**Science of Clothing Comfort**
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**Lecture – 35**
**Moisture Transmission & Clothing Comfort (contd.)**

Hello everyone. So, we will continue with the Moisture Vapour Transmission Measurement. So, earlier we have measured we have discussed several method some measuring the moisture transmission through textile material. And, now we will discuss the method which is sweating guarded hotplate.

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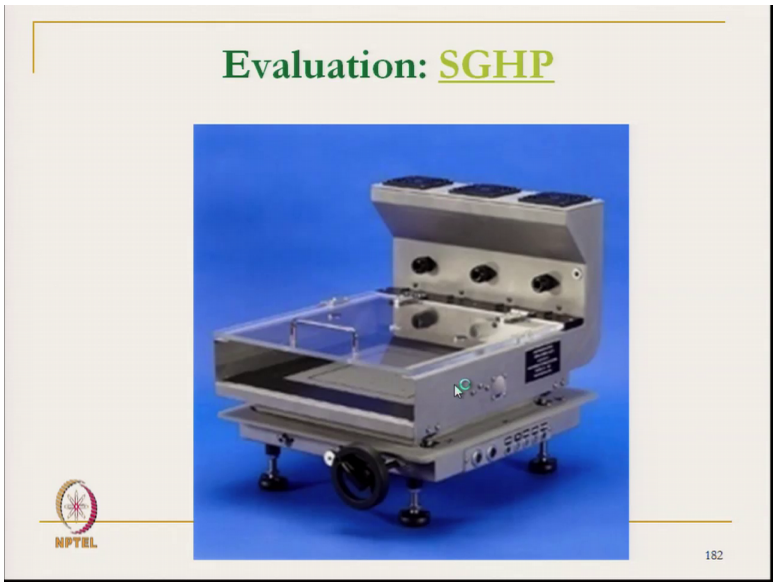


So, this the same instrument which we have discussed earlier the principle is same which is guarded hot plate and let us try to see once again the principle of guarded hot plate.

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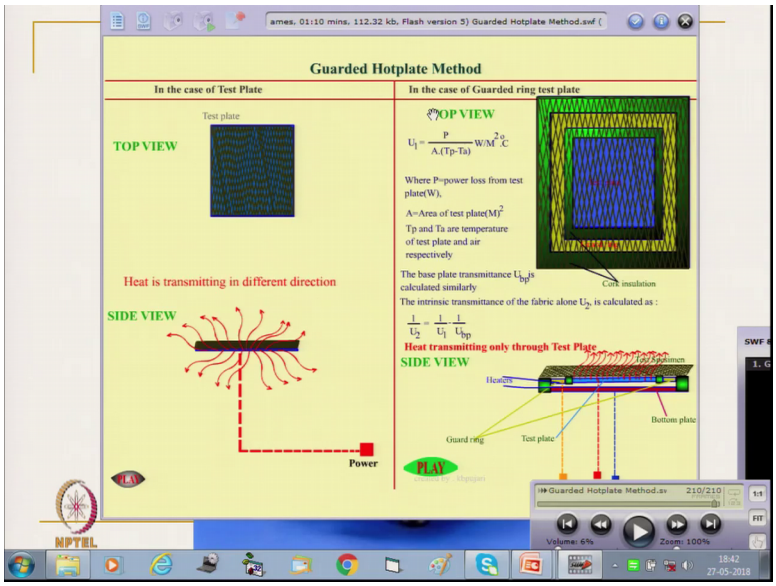


The principle here we have to control the heat flow through the hotplate. So, that heat is not only the heat flowing through the fabric is measured. So, this is the normal case, normal plate it is the side view, it is a top view. Fabric is placed on the plate test plate and test plate is connected to the power source and as soon as its (Refer Time: 01:30) switch is turned on the heat will start flowing at different directions. So, that means, what we actually want to measure the heat flow through the fabric. So, for that to restrict the heat flow other directions that side way and bottom way we have to use some guard ring, we have to use some insulator.

So, this is the top view and this is the side view of the test plate, this is a insulator guard ring is placed and this is the bottom plate fabric is placed over that. So, though both the guard ring and bottom plate and test plate they are heated at the same temperature. So, that no temperature gradient is there and so that the heat is transmitted only through the test plate and fabric sample. And, accordingly we can measure the heat transmission ok. But, in sweating guarded hotplate the principle of measurement of heat transmission remain same. And, in addition to that here the water is being supplied and the plate here it is not the same similar plate, here the plate is a perforated plate. So, it has to actually it simulates the sweating, the principle remain same.

