads to hard or irreversible **sulfating**.



It creates an insulating layer that slows down the diffusion of the acid. Thus it is recommended not to discharge below 50% and recharge back to 100%.

Causality - Corrosion of Electrodes

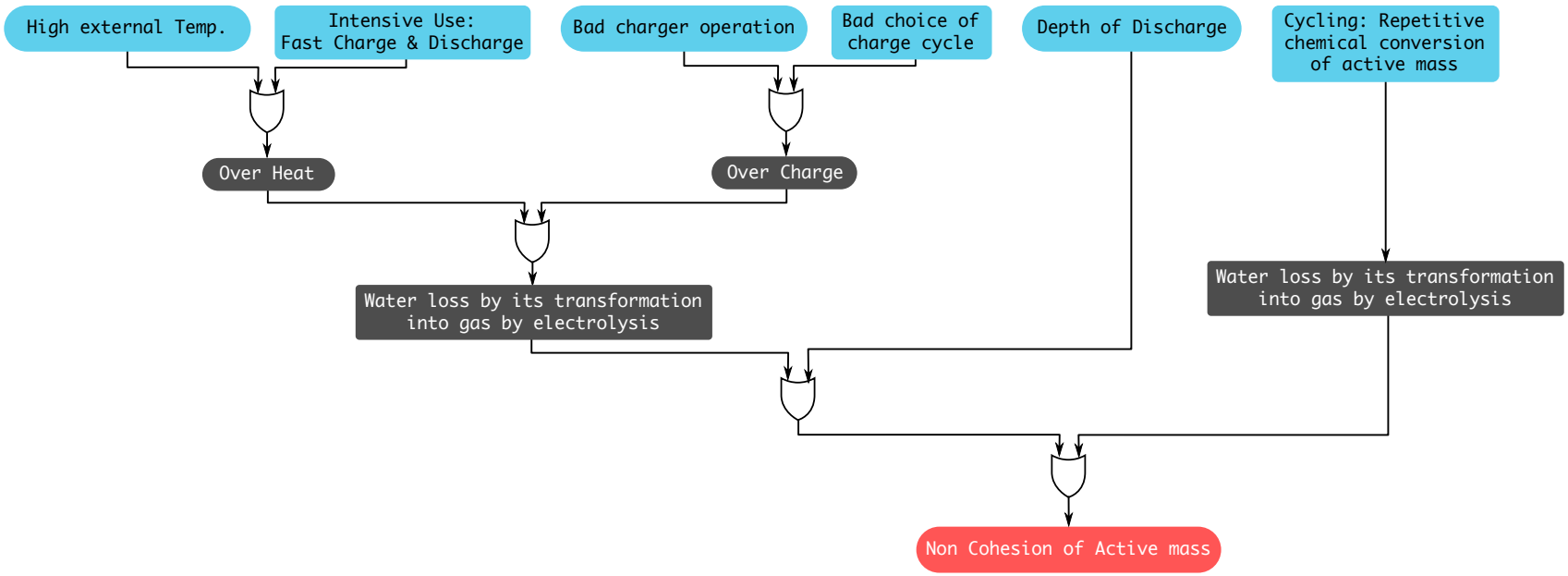
Battery voltage, acid concentration and temperature are the three main factors that drive corrosion. Generally high voltage and increased concentration of acid increases the rate of corrosion dramatically. Corrotion process is proportionately faster with rise in temperature.



As part of grid corrodes, active mass has reduced the electrical conneciton to the terminals. Because of increase in corrosion layer, reduced conductivity, reduced cross section of grid, internal resistance increases reducing the available capacity.

