**Electronics Enclosures Thermal Issues**
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**Lecture – 25**
**OTS standard profiles**

So allow me to continue where I try to leave things some samples I could not collect just now I got the samples. Please have a look at this, which I have taken from the famous pentium cooler.

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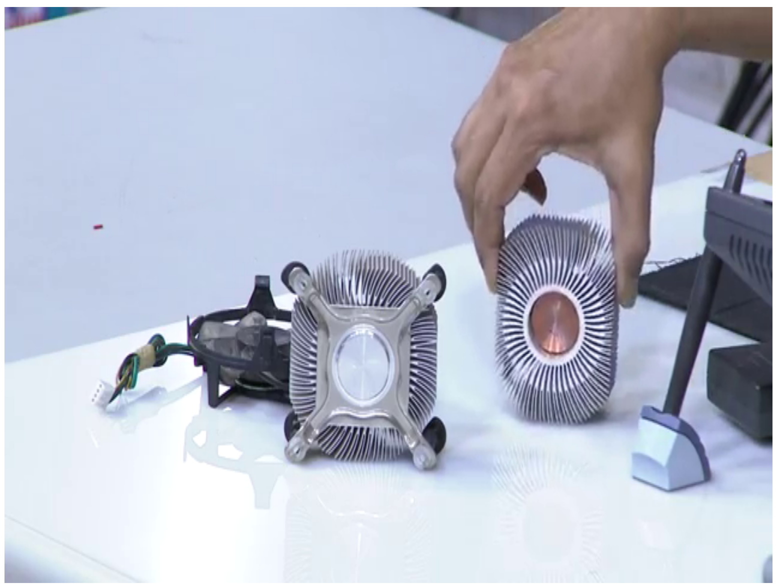

So typically what you see outside is these including that Intel's are name probably it has from an o e m because I do not think Intel will be best in their energy in making these things.

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What is however very important is, that the whole module has been made like this. Right now I cannot see inside whether it is actually a copper core or anything, the whole thing has been welded soldered and welded inside so they cannot see anything.

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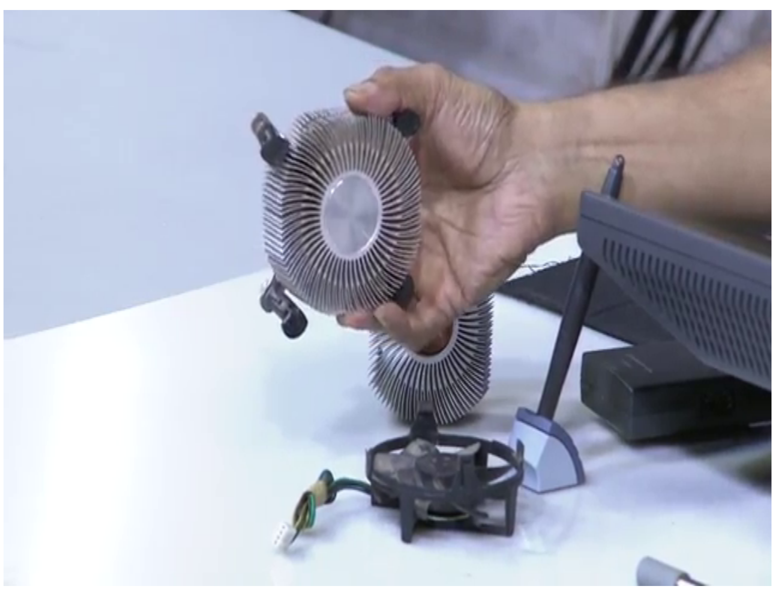

However if we do break it open, chances are it has a high conductivity copper core inside. The advantage of it is to make this heat sink effective that is there is a the think about fin effectiveness of the heat sink. Two things have been done here one of them you will notice is that by conductivity this conductivity from anywhere here to they should be maximum otherwise chances are there will already a drop.

Hence the highest possible what do you call special type copper alloy has been used here I am not very clear as to why this small step has been given? It may be part of some have equalizing the what you call the heat thing is one some of them the core is made up to here and afterword, there is small bore is drilled here I am not been able to figure out may be you should contact those people. And another very interesting thing is you see this fins have a very peculiar first of all they are radial if you are to make it radial chances are you still have some issues about this has to be thick at the base and as it comes out it should become thinner like that.

But it will bit the whole thing because you will end up with a what do you call a sun type of this thing, where while is the bases here and that will need to much gap here, which we cannot do anything about. So what they have done is, he has via media it starts thin, narrow and it will goes little thicker and its splits again so that at the periphery we still have at the periphery, we still have lots of fins which approximately correspond to the fan that has to sit and top of it.