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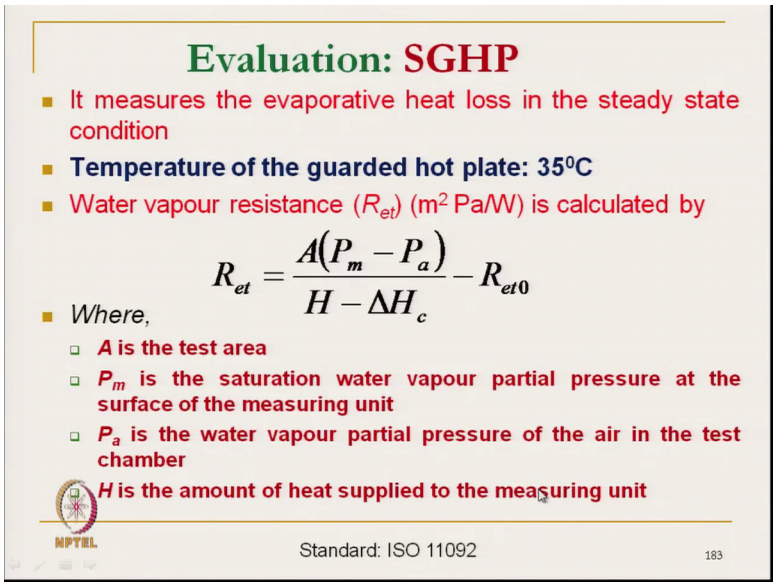


So, the sweating guarded hotplate here: it measures the evaporative heat loss in the steady state condition. In guarded hotplate it measures the thermal transmission heat transmission ok, here evaporative heat loss is measured. So, when the moisture gets transmitted, how much heat it is taking away. So, that will give the idea about the moisture transmission. The temperature of the guarded hot plate is kept at skin temperature which is very important. So, that has to be kept constant here, the water vapour resistance: the total water vapour resistance is calculated. So, that this R et it is water vapour resistance, it including the air layer. Fabric layer and air layer it is actually expressed in terms of meter square Pascal per watt. So; that means, the in terms in terms of heat transmission it is measured.

This is the equation where A is the area and P m is the saturated water vapour partial water vapour pressure of the measure unit; that means, measuring unit is the saturated condition that water vapour is P m and P a is the partial water vapour pressure of the atmosphere. So, this is the water vapour pressure difference and H is the amount of heat supplied for evaporation that is the H and delta H is the correction factor of that and R et 0 is the evaporative constant of the instrument. So, this is the total system.

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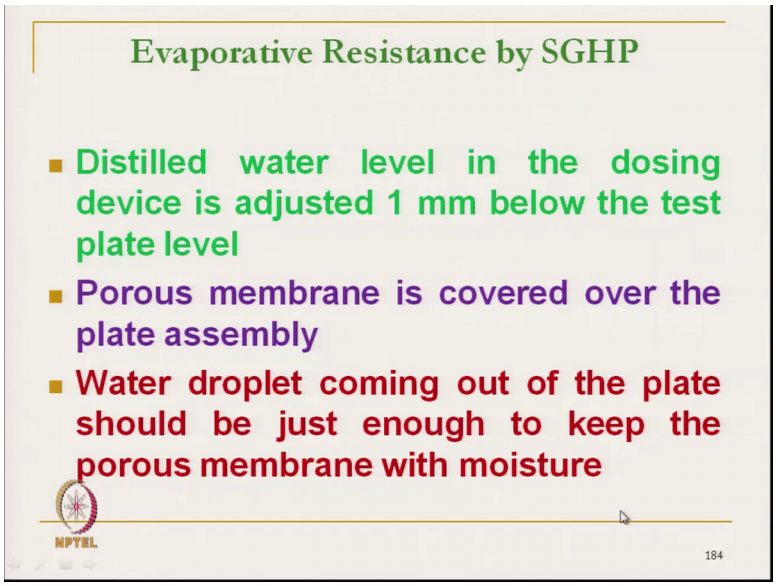


Distilled water level is the dosing unit is there dosing device is there, it is actually depth is adjusted 1 millimetre below the test plate. That 1 millimetre it will be actually the test plate with will automatically siphon that length. It is otherwise, if it is not kept below that. That means, it will be flooded the test plate we do not need the test plate to be flooded. Only the moisture in vapour form will should get transmitted.

