**Technical Textiles**
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**Lecture - 07**
**Textile Reinforced Composites (contd.,)**

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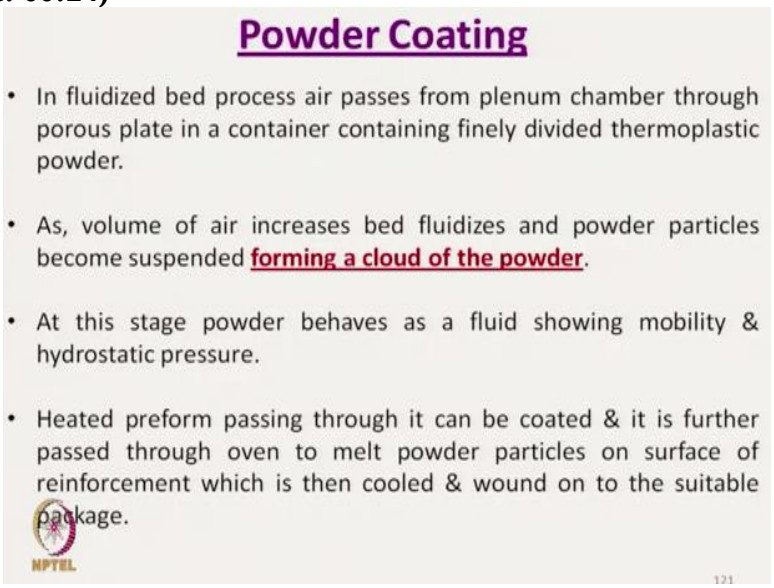


Hello everyone. We will continue with the powder coating technique for manufacturing textile prepreg. So, as I have mentioned already powder coating is done using fluidized bed. So, in this method which has been discussed already that the air is passed from plenum chamber through porous plate in a container where powders are present, powder of thermoplastic polymers are present and once the air is passed through the porous plate it forms basically cloud.

And there will be mechanical adhesion so, this process has its own limitations, because of mechanical adhesion, the powders may come out from the surface. So, in addition to this powder coating, the fluidized bed powder coating, there are a couple of modifications in this methods this I will discuss.

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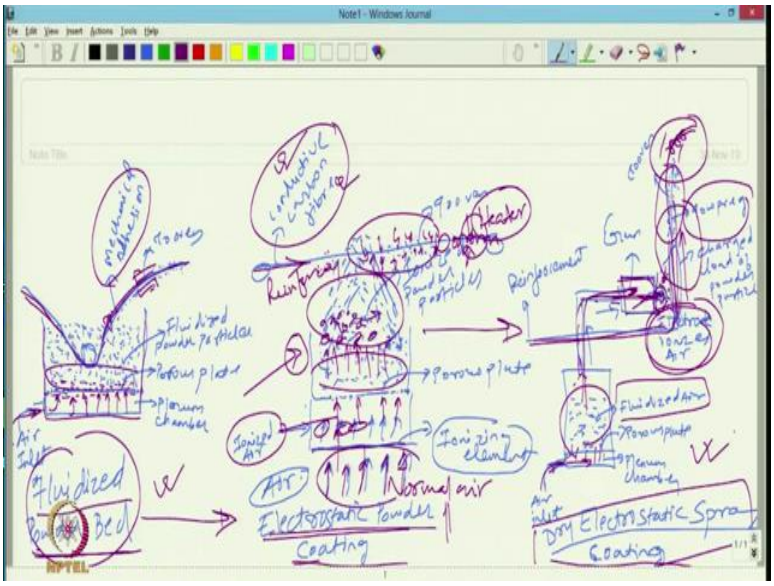


So, if we see the technique which you have discussed here, it is a fluidized powder bed. In this technique, there is a porous plate and over the porous plate the particles initially were present particles of thermoplastic polymer like polypropylene particles, there are different particles are present. And below the chamber, below this particle container, there is a plenum chamber. In the plenum chamber air enters and when this air passes through the porous plate.