So we have this fan which sits on top of it and you see here that center area where the air does not you know go, this fan directly covers all these areas and the moment this fan starts turning to or thing you will notice is, one part of it is probably axial. But then while it exists exit is while this is axial exist is radial like this and the when the fan rotates there is a always one what you call flow is not straight and to make more contact area between the sides of the fin and this, its also have been given a small forward curve about it. This is only my interpretation may be somewhere in the open you probably will have the data in it.

I just wanted to point out the this strikes are whatever it is, somebody has come out with the concept and later on you can work out with the c f d or simulation and all that and work back. Unless the contact is are large the oms also will not be able to help you about it. This is regarding the heat sinks which I have wanted to show you earlier and I manage to get it.

Now second thing is let me get back if you see the morning I left you here because my module did not run well have a look at it again this is part of the bio assembly bio assembly, so we have some special cups and from various reasons, we do not want them to be shaken up or stirred. If you stir it we have a small problem stir is a what you call is a perouse material there is a magnet there, slowly traces in.

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Now it will index into a position where it is (Refer Time: 05:06) lowered onto the microbalance which is attached here. What I would like to what you call bring it notice is that, when we met this item we also wanted to have a provision by which we can cool it or heat it as we like so in another dummy slotted the bag, we can have a small we can have a small well which will it can be heated or cooled and then we can rotate it. The whole carrousel can be probably kept in incubator brought out and we can what you call attach those things here.

So you will see that now why it has been made is maximum amount of carries been taken such that you do not stir it, and the bottom of it is open there could be the medium liquid inside which may spill on this and similarly when you want to place it on when you one of those positions, the device should remember where it is taken it from hand come back again to the same position.

And when we make a drive for the stepper motor what you call system and all inside, the whole basis available as you see I have a base here, I have a base here directly things can be mounted here and next point is that heat should not disturb any of our measurements. And you see very gently it is being place that to prevent any what do you call wrong this thing about the balance because this balance has a three digit precession. So we want to see whether the rate of growth of the germinating seeds are under our control at a given temperature in to what do you call ambient conditions.

Because most seeds they see rate of temperature rise also which is critical. Lot of the root activity and the germination activity is just at the surface. So these are all I have no clue about what it is, now we come to one more demonstration this time by the manufacturer he will explain to you have a look at it a simple demonstration box.

Hi everyone my name is Dan Reist I am a lead engineer and the strategic product development group here at advanced cooling technologies and today we are going to talk about heat pipes and their thermal conductivity values, so we have a demonstration to show you here we have a copper water heat pipe and here, we have a solid copper rod and we are going to be inserting them into our demo box, which has a hot well and a cold well and we are going to be looking at the difference in thermal conductivity between a copper rod and a copper water heat pipe.

So the first thing I am going to show you is we put the copper rod into the heated well we are actually going to be able to see the temperature change as the heat conducts up, the rod because there is a color changing paint on the outside of the surface of that rod so it is a little difficult to see here.

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But the paint is turning from green to yellow slowly and so we are actually witnessing is the heat conduct up that rod, so I am going to let it progress a little further just so you can get a feel for the rate that that it moves copper has a thermal conductivity of about 308 watts per meter Kelvin. So it is a good conductor as far as solid materials go but in a minute here, you will see how much better the heat pipe is ok.

So you can see the color change and its slowly making its way up in another couple of minutes ago it will say that rod which is being inserted the red one is a hot well meaning at the bottom my probably has some oil or some other liquid, that other blue one is a cold well. And then the test specimens have been quoted with a color changing paint usually most LCD materials they will have the exhibit that properties. So depending on the length of it and depending on the rate of heating, the color changes continuously. I tried to point out the same thing to you saying in your old physics class, that used to be a container and then there used to be two or three of them to, high conductivity one is a low conductivity another is an insulator the whole thing is coated in wax, and then your small slider you put hot water inside.

The highly conductive rod it takes heat to the bottom quickly. So there is a small slider with the wax melt and comes down. Medium conductivity it just starts and leaves and the non-conductor does not allow the wax to melt at all. Now in the modern this thing now if you see here instead, we now have a color changing paint so what he has done is he has put this one solid directly in the hot well, next is going to put the heat pipe into the other well so you watch here.

(Refer Time: 10:41) put the copper water heat pipe in and you will see that the color changes almost instantaneously so it is already.

You have seen the whole colour as quickly changed compared to this, I will try to play it back a little and we will see how it starts here watch.

Heat pipe is ok.

So you can see the color change and its slowly making its way up in another couple of minutes ago, it will turns completely yellow but now I am going to put the copper water heat pipe in and you will see that the color changes almost instantaneously. So it is already its essentially the same temperature at the top as at the bottom of the heater block, and so that really demonstrates that high effective thermal conductivity that you get when you use a heat pipe for cooling electronics or other devices.