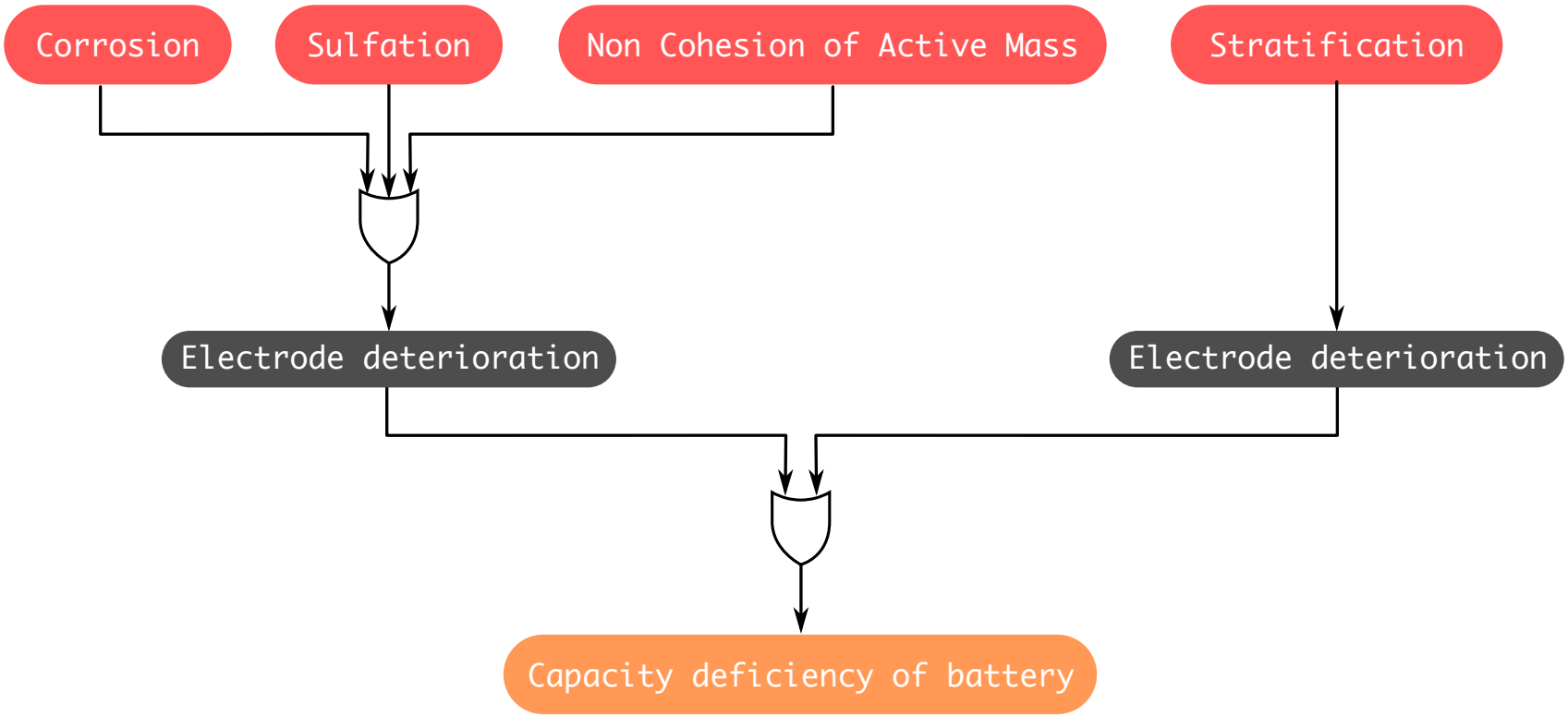
Causality - Non Cohesion of Active Mass

Non cohesion of active material is usually caused by shedding. Enough shedded material at the bottom of the jar can cause an electrical short.



Gassing bubbles due to overcharging can also cause shedding. Depth of discharge and repetitive chemical transformation during charge & discharge are responsible for non cohesion. Over time active mass on battery plates, degrades, changes structure - loosing some of electric transfer properties, reducing the capacity.

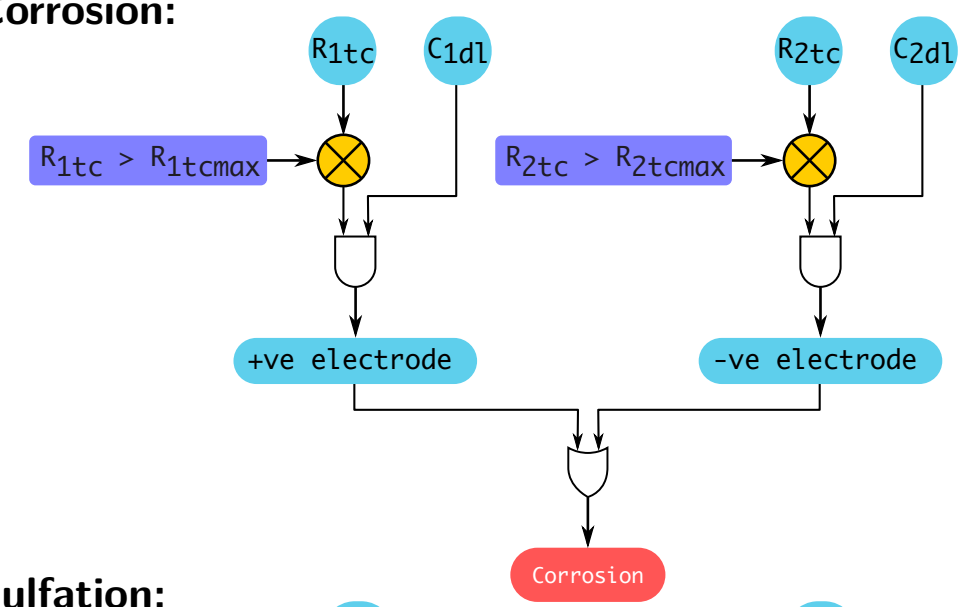
Overall Causality - Loss of Capacity



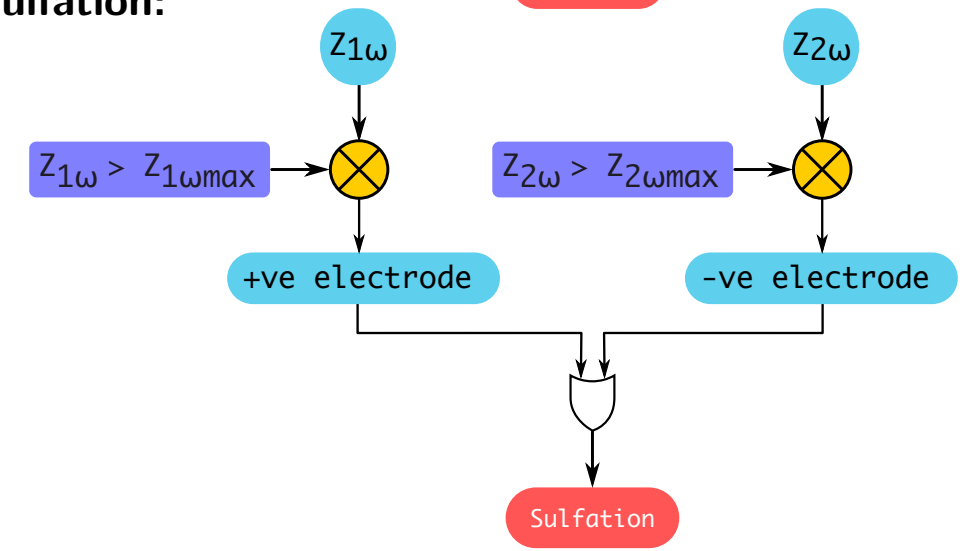
Fault Tree - from electrical equivalent

▸ Goto Electrical Equivalent

Fault tracing in Corrosion:

