Textile Finishing
Prof. Kushal Sen
Department of Textile Technology
Indian Institute of Technology – Delhi

Lecture – 32
Principles of some Finishing Machines

Welcome back to this class on textile finishing. Let us see, what did we do till the last lecture or in the last lecture, we understood in the last few lectures.

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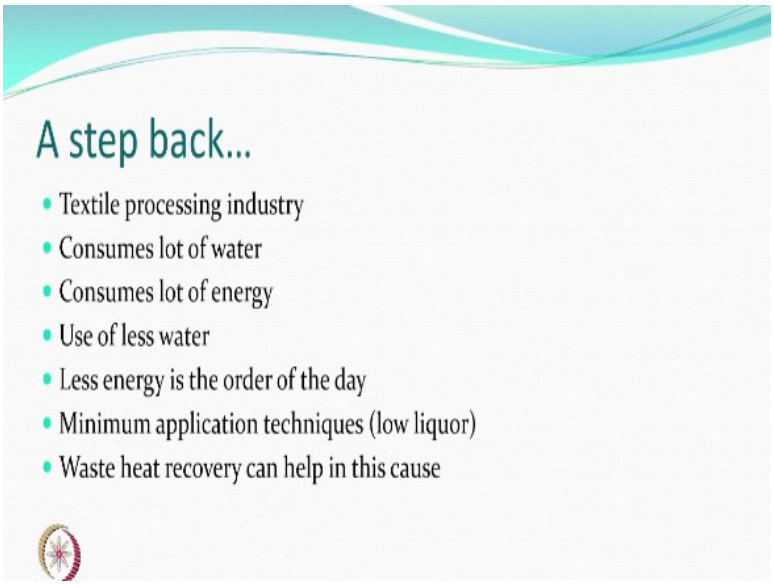

The textile processing industry is consumes a lot of water consumes a lot of energy. So, it is always a good idea to use less amount of water. It is always good idea to use less amount of energy. So, we had minimum application techniques, including foam finishing, gets rolled techniques and so and so forth spray and also how to recover heat from whatever waste is going out of the process system.

The waste heat recovery can help this cause if right kinds of heat exchangers are installed. So, this is for last lecture for this course, right. We will wind up after this. And hopefully, you would have learned this subject, the core of the subject, because everything that we talk about can be talked in as much detail as one wants to talk. So, we will spend some time on learning about some of the principles of finishing machines.

We will not go into detail because the separate course would be required to deal with all types of finished machines and their details. We just talking about principles and why they required and what the advantage and so and so forth. Some of these things will do and hope it will serve the purpose.

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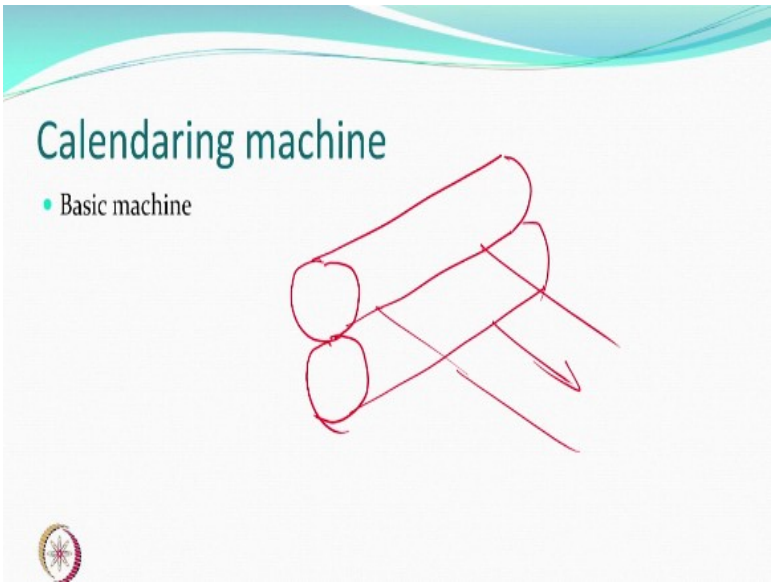

One of the very simple machines, which we call it calendaring machine is part of almost the end of the process type everything when you say well, our finishing is over. Then before you let say sell anything to any client, you would make sure that there are no creases on the fabric. So you do calendaring it says like ironing, what do you do ironing? So you heat the iron and then remove the creases. So that is the best process a small garments can be done by that but it in the melt state it is just like ironing.

So, you have one hot roll or may be a little bit of moist fabric go through this and metallic systems and so it dry a little bit and like an ironing for example a moist fabric it will dry and the creases will be removed and then you can either roll or fold or make batches and then sell so the simple calendaring machine which will be in every process house at the end of finishing process. This is will be used to make sure that the fabric aesthetically looks good.

Simply heating on a followed by a polish roller. That is one. So this calendaring machine sometimes can do some special, you know, roles it can play with a little bit of a smartness. So if you want to increase let us say the shining of a surface.

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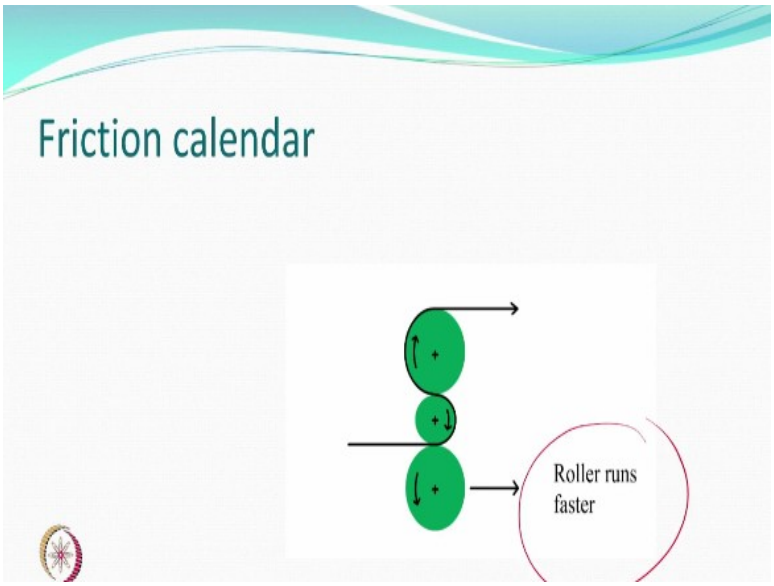

Then the same calendar is modified little bit called a friction calendar. And what it means is one of the polished rollers surface can run faster. So if you run something faster, so these surface can become a little more shiny, the things can fall in place. The hairs can be put in a certain orientation order. And so it is like for example, if you press something like an iron, a very little bit of more pressure, you will see at some places the fabric become more shiner. That is the kind of principle that you have. So it is called the friction calendar.

