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Battery Pack Design.

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1. Introduction to Battery.
2. Construction of Battery.
3. Battery Safety
4. Battery Modelling.
5. functional Safety.
6. Performance Testing.
7. Safety Testing.
8. Battery Mechanical Test

Electric Vehicle Battery :->

An electric vehicle battery is an energy accumulator that stores electricity for transmission It consist of a no. of cell connected in series & parallel.

Types of Battery.

1. Lead Acid Battery. (e- Rickshaw)
2. Hybrid Nickle Metal Battery,
3. Nickle Cadmium Battery.

Lithium Ion Battery :-).

1. Nickle Manganese Cobalt (NMC).
2. Li- manganese (LMO)
3. Li-Phosphate (LFP).
4. Li-Cobalt (LCO)

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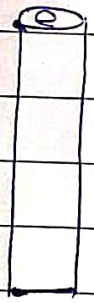
* Selection of Li-Ion Battery :-

Specification	Li-Cobalt $LiCoO_2$ (LCO)	Li-Manganese $LiMn_2O_4$ (LMO)	Li-phosphate $LiFePO_4$ (LFP)	NMC
Voltage	3.60V	3.80V	3.30V	3.60/3.7
Charge limit	4.20V	4.20V	3.60V	4.20V
Cycle life	500-1000	500-1000cy	1k-2k	1000-2000cy
Operating temp	Avg	Avg	Good	Good
Specific energy	150-190 Wh/kg	100-135 Wh/kg	90-120 Wh/kg	140-180 Wh/kg

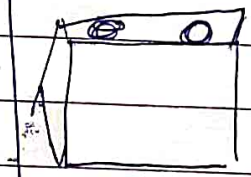
* Construction of Battery cell.

Cylindrical Cell



(A) Small size.
(18650 cell) 18mm ϕ, height 650m)
Hard casing.
Low Individual Cell capacity
Build in Safety feature
Comparably cheap.

Prismatic cell



Dexon, GV.
→ Hard Casing
→ Large size.
→ High individual cell capacity

Pouch cell

→ Soft Casing.
→ Large size.
→ High individual cell capacity.
→ Geometrical deformation during dis-charging.

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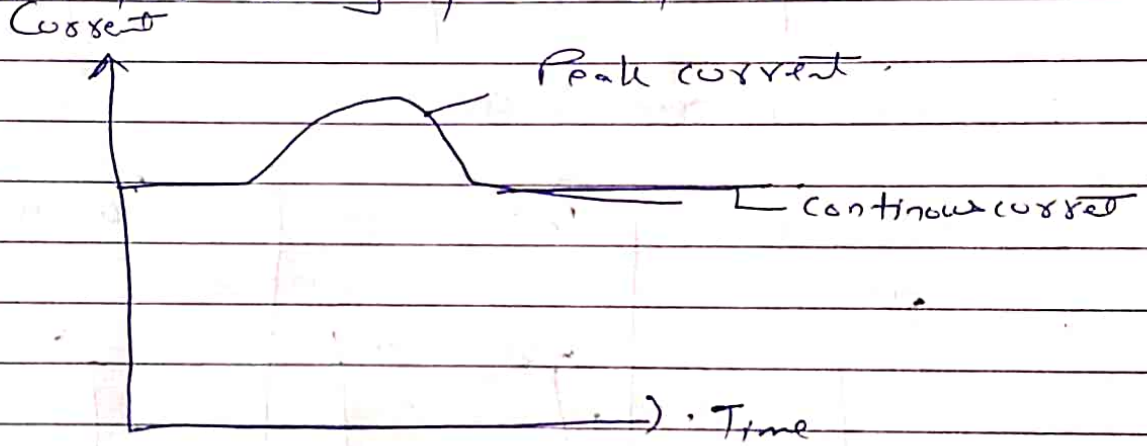
* Performance Design.

(1) Peak current :-).
The peak current is the maximum amount of current which output is capable of sourcing for short period of time.

2. Continuous current :-).
A current consumed by the vehicle at ideal condition for along period of time.



3. BMS Selection.
- The primary job of a BMS is to prevent overloading the battery cells. So, for this to be effective, the maximum rating on the BMS should be greater than the maximum Amperage rating of the battery.

Peak current plays a vital role in selecting a Battery BMS

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4. Spare Availability :-
→ Fixed car floor Battery.
→ Forklift battery pack.
→ E- Rickshaw battery Pack.

5. Cell Selection.
Selection of cell can be done based on the voltage, current, weight, Space etc.

6. Cell Testing
All cell used in battery pack should have same volt.
IR testing of cell.

+ Safety.
① Insulation
② Spot weld.
③ Cell holder :→ Cell holders are used to hold & keep Cells away from each other.

