Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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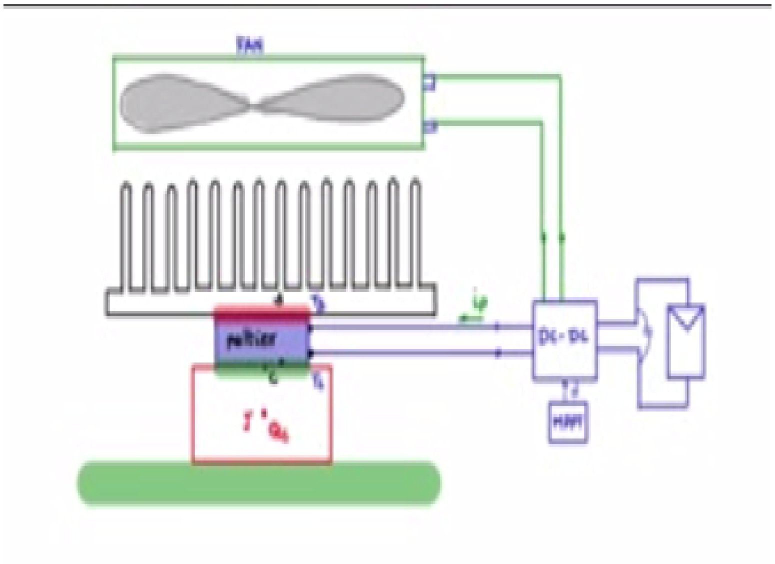

When you consider a peltier cooling system the peltier element itself is only one part of it. You see here that there is already a system which is generating heat and you want to cool it, you want to remove the heat that is dissipated, or this system, you have this red box here could be a box, the insights of which you would like to cool like in refrigeration.

So you would like to remove the heat from the volume of air which is within this box, or you may want to remove the heat form a component which is precipitin or you may want to remove heat from medicine which is kept within this box so that you keep the medicine in a cool environment so this is one aspect which is the objected to be cooled now the object to be cooled is directly in contact with the cold junction of the peltier element now the peltier element in order to pump Qc amount of heat from the cold junction to the hot junction it needs electric power so you need a hole set of electronics like this PV panel DC-Dc converter MPPT fane controller.

So on to enable the peltier junction or the peltier element to act as a heat pump then after that still the game is not over the hot junction the heat has to be removed at the same rate that the heat is removed from the object to be cold, so the heat from the hot junction has to be input out into the atmosphere and not come back into the cold junction part by means of having a low thermal resistance heat sink is one mechanism foreside air cooling and heat sink is another mechanism but unless this portion heat the removal from the hot junction of the PELTIER if that is not done properly then the whole system will not worked properly.

So therefore we will spend some time into seeing how the heat is removed from the hot junction part of the PELTIER means we need to understand some theory on the thermal aspects so that is what is we will try to spend some time in discussing now.

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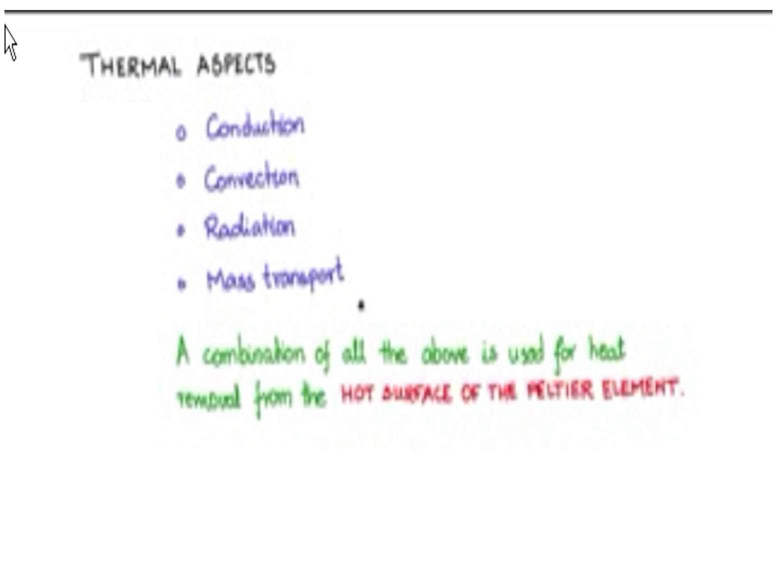

So in thermal aspects mainly we are talking about heat flow, heat removal the heat flow is effected by four mechanisms one is conduction heat flow through conduction, heat flow through convection there is a fluid which is taking away the heat from the surface this fluid can be air, it can be water, we will look at these in detail later. Then a radiation it does not need a medium just like we get heat from the sun solar energy that you get is without a medium and the fourth mechanism is called mass transport just like we have this engine in an automobile which is cooled by circulating water, water as a mass transporting the heat along with its self into the radiator and then it is leaving of the heat in the at external atmosphere by means of blow air which is blowing away the heat through the radiator.

