New Spinning Technologies
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Lecture - 06
Package formation

So, in this lecture we are going to discuss Package formations, how a package is built on rotor spinning machine. You are all familiar with the package that we built on ring frame the name of the package that we make on ring spinning machine is called cop. Now there is a specific requirement of the package that we built on rotor spinning machine.

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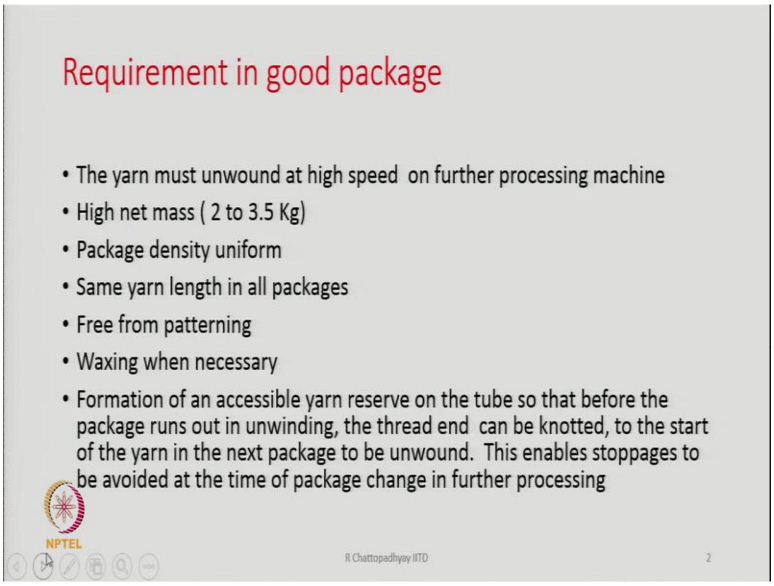

The yarn must unwound at high speed on further processing. This is one of the important requirement of the package formations. The package should have a weight between 2 to 3.5 kg that is the content of the yarn in terms of weight should be between 2 to 3.5 kg. Package density has to be uniform that is across the cross section of the package the density has to be uniform. Same yarn length in all packages. So, whatever packages we make.

So, many production positions and the packages that we make in all the production positions should have same almost same yarn length. Otherwise when we use this package for let us say warping purpose, then lot of yarn will be wasted in cases some packages becomes empty quicker than the other packages. So, we should have almost similar yarn length in all packages to reduce yarn waste during subsequent operations.

It should be free from patterning, patterning leads to some kind of difficulty in unwinding also and the package becomes hard. Where we see a pattern on the surface of the package the surface of the package should looks uniform and smooth. So, the package should be free from patterning.

If we need some waxing then we should have provision to use wax whenever we necessary that is especially when you want to make a pack yarn for knitting operation especially, we have to wax the yarn. So, that we can reduce the friction between the yarn and the knitting needles.

So, in order to reduce friction we usually wax the yarn. So, that waxing it should be capable to put waxing and the waxed yarn should be then packaged formation of an accessible yarn reserve on the tube. So, that before the package runs out in unwinding the thread end can be knotted to the start of the yarn in the next package to be wound that is another important requirement.

So, that you can join the end of a of the yarn that is on the package a with the end with the beginning of the yarn end which is in the subsequent package these two we need to knot them together. So, therefore, this is also very important that formation of an accessible yarn reserved on the tube.

So, that before the package runs out in unwinding the thread end can be knotted to the start of the yarn in the next package these this one will enable stoppages to be avoided at the time of package change in further processing. So, this facility should be there when we make a package.

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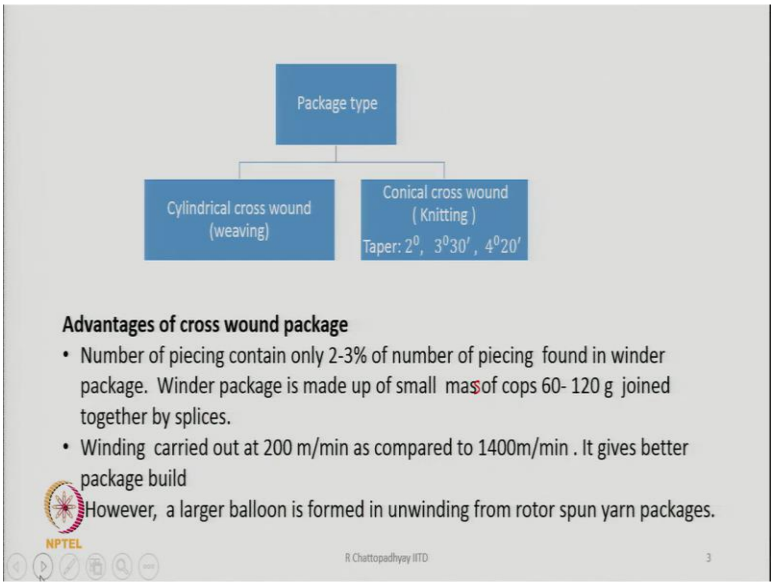