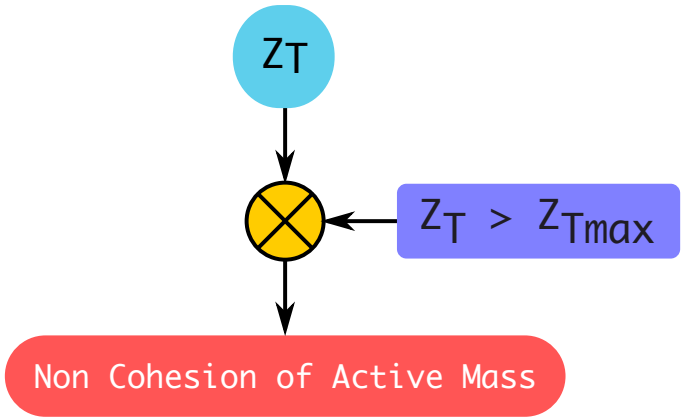


Fault tracing in Sulfation:

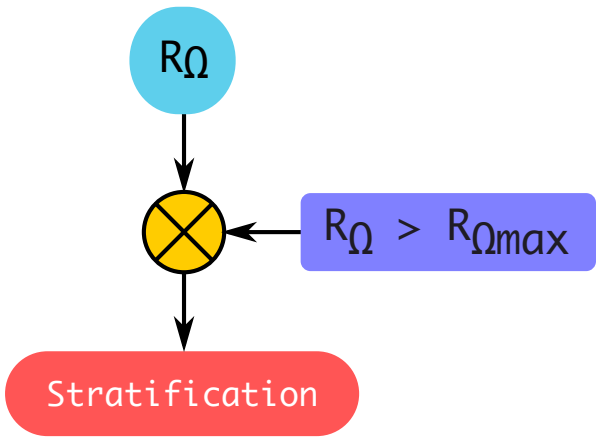


Fault Tree - from electrical equivalent ...

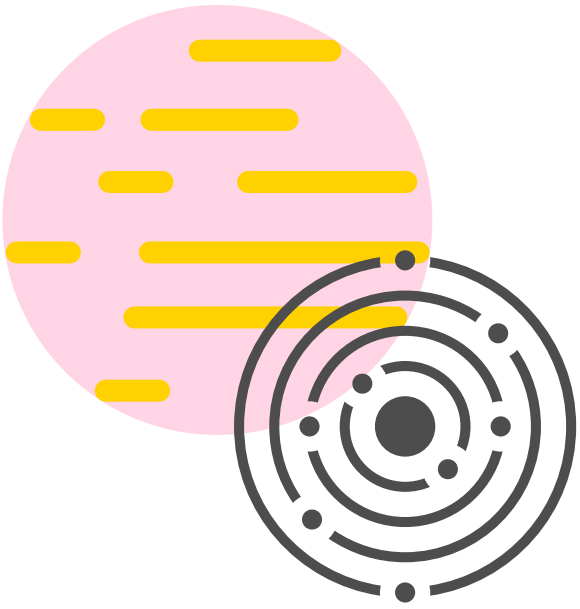
Fault tracing in Non cohesion of active mass:

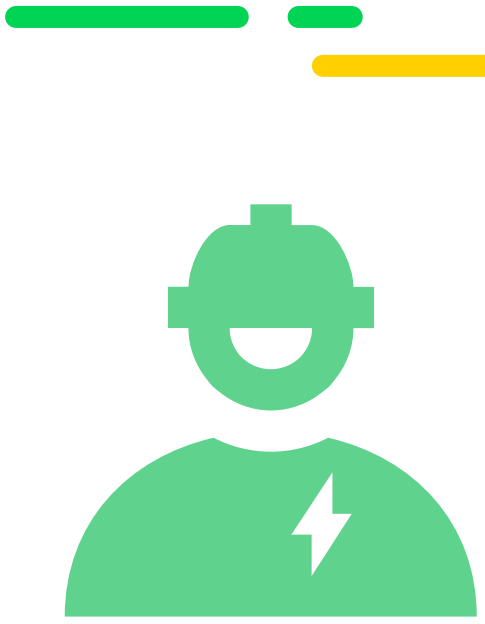


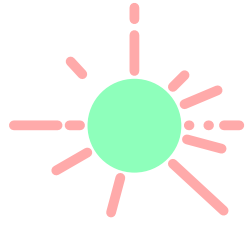
Fault tracing in Stratification:



Instructions







Kind of Charging

- Initial Filling & Charging:
  - @ 5% of Ah for 48hrs.
  - without rise in temperature.
  - final consistent Voltage and Sp.Gr. for 5hrs without heavy gassing.
- Bench Charging (or) Equalizing Charging:
  - @ 7.5% of Ah.
  - rating is reduced when battery is heavily sulfated.
- Trickle Charging
- Regular Charging:
  - for farm lighting or invertor batteries.
  - to meet lighting and other demands.
- Over Charging:
  - extension of regular charging.
  - once a month to prevent inequalities in cells.
- Partial or Radid Charging:
  - for farm lighting or invertor batteries, when there is not enough time for regular charging.
  - @ double the charging rate until all cells are gassing, then reduce to normal rate.

Rating & Time for Charging

Rating:

- As long as excessive temp. & too early gassing are avoided, any rate upto 7.5% of Ah can be used.
- Temperature and Gassing must be watched carefully during charging.
- As a general rule, do not use rate higher than 10A, 5A is better (but takes more time).
- For heavily sulfated battery, less than 5A for days together would comeup.

Timing:

- It is not determined by clock, but by cells, plates, electrolyte ...
- Continue charging until each cell is gassing freely (not violently), for 5hrs. after Sp.Gr. has stopped rising, with constant voltage.
- Charging depends upon the conditions of the battery.