So at the same time we can move from the hot well and insert it into the cold well and you are going to see that temperature very quickly go to the cold temperature and return back to green if we do the same thing with our solid copper rod that process takes one to two minutes. So this is just kind of a really practical example of the difference in effective thermal conductivity between a heat pipe, which is a thermal superconductor and even your best solid metal conducting materials like solid copper that is all for now thanks.

Well I expect that it is about as clear as possible, now while that is from a commercial source I want you to watch we have nearer at home.

In the flow through the tube would be in the low Reynolds number (Refer Time: 12:48) secondly if you think of the.

It is the full one hour lecture by Professor Dasgupta.

I provide additional.

I suggest you what do you call you take time and you know read it on your own.

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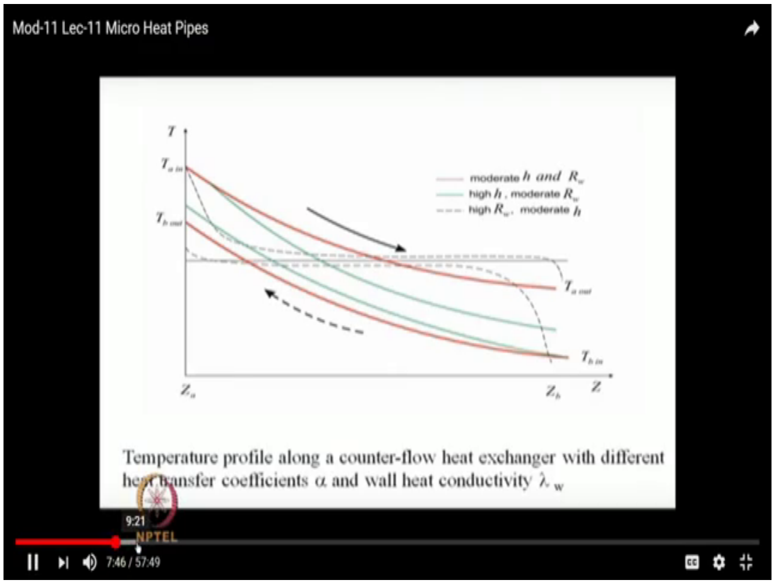


(Refer Time: 12:59) heat source near the near this higher (Refer Time: 13:02) first thing (Refer Time: 13:03)

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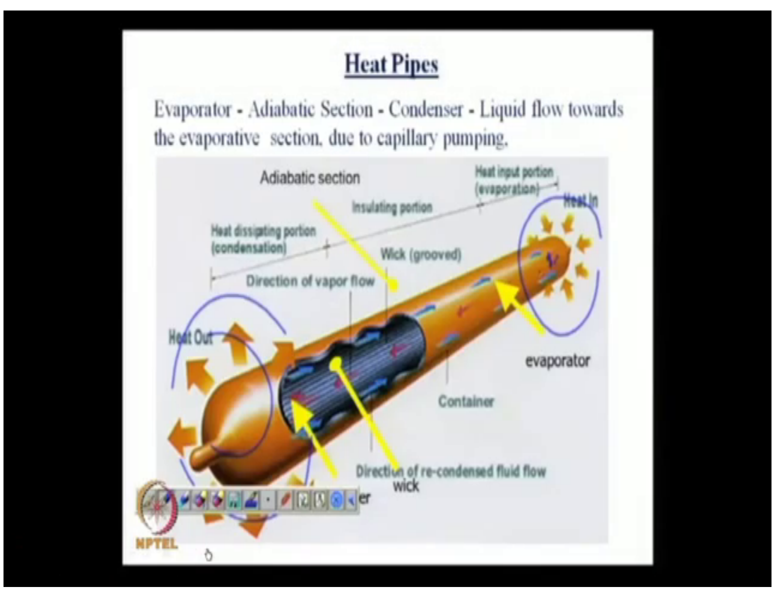


First thing that one should concentrate is its very low thermal conductive.