The porous membrane is covered the test because, the test plate sometime if it gets wet the fabric should not get wet. That that membrane should be porous because, it should simulate the skin, that is moisture in vapour form it should come out and over the porous plate fabric sample to be tested is placed. Water droplet coming out of the plate should be just enough to keep the porous membrane with moisture, it should not wet the fabric should not get wet.

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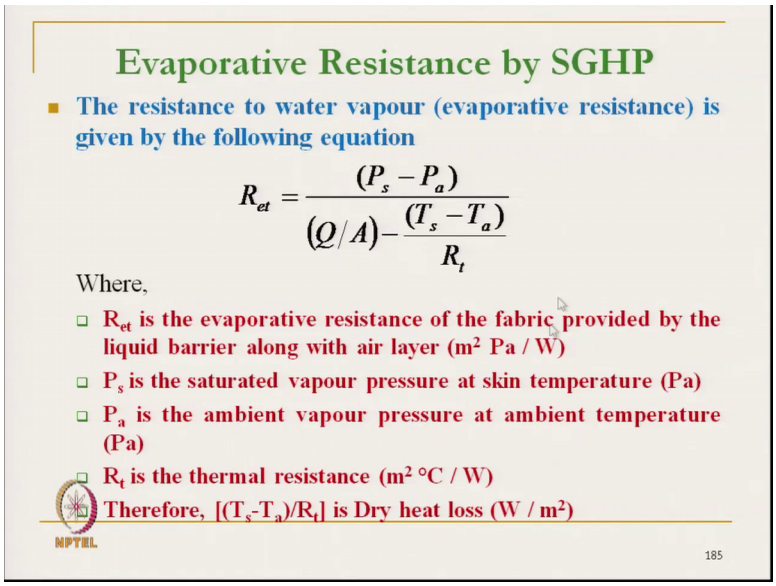


The resistance of water vapour that is evaporative resistance is calculated based on this equation, that we have already seen this equation where Q the R et is the evaporative resistance of the fabric provided by the liquid barrier along with the air. So, R this is the evaporative resistance of fabric along with the air. And, P s is the saturated vapour pressure of the skin that is the saturated vapour pressure. P a is the atmospheric vapour pressure ambient vapour pressure, R t is the thermal resistance.

This is the thermal resistance of the; it also measures the thermal resistance here and therefore, R s minus T s by R t is the dry heat loss. So, it is actually the dry heat loss and here it is a wet heat loss, it is a total heat loss here. So, here we if we a total heat loss and if we subtract from the total heat loss, it is the heat loss due to the heat loss for the evaporation. So, that total evaporative heat loss is this one and by the pressure difference is there.

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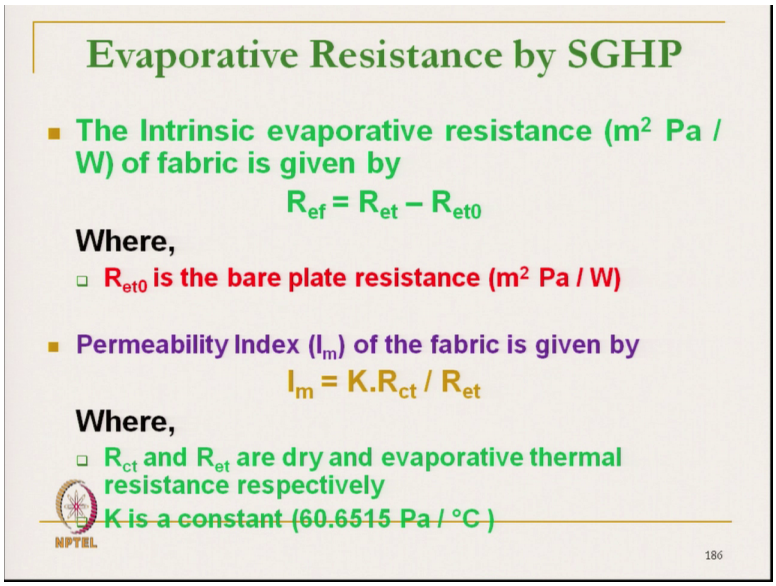


And intrinsic heat loss we can evaporative resistance we can measure by subtracting the heat the evaporative resistance of the air layer. And permeability index we can measure by the dry resistance by the wet resistance R ct which is the dry thermal resistance and R et is the evaporative thermal resistance. So, the ratio gives the permeability index of the fabric. So, we can get the evaporative resistance of the fabric as well as the permeability index and K is the constant for that.

