Heat Exchangers: Fundamentals and Design Analysis
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Lecture - 25
Plate fin heat exchanger (Contd.)

Welcome to this lecture, as we were continuing with the fin types, we are talking about the plate fin exchanger geometrics. And we were we have shown you the different type of fin geometrics possible; we have talked about the plate fin, a plain rectangular fin, we have talked about the trapezoidal fin. We also talked about the offset strip fin, where we found that it is giving extended heat transfer surface area not only that it is giving also or it is I mean simultaneously trying to extend or enhance the heat transfer coefficients.

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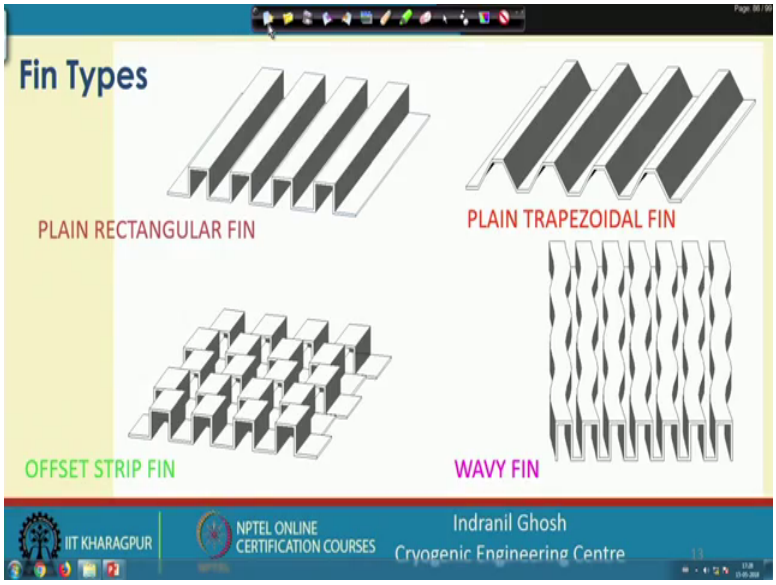

Than we have talked about the wavy fin, where we found that it is the continues fin, but at the same time the geometry of it is such that it is giving breakage in the I mean boundary layer at a regular interval of time, we will have look into it in details in the next slide.

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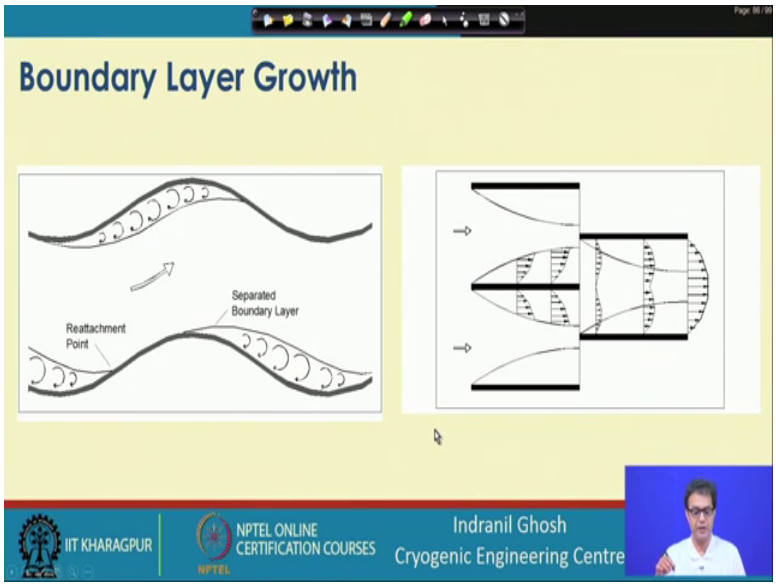

So, here as we were telling in the previous line that we have this is offset strip fin. And this is the other one the other one is the wavy fin as you can understand from the geometry of, this is the geometry of the fin this is the fin passage. And we have this flow taking place in this way. So, when the flow is taking place, we will find that at point there is a separated boundary layer is getting separated at this point or at this point. And there are breaks at this region and again it will joint the reattachment point at this layer. And in this case where we have offset strip fin the flow is taking place and the flow I mean is getting developed up to this part and there is a fresh generation of the boundary layer at this point and this point.