Enters through a porous plate and this, the particles actually it has been fluidized, this air fluidize the powder particle and through this fluidized bed the reinforcing filament is passed and the adhesion here is basically based on mechanical adhesion, there is no other force of adhesion. So, to have proper coating, we have to immediately pass this coated filament through the heater so that the thermoplastic particles melted and cover the reinforcing filament.

Another development of this fluidized bed technique is electrostatic fluidized powder coating. In this method, air flows through the ionizing elements. So this ionizing element is responsible for ionizing the air. So, this is normal air and when it is passing through the ionizing element, it becomes ionized. So, once the ionized air passed through the porous plate and this the fluidized bed here, the particles when its particles are fluidized and as these particles are fluidized and the air is also charged these particles will also be charged with the same charge.

And, as these particles are charged they will start repelling each other and it forms a cloud and another component which is the conductive component of fiber that is the reinforcement

component, reinforcement component. This component, it has to be conductive in nature so, this due to this conductive nature, this charged particle will get attracted on the surface of carbon fiber, typically carbon fibers are used here or any other conductive fibers we can use.

So, these fibers are, these particles are deposited on the surface of the reinforcing fiber, carbon fiber and it is almost uniform and after that before the decay of the charge this is passed through the heate, so that the thermoplastic components are melted and covered this reinforcing filament. So, looking at all this advantage, so this result much better covering as compared to fluidized powder bed. Another method, electrostatic spray coating has been developed.

Here, the air is not being charged initially. The fluidized bed, here the air enters into the plenum chamber through the porous plate it enters into the fluidized chamber fluidizing chamber. So, this fluidized air is being pumped, here we use air pump, it is being pumped to the electrostatic gun where this air with the particle enters through a venturi system and this is a electrostatic electrode it is ionized air through the gun, the air is being charged.

And here mainly the cloud formations are there. As again the ionized air, it is charged the particles, particles repel each other and forms cloud and it is coated. Again here the reinforcing fiber, reinforcing filament, we need a conductive filament. If we do not use conductive filament, we have to make it conductive at least temporarily to have the proper coating. So, this charged cloud powder through this charged cloud of powder, the reinforcing filament is passed.

And then it is covered with the particle, towpregs form, then it is passed through the oven where the particles melted and cover the filament. So, looking at all these 3 techniques, this electrostatic spray coating is the technique which has got is actually promising future to make the towpreg which is flexible in nature using powder coating.

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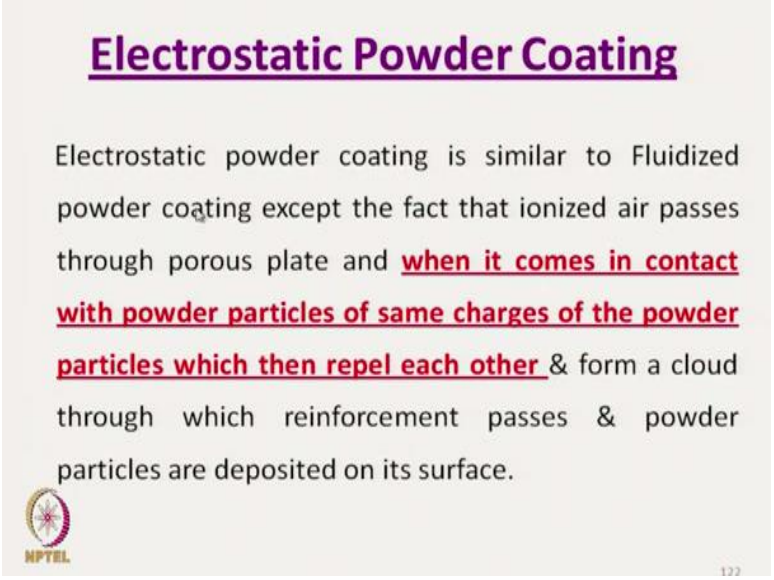


So, as I have already mentioned that electrostatic powder coating here the electrostatic powder coating is similar to fluidized powder coating except the fact that ionized air is passed through the porous plate and dry electrostatic spray coating technique.