So, that dry heat loss we can measure in dry state. So, for to have this data the actual the evaporative resistance of fabric we have to test two times, one is the bare plate testing has to be done to know the moisture vapour transmission of the air. And, we have to test the in the dry condition to know the dry resistance of the fabric dry heat loss of the fabric. So, that we have we should do repeated testing. Next instrument is that the PERMETEST.

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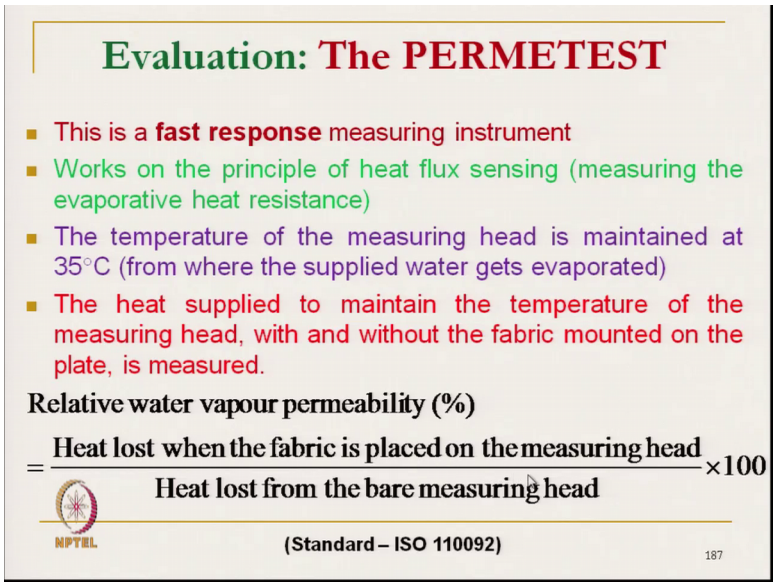


If you want to know the moisture transmission at very fast level, so this instrument gives the result at very fast at faster rate, other instrument we have seen it takes time. So, cup method and all these because it so, here this method it gives the moisture transmission at a higher faster rate. It works on the principle of heat flux sensing. That means, as the moisture gets transmitted it takes away the heat, that heat flux is measured ok. That means, the temperature of the measuring head is maintained at 35 degree Celsius. The heat supplied to maintain that temperature; so that means, as soon as the moisture gets transmitted moisture gets evaporated through the fabric; it takes away the heat of that from that system to maintain that temperature; that means temperature is dropped.

So, to maintain the temperature of 35 degree Celsius the system will draw the excess heat that heat is actually indirectly it is used for evaporation. So, that is how it is indirectly measuring. The heat supplied to maintain the temperature of the measuring head with and without fabric is measured. So, the ratio will give us the idea; that means, relative water vapour permeability is the heat loss when the fabric is placed on the measuring head and heat lost when the there is no fabric, but water will be there.

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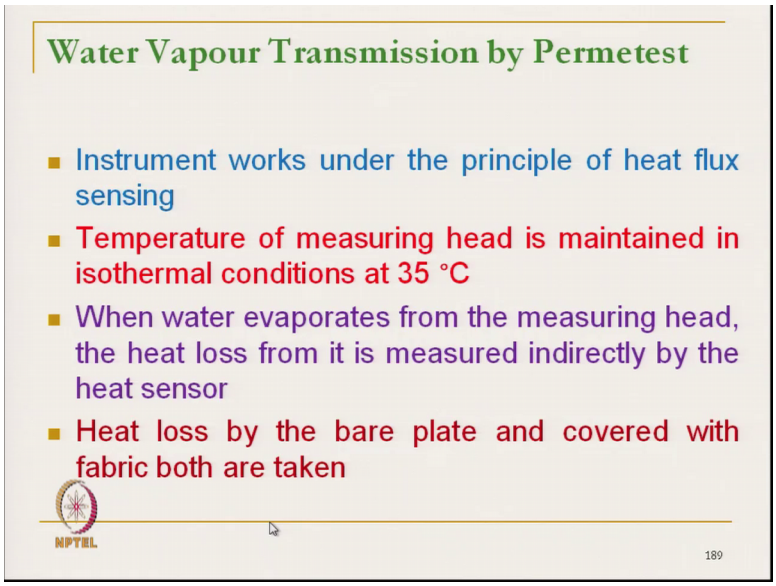


This is the system where, the instrument works under principle of heat flux sensing. So, let us see the principle machine.