So, in every regular interval as I told you that this is the lands length called l, lands length we have at regular interval there is a generation of this or breakage of this boundary layer. And as a result we find that this boundary layer is regularly getting interrupted at these locations resulting in enhancement is the heat transferred at the cost some pressure drop penalty. So, in this one the pressure drop penalty is bit less as compare to this side, but we have I mean particularly when we go for the very high heat transfer, it will look for this offset strip fin. And this is in regular use in different kind of plate fin type heat exchangers.

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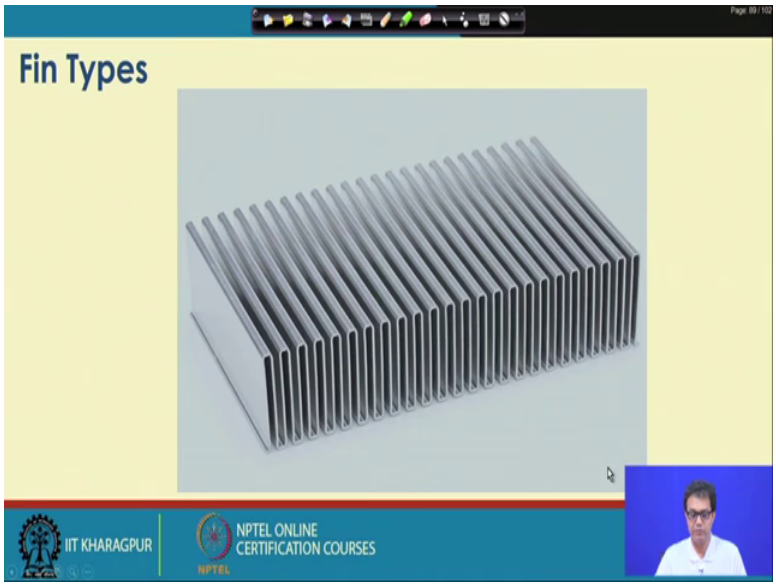

So, again these are some of the pictorial view. This is the plain rectangular fin how it looks like as you can understand that there are several parameters of the plate fin types, where you will find that this is the fin height. For example, this fin height, this fin height can be varied. Similarly, the thickness of fin you can understand that this if someone is making a fin of with thinner one or thicker one, at the same time the fin frequency, I mean the number of fins per unit meter or per inch, some time we call it fin frequency or the number of fins per inch and number of fins per meter. So, that is another parameter that will tell what is the kind of passage fin passages we have. So, 20 ppi, 20 fins per inch or in a 25 fins per inch or 32 fins per inch is the typical language we call for this type of fins.

And fin thickness as you can understand that these are the type of I mean parameter we look for or we have the options, particularly a designer will have options to chose from different height of fin different, fin frequency or different fin thickness and that will change the heat transfer coefficient for different type of fins. So, this is the plain rectangular fin.

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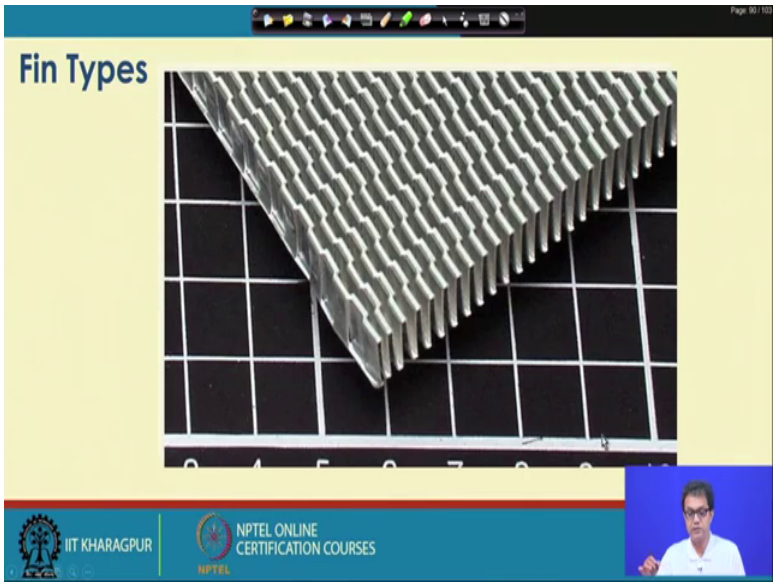

And then we go for the next one here we can see this is the serrated fin or offset strip fin. Here I mean this offset strip fin is also called serrated fin, serrated fin or offset strip fin it is often called. And this often we can go for as you can understand that this flow is coming here getting divided and then a part is taking a flowing through this one, then other part is continuing in this passage. So, this is the regular flow passage, sometimes orginally very rarely it happens that if the flow can taken place on this direction also, this is called the hard way configuration. We call it the hard way configuration. And so but generally you know this is not the obviously, you can understand that the friction factor or the friction will be much higher in this configuration.