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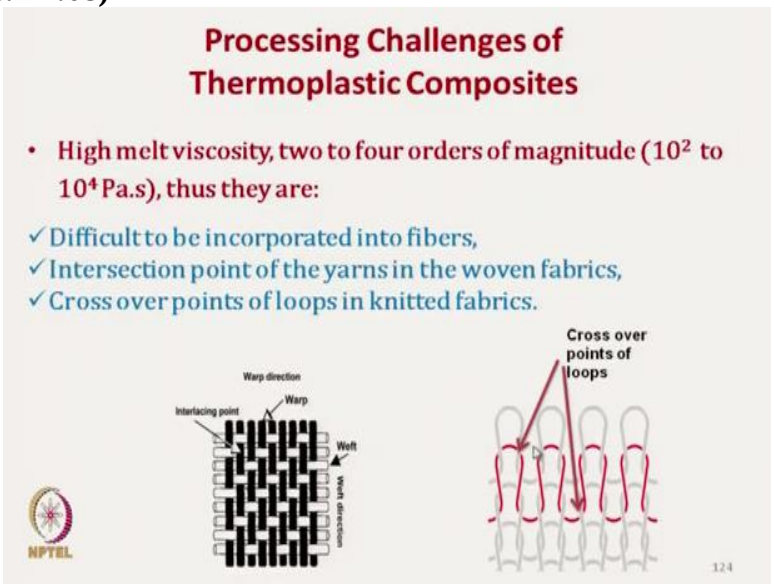


That, these challenges of thermoplastic composite that we have already mentioned, difficult to be incorporated into the fiber due to high melt viscosity. So, at the intersection of woven fabric and knitted fabric in between yarn in between loops.

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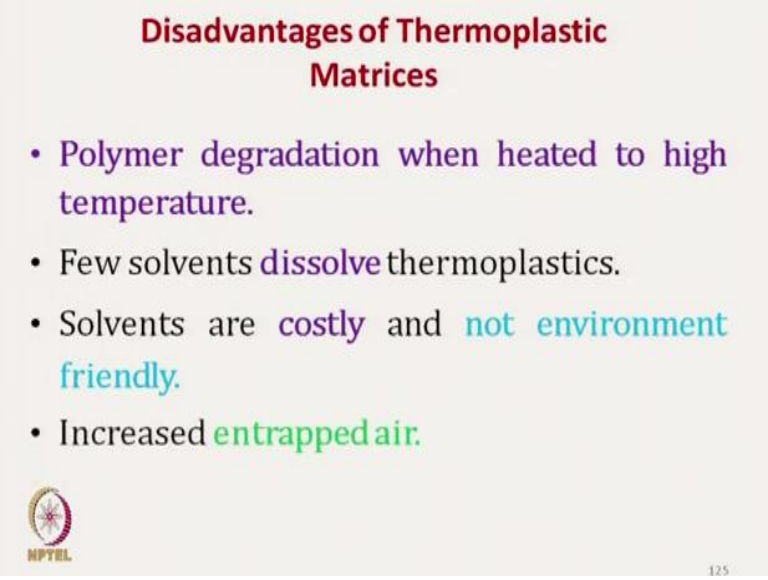


So, polymer degrades at high temperature, it is not normally dissolved because few solvents are they are not ecofriendly and due to that this entrapped air the void content becomes very high.