So using a frictional properties are the friction itself to smoothen the surface, right. So that is the mechanical processes. At best, you may have a moist fabric coming in to the friction calendar area and work around. Sometime very sophisticated sets of rollers are used called a chasing calendar

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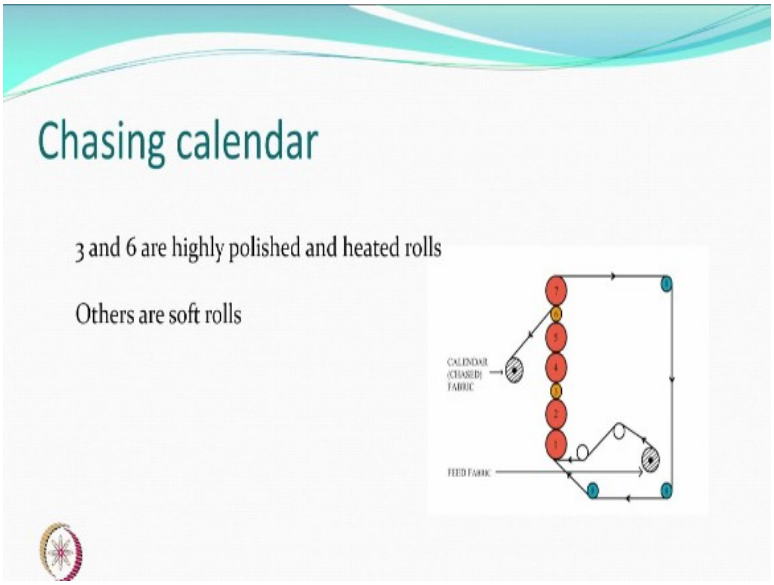

That means the fabric is chasing itself, right? So when it comes in contact with the area, which is a polished surface in this whole sequence roller, all the balls number 3 and 6 are highly polished, and they are also hot. Okay, so that is one part, but the fabric is threaded in a manner that it goes from this side all along goes all the way comes on and then come so at some point there are 2 fabrics coming contact.

So when you have a hard surface versus the metallic surface on both side versus now you have a situation where one surface of the fabric is in contact with another fabric and fabric surface only. So it can highlight the, let us say at will material which can appear more the texture could be seen as the more highlighted its opposite of what the friction calendar was doing instead of making smooth it is making let us say more round this.

Because what is pressing is the yarn and yarn or one yarn is falling on the gap of the other yarn and it gives us very nice look which is non reflecting it scatters the light more and softer look can be obtained by this chasing calendar because fabric is the one which is coming in contact with the fabric and so, fabric itself it is chasing itself.

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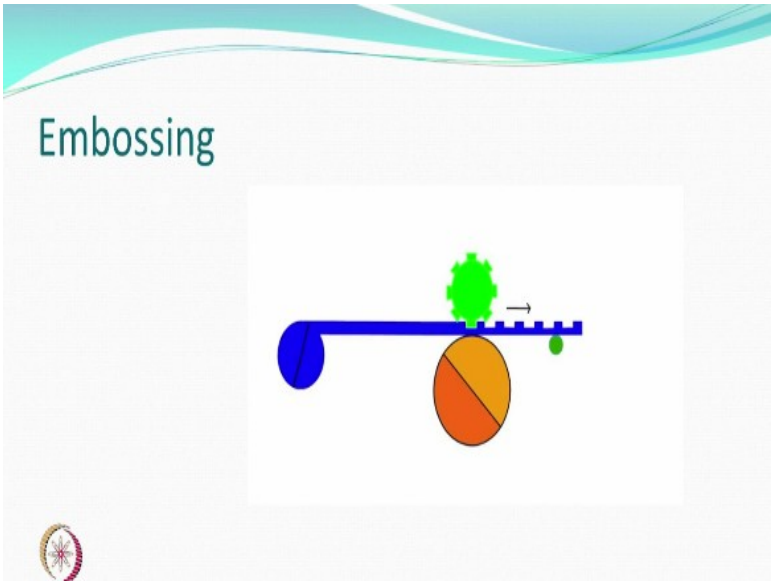

Another type of calendar which is sometimes called embossing calendar that you actually want to have some type of a shape being seen design being formed. So, you have an embossing calendar, which is pressing against let us say, hot roll and you can get impressions. So, if the fabric is moving in this direction, you are creating some of the designs here. And this can be used for example, it could become a watermark or something.

It can give you an impression of some embedded design 3 dimensional effects is something which you will see at the end of embossing you must have seen upholstery and so and so forth material which gave you a different shape. So, based on the design of the embossing roller, you will get some design being seen or printed on the fabric as it moves through this calendaring system.

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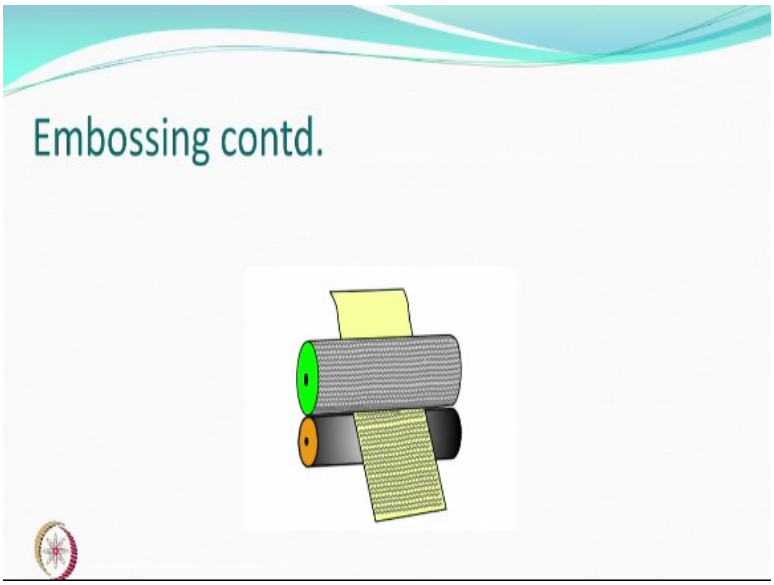

So, if the design is of this type you will get fabric which has got some design of this kind. So, this is what it is whether this effect is going to be temporary or permanent depends on what have you done. If suppose, along with this you have a polymeric system also moving along and with the embossing maybe you can create more permanent effect. Otherwise it can be temporary or you have resin based system which can be cured after this.