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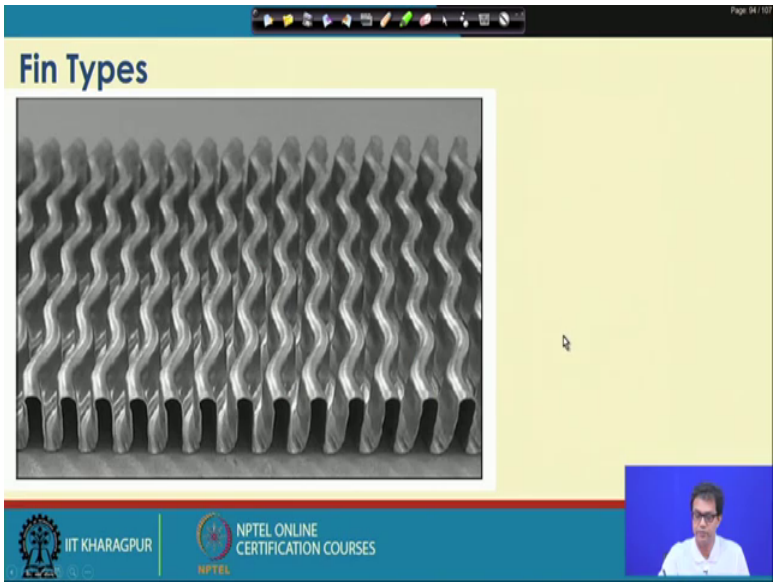

So, now, another type of geometry is the wavy fin here this is uninterrupted fin as you can understand that the fin is the fin passage is like this waviness gives. Often, there is another type of fin very similar to this one it is called the herringbone fin or this is sometimes it is if the geometry is smooth it is the wavy fin type.

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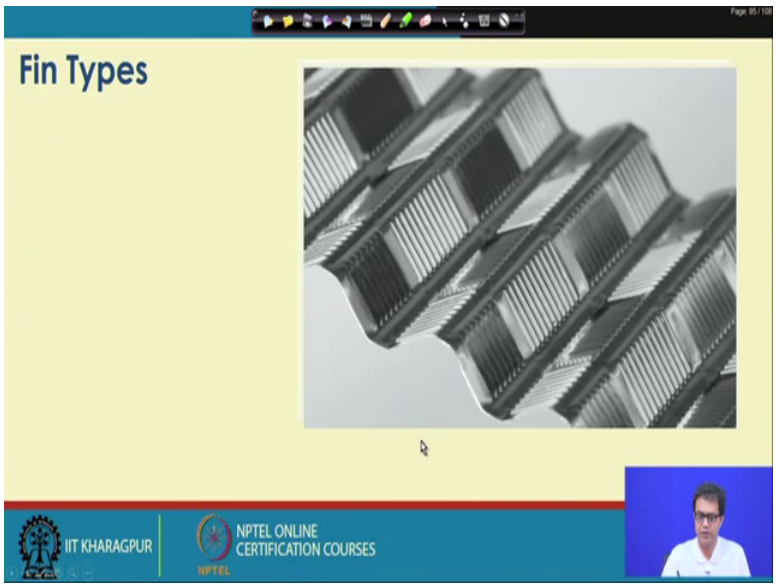

So, now, we have another this is another fin type it is called the (Refer Time: 07:19) fin. So, here what we have up to certain interval of time, if it is a rectangular geometry or say

if it is kind of trapezoidal fin geometry, then you have after certain interval of time you have this kind of opening. And similarly this lowered angel will change after cretin time.

So, if it is on this direction, then it is on this direction, so that means, both this way and that way both the way the fluid can flow thought. So, if we look at it on this direction, say there will be this kind of flow passages, there will be this kind of flow passages, I mean this channels will be like this and as well as like this. So, it will have chance to move from this way and this way and this way. So, this is called the lowered fin. So, this is also is in regular use in different type of plate fin heat exchanger geometrics.