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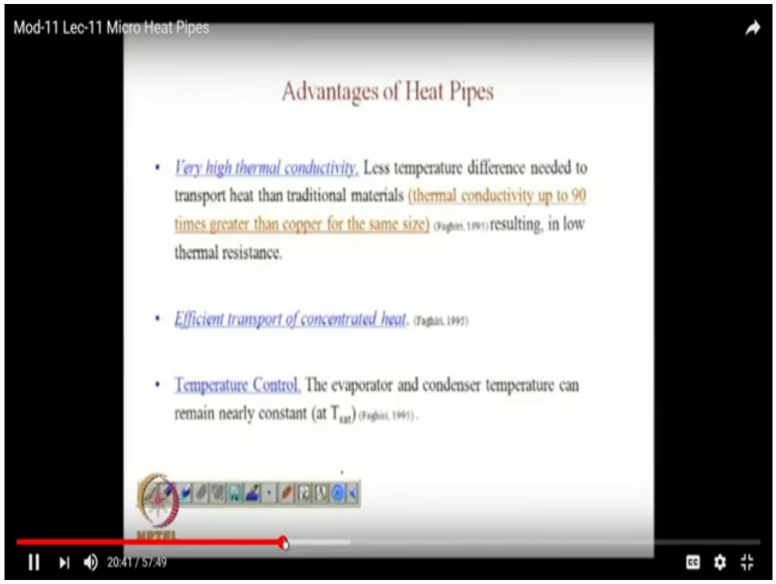


Very high so towards and intermolecular force gradient.

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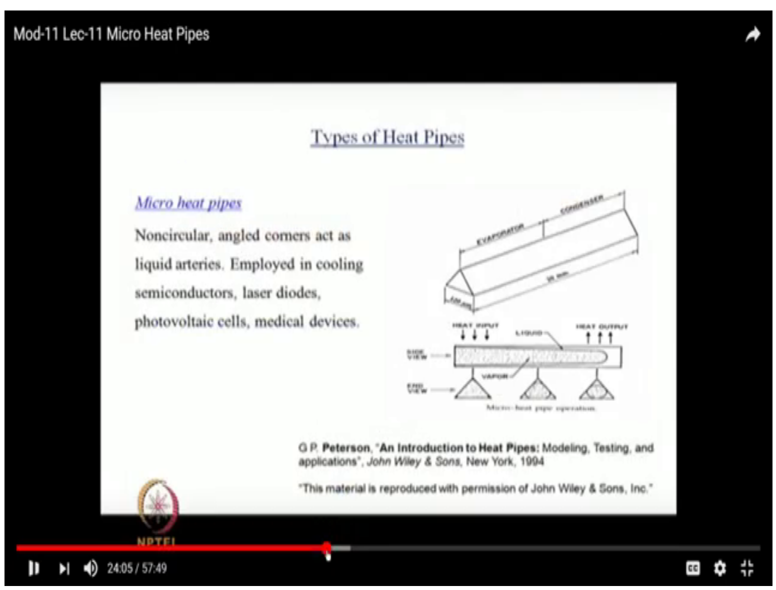


Micro heat pipe (Refer Time: 13:24) where you relate the liquid have undergo let the liquid undergo a change in the radius of curvature.

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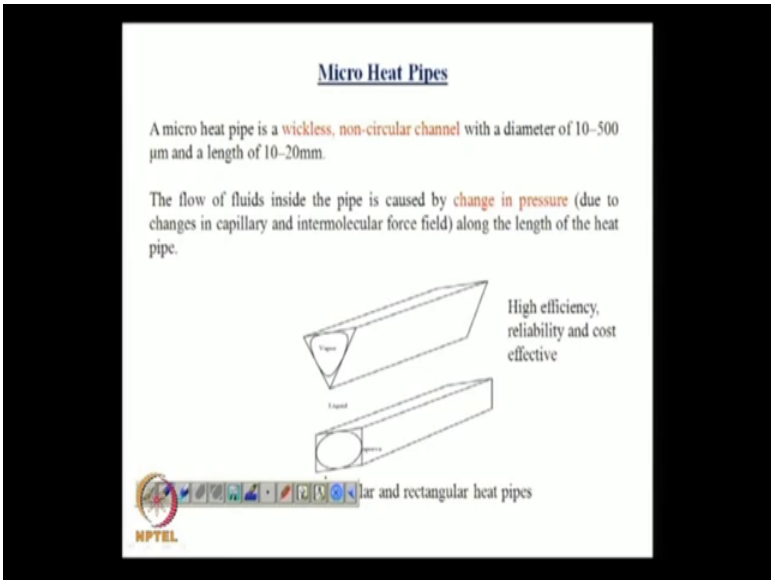


The diameters are between tem to 500 micron and the length could be a few centimeters. In the flow inside the heat pipe is caused by a change in the radius of curvature. In fact a change in pressure caused either by a change in curvature or by an intermolecular, I could not draw it properly but these two are connected (Refer Time: 13:57) known as to even the vapor is going start to return slightly encounter (Refer Time: 14:05) we have a is the temperature of liquid many (Refer Time: 14:08) to drive in which are slowly coming.

see the most important thing you need to notice is, this is a wickless non circular channel has no wick and because of the various very narrow sizes the change in pressure due to changes in capillary and thermo intermolecular force field along length of the heat pipe, seems to heat in the flow. I have not found it anywhere else and I am very much obliged to this lecture module 11 lecture 11 on micro heat pipes, I suggest you go through it because this takes one full hour for you and tremendous amount of analysis and how the forces change all that has been given. You seen that know there is something about the meniscus surface tension, wettability solid liquid interactions govern the behaviour where is interfaces liquid vapor interface.