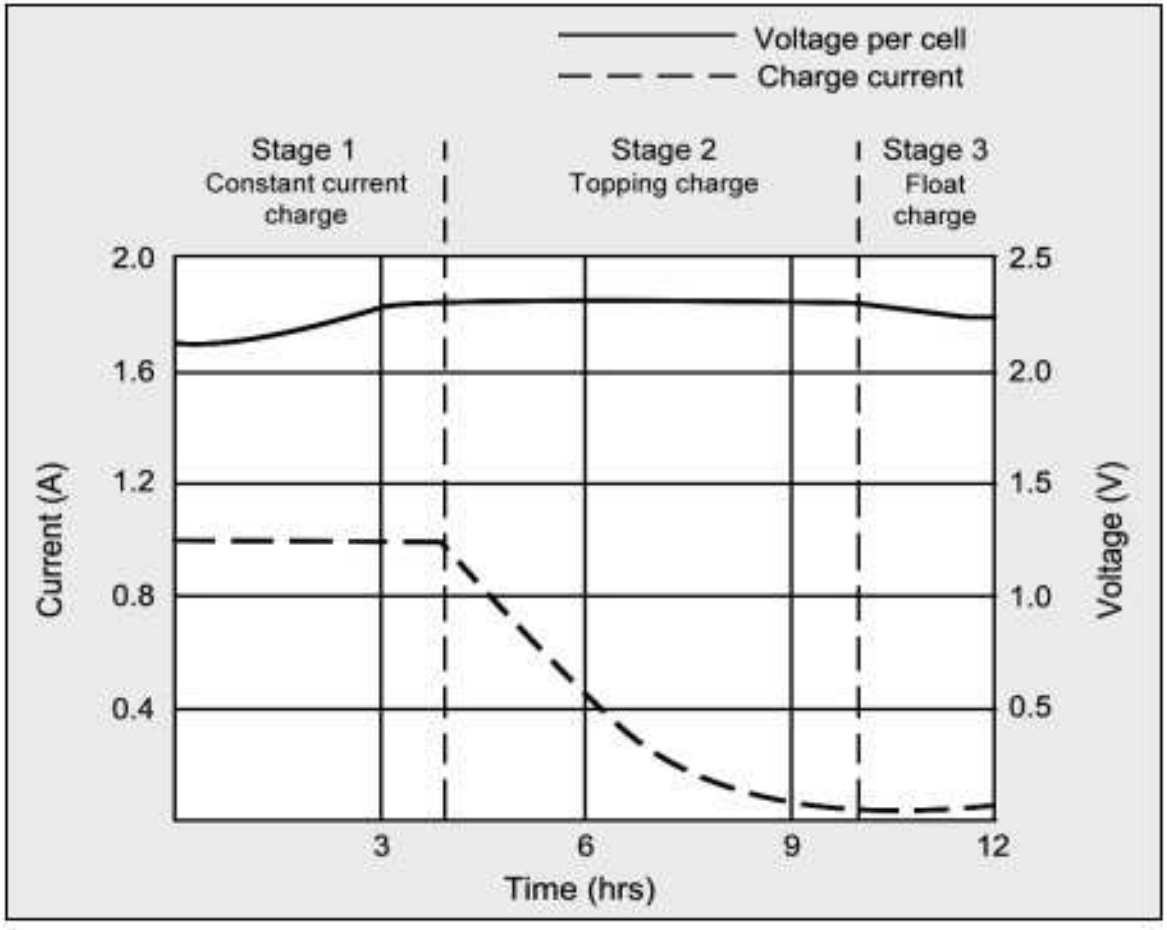
Proper Way of Charging (followed for bench charging)

Optimizing Charging conditions for extended service life.

- Charging is done by CC/CV method.
- Charging time : 12 to 16hrs.
  (*Upto 36 to 48hrs for large batteries until upper charge voltage limit is reached, at which point the current drops due to saturation.*)
- Charging is done in 3 Stages:
  - **Constant Current** (CC) Charge,
    - applies bulk charge upto half of the required charging time.
  - **Topping Charge**, continues at a lower charging current & provides saturation.
  - **Floating Charge**, compensates for the loss caused by self discharge.

During constant current charge, battery charges above 70% in 5 to 8hrs.
Remaining 30% is filled with a slower topping charge for 7 to 10hrs to accept the full charge. The float charge maintains the battery capacity at full charge.

Way of Charging ...



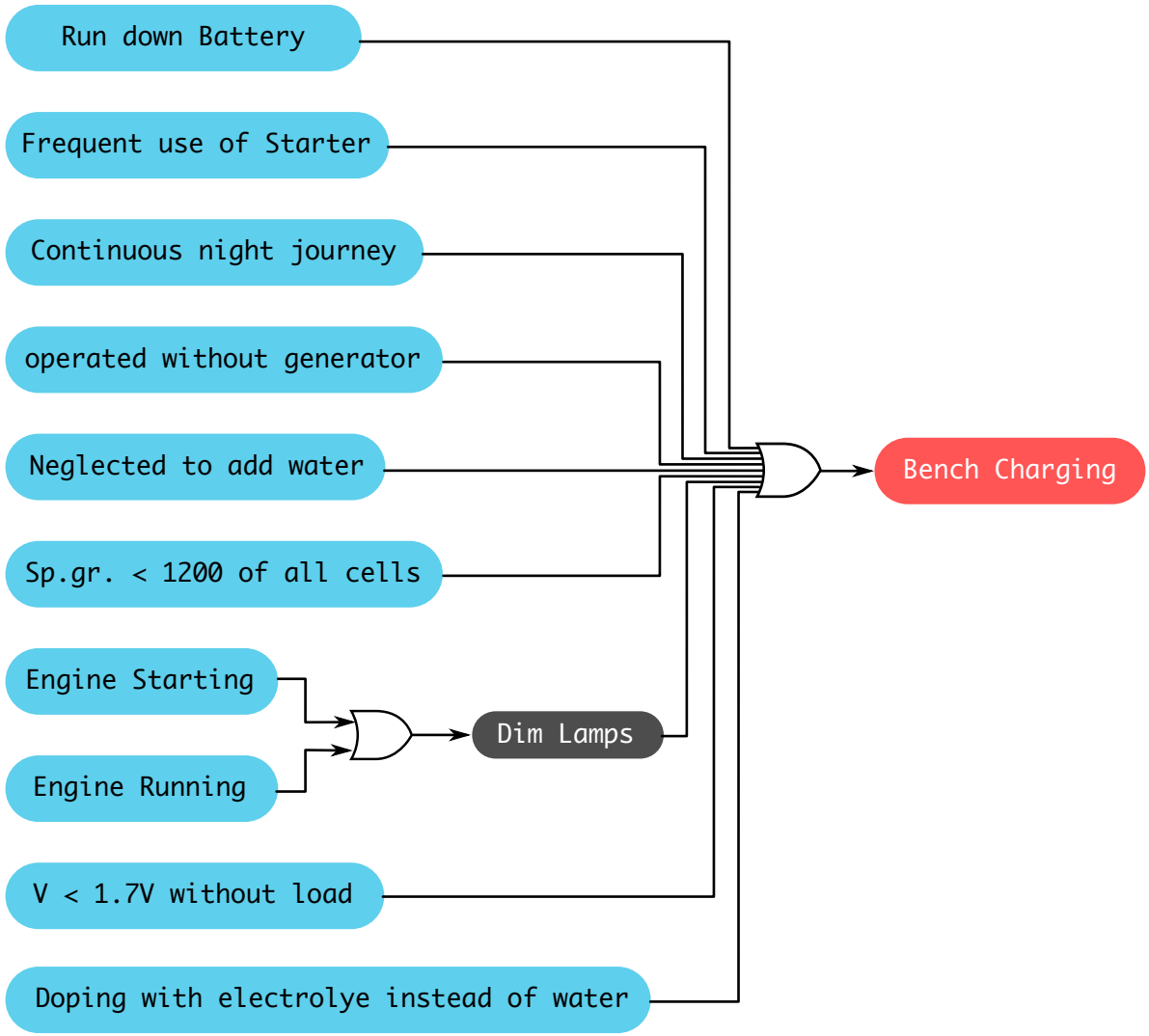
Stage 1: Voltage rises at constant current to V-peak.