So, the impressions can be more permanent. So, the temporary happiness or permanency would depend on what is the chemical if it is only a mechanical process, then it will be temporary process, you want to make it more permanent you have to have other systems helping it.

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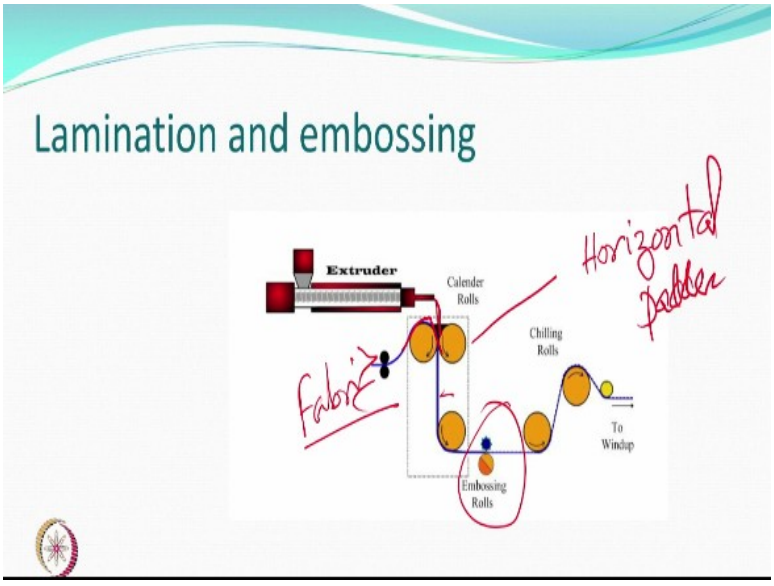

For example, a system where you have a fabric and a polymer which is being excluded as a let us say a molten polymer is coming. This is a horizontal padder kind of a situation. Right. So, what happens is this fabric is coming from here. And the polymer is also coming here and they get in a way come in contact. So, if the fabric is touching the first roller, only one side of the fabric will come in contact with the molten polymer which will get deposited.

So, as it comes out, so, there is polymer on this side fabric on the other side part of it may obviously diffuse also the polymer and so, you take and take it to this embossing area, whatever design that you have, if it is this one of the rollers is hot. So, this polymer if it is a thermo plastic or thermo set, but because we are talking about molten so it is a thermo plastic material. And so, it will get impression, then it is cold by these rollers, ceiling rollers.

And then if you see the final product, it has got a layer of polymer deposited properly laminated on the textile surface and embossing has been done this will be more permanent because the polymer is the one which is taking the impression textile is giving the strength alright. So, you must have seen various kinds of upholstery systems which may be using elimination embossing type of sequence that is that is like calendaring.

So simple calendar with just irons to little more complex which can do this. The shape the 3d design 3 dimensional impressions can be created temporarily or permanently depending on what you do with them.

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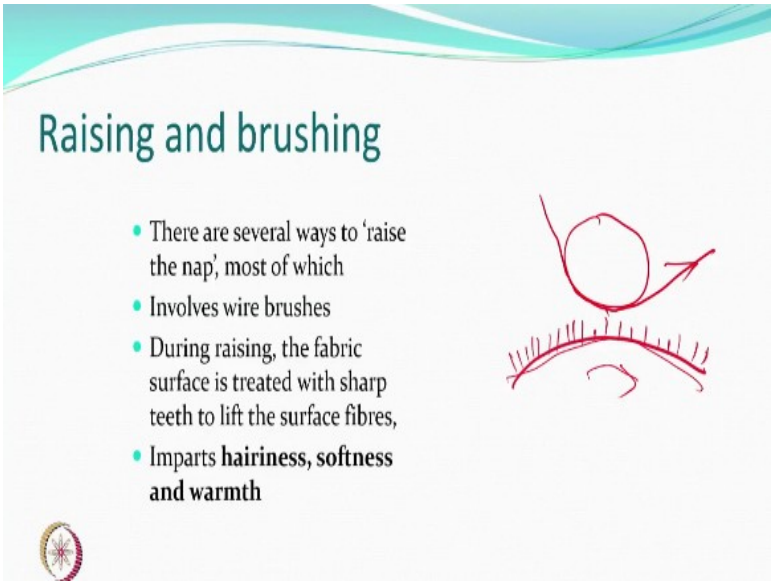

There is another interesting thing with textile people do normally you would remove all the protruding hair from the fabric by rinsing process or we talked about by polishing and so on, so forth. But sometimes people say well, I like some of the fiber if uniformly taken away out from the surface, then it will be a nice idea people like it that is called raising or brushing. So you have metallic brushes fitted on let us say a roller and if there is a fabric which is in contact moving either along this.

Or it can have a situation where the fabric is coming in contact only in a specific area. So, when it moves, the hairs will be coming out. So, based on the length of the brush, the density of the brush the angle and the speed with which these things are going to moving the fabric on one direction the roller in the same direction or the other direction. One can get more or less of the hair coming out which will give you a bit of a soft touch feel on the surface, because the hair is can be getting they can get compressed, okay.

So, there are several ways we talked about, they all would involve brushes, which could be metallic, plastic or sometimes other material also but they are this fabric, when lifts the fibers, then it gets the cushioning effect. And this hairiness can give you softness and warmth, if it is controlled, it looks good, if it is uncontrolled, it bad, right? But good amount of hair would come out and you can see them hairiness, normally you remove the hairiness where you actually want to do the areas but that is the desire.