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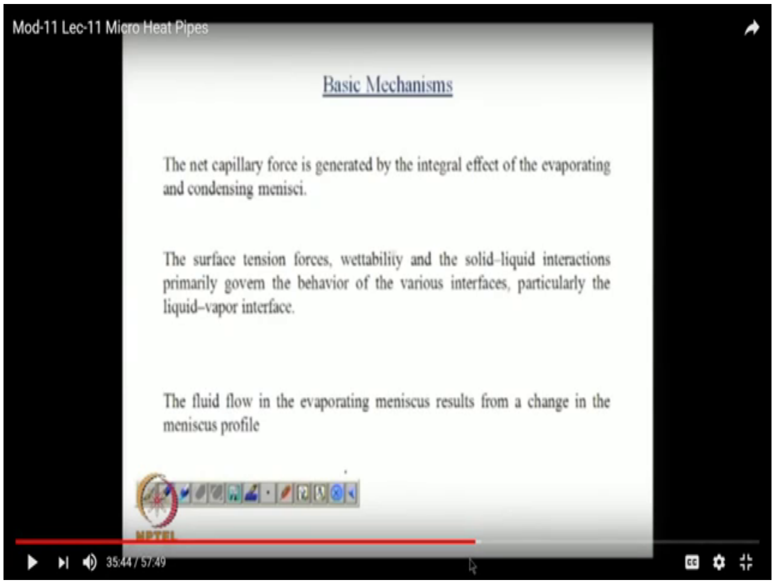


The fluid flow in the evaporating meniscus results from a change in the meniscus profile. This is where probably then you what do you call nano science has come about so while I belong to the old school I am not yet here.

So it is for you to I suggest now please follow it, I am not in what you call this is at one point how the liquid looks and other point have it this thing how the transition takes place along the length.

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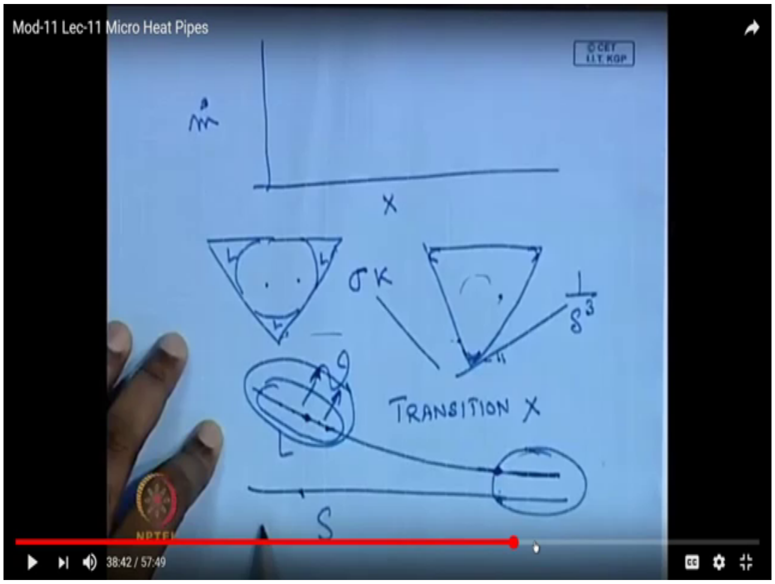


So that has been given here, I suggest to follow this and I am sure tremendous amount of analysis has been done saying.

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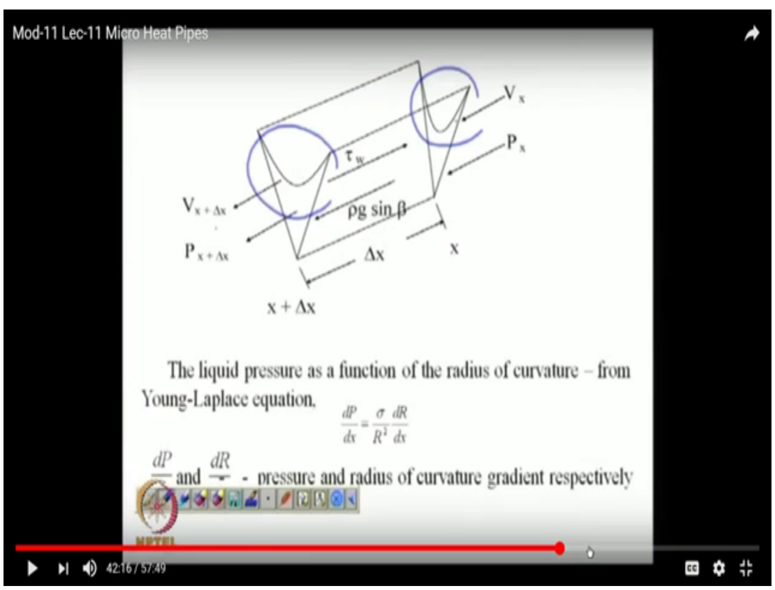


Liquid pressure is a function of the radius of curvature from young Laplace equation and all these things have been derived.