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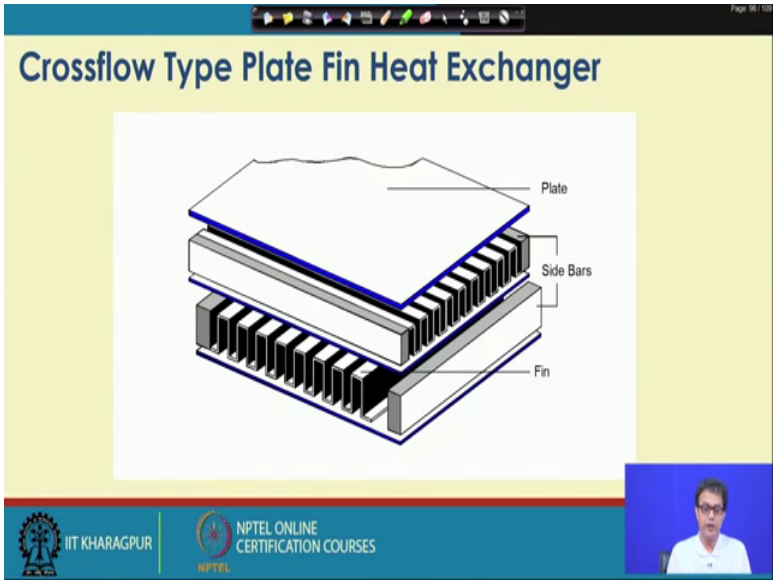

So, now, we are again coming back to the construction of the plate fin type heat exchanger. In case of cross flow type plate fin heat exchanger easily it is easy to understand that we have discussed in the last class that we have two channels through which one fluid is flowing in this direction and the other fluid is flowing in this direction. So, this fluid is flowing in this direction, and this fluid is flowing in this direction. So, they are at rectangle at an angel 90 degree to each other. And this geometry is easy to concept and it is easy also easy to fabricate. Just we have to arrange the side bars and the separating plates and the fins one over the other in a jig. And then we have to assemble them and you have to get it bridged, so that gives you the heat exchanger matrix of the core of the heat exchanger.

But is it that we always go for the cross flow type of heat exchanger in plate fin type of heat exchangers? The answer is obviously, no, we do not go for always go for the plate fin I mean cross flow type of heat exchanger the countercurrent or the parallel flow heat exchanger or cross counter current of heat exchanger or diffident geometrics whatever it is I mean we have learned about is possible with the plate fin type heat exchanger. So, we have to look how it is being constructed.

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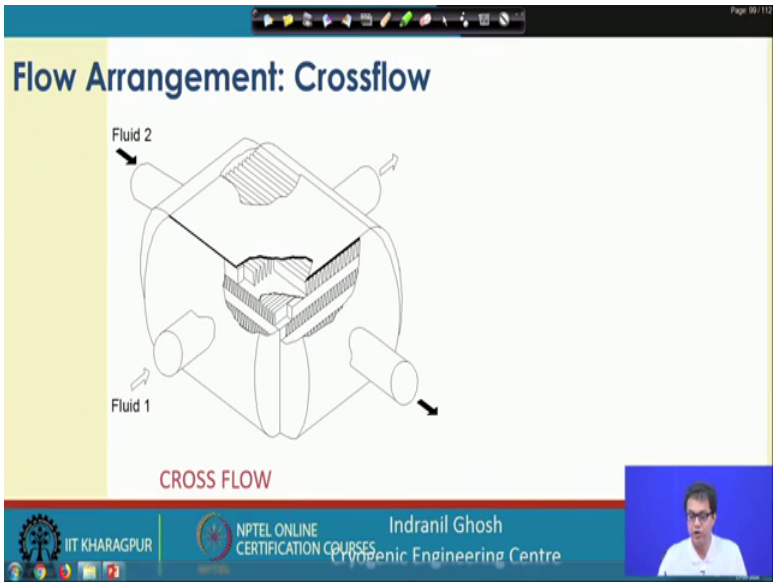

So, in this one this is the typical cross flow heat exchanger arrangement. Now, first of all if we look into this particular geometry, there are cretin things we need to I mean the nomenclature we need to follow. This is the pipe through with the fluid is flowing in, this is the cross flow heat exchanger, this is the two fluid stream cross flow heat exchanger, there is fluid 1 and there is fluid 2. The fluid 1 is flowing through this channel this channel and so on. And when it is flowing through this channel you can understand that the corresponding you know side there will be side bar. Say if it is flowing there is a side bar on this side and this is the primary heat transfer surface area and this is the fin.

