Electronics Enclosures Thermal Issues
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Lecture – 24
Prior art

If we see the working of this module; I will see if we have the VLC media player probably it will work.

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Have a look at it [FL] ; see what is happening is [FL] 1 bit of the device is being picked up ; I think I need to replay the video [FL] ; I think it did not get copied and anyway let it be [FL]. So, it fix up and then it will put it back into a homing position wherever it likes to put [FL]. And then I think there is a problem I will try to bring it back later.

The issue being that each of these wells we can maintain it to any temperature we like. And then we can have these what do you call thermo electric modules built into it there one place we can probably have the thing copied and whole thing to be kept in a place as we like.

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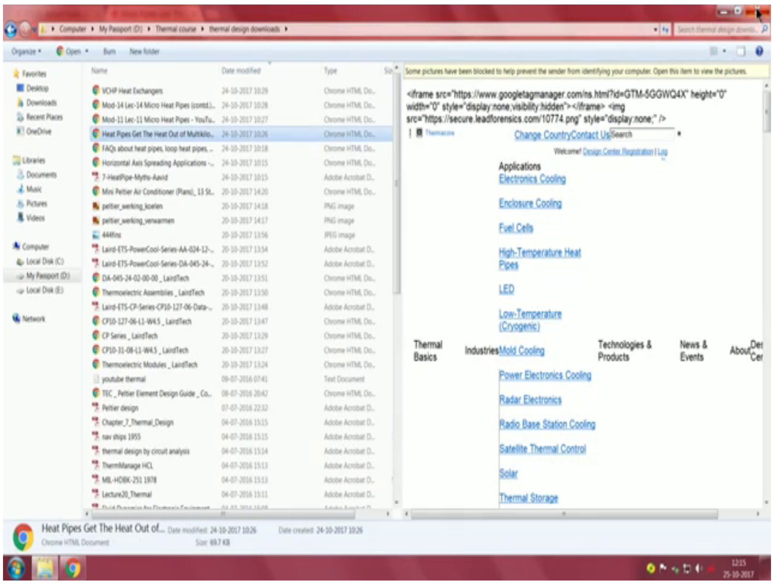

I will now move on to another important thing called heat pipes.

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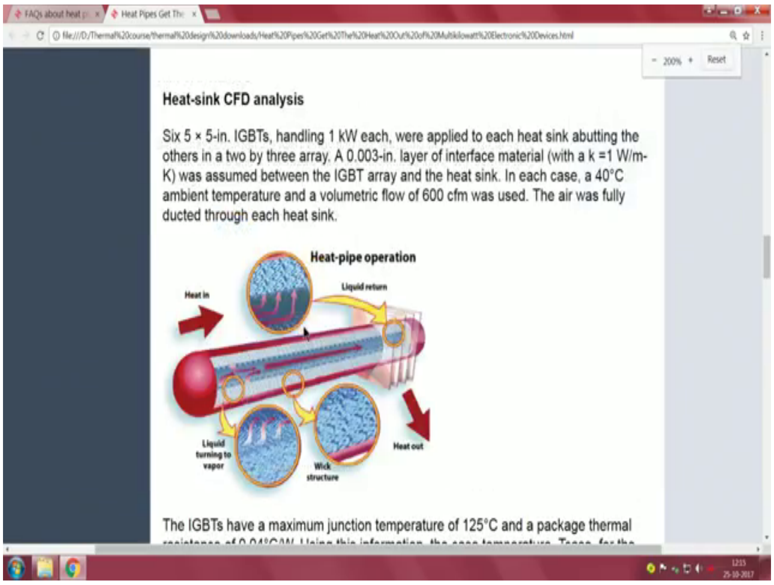

In passing, if you remember I had mentioned to you about a nice way of cooling things which are in a way relatively passive. The idea of passive is in the case of peltier we need to supply huge amount of power to it. So, my own what you call empirical thing is that 3 to 4 times amount of total energy is required to cool a given unit.

This I think so, many times even earlier I have explained to you saying at one point this is a working fluid inside a normal what do you call pipe. Instantly the pipe can even bane insulator it need not necessarily be made of copper, but the end where which is collecting the heat needs to a conductor, other end which needs to be cold needs to be another conductor; in between you have this wicks. So, working medium boils condenses here.

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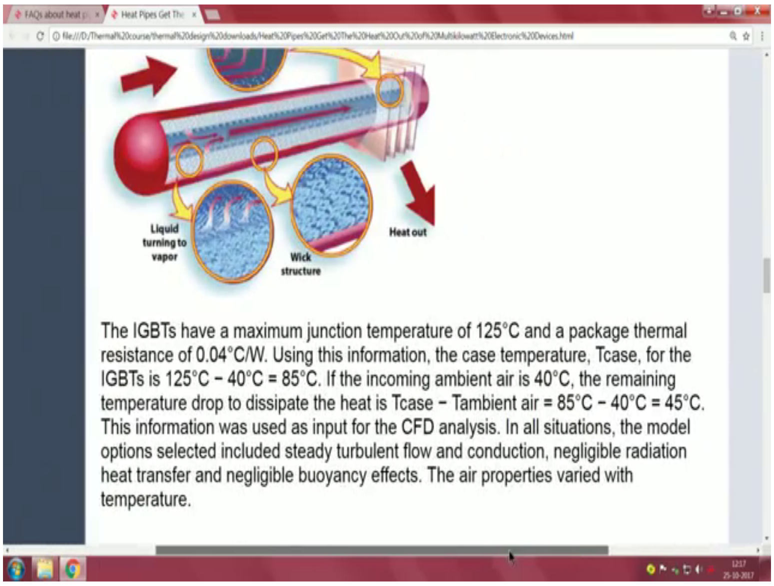

Now, read this. So, you will notice that when we talk about power electronics we end up with very very small raise in temperature with given voltage. Now, we will come back to the beginning of it and see what it is that they are talking about.

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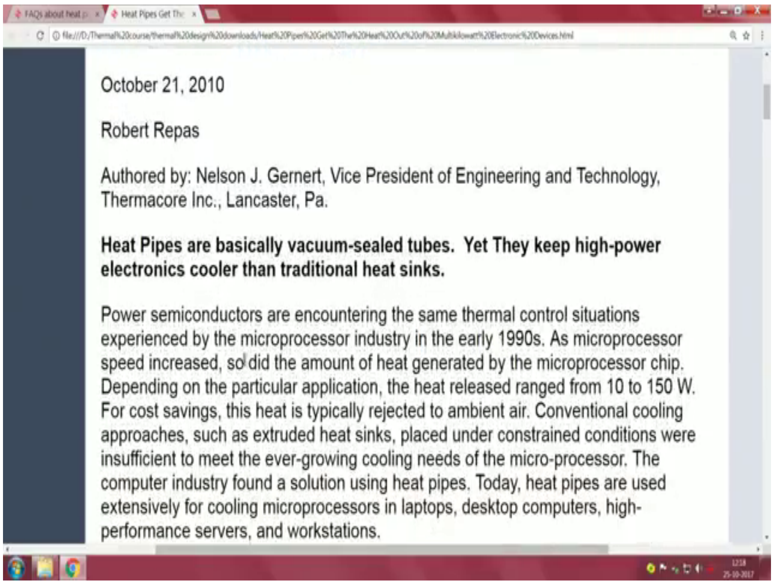
October 21, 2010

Robert Repas

Authored by: Nelson J. Gernert, Vice President of Engineering and Technology, Thermacore Inc., Lancaster, Pa.

Heat Pipes are basically vacuum-sealed tubes. Yet They keep high-power electronics cooler than traditional heat sinks.

Power semiconductors are encountering the same thermal control situations experienced by the microprocessor industry in the early 1990s. As microprocessor speed increased, so did the amount of heat generated by the microprocessor chip. Depending on the particular application, the heat released ranged from 10 to 150 W. For cost savings, this heat is typically rejected to ambient air. Conventional cooling approaches, such as extruded heat sinks, placed under constrained conditions were insufficient to meet the ever-growing cooling needs of the micro-processor. The computer industry found a solution using heat pipes. Today, heat pipes are used extensively for cooling microprocessors in laptops, desktop computers, high-performance servers, and workstations.

Volt heat pipes are basically vacuums sealed tubes; they keep high power electronics cooler than traditional heat sinks. So, if you go down.