4. Cooling system.

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Cell Assembly Models :→

1. Battery Connection in Parallel.

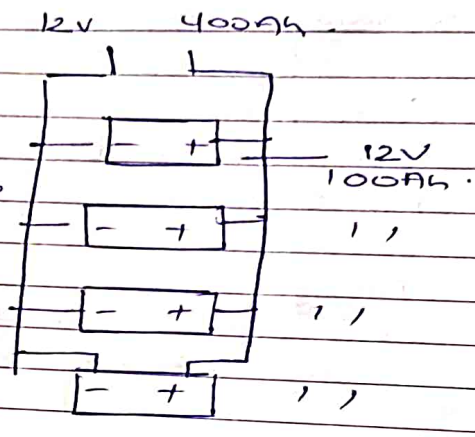
→ Voltage Rating.

$V_t = V_1 = V_2 = V_3 = V_4$

The total voltage of complete battery pack is equal to voltage of single battery pack.

Ex. $V_1 = V_2 = V_3 = V_4 = 12V$.

$V_t = 12$.



→ Current rating.

$I_t = I_1 + I_2 + I_3 + I_4$.

$I_t = 400Ah$.

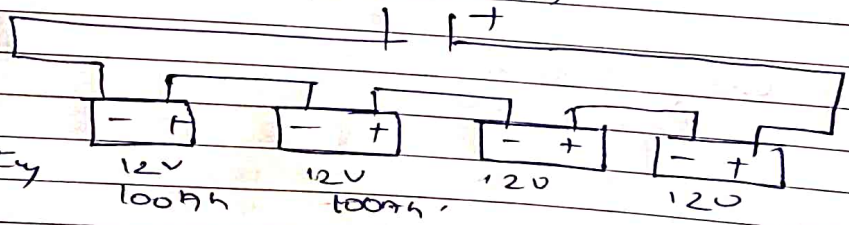
2. Battery Connection in Series. 48V 100Ah

$V_t = V_1 + V_2 + V_3 + V_4$

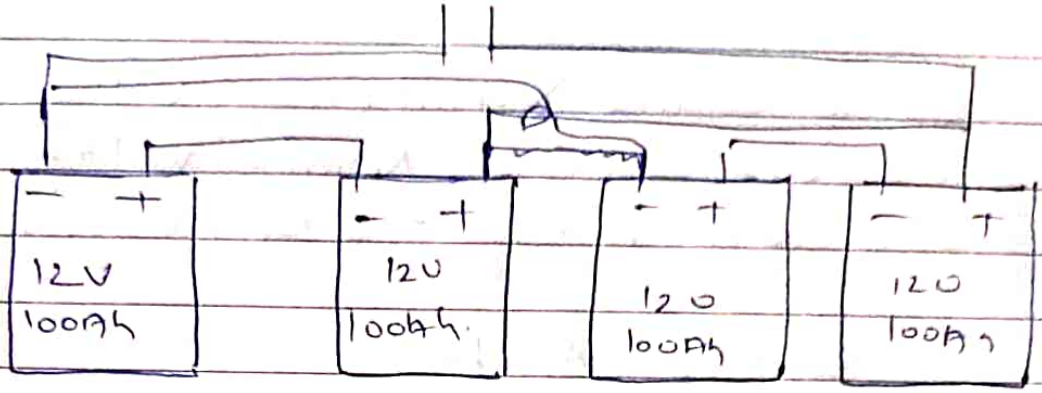
$V_t = 48V$.

$I_t = I_1 + I_2 + I_3 + I_4$

$I_t = 100Ah$.



3 Battery Connection in Combined :→



$(V_1 + V_3) + (V_2 + V_4) = 24V$

$V_t = 24V.$

Current Rating.

$I_t = (I_1 + I_3) = (I_2 + I_4).$

$I_t = 200Ah.$

Cell Assembly Models.

→ Power = Voltage × Amphere hour.

$P(Wh) = V \times Ah.$

→ Combination of series & parrallel cells

To build a battery pack of 48V 30Ah cosidring LFP cells. (Nomiral Voltage - 3.2V, Current - 6Ah).

To get 48V, who have to connect 15 cells in series.

To get 30Ah, Connect 5 cells in parallel.

Therfore total no. of cell :→ 15S × 5P = 75 cells.

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* Selection of Charger :-).

→ No of series × Full charge voltage.
Considering LFP cell Nominal voltage - 3.2V, full charge voltage - 3.65, current 6Ah.

For 48V 20Ah batt.
Charge = 15 × 3.65 = 54.75V.

* Calculation

Battery Pack Calculation :-).
Design a battery for 100km if vehicle is running for 25km/hr speed, current consumption 5 Amp taken at 48V 1500 watt Motor?

(1) Power = Voltage × Amphere.
Power required at 25 speed P_{20} = 48V × 5 amp
P_{20} = 240 watt.

2. Travel factor = $\frac{\text{Total distance}}{\text{Speed}}$.
= 100/25
= 5

Power required to travel 100km =
P_{20} × Travel factor.
240 × 5
Power P = 1200 watt = 1.2kw.

Take charge discharge efficiency of Li Ion Battery = 87%.