So mechanical finish other is where you want very small little raising to be done not too much. Then instead of brushes use emery cloth which can upgrade the surface little bit okay.

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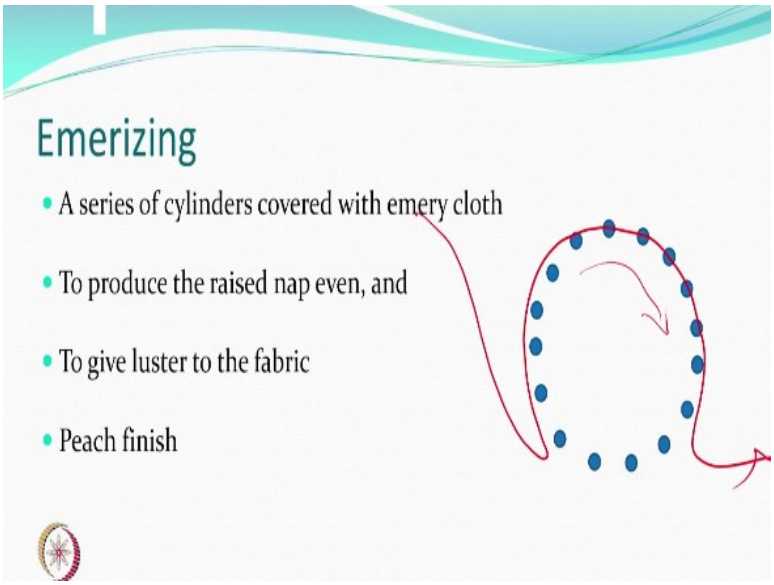

So there can be a large number of rollers which have got emery there is a large number of roller each of them can independently move or rotate freely also and they are in a whole system the fabric can move all along and go out and this whole system will make sure that very mildly the surface is being touched. Now, the quality of abrasion that you may get depends on the grains, which are there on the emery paper or emery cloth. Now, emery cloth now this therefore can give you very small little rays of little smaller very very small hair and different kind of finish.

So you have series of rollers is shown here which have wrapped emery cloth or paper. So they produce very very small even nap and therefore give luster also little bit because very small things that happening and gives a very soft and sometimes people are selling these kind of products they call it peach finish like you have seen the peach fruit. If you look at the surface, something like that. And textile by itself is very flexible. It looks pretty nice, soft to touch, but does not have long hair. Right? A little bit of raise.

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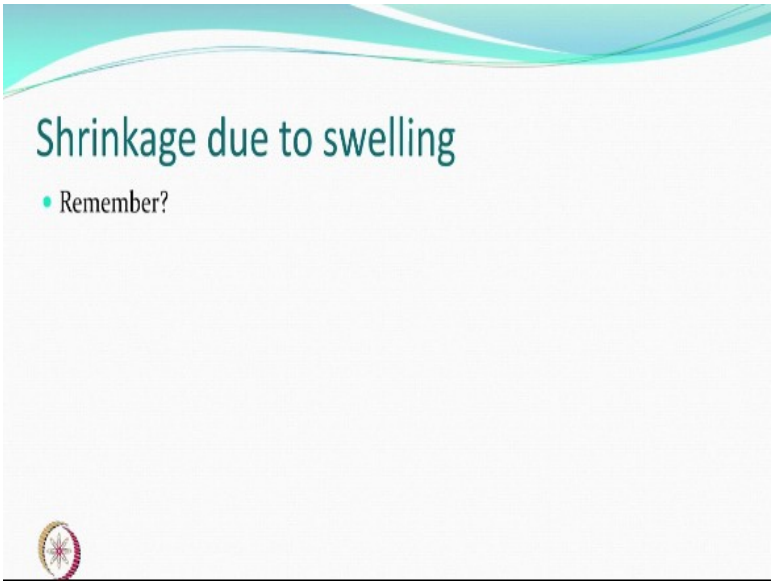

Before we go further, remember shrinkage due to swelling like somebody said you want to have a cotton fabric stitched before you have the cotton fabric says please wash it otherwise, the garment will shrink. So, that was because of shrinkage due to swelling. So, we understand the shrinkage due to swelling you understand that remember. We talked about 3 types of shrinkage is relaxation shrinkage.

Shrink is due to swelling which is for hydrophobic fibers, cotton and so on so forth and fainting which is only for will know the fiber has fainting shrinkage, shrinkage due to swelling has been handled, there is a process which we call it sanforizing.

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So, this finish is a sanforizing finish, where what we are doing is that you pre shrink the fabrics uniformly. So, that excess length of yarn is available so that when it swells, it does not shrink further because you have already done the compressor shrinkage before. This type of a thing is called the sanforizing processes and sanforizing finish, it obviously shrinks the fabric little bit. So that finally done shrink.

That is one and it is a special finish in case you see any fabric pieces and sanforizing very clearly to mention on the visible portion that is sanforized fabric and will charge you more money also for this. So the principle of compressive shrinkage here is that there is a ball and there is a endless rubber belt to see you see this belt. This is endless the rubber belt. So w will go all along and come back know.

This role of course is a role so fabric is this is the fabric which will move from here go all along like this over the rubber belt and then in between the rubber belt and the roller and then get out from here simple thing fabric very moist little bit before you enter. But can you imagine just do this and suddenly find whatever you want you can do that you will get it and what do you mean by that? See, at this portion if you see this is convex.

So rubber is stretched here, rubber roller is stressed on the convex portion the fabrics comes in contact while on the convex portion while the rubber is stretched, stretched. Okay, and the fabric remains in contact now. It does not slip and as it is moving as it moving it comes in this area which is convex concave. So, this area is concave from convex to concave this change. So, what happens is the surface of the rubber on the convex area was stretched fabrics comes in contact with the stressed portion.

This whole thing moves to another portion immediately which is concave and therefore, the surface of the rubber obviously inside compresses, the fabric also has to along with it can get compressed fabric gets compressed. So, fabric in a normal state comes in the extended portion of the rubber within the outside convex rubber and then it goes to the concave area where there is a compression rubber is going to get compressed from the inside because that becomes the inside

portion, the outside of the rubber portion becomes inside of the bent area curved area and so it gets compressed.