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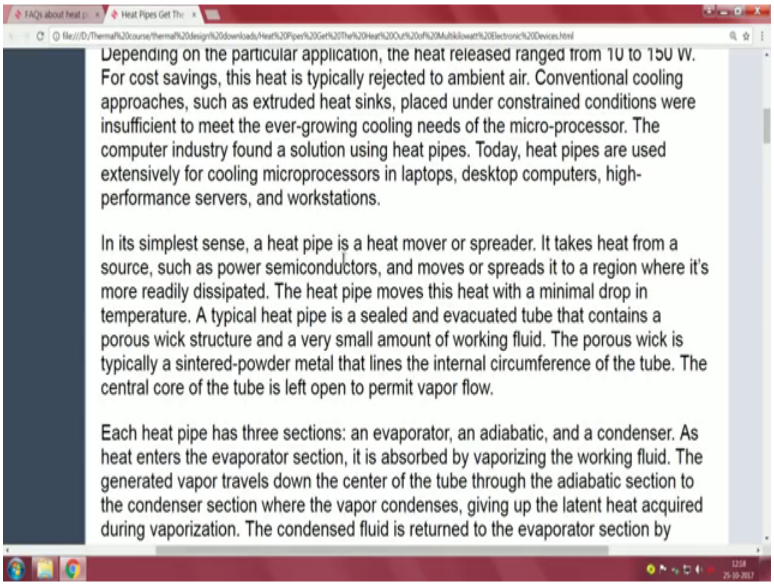
Depending on the particular application, the heat released ranged from 10 to 150 W. For cost savings, this heat is typically rejected to ambient air. Conventional cooling approaches, such as extruded heat sinks, placed under constrained conditions were insufficient to meet the ever-growing cooling needs of the micro-processor. The computer industry found a solution using heat pipes. Today, heat pipes are used extensively for cooling microprocessors in laptops, desktop computers, high-performance servers, and workstations.

In its simplest sense, a heat pipe is a heat mover or spreader. It takes heat from a source, such as power semiconductors, and moves or spreads it to a region where it's more readily dissipated. The heat pipe moves this heat with a minimal drop in temperature. A typical heat pipe is a sealed and evacuated tube that contains a porous wick structure and a very small amount of working fluid. The porous wick is typically a sintered-powder metal that lines the internal circumference of the tube. The central core of the tube is left open to permit vapor flow.

Each heat pipe has three sections: an evaporator, an adiabatic, and a condenser. As heat enters the evaporator section, it is absorbed by vaporizing the working fluid. The generated vapor travels down the center of the tube through the adiabatic section to the condenser section where the vapor condenses, giving up the latent heat acquired during vaporization. The condensed fluid is returned to the evaporator section by

In its simplest a heat pipe is a heat mover or spreader takes heat from a source such as power conductors and moves it to a region where it is more readily dissipated. Heat pipe moves this heat with a minimal drop in temperature; typical heat pipe is a sealed and evacuated tube that contains a porous wick structure and a very small amount of working fluid.

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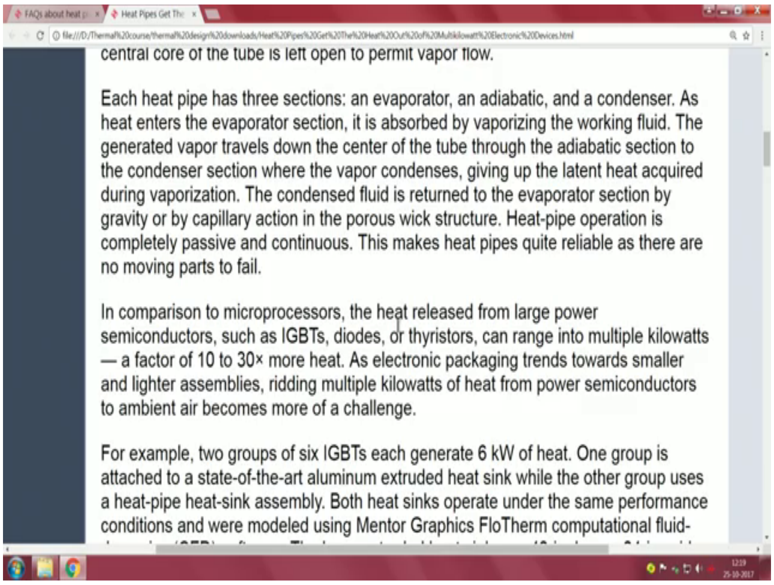

Porous wick is a sintered powder metal that lines internal circumference of the tube; the central core is left open to permit vapor flow an evaporator an adiabatic and a condenser as heat enters and so, on you read it for yourself.

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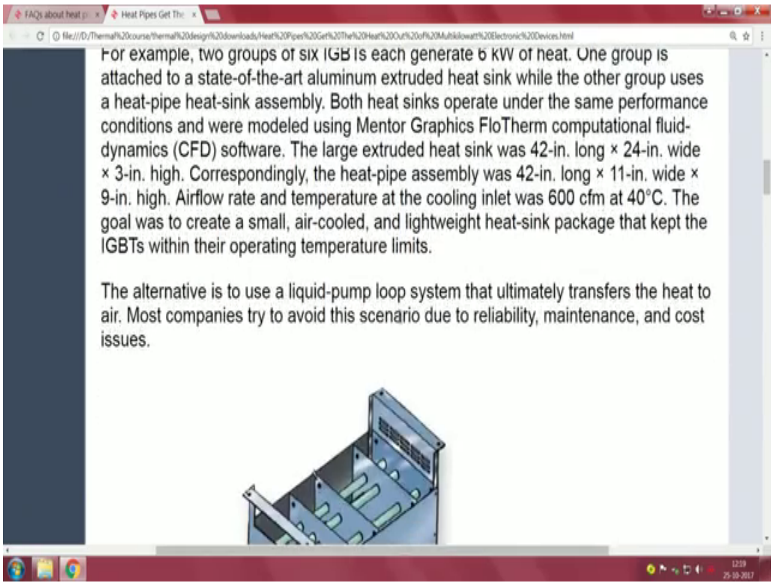

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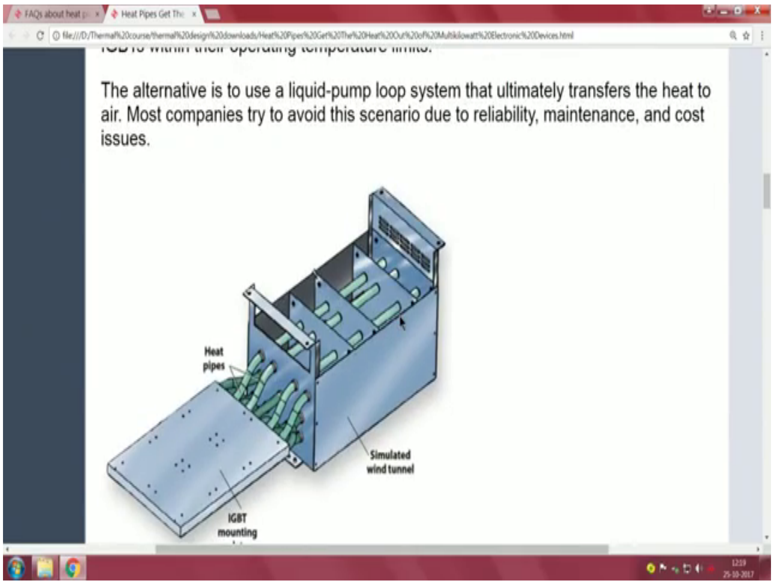

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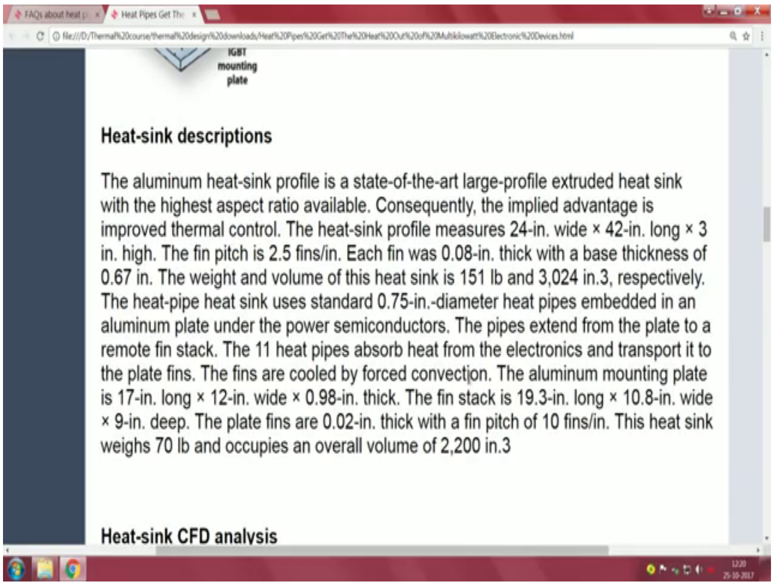

So, yourself you can go to thermal things and see things that have been given here as it is.

