Indian Institute of Science

Design of Photovoltaic Systems

Prof. L .Umanand
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

NPTEL Online Certification Course

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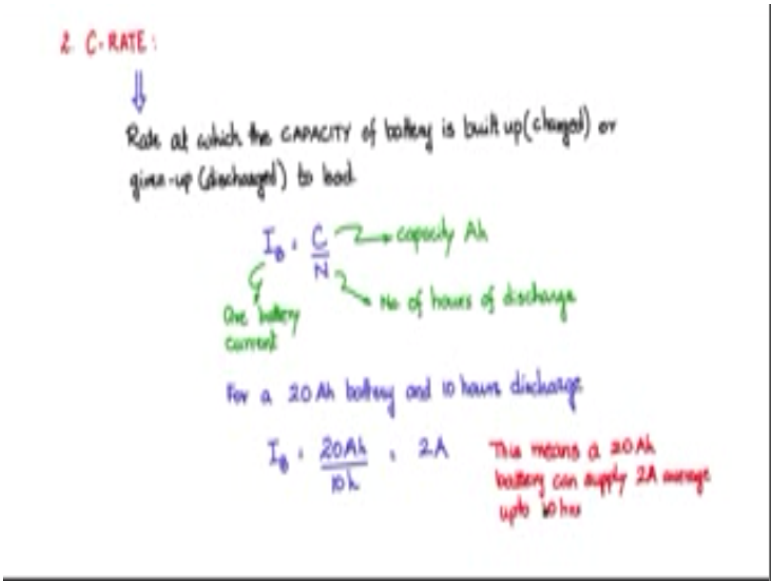

Another important parameter of the battery is the C read what is C rate the rate at which the capacity of a battery is built up filled up what we call a charged charging or given up discharged to the load is called the C rate of the battery see if the, the C rate normally refers to the discharge current of the battery but nowadays the charging up of the battery has also become very important you would have seen fast charging super fast charging characteristics of the batteries coming into commercial usage.

Now so along with the discharge current the charging current is also equally important so today the C rate refers to move more to the capacity of the battery being built up or given up the rate at which it can be discharged the rate at which it can be charged up we have a simple equation here $I_{B,}$ I_B is the battery average current is equal to C/NC is the capacity we are taking the ampere our capacity and n is the number of hours of continuous discharge.

So if you take a simple example you see that for a 20 ampere hour battery and 10hours of discharge I_B is 20 ampere hours white and hours which is 2 amps but it is simple but what it means is that a 20ampere hour battery is capable of supplying 2 amps average current to the load up to 10 hours however no dart to amp average current to the load to amp discharge current to the load for 10 hours.

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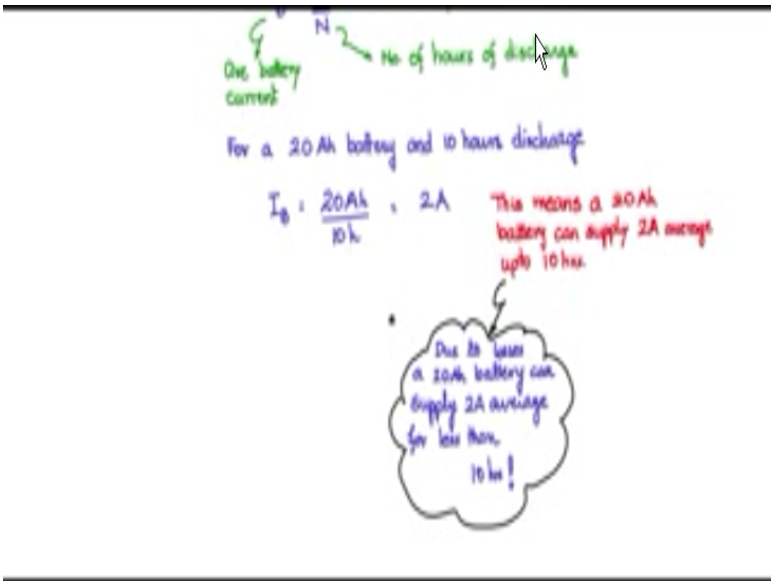

So 2*10 20ampere hours would ideally be the capacity and the discharge current relationship however in practice it is not so a 20 hour 20 ampere hour battery if you have been charging at 2 amp average current rate for 10 hours it would be much more than 20 ampere hours or you should say that 20 ampere hours is consumed in much less than 10 hours so you should read it as something like this let me make some rule due to losses a 20 ampere hour battery can supply to an average current for less than 10 hours.

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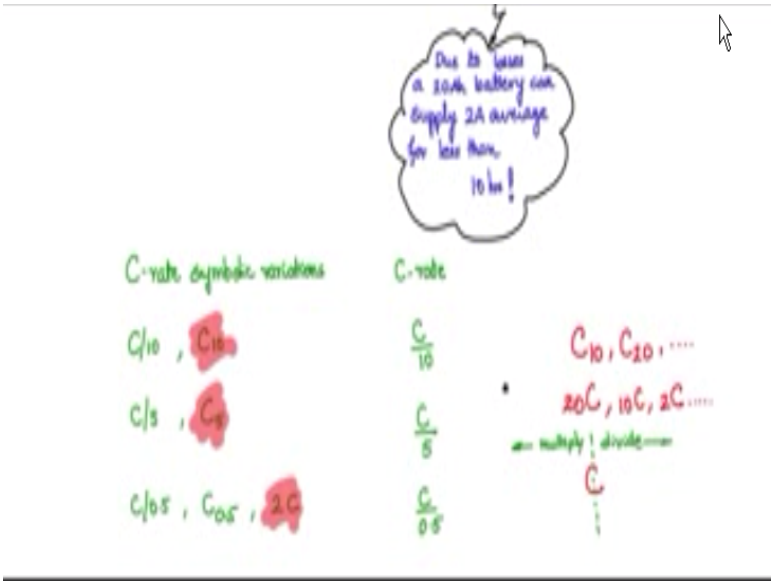

So this is what you should actually use in practice not the ideal one but however for benchmarking we still use this equation C rate symbolic variations means there are many representations of the series in the literature and in the web so probably some examples here will give you some idea inside C/10 means $1/10^{th}$ the capacity we needed the discharged current it is also indicated as C_{10} 10 coming to the right of C.