So, fabric because cannot go anywhere, it also gets compressed after this what you get is a compressed fabric uniformly. So, it would have shrunk already by this process. How much it will shrink depends on the thickness of this belt. Larger is thickness, which could be pretty high it could be 4 inches six inches thick rubber and less rubber blanket rubber it goes from convex to concave changes will be more.

So, very simple system as a principal can actually give you fabrics which will not shrink further because of the shrinkage due to swelling that is what we are controlling here. So, when this well there will be extra length available so that it can be accommodated without extra pulling pushing.

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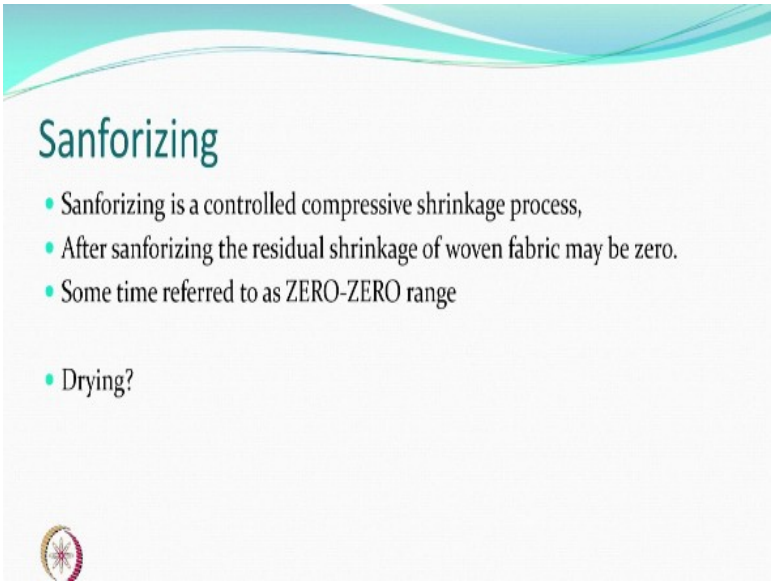

So, it is a controlled compressing shrinkage process number one. This based on the efficiency of the process at the end of the process, there may be a situation that a fabric does not shrink at all it if you do washing, it will give you zero shrinkage good for the user. Therefore sometime this whole machine also instead of calling sanforizing machines calls also ZERO - ZERO range that is zero and work direction zero and shrinkage zero shrinkage in both directions drying has to be done. It may be slightly moist fabric and dry fabric.

Drying must be done be very carefully you will just talk about a little bit of palmer dryer which is a kind of dryer which is used immediately after the fabric comes out Right.? If the fabric as it comes out will go through a drying machine which is a special drying machine called the palmer dryer and we will talked about in few minutes. So before we end this sanforizing machines let us talk about drying machine because whenever you say wet the fabric drying of the fabric also.

And so simple drying machine this is what we will talk about it is a essential process in every wet processing sequence know you cannot keep wet fabric a long time because it get stained and all kinds of problem so you have to dry. And sometimes we anyway doing drying you do washing and you have to dry.

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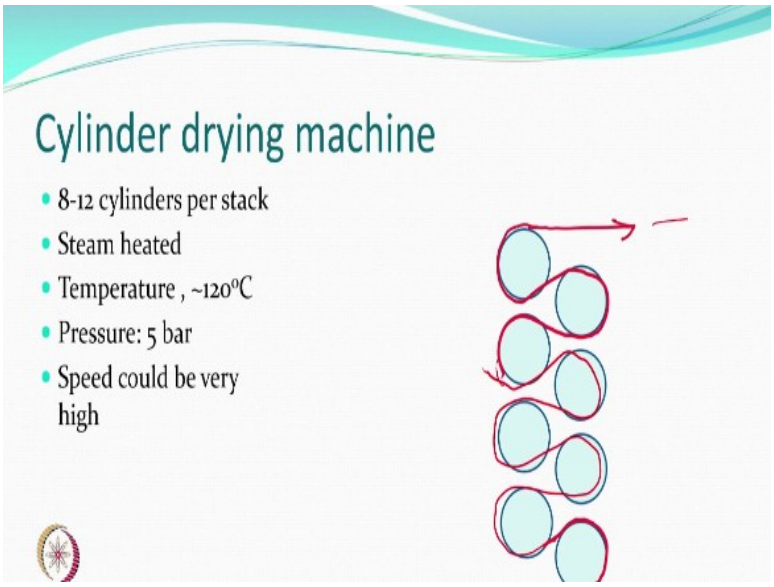

So somewhat simple drying systems are we will just talk about cylinder drying machine so cylinder drying machines there are stacks of cylinders right.? Where the fabric is threaded right goes like this is goes like this goes like this and up to this point and goes out and these are heated by steam and all the cylinders are heated by steam fabric is in contact with metallic surface and so heat is transferred from the metal to the fabric and the water evaporated all over alright.

So one stack this is one stack there can be another stack of this type where fabric will go in the reverse direction go to the bottom and go out so based on what speed you want to run, what is the thickness of the fabric the GSM of the fabric rate at which you want the evaporation to take

place they can be more than one stack definitely and each stack may have 8 to 12 cylinders drying cylinders. Okay

This is called cylinder drying machine steam heated as beside water heated temperature of this cylinder could be 120 degrees and so easy evaporation takes place pressure of the steam which is could be 5 bar around the same which you give about 120 to 125 degree centigrade. Speed could be very high almost run the machine at 50 meters to 100 meters permanently it can go if you have more number of cylinders it can go very fast the thing which I am talking about is like you to find out.

Obviously when the fabric getting dried the steam will condensed also in the cylinders how do remove the condensed water I think you may like to checked it out or think out by yourself how do you remove the condensed water and if you do not remove condensed water because the gravity the water will also to the bottom and at some time it may be too much i do not want to unnecessary keep the condensed water inside what you do with that of course when you got the hot water out you will probably take go through take it through the heat exchanger so that heat also recovered that of course you will do.