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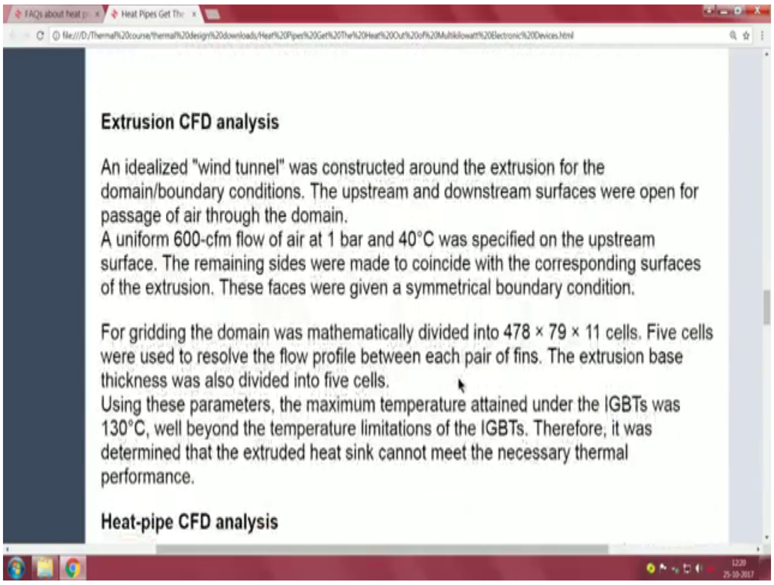

So, lot of analysis has been carried out.

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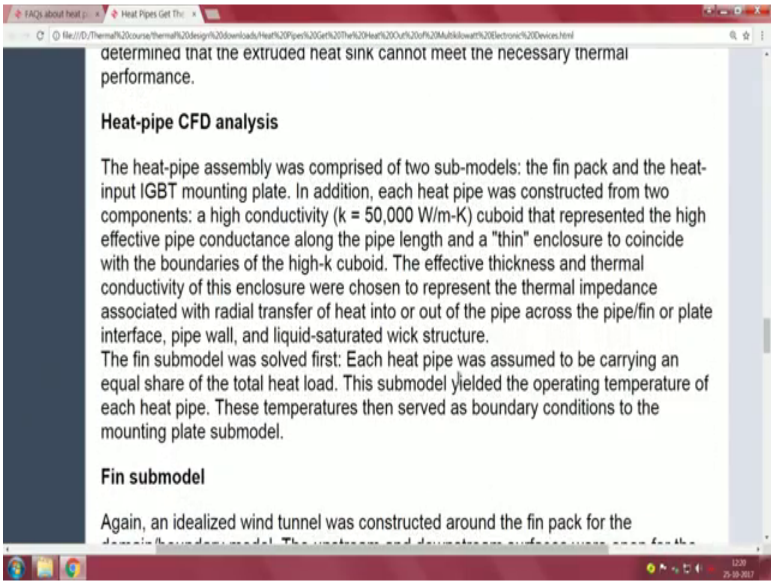

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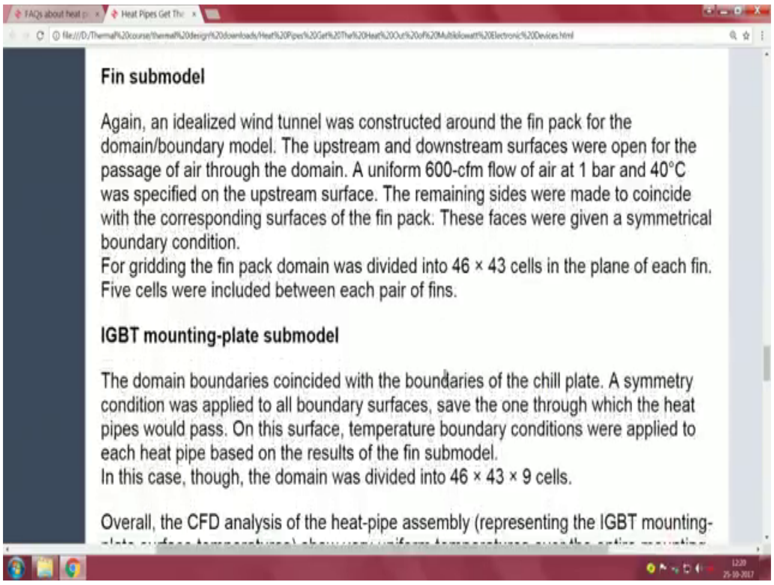

So, it is a matter of I think you know it your leisure you can read things.

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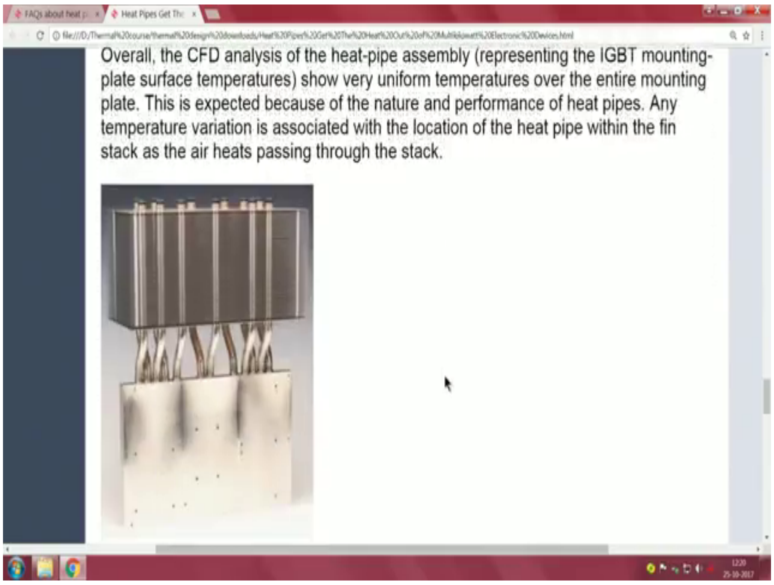

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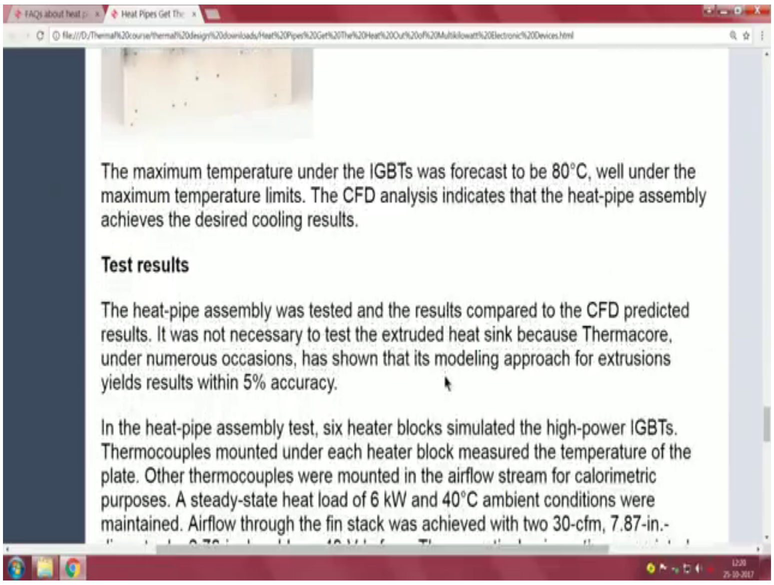

Test results heat pipe assembly was tested compared to the CFD predicted; six heater blocks simulated the high power IGBTs; thermocouples mounted and so on; acoustical noise is a thing.

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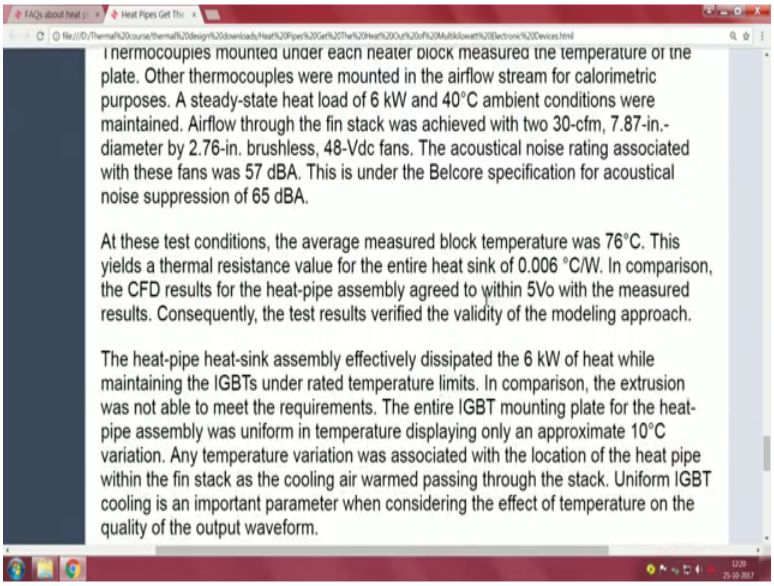

At this stat condition the average measure block temperature or 70 to 76 degrees; this yields a thermal resistance value of the entire heat sink of 0.006 degree centigrade per watt.

So, this is the sort of things which we were talking about all the time.