Package type could be two types one is cylindrical cross wound package, which is mostly used for weaving and the conical cross wound package which is mostly used in knitting. Now, advantages of the cross wound package number of piecing contains only 2 to 3% of the number of piecing found in winder package. Winder package is made up a small mass of cops of 60 to 120 g joined together by splices. So, because we are directly you know making a package of 2 kilo 2.5 kilo.

So, therefore, the number of piecings is much less in the case of cross wound package. That we make directly on the ring frame on the rotor spinning machine whereas, when you make the wound packages then we make it from small cops that you produce on ring spinning machines. And the content of yarn in a cop could be 3000 to 5000 m of yarn.

So, we need so many cops to make one cross wound package which is could be a cone or a cheese and once one cop get exhausted, we have to we have to take the yarn from the next cop. And they have to be joined by a knot so, piecings becomes too many that we can avoid when we make a big package of 2 to 3 kilo directly on the rotor spinning machine.

The other thing is winding is carried out at 200 m/min as compared to 1400 m/min. So, one have to remember that in the case of rotor spinning machine. When you are directly producing the yarn and winding it on a package the typical rate the velocity of the yarn that goes into the package is around 200 m/min.

Slower winding in a way in a very slow at a slow speed whereas, when you try to make package on winding machines from the ring frame cops. The speed can go up to 1400 m/min that mean the speed of winding is very very high in the case of packages built on winding machines and these machines are basically meant to make packages from cops.

There the rate of the speed is very very high and that at that high speed you need very good quality yarn also. So, that the end breakage is much less and we will be able to produce a package which is we have good quality whereas, in the case of rotor spinning machines the winding rates are much much slower it is only around 200 m/min. And as a result because the speed is less the package quality is usually better; however, a large balloon is formed in unwinding from rotor spun yarn packages when we try to unwind the yarn.

Suppose we want to wind the yarn again suppose the suppose I produced cheeses or cones on rotor spinning machines and then we want to go for the traditional winding machines on which we will make again either the cheese or cone. In that case because you want to do it sometimes in order to probably produce a package of certain you know particular weight or we want to get rid of certain faults which are there in the rotor spun yarns.

So, because of that sometimes it may be needed we have to remember that a large balloon is formed in unwinding from rotor spun yarn packages because the diameter of the package is much larger in comparison to the diameter of a cop; So obviously, the balloon becomes large.

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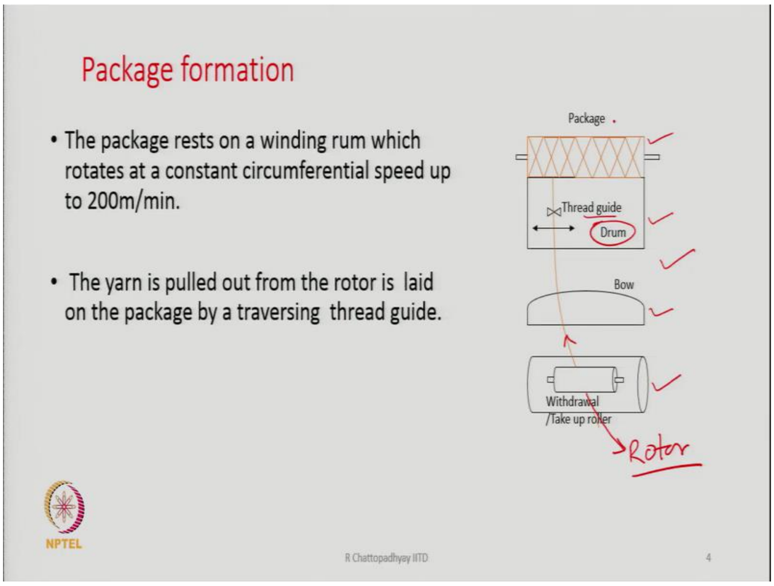

The package formation we are showing here a diagram which gives you an idea about how the package formation part looks like. So, here is the withdrawal or take up roller and then there is a bow we will come to that why this bow is required and then we have the winding drum there is a thread guide and the package rest on the winding drum.