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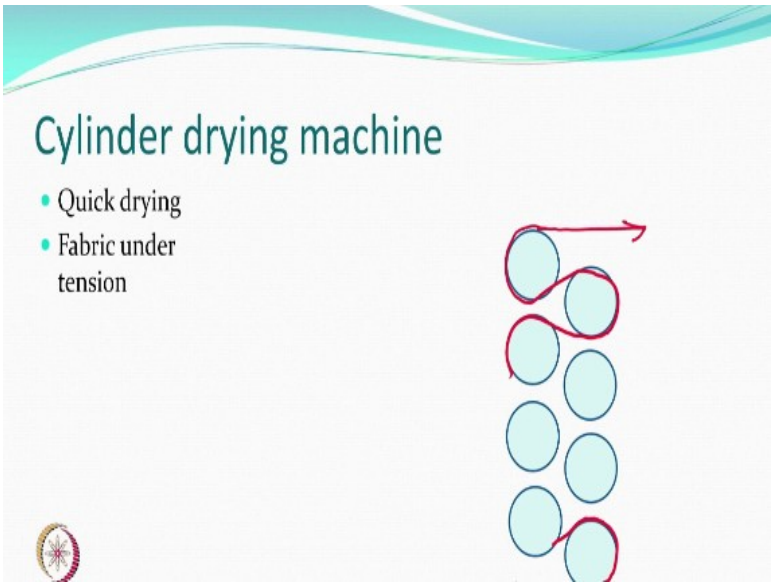

So quick drying this is the type of machine which required the fabric remain under tension you know so that it touches the surface of the cylinder all the time so it would be under tension. If

very light weight fabrics are there like ciffon and so would you like to use this type of machine for drying because you do not want materials which is texture is more important to be under tension when you drying our aim is to dry the water and not change the texture. So this machine may not be good so you may have some other kind of machine where the machine called festoon drier.

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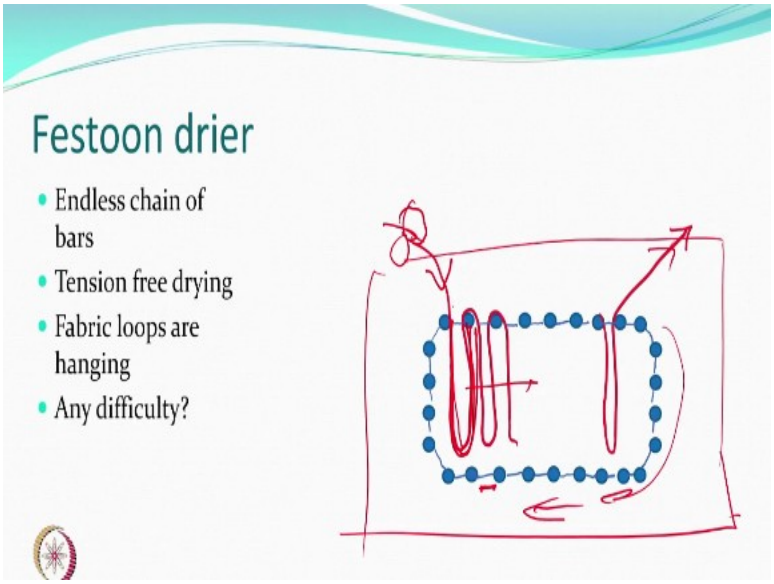

And what is the festoon drier. You see this is got you can see the a series of let us say, right, the rods endless series of rods, endless series of rod which moves slowly like this and goes on this thing where there are gaps. The fabric is fed at a speed which is much higher than the speed at which this thing is moving, it is an endless chain of rods one rod, second rod, third rod. right, so there are rods. So, the rod 1, rod 2, rod 3, rod 4, this whole thing is moving like this right. But moving at a slow speed, the fabric is being fed at a faster speed,

How much faster fabric is supposed to make a loop as it is moving out. So it is moving faster it makes a loop and this loop moves at the same speed at which this chain is moving right. So the loops are being formed. By the time this moves there, the other one comes in the sequence and the loops are form. The length of the loop is approximately same because the speed of the fabric with which is going of course it is you can say this much motion is equal to this much of a fabric right. This much motion of the chain at that particular time, so, much of fabric is being fed.

So, that loop is formed. So, loop also keep moving in one direction and then obviously at the same speed it is pulled out and this thing goes out right. And of course, you would like all of this to be inside a close chamber. So, that hot air goes in exhaust comes out, I mean the fresh air the humidity has to be maintained. And so, the exhaust goes out which is hot, which has got moisture, which can be passed through, shall we say, another heat exchanger. So, that incoming air comes out which will be required all the time. So, this is your festoon drier.

So, you have endless chain of rods or bars. Tension free drying. So lightweight fabrics can be dried in this type of machine, fabric loops are hanging, right. So do you see any difficulty? The same difficulty, the difficulty will be that you cannot force the air at a much faster because for it if you do then they will be flattering of these loops and they can, so it will be relatively let us say calmer environment. So you will be having hot air jets falling onto the loops. So that evaporation takes faster but the velocities of the things are not going to be very high. So that is the festoon drier for you.

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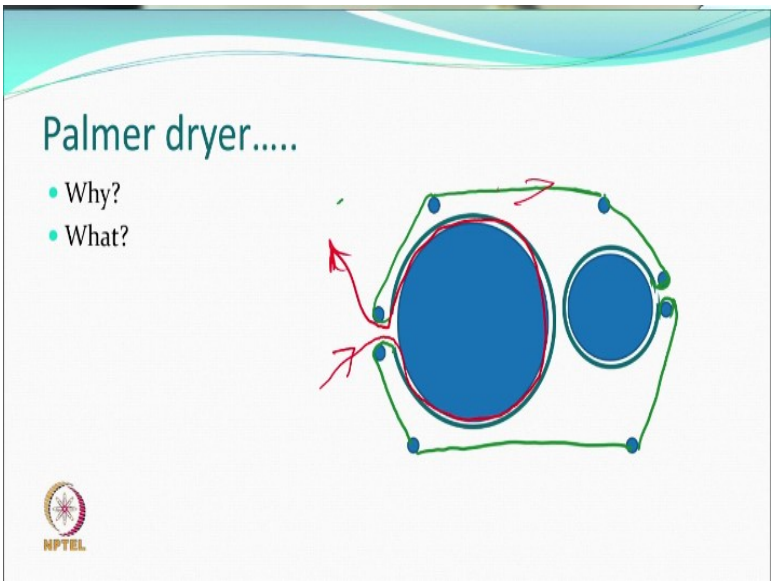

This is the palmer dryer we are talking about know the sanforized fabric instead of being drawn dried on a cylindered no way too much tension you want compressed fabric to dry in the same state. So, that fabric for example, will come to this palmer dryer. Here, the fabric can remain in a compressed state drive without tension. So, the fabric for example, which was coming from a

sanforized unit will come from here go all along this because it is being held by endless belt So, tension is not there.