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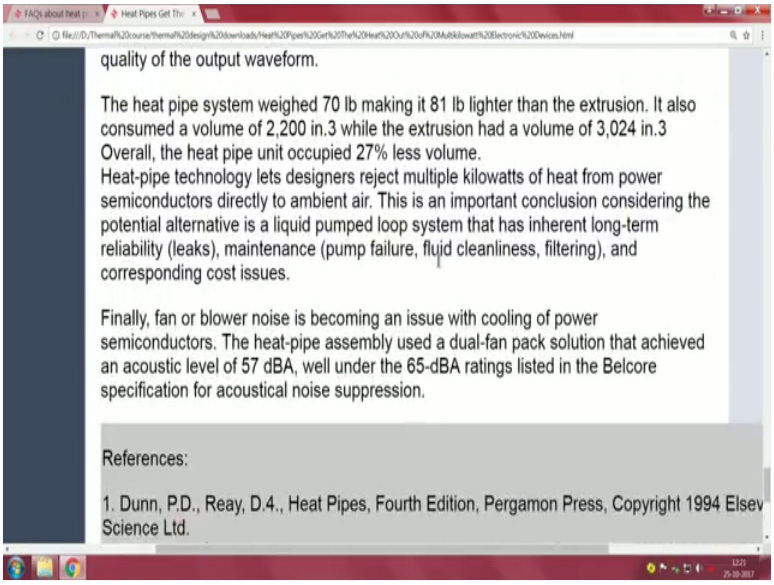

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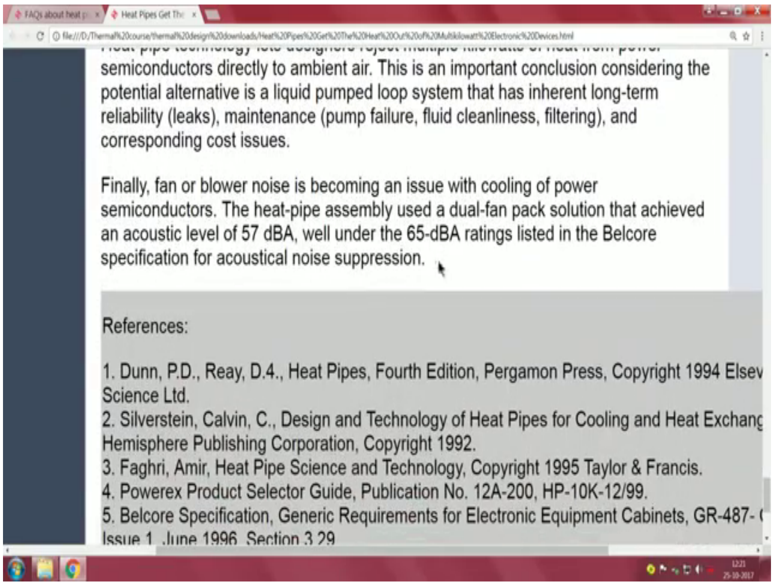

Somebody has made this what do you call presentation; I suggest you can try to read about it.

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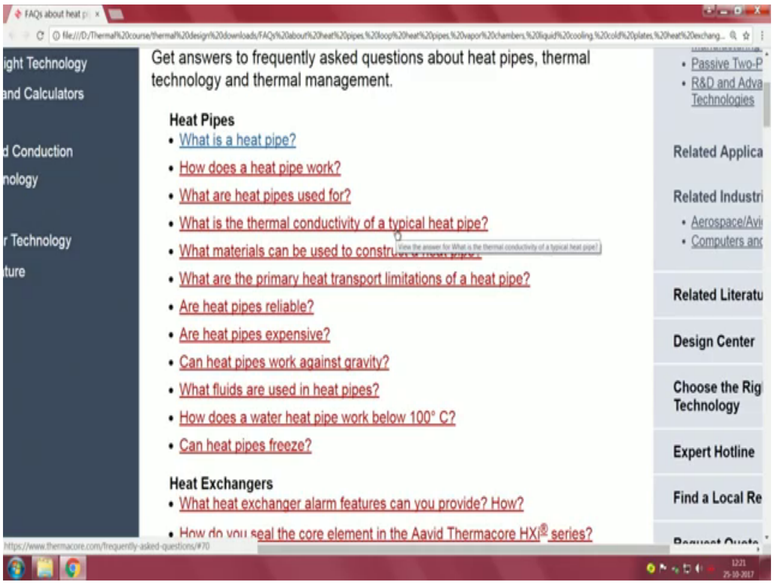

Typically heat pipe work; I have used what is the heat pipe I have showed you what are the used for I mean it is there absolutely.

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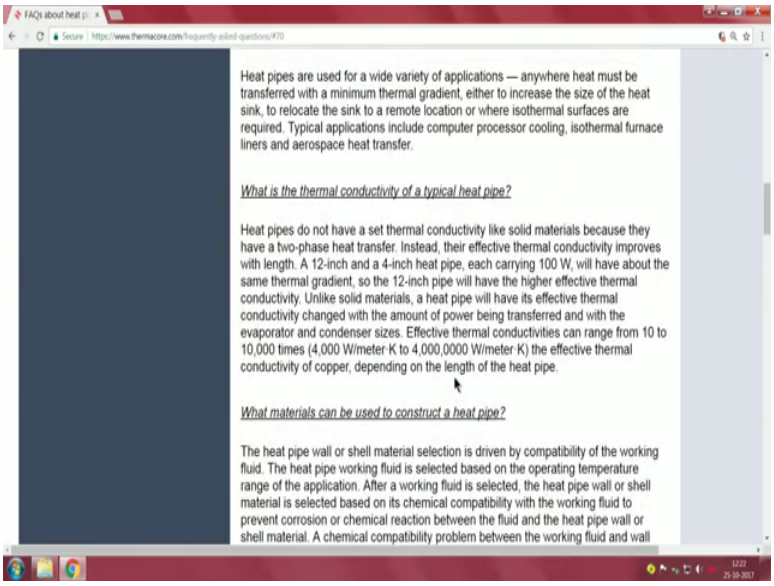

This is a very interesting thing; seen that the intentionally, I wanted to show you in print. Effective thermal conductivities can range from 10 to 10000 times; the effective thermal conductivity of copper. So, figures do not lie these are not statistic; so, they are not you know other type of lives also.

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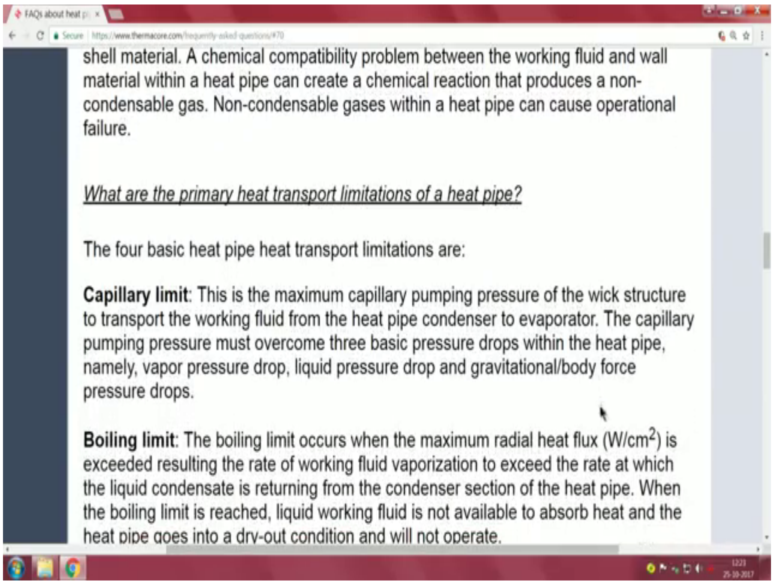

So, we have here lot more what are the 4 basic heat pipe heat transport limitations are capillary limit.

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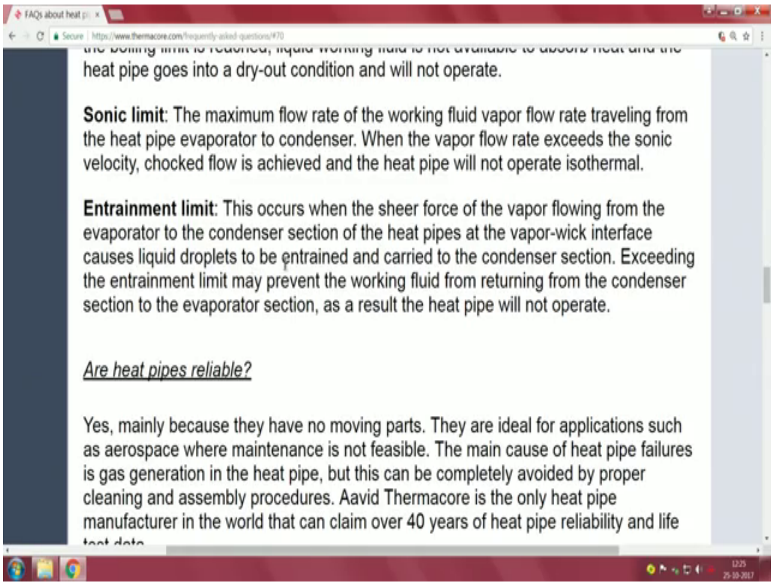

This is the maximum capillary pumping pressure of the wick structure transport the working fluid from the heat pipe condenser to the evaporator. Capillary pumping pressure must overcome the basic pressure drops within the heat pipe; vapor pressure drop, liquid pressure drop and gravitational body force pressure drops.