And the cold water is again circulated removes the heat and carries the heat through the mass of this water and again through the radiator and gives it off to the atmosphere so that it one example of mass transport and we will look at these mechanisms so that we can design at proper thermal heat sinks or combination of heat sink and force cooling so that the heat is removed from hot surface of the entire element. Surface of the Pelletier element. So this is an important aspect and your whole refrigeration or the Pelletier cooling will work only if this aspect is mastered.

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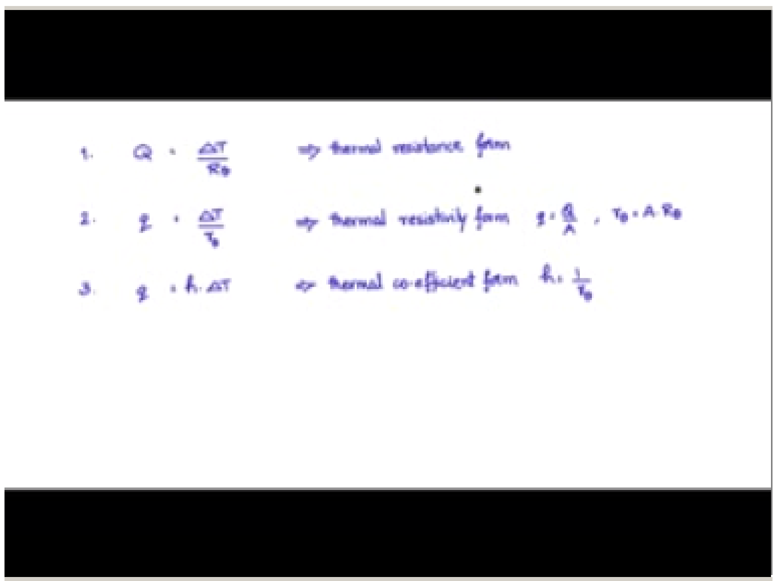

Let us look at the thermal relationships that you will be using frequently in designing the Pelletier cooling thermal systems. We know that the main constitute relationship is ΔT is proportional to the heat power flow Q and $\Delta T = R_\theta$ X q the constant of proportionality is called the thermal resistance Kelvin per. There are some modifications to this relationship in slightly modified form essentially it is same relationship but literature as few variants. I think you should be aware of these variants.

So that you can use any of the relationships seamlessly in your design, consider block a conductive block like this and assume that one side one surface is at temperature $_{T1}$ and other surface is at temperature $_{T2}$ and heat power is flowing in this direction Q through this conductive block that is thermal conductive block it is flowing through this, so it is flowing by this conductive medium.

Now there is the area of cross section consider orthogonally to the flow of the heat power and that area we will call it as A. now Q that is the heat power/ the area of cross section to the orthogonal flow of the heat power Q/A is defined as Q and this is called as the specific power w/m^2. Now consider this relationship $Q= \Delta T/R_\theta$ now if I divide it by A the area of cross section Q/A is $\Delta T/AR_\theta$.

Now this is Q and $\Delta T/AR_\theta$ is defined as lower case R_θ and this called thermal resistivity so R_θ which is a.rθ, a.thermal resistance is called thermal resistivity and it has the units you know the units of R_θ which is degree Kelvin per watt you have the area network coming into the picture so degree Kelvin meter square per watt now there is another form also which is prefer under literacy $q=h\Delta t$ where $1/ R_\theta$ put as h and that is called the thermal coefficient.

So you will see many literacy using thermal coefficient what it basically means is it is nothing but 1/ thermal resistivity and it has inverse units of this watts per meter square per degree Kelvin so watt per degree Kelvin per meter square so these are the three major forms of the relationship the original relationship that we put forward generally used and common in the literature let me just write that down summaries it and write it down.

So the first one $q=\Delta t/r\theta$ so this is called the thermal resistance form R_θ is thermal resistance second one specific power q is Δt/ lower case R_θ and this is the thermal resistivity form where q is heat flow power watts by area across section orthogonal to the heat flow q/a and R_θ thermal resistivity is a. thermal resistance the third relationship $q=h.\Delta t$ where you can say this is the thermal coefficient form h is $1/ R_\theta$ so these are the three forms of the thermal relationship that is generally used by people used by used in the literature for designing thermal systems.