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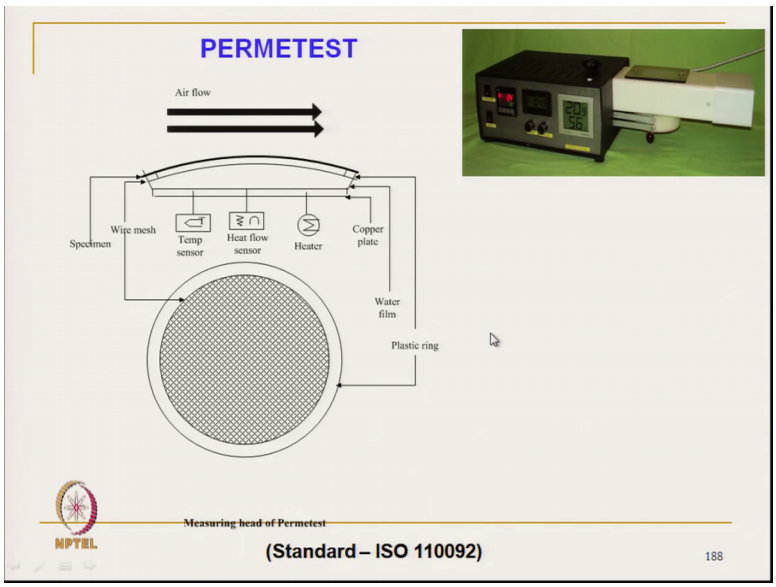


This is the wire mesh and plastic ring and this wire mesh is there at above which the fabric specimen is there. This is the top view, this is the side view and water film is placed here water film is there. So, as soon as the it is heated it will water present in this place will get evaporated. And, the temperature of this total system will drop. To maintain this temperature this will actually this is the heat flow sensor.

So, that to maintain the temperature it will draw extra heat from the heater and that extra heat is actually measured by the heat flow sensor. So, that is the quantity of heat, heat flux the temperature of the measuring head is maintained at isothermal condition which is 35 degree Celsius. When the water evaporated, evaporates from the measuring head, the heat loss from it is measured indirectly by heat sensor. And, heat loss by the bare plate and covered with the fabric both are taken and the ratio is actually measured.

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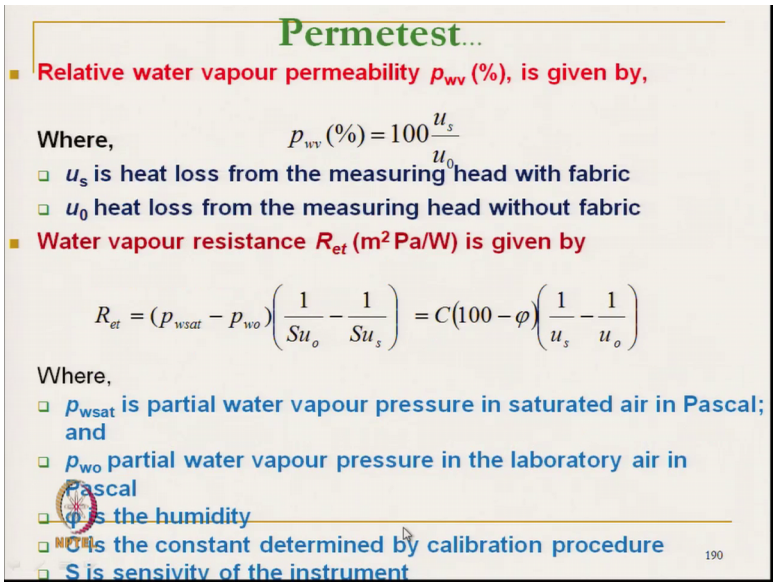


So, this is the way of expression ok, R et is the water vapour resistance ok. If we measure the; and relative water vapour permeability is the heat loss from the measuring head and heat loss from the without fabric, with fabric and without fabric. So, this way we can measure the permeability characteristics or water vapour permeability characteristics and water vapour resistance.