So, orientation also seems to make a difference; next comes to boiling limit. Boiling limit occurs when the maximum radial heat flux is exceeding resulting the rate of working fluid vaporization to exceed the rate at which liquid condensate is returning from the condenser section to the heat pipe. It is a little like your mud pots there is general I do not know its myth or what do you call nice dream; aerometric dream that if you take a for its pot and then put water into it, it becomes cool.

There are people who claim I find it as called as a refrigerator; that is if you have a good cooling system I mean what you call this evaporative cooling versus a bad what you call normal refrigerator; probably there about the same, but it never can beat a you know power in devise. And the rate of diffusion of the liquid through the; what you call that material of the pot has to match with the evaporative capacity is everything is matched you get the cooling which you are talking about.

So, it involves two things dryness of the air outside and the amount of the air that is flowing and so, on. Same thing happens here rate of working fluid vaporization and liquid condensate returning from the condenser section of the heat pipe. And the boiling limit is reached liquid working is not available to absorb heat; the heat pipe goes into a dry out condition will not operate; it is the whole thing becomes hot and it is not able to this thing what you call operate.

Maximum flow rate of the working fluid traveling on the heat pipe evaporator condenser; and the heat flow exceeds the sonic velocity chocked flow is achieved and the heat pipe will not operate and entrainment.

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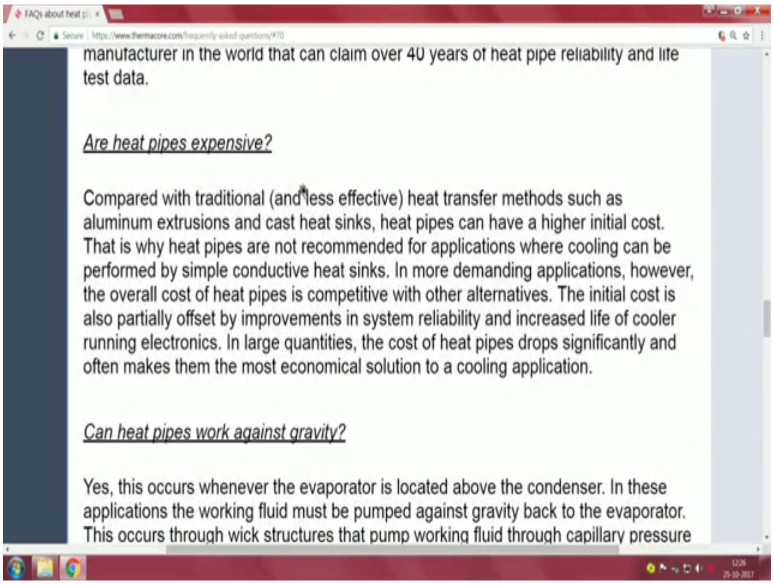

When the sheer force of the vapor flowing from the evaporator to the condenser or the heat pipes at the interface causes liquid droplets to be entrained and carried to the condenser exceeding the entrainment and so, on.

In certain conditions it will not works; so, it is unlikes putting simple copper tube and expending to work. So, at the reliable of course, yes they have no moving parts ideal for applications such as aerospace where maintenance is not feasible. Main cause of heat pipe failures is gas generation in the heat pipe can be completely avoided by proper cleaning and assembly procedures and so, on and so, on are expensive.

Yes, initially they are very expensive to start with as (Refer Time: 13:15) not the design cost and this thing do not simple to design those things. If cooling can be performed by simple conductive heat sinks that is the best way to do it. In more demanding applications overall cost of heat pipes is competitive with other alternatives; initial cost is partially offset by improvements in system reliability and increased life of cooler running.

Large quantities the cost of heat pipes drops significantly and often makes them the most economical solution to a cooling application. Certifically in that what do you call IGBT cooling and all that and I have also shown you in the earlier picture, a game console such places you have a margin in the reality is there.

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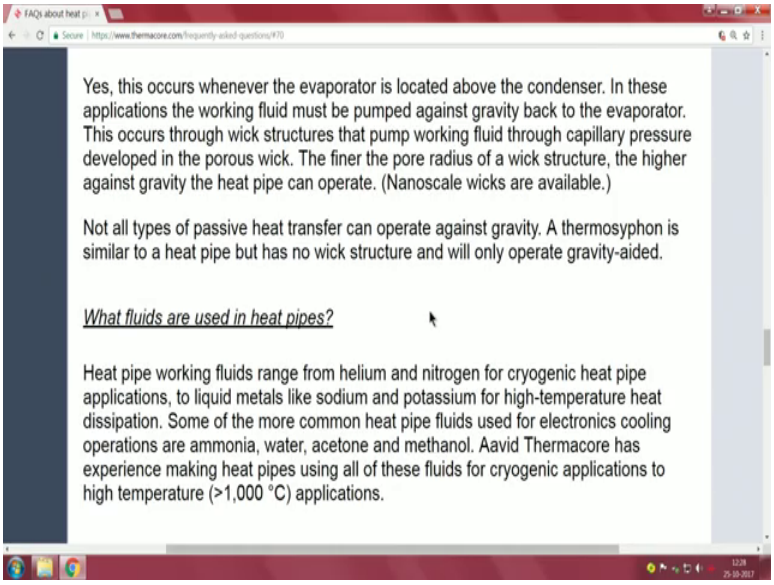

But then remember some of the game places even first liquid cooling is used. And we come to important thing can they work against to gravity are it has to be horizontal. The pictures they have shown there is shown horizontal; in these applications working fluid must be pumped against gravity back to the evaporator. This occurs through wick structures and pump working fluid through capillary pressure; finer the pore radius of a wick structure the higher against gravity nanoscale.

Not all types of heat transfer can operate against gravity; a thermosyphon is similar to a heat pipe, but has no wick structure and will only operated in gravity aided. So, depending on it is natural if the condensing section is on top and the heating section is on the bottom; obviously, it can work if it is upside down it will work slightly you know differently.

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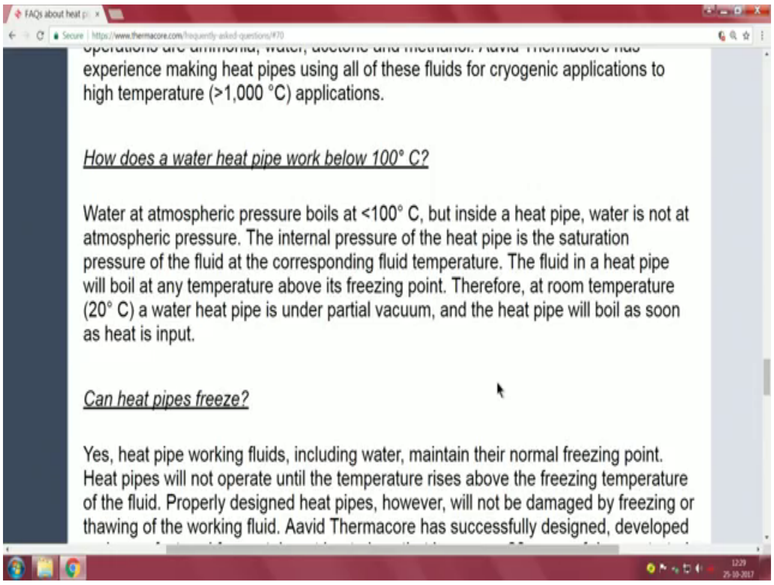

So, we have working fluid helium and nitrogen for cryogenics to liquid like sodium and potassium metals for high temperature heat dissipation; more common heat pipes used ammonia, water, acetone and methanpl. You can make it yourself you go to YouTube I will show you one or two pictures of those things.

What we have is probably normal alcohol that is what you call methyl alcohol. And these are acetone is a common solventer; so, you have mixture of a all these things. So, we have all this stuff here.

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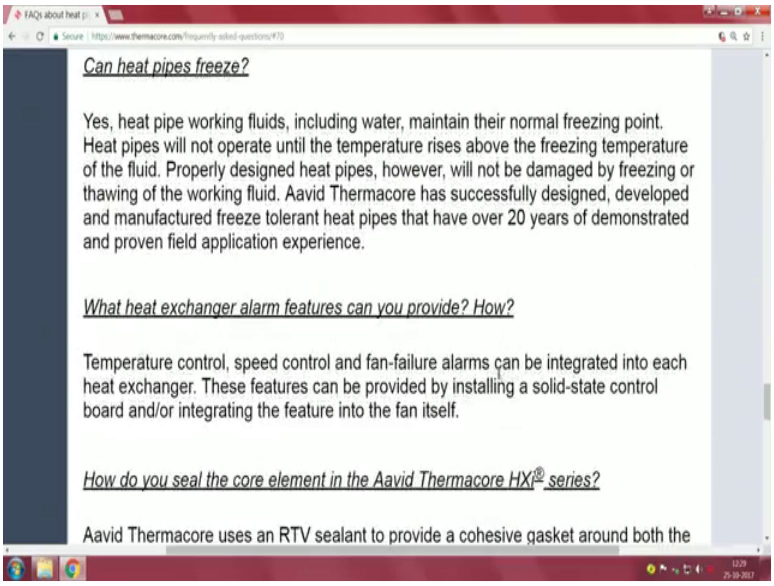

So, all these things if I suggest know we will get back if there is a way of coming back.