And this is the end plates. So, the two plates at the two extreme end are the end plates. So, this is end plate at one end; there is another end plate at another end. This is sometimes called end plate or it is called the cap plate. So, in between we have the different layers. So, this is say layer 1, we have some type of fin and then we have another layer say may be you know it is triangular fin. Then we have another say this

one, then we have this rectangular one and then we have the wavy fin. Though it is not in cross flow configuration it will not look like this I mean this corresponding layer will be like this and that will be similar and here this is blocked. So, you cannot see anything from this end.

So, like that if we have this arrangement this is easy to construct as I have said. But at the same time we can also go for the other construction, we will come to that part soon. So, here we have the headers, this is the header. So, the fluid is coming to the header, it is getting collected and then it is going to the individual channel designated for the fluid 2 or the fluid 1. So, this is the header for fluid 1 and this is the header for fluid 2. This is the incoming fluid, this is the exit fluid. And again you know the fluid will be collected in this header and then this fluid 2 will come out.

Similarly, all the fluid will be first accumulated in the header then it will be getting distributed to the individual channel then finally, they will be collected in the outlet header and then it will move out. So, that is how this cross flow heat exchanger plate fin cross flow heat exchanger looks like.

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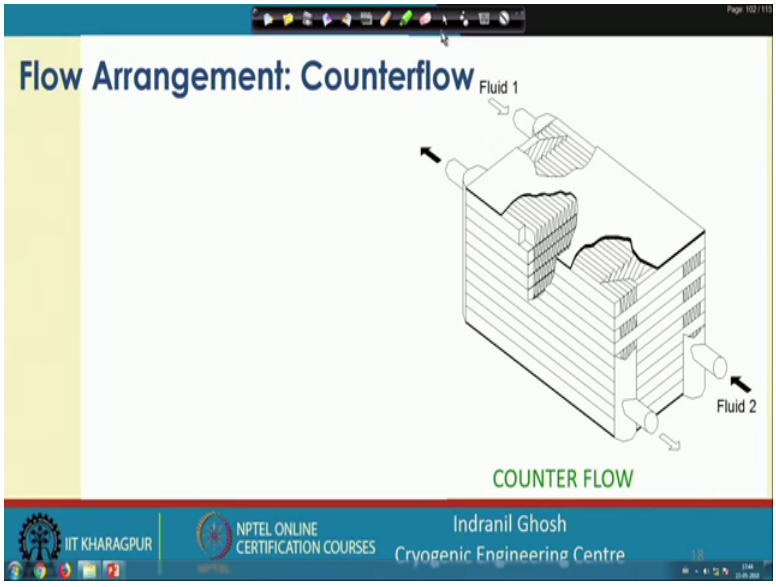

Now, we will quickly look into the design of the counter flow heat exchanger. Now, as you can understand that both the fluids have to enter from you know in one layer this fluid has to go on this side or in countercurrent exchanger the next fluid has to come on the other side. So, what we do is that what we put here is a kind of distributor. So, here

the fluid is entering from this end, this is say for fluid number 1. Say fluid number 1 is the entering from this end it is coming over here and as you can understand this is getting distributed and coming like this and then it is coming like this and coming out finally, this way.

So, what we have if we take out this one like this way we will find that we have this path then this geometry it is this is the distributed, we have different kind of distributors and then it is getting like this. And then again it will be collected finally, and then it will be coming like this. This will be this and then we have this kind of distribution on this side, this kind of distribution on this side. So, this is how it is getting distributed. So, this is what is having in one layer. So, the very next layer, what you will find is that another layer this is how it entered, and how it has come out. This is one direction.

The next fluid - the fluid 2, it is entering in next level. So, in the next level, you will find that this fluid is entering this is entering from this end. This was designated for the first one this is for the second one and it will entered like that and again it will find some kind of distribution their and then again it will be channelized like this and it will be channelized like this. So, between this two regions, you will find that their this two fluids fluid 1 and fluid 2 are flowing either parallel or counter parallel to each other, so that is what is the counter flow arrangement. And we have the distributed fins at the entry at exit. And we need to carefully designed that distributor for this countercurrent heat exchanger. So, when it is two stream countercurrent heat exchanger, we have this kind of distributor.