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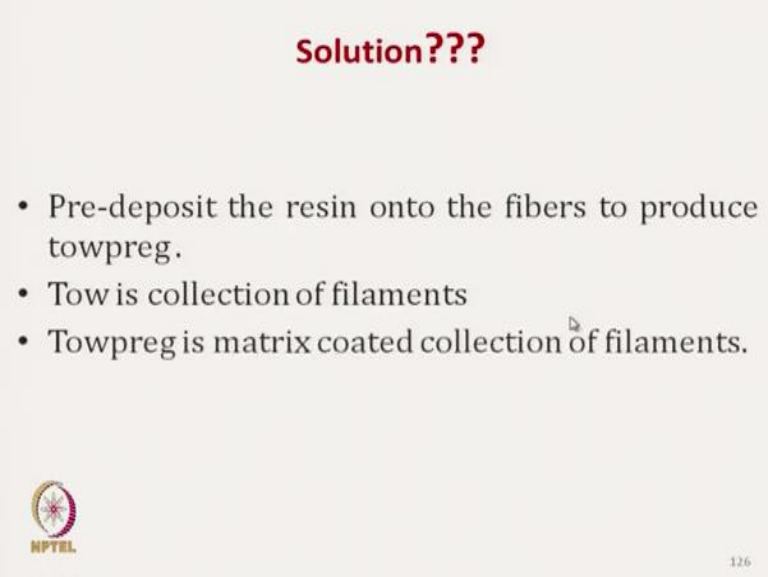


So, the solution is that pre-deposition of resin in the, to form the towpreg. So, the resin is pre - deposited on the filament surface. So, tow is a collection of filaments and towpreg is a matrix coated collection of filament.

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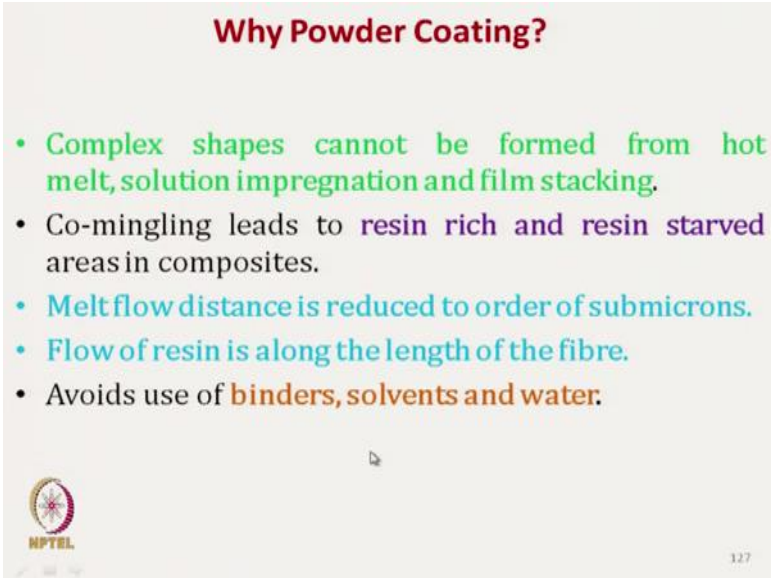


The powder coating is important, because complex shape cannot be formed from hot melt solution impregnation and film stacking technique. Co-mingling as I have mentioned that it has got its problem of resin rich and resin starved areas. So, here the melt flow distance is reduced to a submicron level so, in fact there is no melt flow distance required. Here the flow of resin towards the length along the length not across the length, here we do not use any binder, solvents or water.