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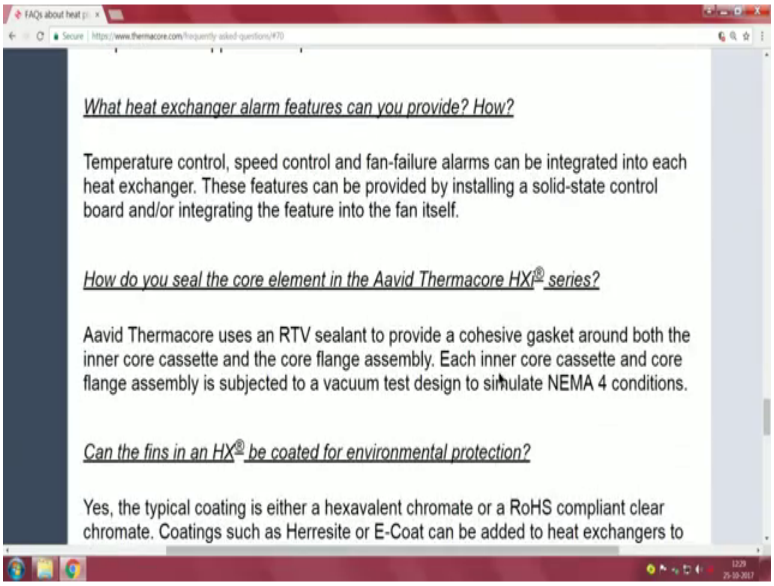

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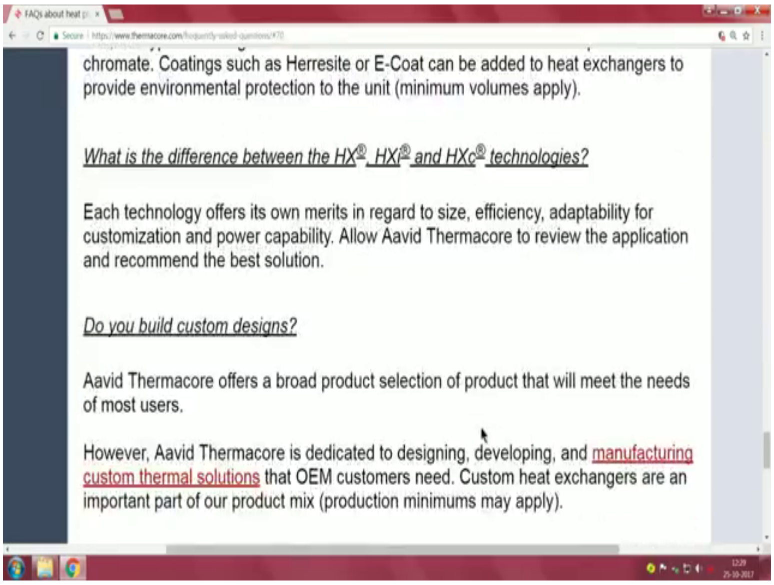

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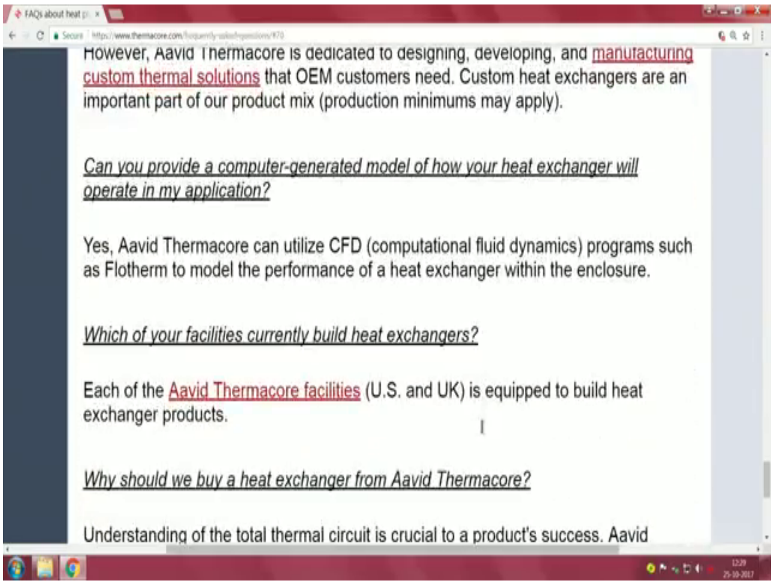

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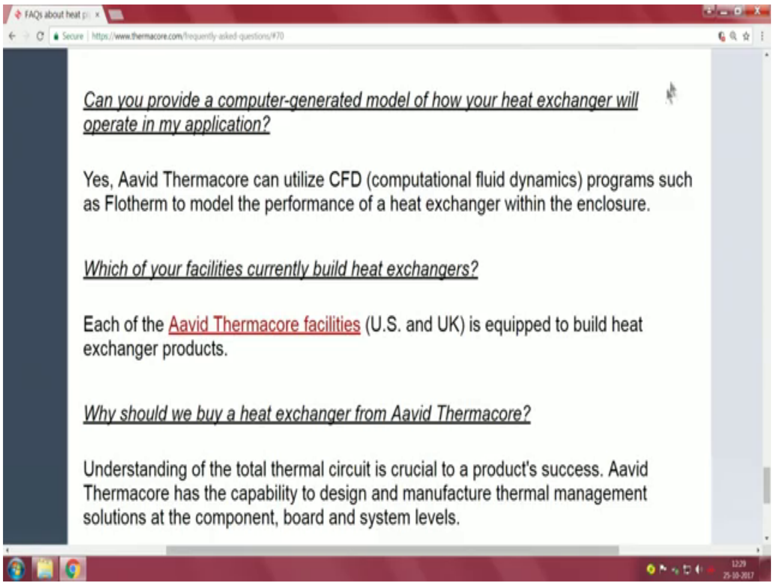

So, we have so, many things which are mentioned here.

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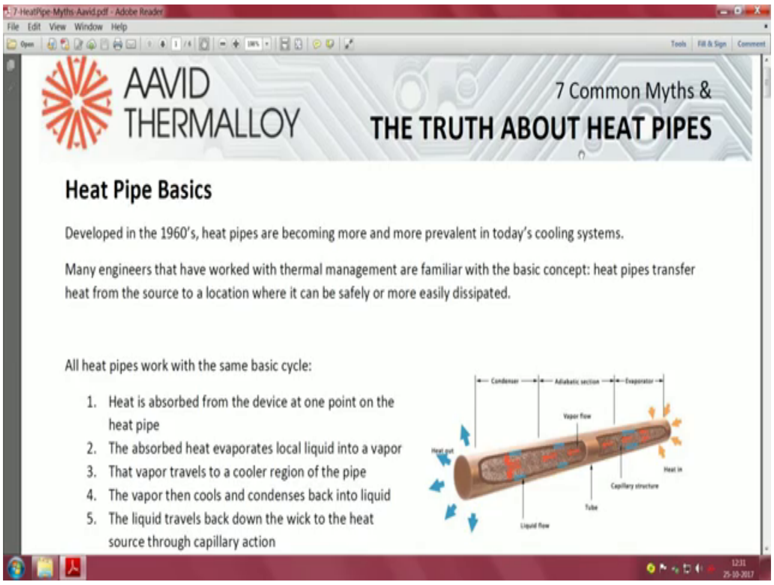

Let me show you a little more about few other things I could not retrieve the thing in time.

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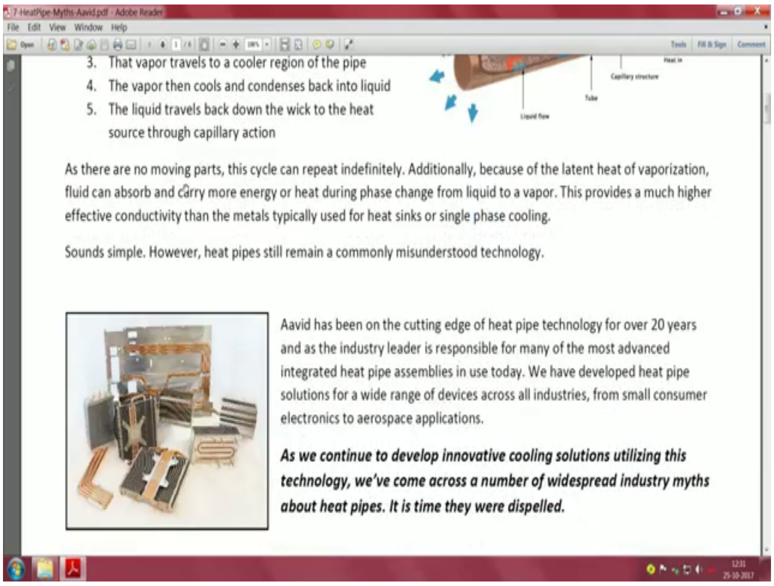

So, these are all basics and you will notice that these are all probably spinners of various what you call government sponsored or things here. So, this basic working and you see here we have beautiful assemblies which have all these things.