Stage 2: Current drops; full charge is reached when current levels off

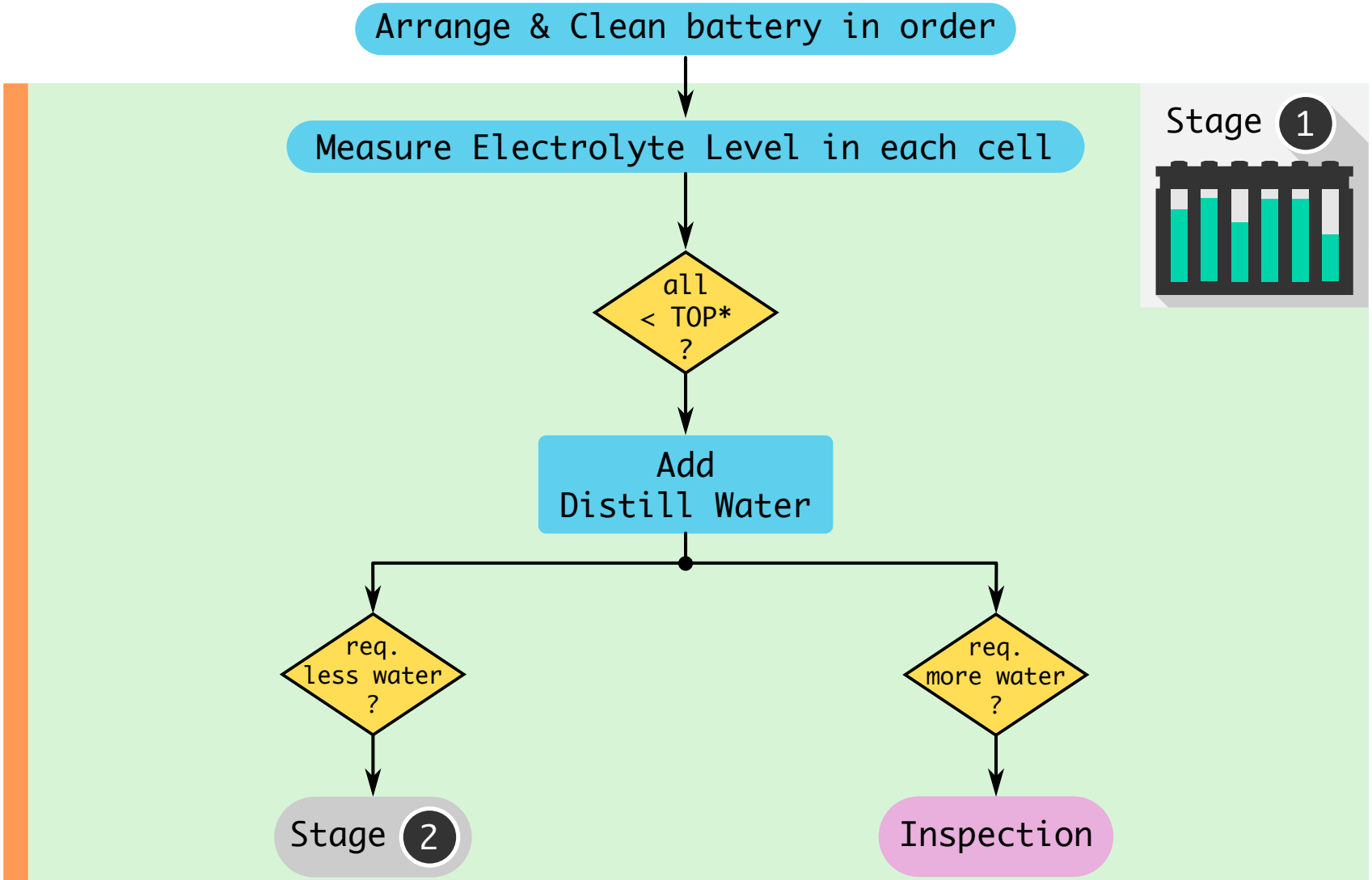
Stage 3: Voltage is lowered to float charge level

Courtesy: *Battery University*

When to Bench Charge ?