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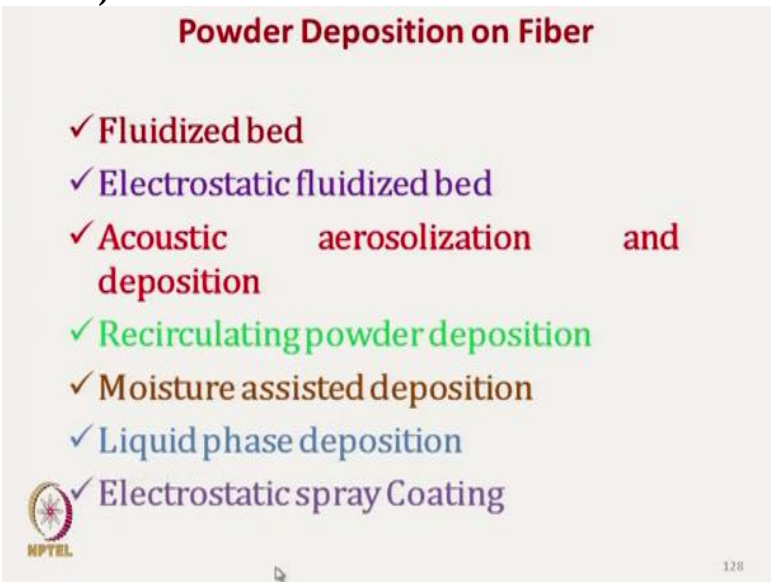


So, these are the 2 techniques we have used, discussed fluidized bed, electrostatic fluidized bed, acoustic, aerosolization and deposition is also there. Recirculation powder deposition, moisture assisted deposition, liquid phase deposition. These are the powder deposition techniques and

electrostatic spray coating. So, now, I will discuss the electrostatic spray coating, which has already been discussed a little bit.

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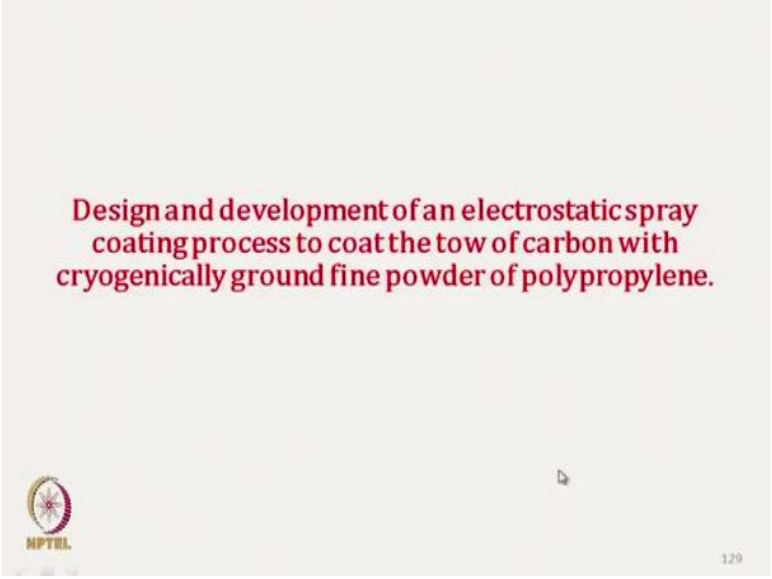


Here, I will discuss the development of this technique, the powder which is used it is cryogenically grounded powder fine powder of polypropylene.

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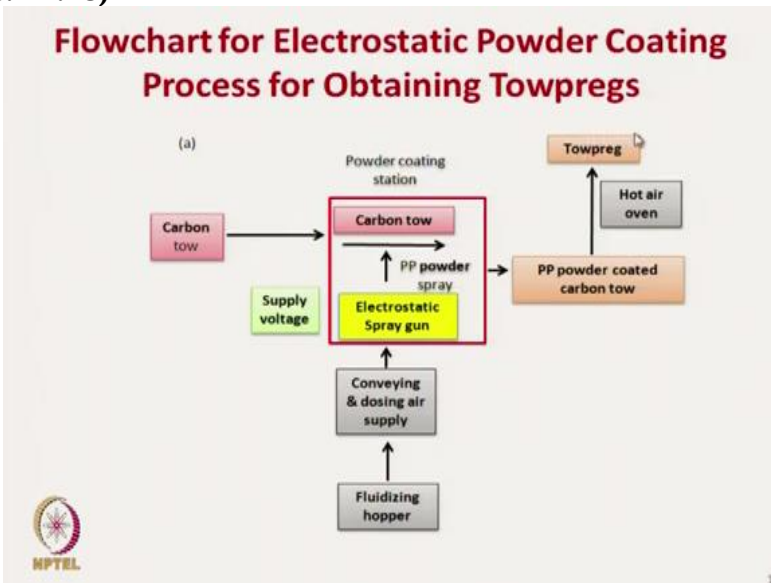