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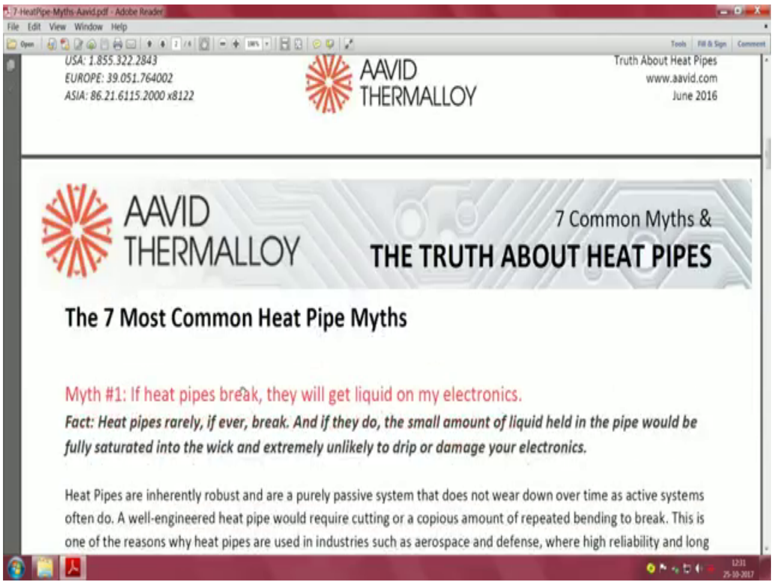

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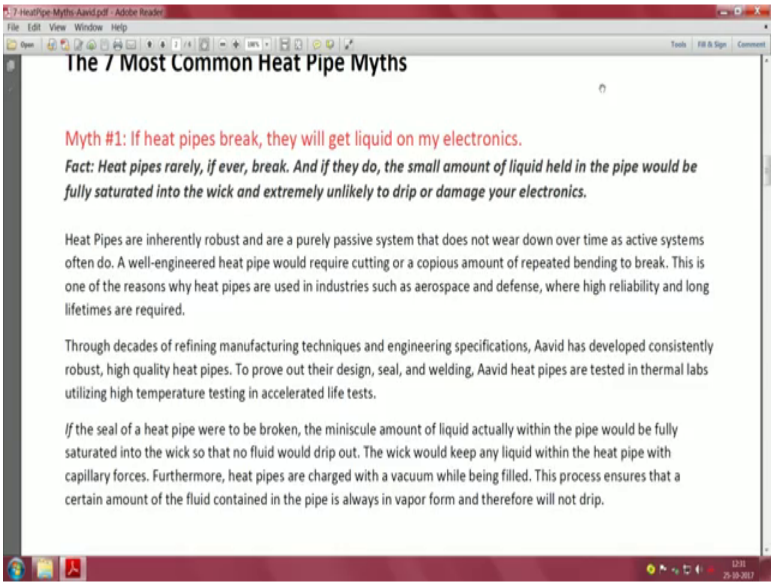

Now, myths I think you should read it yourself; it is not liquid cooling it does not need type of pressure tight what you call design. And it is generally being under vacuum and the moment any leakage comes no liquid will ever come out and likely to short circuit your device as compare to water cooling or other things ok. The miniscule amount of liquid actually within the pipe would be fully saturated into the wicks or now fluid will drop out.

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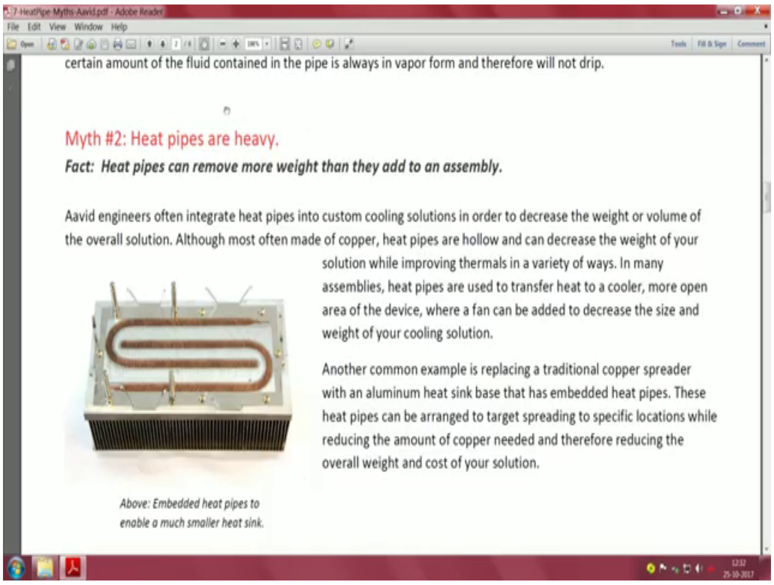

Second myth heat pipes are heavy; the moment you talk about piping you probably you know confess with it plumbing ; not necessary what looks like a simple copper tube with two projections are both ends, the reality is it is not true.

So, if you were use a copper pipe which has the equivalent thermal conductivity and huge heat sinks; that would be much much heavier than a heat pipe; because basic place which we take away heat from that will be small and be working fluid and that will be small. The last heat spreader will be about the same because we need to spread heat to the ambient.

And then the temperature only thing is you have a little bit of control; you make the heat sink run at a higher temperature. The more delta t with ambient that is heat sink surface temperature to the ambient the bet of the heat transference. As I have explained to earlier cold the heat sink is not doing anything it just you know made for the creative purposes. And another important thing is there is a more open area of the device where a fan can be added to decrease the size and weight of your cooling solution.

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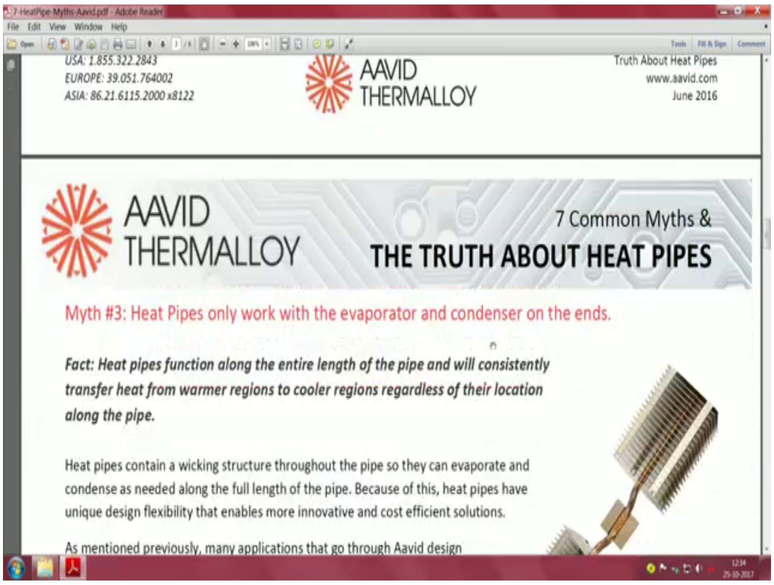

So, if you take away the heat way convenient point then.

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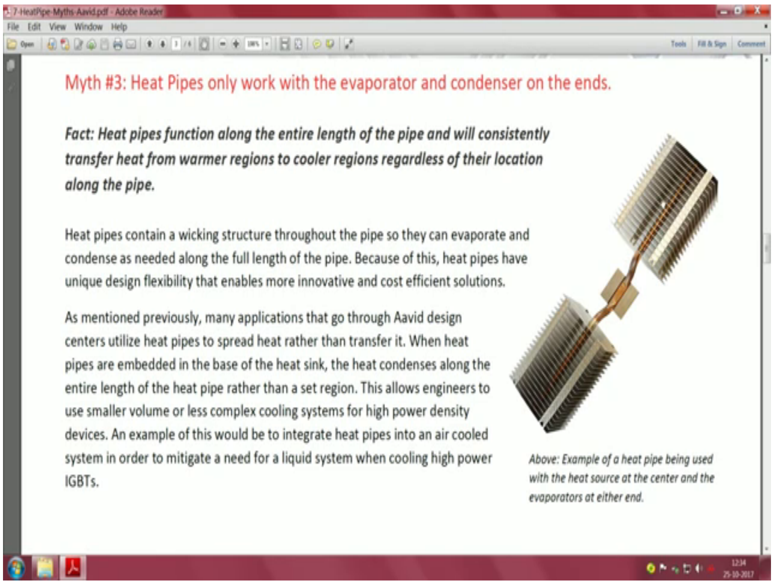

Very interesting thing here; so, far things we have shown are there is a long tube in which there is warm and cold region and hence know it should be long thing. Heat pipes have design flexibility they can have more costeption solutions heat pipe being used with the heat source at the center and the evaporators at both the ends ; you have seen that no? The heat is being spread into two structures; so we have here heat source which you know sends it to the various you know places and where the evaporation can take place.