And last segment of this which is the moisture sensing of the clothing. See moisture sensation is extremely important and its directly affect the comfort.

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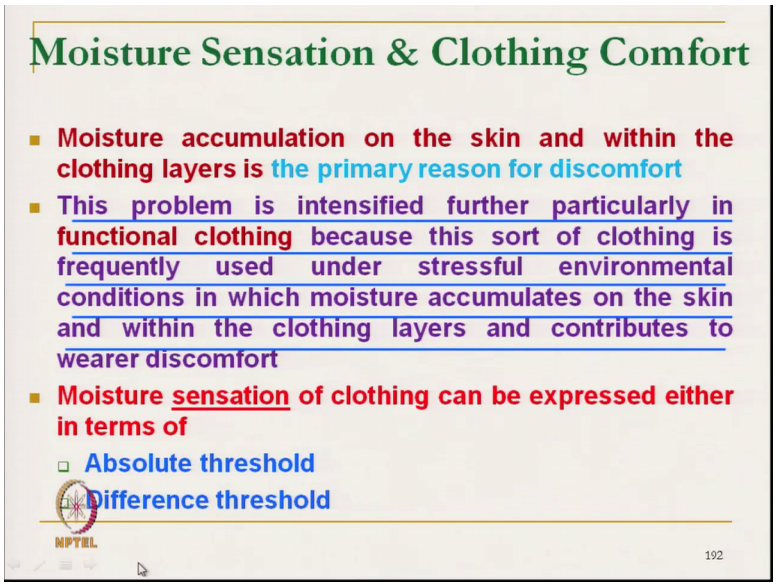


And the accumulation of moisture on the skin and within the clothing layer is the primary reason of discomfort. And, this problem is intensified further particularly in functional clothing because, when we need comfort as well as the function and most of the functional clothing are covered with the outer layer which is basically coated. So, in that case moisture vapour permeability is restricted ok, it does not flow, free flow is not there. So, this problem is intensified in functional clothing because, this sort of clothing is frequently used under stressful environment, in which moisture accumulation in the skin and within the clothing layer is there and contributes to the wearer discomfort.

So, sensation of moisture comfort moisture inside the microclimate is extremely important. And, the transmission characteristics we have to understand clearly. Transmission in the form of liquid moisture and in the form of vapour moisture in vapour form and it is actually a sensation of moisture can be expressed either in terms of absolute threshold or differential threshold. So, that is that psychologically we can get some sensation and this all these sensations are related with the transmission characteristics. If we can control the transmission characteristics properly we can get comfort ok.

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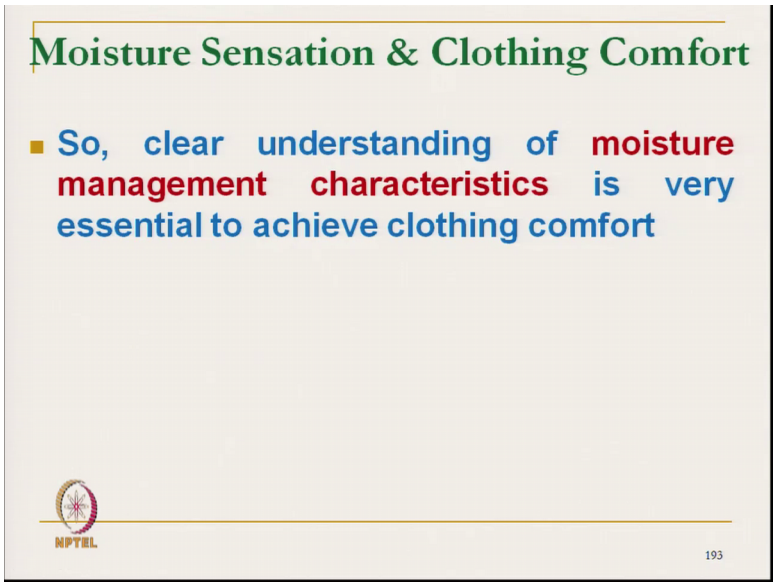


And so, clear understanding of moisture management characteristics is very important, very essential to achieve the clothing comfort, it is very important. So, to if we want to achieve the clothing comfort. So, we have to understand the moisture transmission characteristics, how to manage the moisture within the textile material.

And, with that we will end this session of moisture related comfort.

Thank you.