If we see the flowchart for this method, that is electrostatic powder coating process, carbon tow is used that is multifilament carbon, fluidized hopper, conveying and dosing air supply. So, then after that the electrostatic spray gun. So, this electrostatic spray gun, it charges the particles which is coming from the fluidizing hopper and forms cloud in this one and this carbon tow is covered with the polypropylene powder.

So, polypropylene powder is coated with the carbon tow, it is coated carbon tow and after that it is passed through the hot air oven, which forms that open. This towpreg is very flexible in nature and we can form the woven fabric or any other textile structure out of that.

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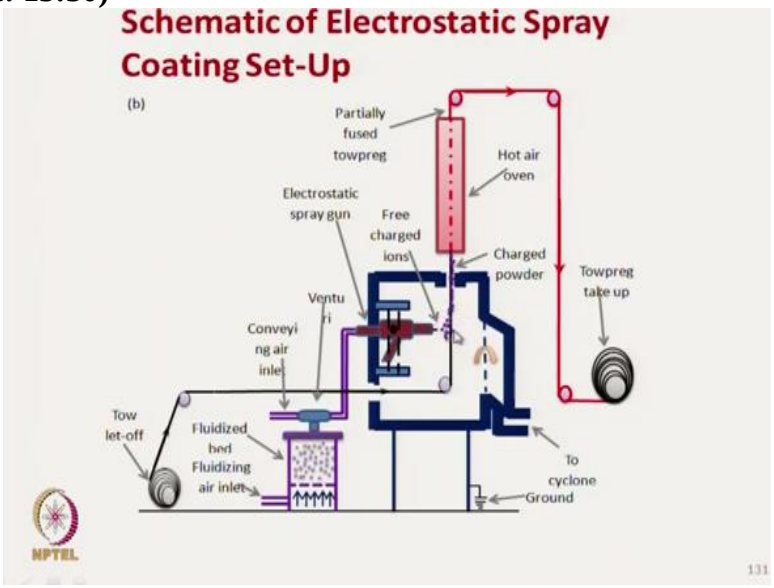


Now, if you see the schematic diagram here, this is the tow, it is a carbon tow in our case and here, this is the air inlet, plenum chamber as I have mentioned here and this is fluidizing bed and this is the venturi. So here the conveying air inlet is there at high pressure, this venturi and air pressure it helps the particles to pass through this path and enters into the electrostatic spray gun, where the particles are being charged.

And this charged particles are deposited on the surface of the filament carbon filament and immediately after that it is passed through the hot air oven so, partially fused towpreg, then ovened on a package so, this is used for making the preform.

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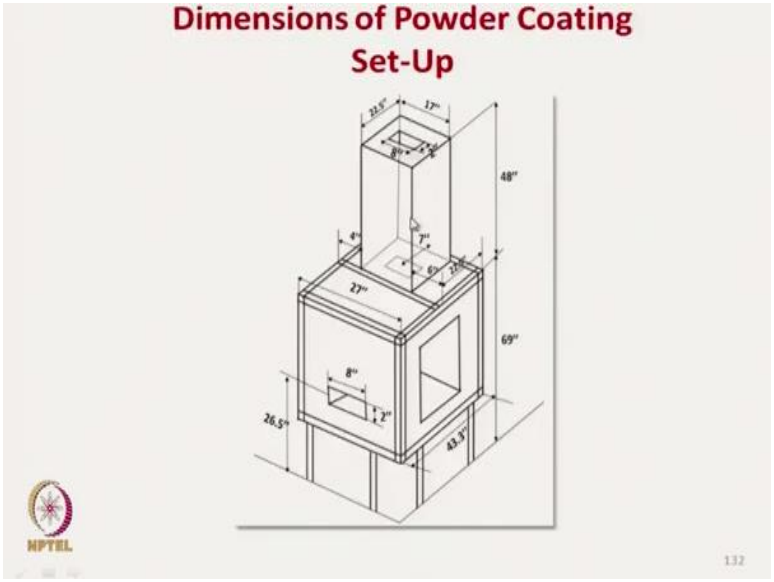