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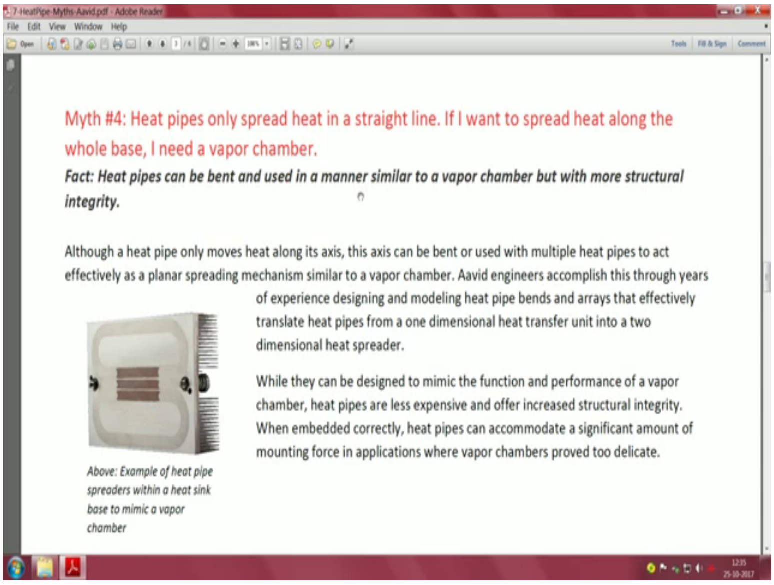

Heat pipes only spread heat in a straight line; if I want to spread it along the whole base I need a vapor chamber. And here it is given here saying heat pipes can be bent and used in a manner similar to a vapor chamber with more structural integrity. Vapor chamber is what elsewhere it will; it is small you know thing which is mounted on top of a chip so, that the you know boiling and condensation can be taking place at the border time. So, we have here a heat pipe which looks little like a vapor chamber.

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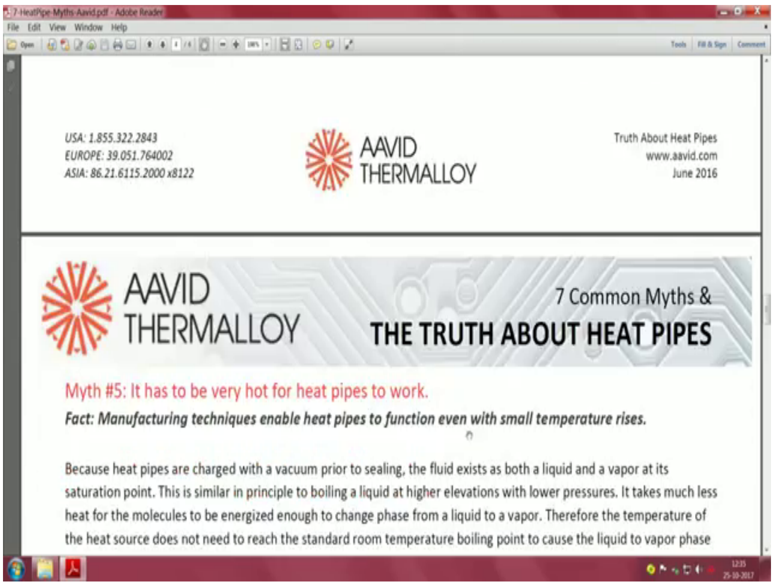

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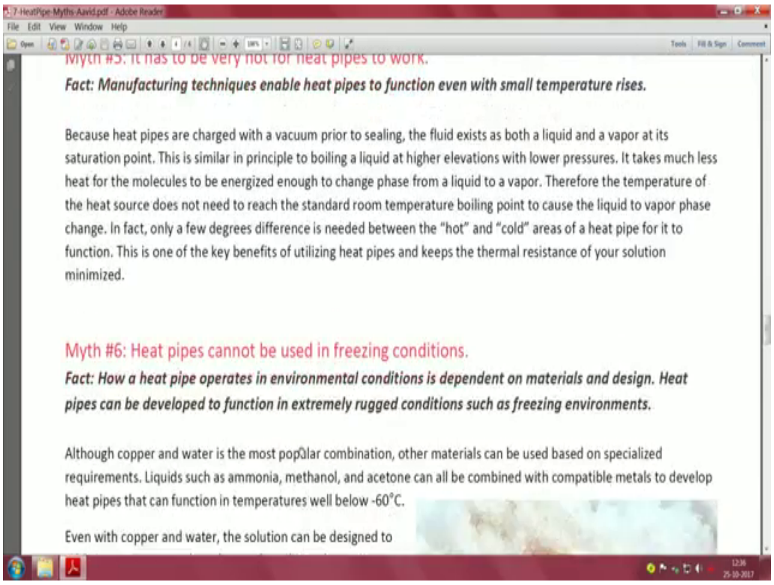

Next it has to be very hot for heat pipes to work; that is another thing which is true in the case of actual simple convective heat sinks, but in the case of what you call heat pipes we have a control of it. The temperature of the heat source does not need to reach the standard room temperature boiling point to cause the liquid to change. In fact, a few difference is needed between hot and areas of a heat pipe to make it function one of the advantages.

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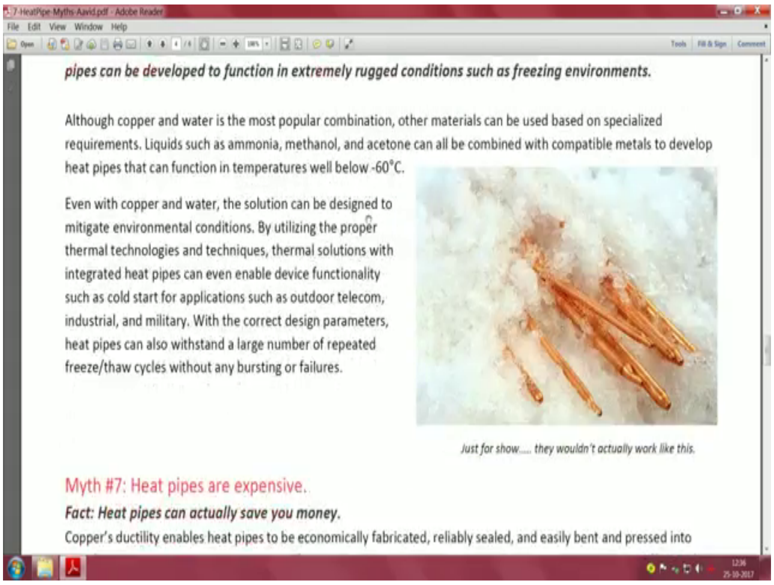

Than heat pipes cannot be used in freezing conditions; how heat pipe operates in environmental conditions is dependent on materials and design. Heat pipes can be developed to function in extremely rugged conditions such as freezing environments also.

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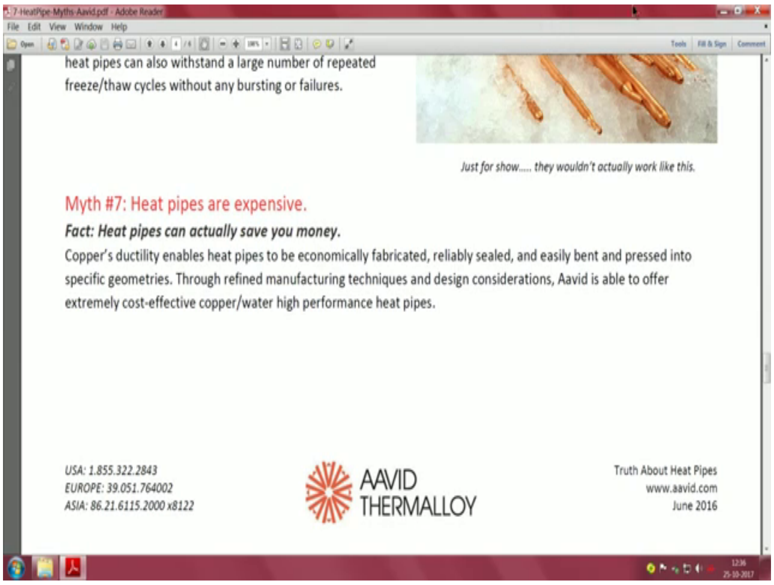

Expensive no because he is the merchant to selling in and for given application, it is not necessarily to be that expensive. We have various options here to worry about are rather know start making things as we like.

Now, I thought I will take you to some links which I have saved. I hope I am able to retrieve it here, it has to connect to the, what you call internet. So, one of our Professor Das Gupta and Doctor Somanath Gangully of IIT Kharagpur, they have made this video and some reason it does not seem to be loading fast enough.

So, next round when I get a chance I will oppose this links to you. And I am sure you will be able to retrieve these things and show them how well they work. So, at this point probably I will give a break and we will try to get back and see how best we can; there are some problem with the there is some problem with the video, I am not able to show in eventually I will show it. So, thank you after I download the videos; I will try to show you so.

Thank you for a while now.