Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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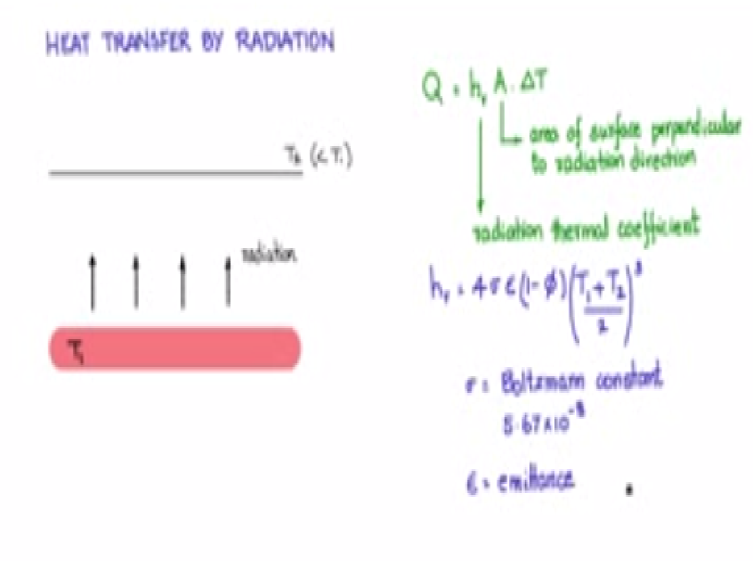

We had discussed heat transfer mechanism by conduction, heat transfer mechanism by convection free and forced convection. The third method, third mechanism for heat transfer is by radiation, radiation is a transfer mechanism from a hot body through electromagnetic waves, it does not need a medium for transferring the heat. So let us say that you have a hot body like this at temperature T1 and it is radiating heat through electromagnetic radiation.

And let us consider an imaginary boundary here at some distance. And it is at temperature T2 which is less than T1. So what is the Q received at this imaginary boundary, the heat in watts is given by this hr.A.ΔT this is the thermal coefficient relationship. A is the surface area perpendicular to the radiation. H is the thermal radiation of thermal coefficient, and it is given by another empirical relationship 4 σ(ε1-ɸ)(T1+T2/2) where σ is the bolts man constant which as a value of 5.67 $^{-8}$ ∈ is the emithance is the energy m emitted relative to that of a black body so it is a property of the material and depending upon the material the value of the emithance will be different.

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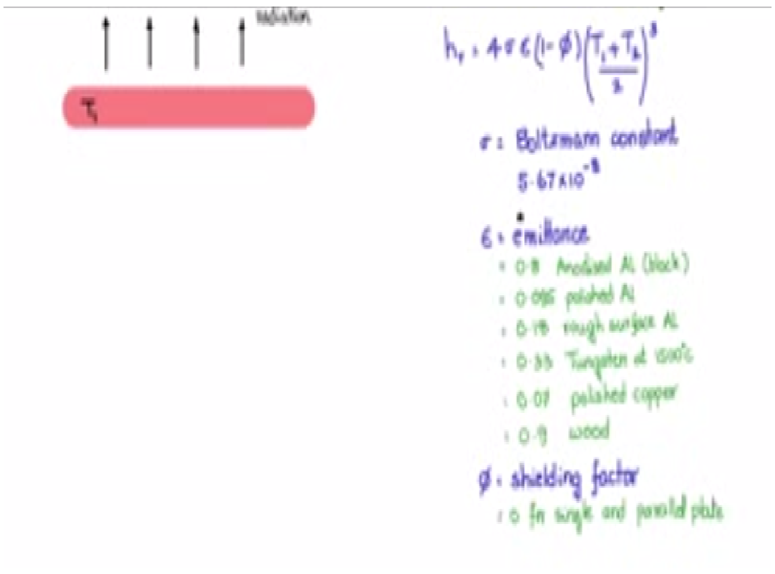

Let me list down few of the emithance values 0.8 for anodized aluminum black anodized aluminum 0.095 for polished aluminum emithance of polished aluminum is less than 0.18 for rough surface aluminum I am mentioning aluminum because most of the heat snicks are made up aluminum 0.33 for tungsten at 1500^0 c 0.07 for polished copper and 0.9 for wood, charcoal.

So these are the some of the typical emithance values of common material Ø is called the shielding factor it is whenever there are many parallel plates so some of the in between plates are shielded but for single and 2 parallel plate system the shielding value is 0 so this is the relationship that you can use for finding out. The heat received by radiation the 4^{th} heat transfer mechanism is heat transfer by mass transport so here movement of a fluid mass is used for transporting heat from one to another place it is a common mechanism used in refrigerators where the free on fluid is used for transferring heat from.

The chamber to and evaporator and then gets a exchange to the ambient through a radiator even in the car the heat from the engine is removed by the flow of water and then get removed out into the external ambient through a radiator so these are mass transport examples so let us consider a pipe, so it is along pipe.

So I am going to indicate this by the symbols at it is a very large long pipe so this pipe as inlet and exit so at the inlet you have the flow of this fluid coming in it is cold fluid here and at the outlet the fluid is going out and it is hot fluid so somewhere in between it has accumulated heat and then it is carrying the heat away.

So the fluid flow here this is a temperature T1 this is the cold value this is temperature T2 this is the hot value in between we have a Peltier junction a Peltier element the terminals of the Peltier element and that is connected to a body which is actually dissipating heat and you want to remove that heat that this body, hot body is dissipating so this Peltier element is pumping the heat from here into the fluid flow let us say if it is water into the water here.

So this is the Peltier element and this is the hot body and the Peltier element that is usual we have the appropriate DC DC convertor electronics and the powering up from the PV panel and delivering the necessary energy for it watt as a heat pump now the heat that is flowing from the hot junction of the peltier into the fluid is Qh and what is being removed from the body hot body that is dissipating heat is Qc.

And there is the amount or energy that is being pumped into the peltier through the electrical domain that is E so Qh what is being pumped into the actual water body or fluid body is given by dm/dt m is mass here mass flow cp*T2-T1 hot- cold the hot temperature- the cold temperature so this is the heat flow relationship for mass transport where dm/dt is called the mass flow rate C_p is called the specific heat of the fluid.

So it depends upon the fluid and this is ΔT and the specific fluid is given as J/kg/^{0} K and it can be obtained from scientific tables for specific fluid material. Now $R_{\theta m}$ the thermal resistance for the mass flow rate if you look at this Q = ΔT/ thermal resistance, so you can it is 1/value so the thermal resistance is given by 1/dm/dt.cp so you see that if the specific heat of the fluid is high and the thermal resistance will come down so if I use a fluid with a very high specific fluid like fusion you can have a very low thermal resistance another important factor is contributing to heat removal is not actually the thermal temperature difference as was in the case of conduction convection.

And radiation here it is more controlled by this thermal resistance which is highly dependent on inversely proportional to the mass flow rate by controlling the mass flow rate there is if I am having a pump which is pumping the fluid in by controlling the speed of the pump you can regulate the thermal resistance so that is the nice dynamic property of this mass fluid which can be controlled by effects external effects other than temperature difference so in this way you can remove heat out of our body through the Pelletier junction by the mass fluoride mechanism tool.