So, like what is shown here is like a cheese the package rest on the winding drum which rotates at a constant circumferential speed of 200 m/min is not that the speed has to be 200 m/min it could be 180 m/min or 150 m/min the speed is adjustable, but the package is friction driven.

So, drum rotates at a certain speed which is fixed and the package rests on it and therefore, the package gets a drive from the drum itself. This drum is actually driving the package because of friction contact and as a result as the package diameter grows with time the surface speed of the package remains practically same. Since it is friction driven so, that is the advantage we get by having friction driven package.

The yarn is pulled out from the rotor. So, if this is the yarn I am pulling out so, this side I have the rotor from this side the rotor is there that yarn is pulled out and yarn is going in these directions. So, the withdrawal roller, the take up rollers, withdrawal roller they are actually pulling the yarn out from the rotor and then delivering it to the package formation unit consisting of the package itself and the winding drum.

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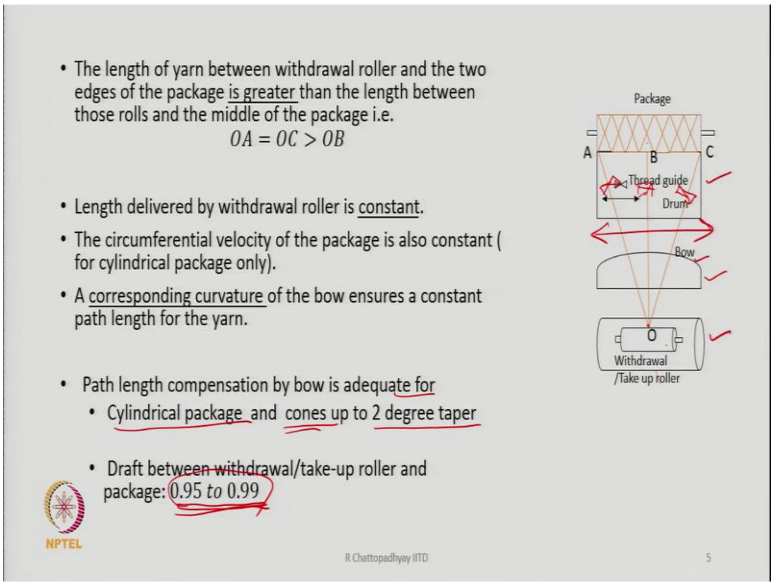

The thread guide which is there in between is doing a job what its continuously oscillating this thread guide is not is you know, which will be here in this position in the previous it is it could be here or it could be sometimes here or it could be sometimes here this is thread guide position. So, thread guides is actually guiding the yarn or laying the yarn on the surface of the package that is the job of the thread guide.

So, thread guide keeps on moving from left to right, right to left. So, thread guide is given an oscillating, oscillating movement and it keeps on laying the yarn on the package surface. And because I want to lay the yarn over the entire length of the package therefore, it will go from end ‘A’ to end ‘C’ and from ‘C’ to ‘A’. Continuously the thread guide is oscillating that is the job of thread guide.

Now, as a result of this is what is required because the entire length of the package has to be filled up with yarn. And hence we have to move the thread guide at a certain velocity the length of the yarn between the withdrawal roller and the two edges this is the withdrawal roller positions and ‘A’ is one edge ‘C’ is another edge.

So, the length of the yarn that is OA and OC and OB are the length of the yarn between the withdrawal roller and the package at three different instant. OA and OC are at the edges or you can say three different positions and OB is at the center. If we look at this, it is very clear that OA and OC are of same length whereas, both of them are greater than

OB. So, the length of the yarn between the withdrawal roller and the package always changing this path length is not constant.

So, when the path length is increasing how from the extra yarn will come because the speed of the withdrawal roller is constant and the speed of the drum or the package is also constant. If both of them are constant and at some point of time we need some extra length of yarn that is at the edges when we are going from OB to OA directions or OB to BC directions then we need some extra length of yarn where, from this extra length of yarn comes if this length does not come there is a possibility of thread breakage.