The belt may be under tension with a fabric just slowly moves no tension in any direction on the fabric is given. And so it goes inside this big drum which is heated and there is the just endless belt which is compressing the fabric here. The fabric is already bent is coming out of the sanforized zone into this all right. And then if this belt becomes wet, there is an auxiliary drying unit it moves over it the belt gets dried and the dry belt again comes in contact and so, this process goes on.

So, very important beautiful drying system is got a big large drum and a small auxiliary drying drum which is used for drying the belt. The last drum dries the fabric in tension less state and the fabric which is sanforized obviously need that kind of a condition you do not want to stretch it till it is completely dry. Just a few more points that we will talk about stenter.

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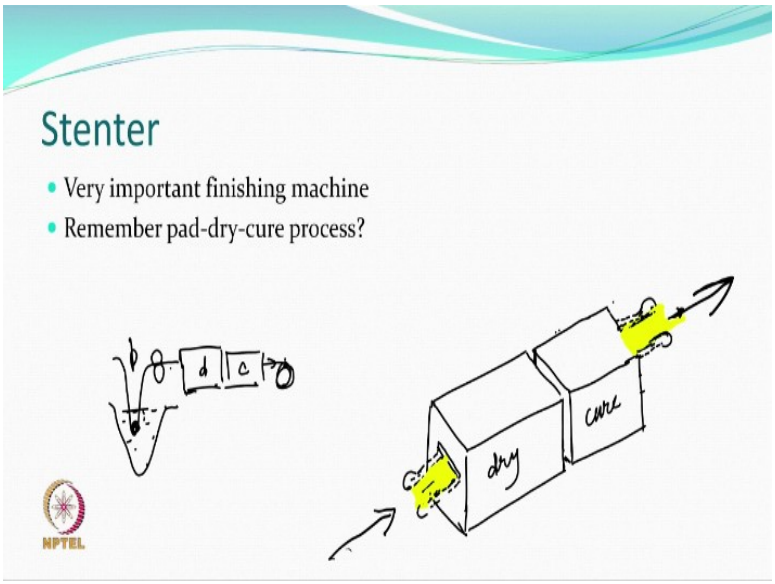

Which is the most important machine in the finishing system. If you remember pad dry cure process, so after padding, the drying and the curing takes place in this machine not on a drying cylinder or not on a festoon. Right so this is if you do pad dry cure of a process like the raising finishing is this is the machine, philomel tendency this is the machine. So, when you do the finishing process this is very important machine.

Now it is a very big machine and it has got many purposes to them one of the main most important purposes dimension control. So, if you want the width to be controlled, this is the machine you will control the width, you want the lengths to be controlled. This is the machine you will control the length of final length of the fabric. So, this will this the type of machine which will do stenter, so stenter obviously has chambers where the fabric which you let us say shown here in yellow is picked up by and less chains on both sides.

There are chains which hold the fabric from the salvages or near the salvages, they can pull or relax depend on what is the treatment that you want to give and then it takes all along the drying area and the curing area or sometimes called polymer rising area cross linking will take place there. So, you may not have one chamber for dryer than we more chamber for drying they be more chamber for curing because what is interesting is?

How much water is coming in and what is the moisture which is going out at the drying stage then the temperature of the curing will be much higher and so, cross linking may take place there. Complete dimension control. This is one of the beautiful machines.

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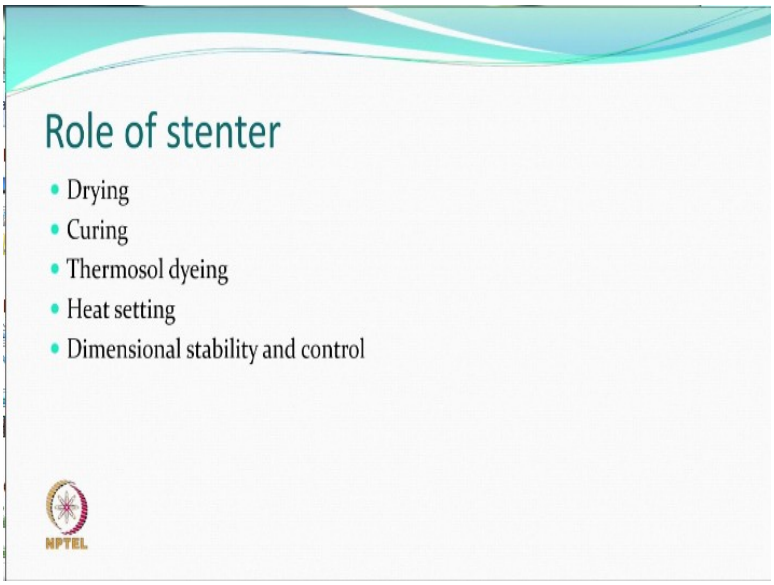

So, the role of the stenter is drying of course, curing yes thermosol dyeing if you had disperse dyeing can be around dyed by a thermosol process at higher temperatures, this type machine will work heat setting we talked about will be done on a stenter the cause it gives you dimensional

stability and complete control. So, synthetic fibers want to shrink. So, you will allow them to shrink, the change will come closer and then shrink it can take place all this is stenters so very important machine.

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Various types of clips are used or pins are used to hold so, this is a example of some pins so, there are chain these are link of a chain, these are pins where the salvage is pushed. So, you can if you want to pull or push, you can do that completely control. So, these links are then linked in some manner which go all around. So depending upon whatever link it can go like this, or it can move like this. Right?