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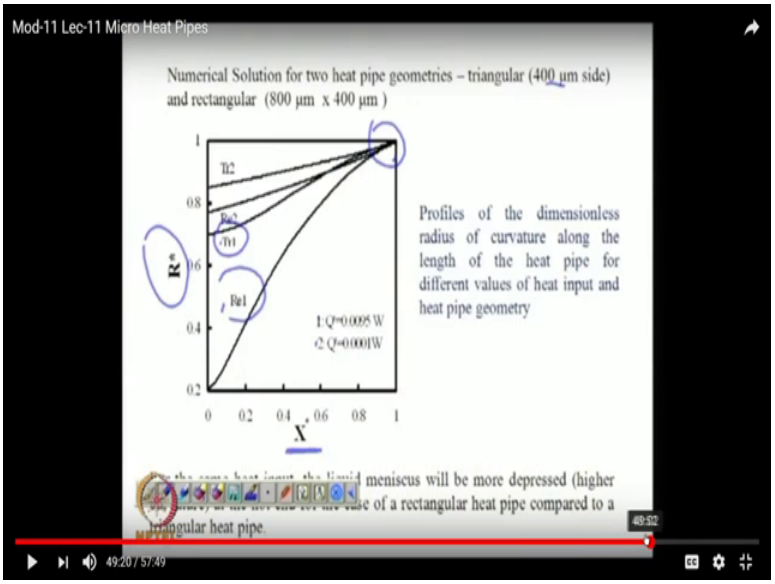


To be honest I have not used it and as such no I cannot what you call comment on it, but I suggest you need to check on this for a triangular and the rectangular.

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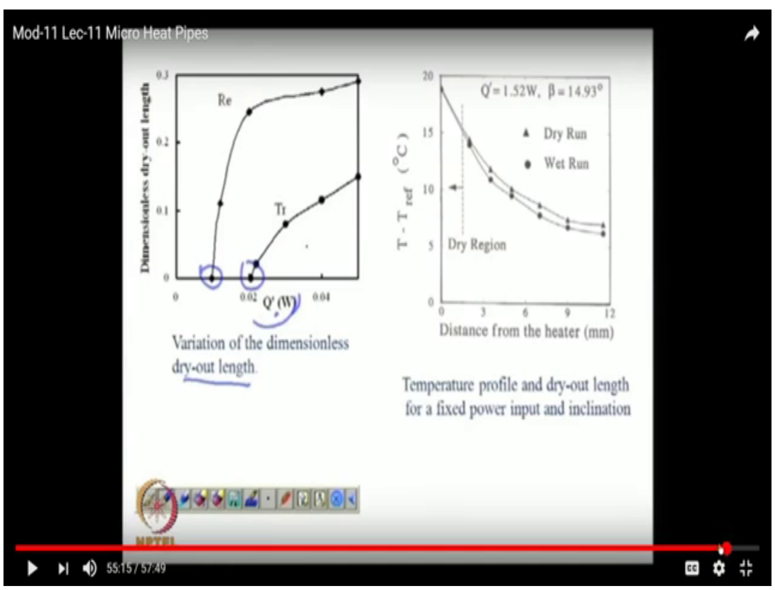


They have done you know tremendous of and analysis in this, and then there is a follow up lecture also on this there is a.

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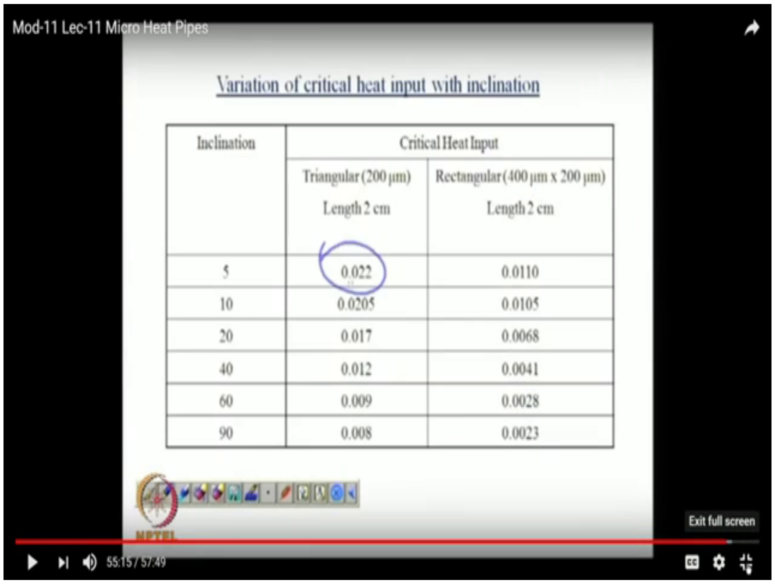