So, therefore, what we should do there is a bow as shown it here. The bow is doing the job to provide or to you know to create a path length of the yarn which is almost constant, that is, from OA to OB as the yarn moves the path length as shown in the diagram is decreasing, but if we make the yarn move over a bow as it is shown it here then the that because the yarn is moving over the bow.

And hence the path length is going to be almost same because bow itself will lift the yarn and the length OB and OA will be practically same as it comings towards OA the path length of the yarn is going to decrease. And hence we are compensating the variation in path length by just having a bow shaped small you can say a thin kind of rod which we place over there, which is fixed by the bow itself is taking care of the change in path length.

So, path length compensation by the bow is adequate for cylindrical package and also sometimes to cones up to 2° taper; when the taper is very low then also this bow is going to work. The other thing which is important is the draft between the withdrawal roller and the package.

We all know the definition of draft, definition of draft is the ratio of surface speed of the delivery roller to the surface speed of the feed roller that is what is generally the definition of the draft. So, in this case the delivery roller we can say is the package which is actually pulling the yarn and winding on it and the yarn is basically being say being fed to this is by the withdrawal or take up roller.

So, withdrawal take up roller is in this case is the input and the amount the length of the yarn which is wound on the package is the output. So, mechanically we can say this is my input roller this is my output roller. So, the ratio of surface speed is the draft and this ratio is around 0.95 to 0.99 that is it is less than 1. We know that a draft more than 1 means it will be under tension whatever is there in between these two feed and delivery that will be under tension, but if it is less than 1 this basically means I am feeding more and taking up less.

So, what we do that in this machine this is the draft value 0.95 to 0.99 and with this we actually control the tension in the yarn that is going to be wound on the package. And as a result we are going to make the package harder or softer by adjusting the draft in this particular zone, that is, the purpose of this and therefore, the draft is kept less than 1.

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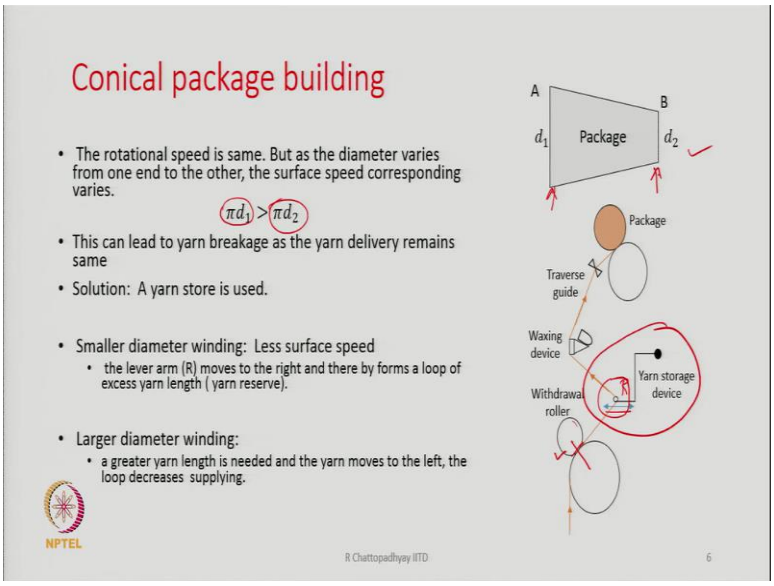

Next conical build package the issue is here a cone is shown the two edges ‘A’ and ‘B’ and at the edge ‘A’ the diameter is ‘d_1’ the package and the edge ‘B’ diameter is ‘d_2’. The package rotates at the same rotational speed, but as the diameter varies from one end to the other the surface speed correspondingly varies. Here also the conical package is driven by the winding drum and the package rotates at a speed, but at a particular speed at any instant of time at that speed the circumferential speed at ‘d_1’ and ‘d_2’ are going to be different.

And at ‘d_1’ is going to be more than the ‘d_2’; that means, speed correspondingly varies because circumferential area are different ‘πd_1’ is more than ‘πd_2’ whereas, the rotational speed which is ‘n’ is constant. This can lead to yarn breakage as the yarn delivery remains same. So, solution is we need a yarn storage and the yarn needs to be stored. So, along the path length of the yarn starting from the withdrawal roller or delivery roller to the package here we should must have a kind of system.

So, that a little bit of excess yarn can be stored and for that what we have is this, as it is shown here yarn storage device could be there small diameter winding so; that means, when I am winding on the smaller side; this side is being wound what happens if you look at this path length of the yarn here is a lever the lever arm is let us say ‘R’.