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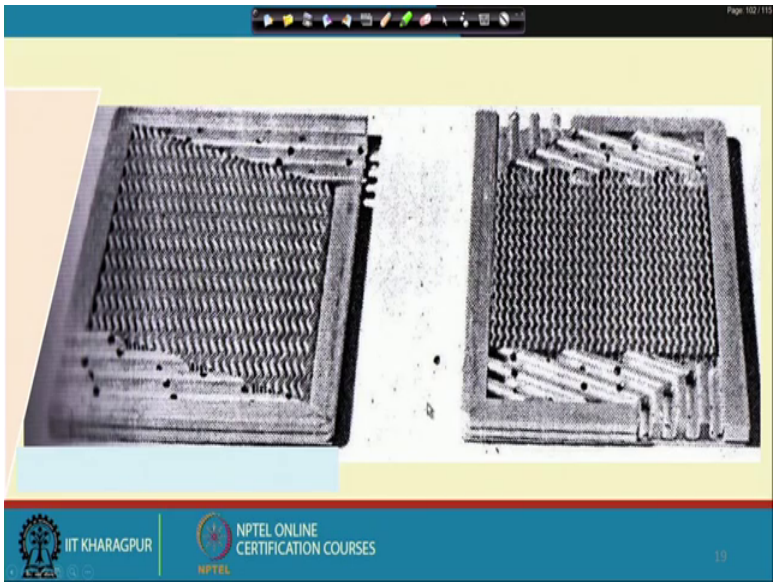

There are different type of distributors. So, here comes the some view of the distributor. Here you can see that this is the kind of perforated fin the in one layer the fluid is entering like this then you know it is coming like this, and finally, it will move out from this direction. So, one fluid just on top of it where is the side bar, these are the side bars. So, this fluid is only you know able to come out from this angel and it will come out from this end. So, this is the direction of the flow, this is where it will enter, this will follow this path then it will come out from this end. What is about this one just on top of it, if we put this one it will come over here this will come over here this will follow this path and then it will come out and this is finally, coming out on this side.

So, if we just superimpose on top of this, this two layers, if we put one top of the other, so here we will find that one fluid is entering from this end the other fluid is entering from this end. So, but they are not mixing with each other, but they are constructing a kind of this fluid flowing in this direction this fluid is also in this direction. So, this is constituting a kind of parallel stream heat exchanger. But instead if we say that one fluid is flowing in this direction and moving out on this direction, and if we allow another fluid to enter from this end, if we allow it to enter from this end allow it to go like this, and then it comes out here getting distributed over here and moving out. So, now, if we superimpose one over the other we will find that it is constituting a kind of countercurrent plate fin type heat exchanger.

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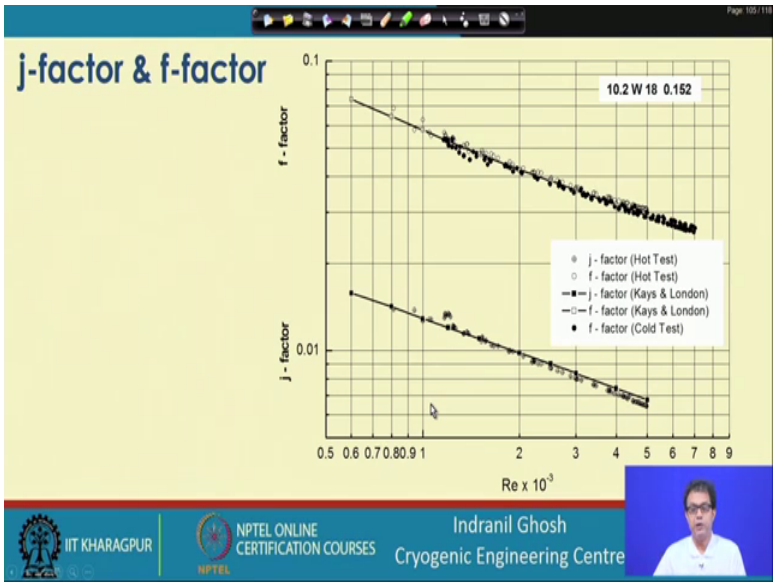

So, next is the about the j and f-factor of heat transfer pressure drop correlations that is to be determined for each plate and then we will go for the actual analysis of this kind of plate fin type of heat exchangers. We will talk about this in details about how do we determined this j-factor and the f-factor. This cold one j-factor and f-factor this is particularly for a wavy fin of 10.2 height then W is for the wavy fin. 18 is the fins per inch and 0.152 mm is the thickness of that fin. And we have different kind of j-factor and pressure drop relation for the plate fin wavy plate fin. So, these are the kind I mean for each fin we will have a different kind of characteristics like the heat transfer and pressure drop. And we have to look in to this kind of pressure drop and heat transfer co relations for these fins before we take up the heat transfer analysis.

Thank you, thank you for your attention.