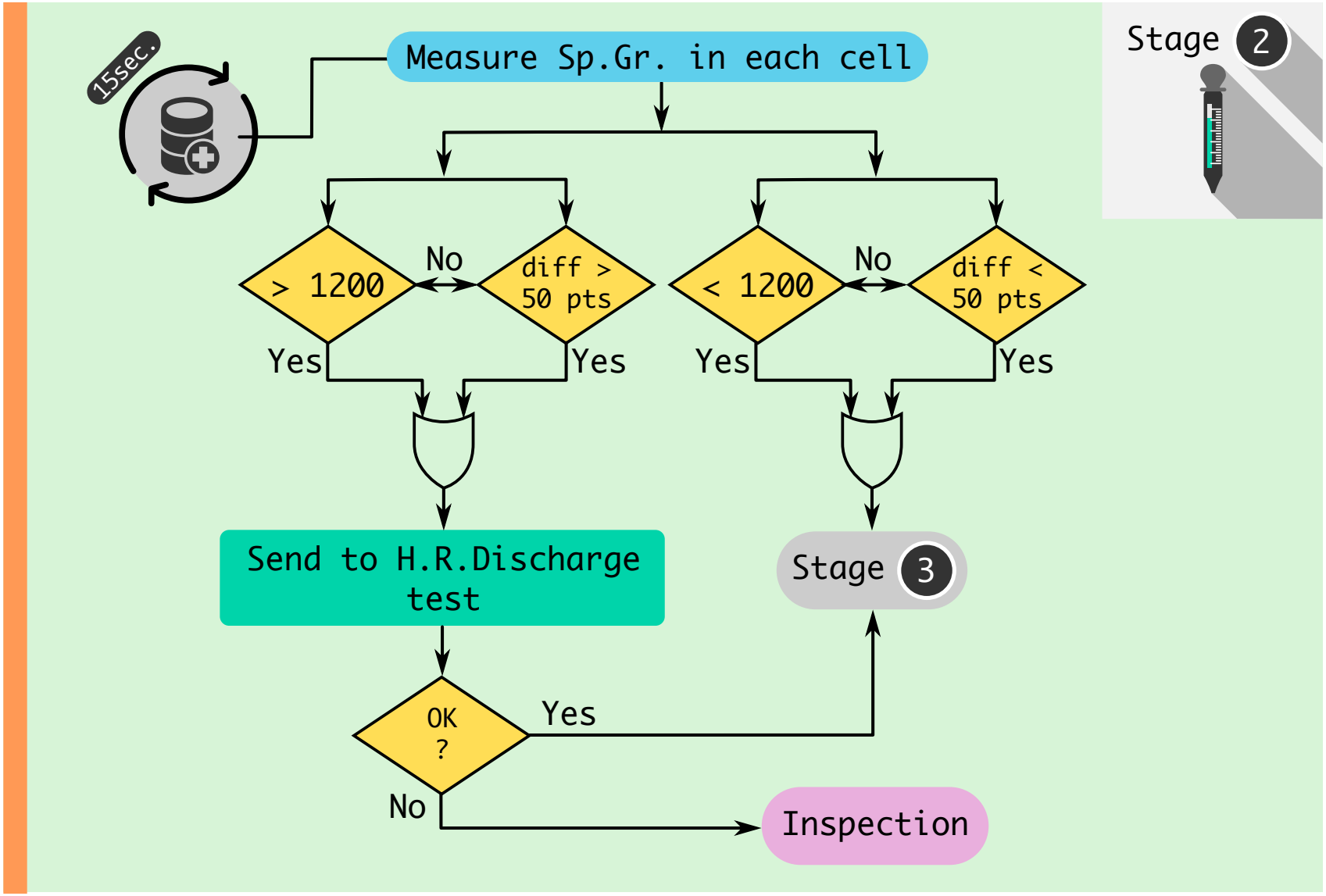


How to Bench Charge ?