The lever is fulcrum over here and the yarn is made to pass over a guide and the guide is connected to the lever itself. And the lever and the lever arm can be pulled towards the right hand side and also it can move to the left hand side as shown here by this blue arrow, that is, it can go or you can say; you can say you can little bit of swinging action is there with because of the lever. So, lever yarn will move to the right and thereby forms a loop of excess yarn length when I am winding near the smaller diameter.

Because this time the surface speed has reduced and if I and if I am continually I am withdrawing the same length of yarn because the speed of the withdrawal roller this roller remains same. So, whatever is pulled out from the rotor is same length, but I am now when the thread guide has gone towards the smaller diameter package is actually asking for little lesser length of yarn, but I am feeling the same length.

So, there is going to be an excess amount of yarn this excess amount of yarn is actually then taken care of because the yarn has been pulled towards the right hand side. So, this loop is going to increase and thereby it will be taken up, excess length will be consumed because the lever is going to pull towards it; when the reverse is happening that the thread guide has gone towards the larger side now the package will looking for more yarn.

And hence the lever arm will move towards the left hand side and the extra yarn length will be then supplied. So, by having this particular you know yarn storage device you can say will be able to build a package, which will be having which will have uniformity in terms of its you know we can say the density of the yarn and we will be able to avoid the end breakages because the yarn will be either too tight or some time the one edge it will be too tight.

And the other edge it will be too it will be little softer because the tension in the yarn cell will going to vary as it moves from one end to the other end. So, the tension variation is going to be is going to minimized by having this yarn storage device.

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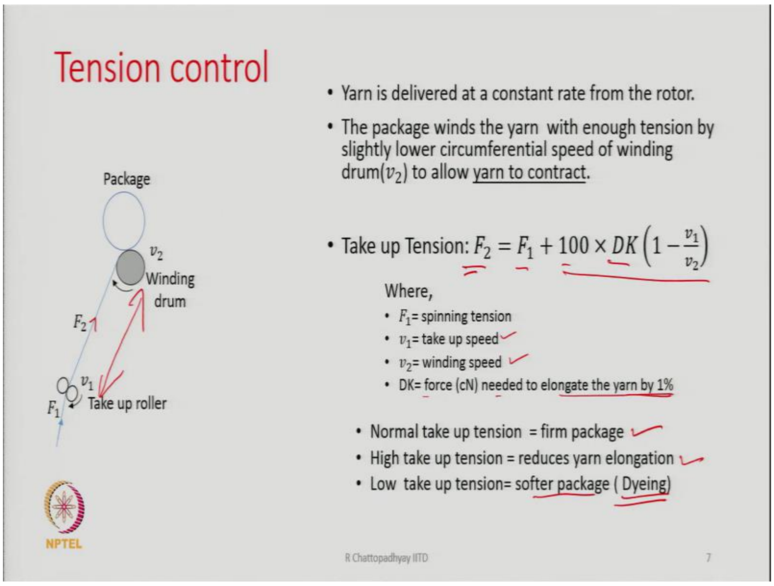

Besides this we have a special tension control also is there in the machine because we need to form packages of different density depending upon the end use of the package sometimes some packages we want to dye. And in order to ensure that the dye liquid can flow easily in all the layers of a package, the package density needs to be little lower. If the package density is very high then the in the dyeing process, the dye may not be able to penetrate fully into the inner layer of the package.

And therefore, there could be a differences in the depth of the dye shade that we get from the surface to the core of the package. So, therefore, we need sometimes if the yarn is meant to be dyed in the package form we have to go for a soft package or sometimes we need to produce a hard package; hard package yarn content can be increased.

So, how do we make that for this as I said earlier that ultimately the tension is mostly decided by the draft between the package and the take up roller that in this zone how much draft we are keeping. This take up tension 'F_2' the tension in this part of the yarn 'F_2' is

$$F_2 = F_1 + 100 \times DK\left(1 - \frac{v_1}{v_2}\right)$$

Where 'F_1' is the spinning tension as we pull the yarn out from the rotor speed, 'v_1' is the take up speed and 'v_2' is the winding speed and 'DK' is the force needed to elongate the yarn by 1%. This formula has been stated by some author and take up tension can be decided if we have the values of 'F_1' and 'v_1', 'v_2' and the 'DK' is the force needed to elongate the yarn by 1%; that means, we need to put the yarn under little tension if the yarn is not under tension during winding then the package is going to very very too soft.