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So there are if you do not want the pin marks then there are clips which just hold the fabric and then pull. And sometimes they are combination hybrid kind of system where it is a clip as well as pin system, whichever you want to use, one can use all these type of things will be part of, let us say, stenter, but it is a very sophisticated machine also other than drying and thing because it must sense the salvage correctly. And then pears the pin or clip hold by a clip right.

So, unless if the salvage is on some other side and clip it somewhere else, either in the center or somewhere else, you can have tears also. So it has to be very accurately done. So, there are electromechanical sensors which sense the edges of the fabric and the rails are guided to the salvage so that they clip okay. Humidity control is required because if the humidity in the chamber becomes too high rate of evaporation very slow, which is obviously nobody will desires. So fresh air has to come and the hot air has to go out other than the heat.

The temperature measurement and then the recovery, people like to measure the humidity of the exhaust as it is coming out because it tells you the idea as to whether the humidity in the chamber is more or less if it is humidity is more you will like draw more fresh air. If it is less, you will like to slow it down. Right. This is how you will like to control the humidity there other than the motion control, temperature control all that has to be done.

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An industrial stenter may look something like this can also move at a very fast speed depend on what you are doing capabilities there, that is a long machine that takes large area very important machine from the finishing point of view right.

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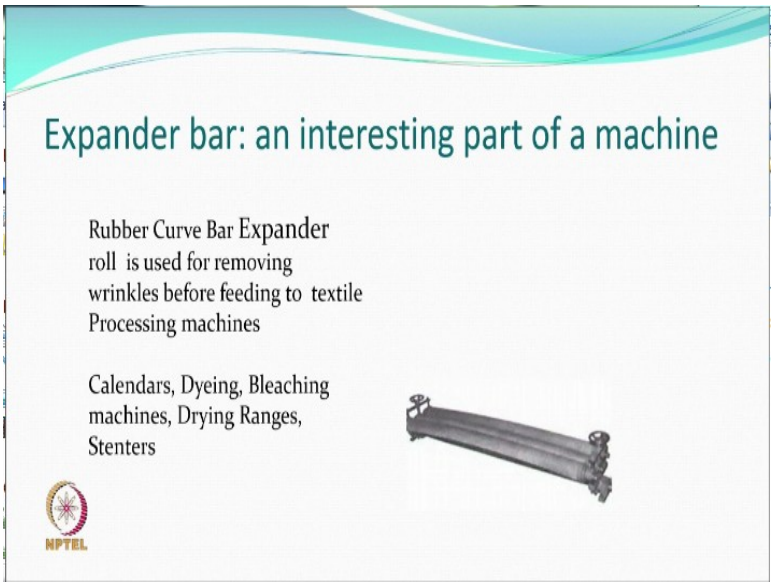

Last thing every machine processing machine may have something called an expander bar something like this an expander bar is the fabric first passes over these so that it gets streched in the width direction. So there are no creases to remove the creases. This is what may be a part of every machine and the feeding system around the feeding system. So you may have if you visited any industry, you may have seen see any machine you will have something like this. There are many guide rollers but this is one of the important one.

This is not just for guiding, but to make sure that there are no creases as it is being fed to the stenter or any such machine, like even a cylinder drying machine, if folded fabric goes over the thing is not good single layer, it must go in an open with form. All right, find out this expander bar rotates, but on a curved axis, how does it happen? Find it out yourself. I am giving you one design problem as an engineer you are supposed to do designing.

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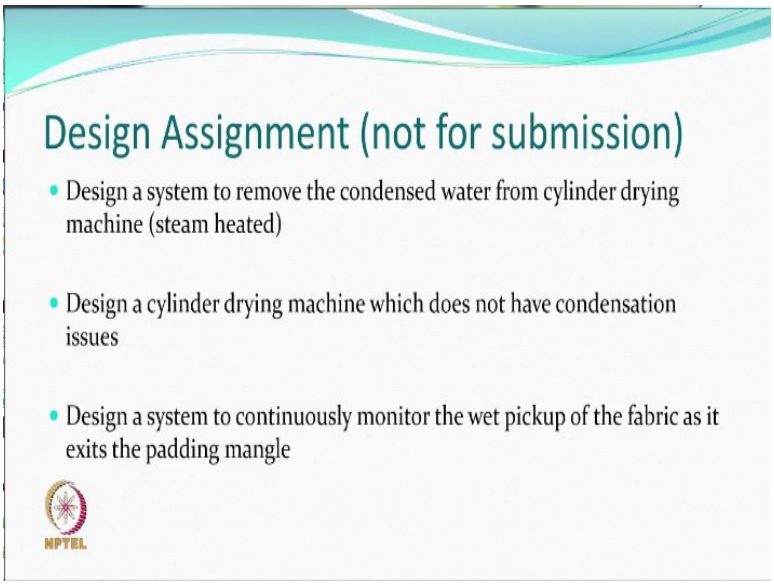

So, suppose we do not have to submit anywhere this is not for evaluation purposes. You can do it yourself in this do whatever. You want to design a system to remove condensed water from cylinder drying machine, steam with get condensed, something what probably happening you will find out you want to make more efficient system. What will you do? Do it yourself design a drying cylinder drying machine which does not require it does not have condensation issues at all no condensation issue.

How would you do that you can also think of designing continuous monitoring of moisture on a fabric as the fabric is going in it is certain amount of moisture as coming out because certain amount of moisture based on that your speeds temperatures etcetera will have to be adjusted. Can you design some kind of a sensor like this will like enjoy this. Keep doing it well think about it, read as much as you can. Coming to the end, right. We have learned about some of the finishing machines and their principles. Remember we are not talking about details of the machines.

We are ending this is the last class and I hope you have learned something out of it with throughout this whole thing. We have been talking about principles. Somewhere chemistry has come again principle, we are not looking at recipes, you have not been talking about temperatures, times required their optimization processes which can be done as long as you know why you are using, what you are using? So this was the first course, which gives you an overall objective, overall feeling of what finishing is all about.

But if we want to know more, maybe an advanced course may have to be floated or attended. Maybe we will meet sometime, maybe this type of forum itself, where we can probably discuss advanced level finishing courses also. So at the end, I hope you have enjoyed and wishing you all the best for the final exams of this course, all the best.