So the C rate value will be C/10 which means this will be the amount of discharge current flowing for this much amount of hours to give you this capacity C by 5 also indicated as Cπ in some literature and the discharge current is C/π C/0.5 also indicated as 3.5 and also indicated as to see you see the integer number is on the left of C and the discharge current value is C by 0.5 or to see.

So what is more popularly used probably is something like this you see here see with an integer on the right see with an integer on the right 5 with an integer on the left giving you C_{10} C rate C 20 rate so on you have the 20 C rate R 10 C2 C so on so in general if you take C and if you take the left hand side the left hand side the integer if you find an integer on the left hand side of C you multiply with the capacity if you find an integer on the right hand side of C you divide the capacity so if it is C10.

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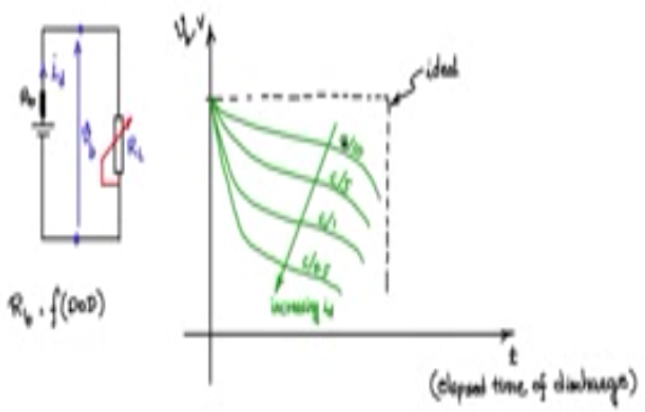

You say the discharge current that it, it capable of delivering is C/10 C 20 the discharge current the battery is capable of giving EC by 20 if it is20 C the discharge current that the battery is capable of discharging is 20times C 2 times C likewise so you see that the C rate is quite an important parameter to be considered especially when you are sizing the battery consider a simple battery circuit a battery which is connected to a load RL like this as shown let us mark ID as the discharge current battery is discharging to the load and ID is flowing out the battery.

And into the load in the direction as shown here and if you take the terminals of the battery and across the terminals of the battery shall we be the battery voltage now for this simples are killed let us plot a graph of time on the x-axis and the time represents the elapsed time of discharge so you set the load or else to some value such that some discharge current is flowing through this load and allow it to flow for some time T then ID into time T would be the ampere hours that is discharged from the battery capacity discharged from the battery.

Then on they-axis we have the battery voltage in words ideally we expect the battery voltage VB to be a constant like this it is supposed to be a constant like this for however long I need is flowing through the external load RL we could have the load has a real static resistor and vary the load to get different values of discharge currents ID whatever may be the discharge current in an ideal sense the battery voltage VB will be constant like this for how much overtime the current discharges till the entire capacity of the batteries remove from the battery.

At which time the battery would have lost all charge and the voltage will start dropping down trusts it drastically as shown here so this characteristic is an ideal characteristic and you will not see such a characteristic in reality in practice the characteristic will be much different let us say we set the RL value to some value and some ID is flowing through the load resistance a practical characteristic will look something like this the voltage drops with time as ID starts flowing out of the battery the charging out of the battery ampere hours are being removed.

The charge is being removed and the battery will start losing the voltage and the voltage starts decreasing like this as shown this drop in the voltage is due to voltage lost in the dynamic internal resistance of the battery, battery has an internal resistance let me show that indicate that like this so this resistance will call it as R_B, R_B is not a fixed constant resistance it is a dynamic resistance it is a nonlinear resistance it's a function of many parameters including the chemistry of the battery but R_B is a very significant dominant function of depth of discharge for the battery.

The depth to which the battery has been discharged if it is fully charged then are these low very low and as more and more charges remove the battery the RB value will increase so that is what is indicated here, here when the battery has not discharged much time is not elapsed much you will see that R_B is low and V_B is at almost full battery voltage and as time progresses ID is flowing out of the battery high D into T will be the amount of charge that is removed from the battery.

And you will see that as the charge is removed the depth of charge increases depth of the charge increases as also increases and more and more drop starts appearing across our B and therefore the terminal voltage VB drops like this let us say that this characteristic is for as C10 C/10 rating that is if C is the capacity of the battery C by 10 amount of current is being discharged from the battery by appropriately setting the value of RL now let us say I have another hide you setting by adjusting the earlier Warren and I yeah I do C/5.

Once if the capacity amount equivalent to that is discharged you will see that the dynamic resistance increases much more rapidly and the falling voltage is much more rapid so C/1 and C/0.5 or to see you will see that the drop in the voltage increases very rapidly with the amount of the charge current and with the C rate as shown here so this you will see this family of cover that have a marker indicates particles increasing discharge current ID increasing ID.

So it is very important to note that C rate plays a very important role in deciding the battery because if you want to have a battery where you want to have a specific discharge time the x-axis and you want to have the battery voltage terminal voltage within a particular limit then you will have to choose an appropriate C rate of the battery so this will matter and also the appropriate depth of discharge so these are important parameter that you should consider while selecting a battery for a given application.