| Inclination | Critical Heat Input | |
|---|---|---|
| | Triangular (200 μm) Length 2 cm | Rectangular (400 μm x 200 μm) Length 2 cm |
| 5 | 0.022 | 0.0110 |
| 10 | 0.0205 | 0.0105 |
| 20 | 0.017 | 0.0068 |
| 40 | 0.012 | 0.0041 |
| 60 | 0.009 | 0.0028 |
| 90 | 0.008 | 0.0023 |

So in today's class what we are going to do is to recapitulate on what we have covered in the last class and then think about the components of pressure, liquid vapor interface is comparable to the reciprocal of the hydraulic.

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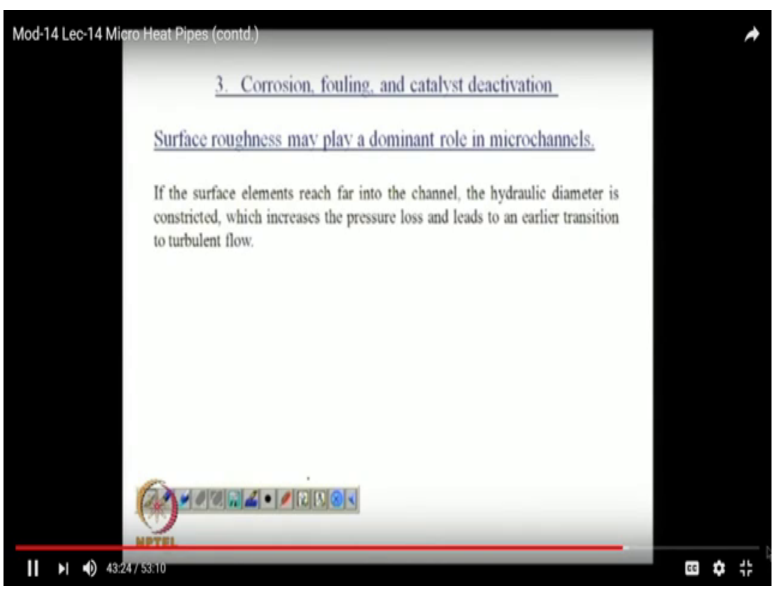


You please read the whole thing.

So this (Refer Time: 17:14).

Small part of it is repeated because for the people to understand.

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And then they this thing know saying surface roughness play may play, I mean dominant role and all that and in the conclusions.

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It is a matter of time that they will eventually be available whenever we want.

Which?

Those things I just wanted to find this out and then take leave at this point and then will try to get back to more practical this thing especially, what a vapor chamber is. So in the next meeting I will come back and talk a little more about, there are small vapor chambers which do not have a wick it is a little like boiling water in a closed container.

So at the bottom the what a call the phase changer you know mechanism will allow boiling and then directly on top it gets cold and along the lines or inside the thing itself know, why farming they I mean moisture condenser and continuously things take place. So that is a typically a simple vapor chamber, you have a small what you call small container filled with the liquid and then continuously things change in it.

And again a little bit of theory little bit of experiment and finally have commercial devices available, which are directly fixed between the chip surface and between the heat sink because we need a very big what you call very low degrees centigrade per what the thermal resistance has to be low and there you cannot afford to have huge volumes like this.

Its expensive it is what do you call heavy and doubtful you know this thing cost effectiveness. But in a case like this we have we have no choice it is a must so thank you I will stop here, I did not want to play the full video I kindly go to the back to the NPTEL channel, look for this micro heat pipes from IIT Kharagpur and beautiful treatment has been done here. And coming back if you still are interested that stuff about the mix about heat pipes are also given here.

I will search same the same company talks about same this thermal alloy, avid what I have spoken or what is taken from their main website this lady will explain you have a located mostly saying how this is as good as the other.

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(Refer Time: 20:25) experience with designing and manufacturing heat pipes and heat pipe assemblies heat pipes are the best way to transfer heat spread heat or increased heat sink fit efficiency. His custom avid heat pipe assembly this assembly can dissipate up to 150 watts heat pipe assemblies have three zones that contribute to the heat transfer ability the first zone of the heat pipe the evaporator is where the heat absorbed from the device evaporates local liquid into a vapor.