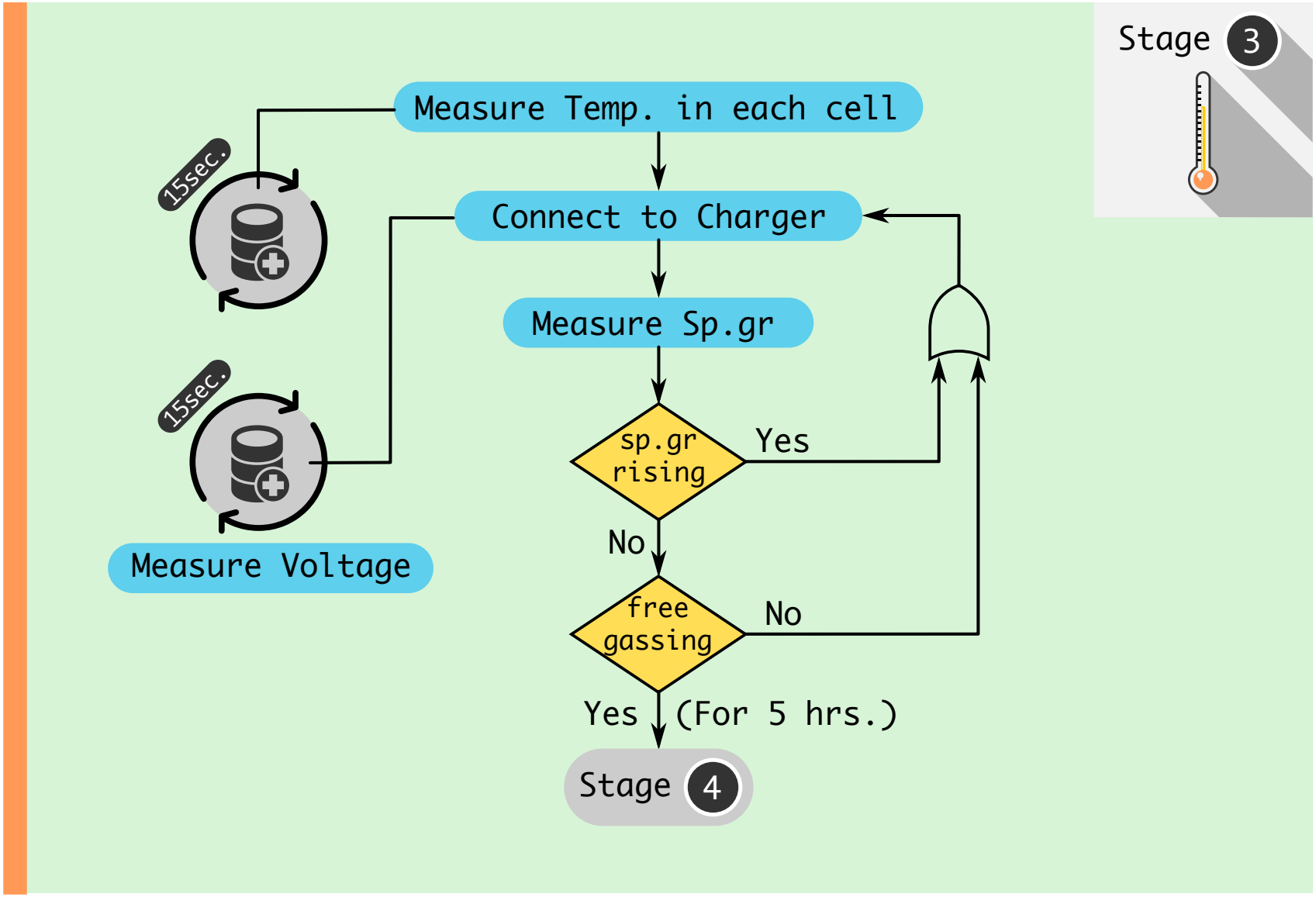


TOP - Top Of Plates

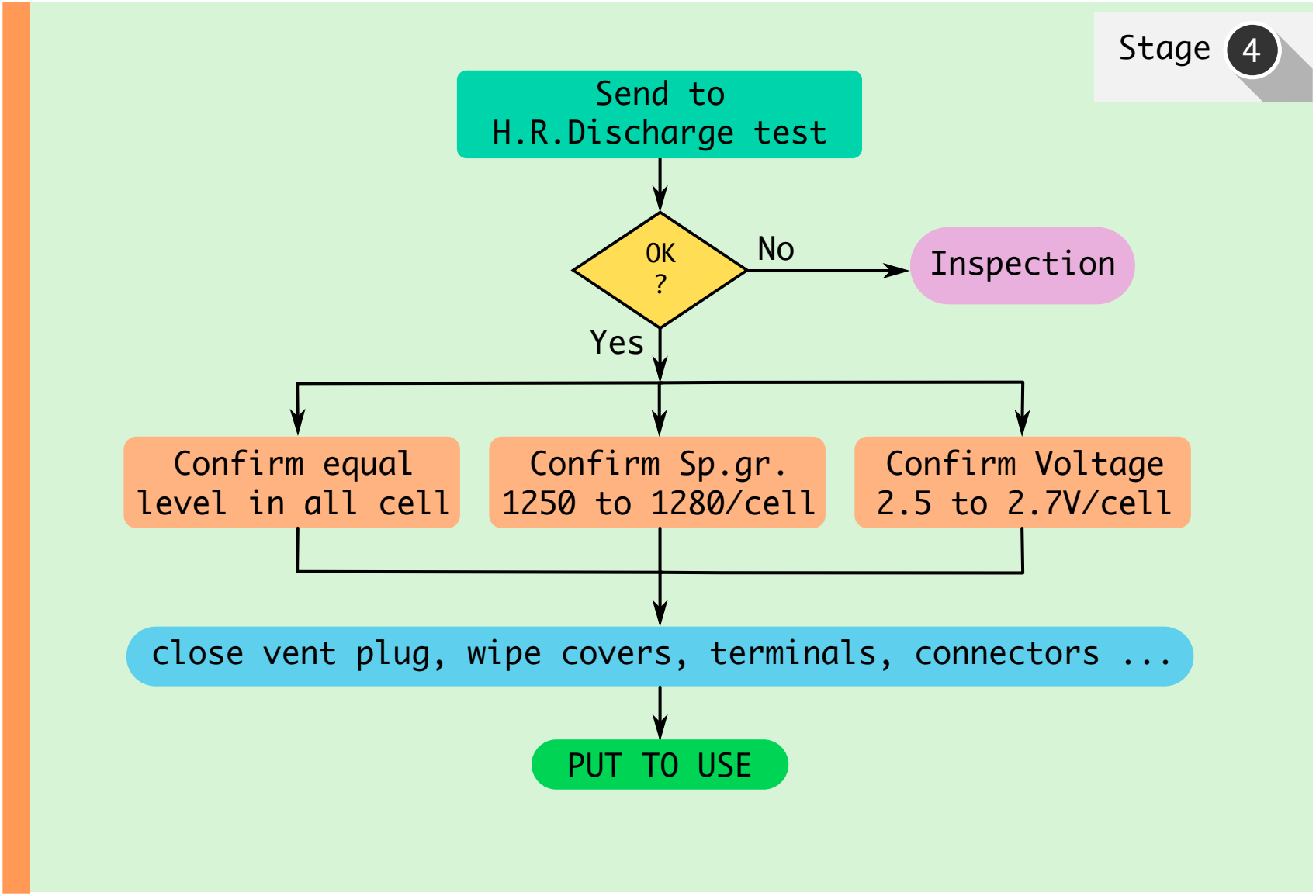
How to Bench Charge ? ...



How to Bench Charge ? ...



How to Bench Charge ? ...



Troubles while Bench Charging ...

- Battery kept long time in discharging condition.
- Neglected to add water.
- Battery overheated by excessive charging rate.
- Shedded sediments causing short circuit of plates.
- Impurities attacking the plates and changes active materials to other substances.
- Separators may be clogged.
- Spongy lead may be bulged.
- Positive plates may be buckled.
- Sp.Gr. will not rise because of sediments - not enough to schort circuit.
- Sp.Gr. will not rise when impurities are added.
- Sp.Gr. will not rise when spilled electrolyte is replaced with water.
- Sp.Gr. will not rise when too much water is added.
- Battery will not hold charge due to impurities(ex: impure water).
- Battery will not hold charge due to shlow short circuit because of defective separators or excessive sediments.