So, we have to wind the yarn under some tension and this is how the tension can be adjusted. So, normal take up tension creates firm package, high take up tension will reduce yarn elongation and low take up tension will make a softer package which is used for dyeing of the yarn in cheese form or in cone form.

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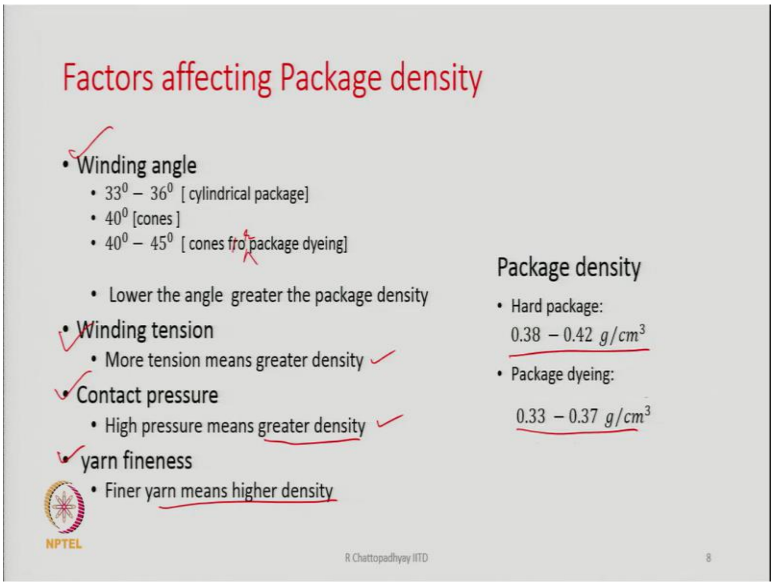

Now, factors affecting package density typically the winding angles are 33 to 36° for cylindrical package, 40° for cones and generally 40 to 45° for cones for package dyeing. Lower the angle greater is the package density, the winding tension more tension means greater density.

So, by if I want to go for a high density package then I have to go for higher winding tension and that can be adjusted by adjusting the speed of the take up roller and the package and the drum or the package. The other thing that affects package density is the contact pressure; high pressure means greater density. So, the packages are resting in an arm and the arm is basically acting as a lever and the arm holds the package and press it down against the winding drum.

Therefore, how much pressure is applied by that drum by that sorry lever which is holding the your the package and then pressing it against the drum that contact pressure also has influence on the density of the yarn within the package. Otherwise finer yarn also means high density the yarn become fine the density also increases because there will be more number of layers within the package. Coarser yarn the number of yarn layers for a given for a given weight will be less.

For the same weight, If I want to make a package from finer yarns the package there will be more length of yarn there will be more number of layers and at the addition of more and more layers the package density is going to increase that is why yarn fineness also play a role in package density. So, winding angle is one factor, winding tension is another factor, contact pressure; force with which we press the package against the drum is another factor and the fineness of the yarn is another factor.

So, many factors are there which can affect the package density. Typical density is stated here these are some value that has been now given or reported by some authors. So, we are using this values as suggested by some authors with this we close this discussion that is the package formations.

So, the main important points regarding the package formation is that the winding unit is basically very very simple in terms of constructions and what we have is basically a winding drum and a package rest on it then there is a thread guide, which will continually oscillate and lay the yarn. And there is a bow over which the yarn will continuously move from one end to the other end of the bow and then there is a take up roller withdrawal roller which will pull the yarn out from the rotor.

So, all these elements makes the winding unit and in the winding unit we are concerned about the quality of the package where, we have to see that there should not be any patterning. The second thing is we will try to adjust the package density depending upon the end use of the package and we want to make some sometimes soft package which is meant for dyeing operations.

Otherwise we will try to go for normal package or hard packages the point is harder the package more will be the yarn content. So, from the yarn content point of view hard package is good because it will contain more yarn, but if that yarn is meant to go for dyeing then it is bad. The other thing is the all the packages that we have should have almost similar length of yarn. So, that the wastage of yarn can be minimized this is something which is very important and the industry has very much concerned about the yarn wastage during winding operations.

So, that; that means, that the content in terms of not only weight, but the length part in each and every package should be very close to each other; too much differences mean lot of hard yarn waste. And yarn at this stage cost a lot because we have already gone through all the processes. So, more is the you know hard waste we produced more loss will be there for the industry. So, with this we close this particular session learning and.

Thank you very much.