This vapor travels through the second area the adiabatic cavity of eighty pipe into the third zone the condenser, which is the cooler region of the heat pipe here the vapor cools and condenses back into a liquid through capillary action the liquid then returns to the evaporator region of the pipe and then the cyclic repeats because of the latent heat of vaporization water can absorb and carry more energy or heat, during phase change from liquid to vapor this makes it so much more conductive than the metals typically used for meetings.

Unfortunately although heat pipes have been used since the 1960s, they are commonly misunderstood technology (Refer Time: 21:32) myths heat pipes are heavy (Refer Time: 21:33) pipes (Refer Time: 21:34) heavier and more expensive materials. For example replacing a copper base here is a solution from earlier that can dissipate up to this one here.

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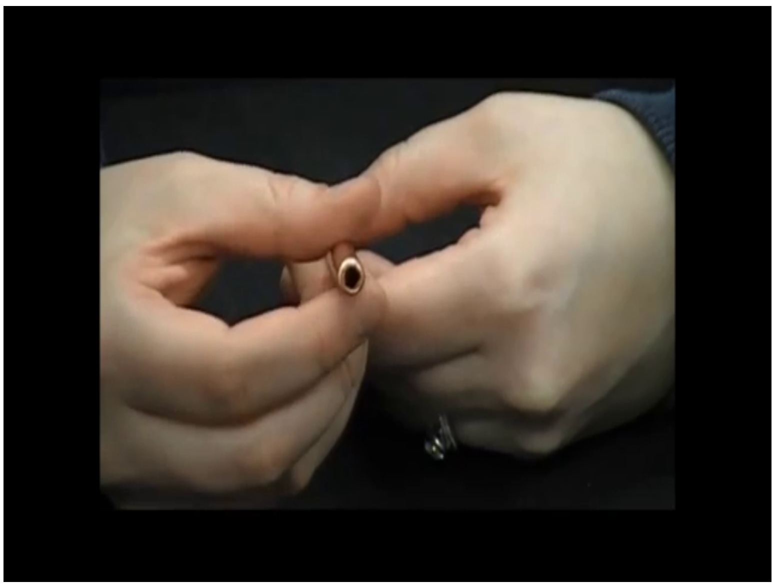

Myths heat pipes are heavy (Refer Time: 21:55) myths liquid will get on my electronics (Refer Time: 22:00) myths heat pipes are one of the most reliable two phase liquid cooling solutions and rarely if ever break if one did the miniscule amount of liquid actually.

So that is a pipe cutter that tube cutter she try to make a dent and open the heat pipe.

Here I am going to open up a pipe and we are going to drip out some the liquid that we find inside this is going to take a few moments (Refer Time: 22:39).

Looking at all the pictures we are seen so far, as you already to split into and then there is a bigger ready so what happened to the liquid? We do not send a liquid anywhere nothing no liquid so all the liquid is already in the.

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It is directly observed in the wick so you are long likely to have any liquid leaking.

Myths heat pipes only work with the evaporator and condenser on the ends truth heat pipes work along the entire length of the heat pipe, heat pipes will consistently move wherever it is hot to where it is cooler because of this they are often used for spreading heat and not just transferring it here are examples of heat pipes being (Refer Time: 23:20) speeding use as spreaders in the base and here are solutions, where the evaporator is in the middle myths. Heat pipes cannot be used in freezing conditions, truth this is false in two ways how heat pipe operates and given ambient conditions is dependent on materials, most commercial applications use copper and water ultimate other materials includes can be utilized depending of highly specialized requirements, allowing heat pipes its working even the most rugged conditions secondly even with copper and water the solution can be designed to mitigate environmental conditions such as started in a cold environment.

I hope you found this video informative if you have more questions on heat pipes and their applications contact avid you can also order one of our heat pipe, fits heat pipe fits our tools to enable our customers to explore test and build with heat pipes in their own labs and experience prototyping your own heat pipe cooling solutions.

So search for yourself long ago we can go to your library and then look up various things right now technology, now permits us to search for it directly online they only what you call caution here is something like the perpetrium mobile, something like you know what you call get power you know my this and all they are all fake and fraudulent thing, there all made may be like a gag. But the reality is if you actually go to serious what you call lecturers, anywhere in the world including what you call some manufacturers they give you a lot of information directly.

Now the second point is it worth for you have to trying out let us say you are a curious person yes there again one more time there are ways of making a heat pipe and so on and if you go back again to the YouTube channel, you will probably find how to attempt to make your own heat pipes same thing it is with peltier peltier modules are available, you can in fact order them online and then try to build your own systems as you like.

So, I will take leave of you now at this point.

Thank you.