Probable Cause

- **IF** : Sp.Gr. not raising to 1280

  THEN : make cadminum test; ascertain condition of plates

- **IF** : one cell fails to charge

  CAUSE : may be due to internal defect

- **IF** : cells not take half a charge

  THEN : battery is defective

- **IF** : Sp.Gr. is $>$ 1280

  CAUSE : doping of electrolyte

  THEN : refill with distilled water; charge for 10hrs twice; Fill back with 1250 Sp.Gr.

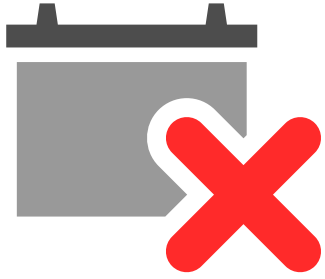
- **IF** : Hot on normal charging

  CAUSE : badly sulfated; has partial short circuit

- **IF** : electrolyte is milky white

  CAUSE : presence of impurities

Battery Tests



Tests conducted on Batteries

Lighting ability Discharge test / CAPACITY TEST: Continuing for 5hrs. to a final voltage of 1.75V/cell, after charging for 24hrs. the battery discharges to 20% of its capacity - while readings are measured at 30min. interval.

Starting ability Discharge test / HIGH RATE DISCHARGE TEST: After 24hrs. of fully charging in cold bath at -15°C, battery is discharged as per standard of 30sec. To reach 9.1V and extends upto 6V of battery voltage at intervals of 5sec or 10sec. (@ 30sec. 9.1V is passed OK).

Cycling Discharge test: New batteries are cyclically charged and discharged at the normal rates to come up the battery.

Backup test: Conducted for invertor batteries after checking voltage, Sp.Gr. in each cell. Discharging at 200W or 400W as per standard of 13.2V for 100Ah or 150Ah for 2hrs.

Life Cycle test: For all batteries (automotive/invertor) for 400 cycles 5hrs. charge at normal charging and 1hr discharge at 20A. For every 25 cycles batteries should be charged fully and capacity test to be conducted.

Torque test: For automobile battery upto 400 cycles, 1.15hrs charge at 20A and 15min discharge at 80A. For every 50cycles battery fully charged and the capacity test to be conducted.

General Tests

General Inspection: Helps in deciding what must be done.

- Is battery loose ?
- Are cables loose ?
- Is there corrosion at terminals ?
- Is top of battery wet ?
- Is top of case acid soaked ?
- Is lower part of case acid soaked ?
- Are ends of case bulged out ? - may be due to battery having been frozen.

Operation Tests: Turn on the lights & continue

- If its dim : then battery is run down or defective, may be put to bench charge.
- With lights burning and started switch to be closed, – if the ight is very dim, the battery is run down or may be defective.

General Tests ...

Questioning the Driver/Battery man:

- Has water been added regularly ?
- Has impure water or river water ever been added to battery ?
- Has too much water been added ?
- Has electrolyte replaced by water ?
- Has battery been idle or stored without regular charging ?
- Is the vehicle operated at night than in day ?
- Is starter used frequently ?
- What is the average driving speed ?
- How long engine is usually cranked before starting ? (must not exceed 10 seconds).

General Remedy

ALL CELLS SHOW LOW GRAVITY OR LOW VOLTAGE		
Reason	***Problem***	***Remedy***
Loose/Dirty terminals	Reduced charging rate or open charging circuit	Tighten & clean connections
Corrosion on terminals	Reduced charging rate or open charging circuit	Clean corroded parts & vaseline coated
Broken terminals	Reduced charging rate or open charging circuit	Replace new terminals
Generator not charging	–	Replace the alternator
Charging rate too low	–	Replace the alternator
Acid/moisture on top of battery	Causes corrosion and current leakage	Remove the things
Short circuits in wiring	–	Repair wiring

General Remedy ...

GRAVITY READINGS UNEQUAL		
Reason	***Problem***	***Remedy***
Acid/moisture on top of battery	Causes current leakage	Remove cause
Tools/wires on battery	Causing short circuits	Remove things
Electrolyte or acid added to cells	–	–
Electrolyte spilled and replaced by water	–	
Grooved side of separators placed against negatives	–	
Cracked/leftout Separators	–	
Old plates used in some cells and new in others	–	–
Impurities in cells	Low Gravity	–
Shorted Cell	–	–
Cracked Jar	–	–

Simple guidelines for Charging

- Charge in well ventilated area.
- Choose appropriate charge program for Flooded, Gel, AGM, etc., batteries - on recommended V thresholds.
- Recharge after each use to prevent sulphation.
- **Do Not** store on low charge.
- Plates must be completely submerged in electrolyte.
- **Never** Add electrolyte.
- Fill water after charging to avoid spillage during charging.
- Gasing in a flooded battery indicates, full state of charge.
- **Do Not** let electrolyte to freeze.
- Avoid charging at temperature above 50deg.**C**.

Care to be taken by Electrician

- Alternator must be checked frequently for output. Worn out bearings, carbon brushes must be replaced.
- Fan belt checkup and to be replaced on scheduled manner.
- Fan belt tension must be checked in frequent intervals.
- After fan belt replacement or end routes breakdown or alternator breakdown - a bench charge is advisable.
- If fault is ascertained with starter - would run down the battery - replace immediately.
- Damaged braided copper strip may be replaced.
- It is advisable that whenever FC or half FC all connections should be checked and replaced when required.
- Whenever starter or alternator received for reconditioning, essentials like bearings, carbon brushes must be replaced without fail.
- A perfect record of topup, bench charging and replacement of alternator or starter should be maintained for each vehicle.
- Whenever the vehicle is kept idle for more than 2 days, the battery may be charged in bench.
- It is best practice to make bench charging every 6 months.

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