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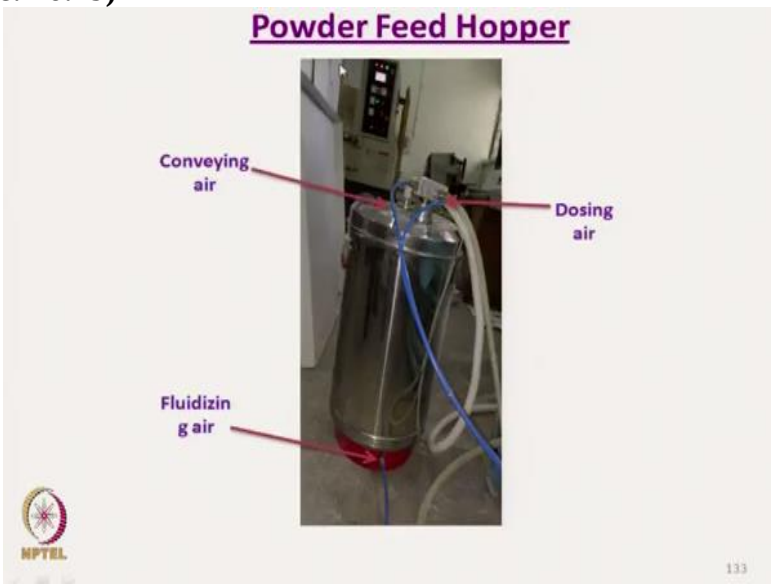


This is the chamber powder coating setup. Here, powder feed hopper, this is the powder feed hopper. So, conveying air is there producing air at this is the fluidizing air and this is the dosing air.

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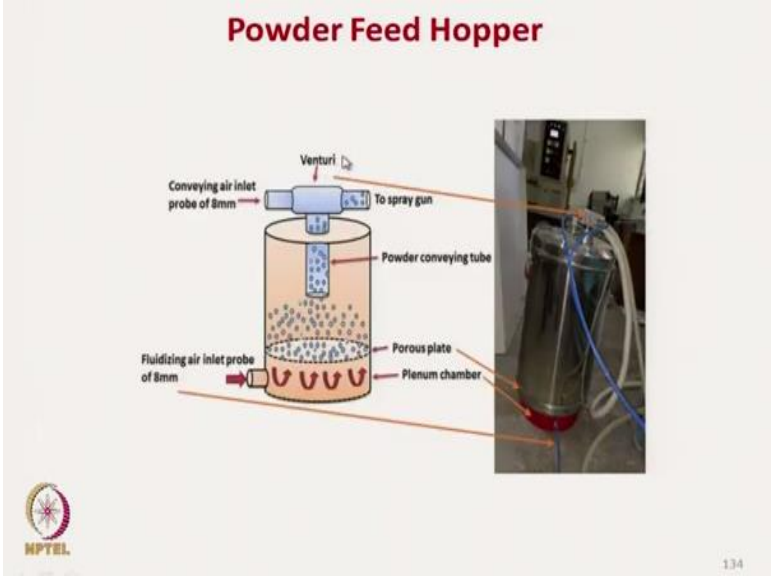


If you see this is the venturi it has got its so here this is the fluidized bed, porous plate and here it is a plenum chamber and this powder is being conveyed and to the it is going to the spray gun.

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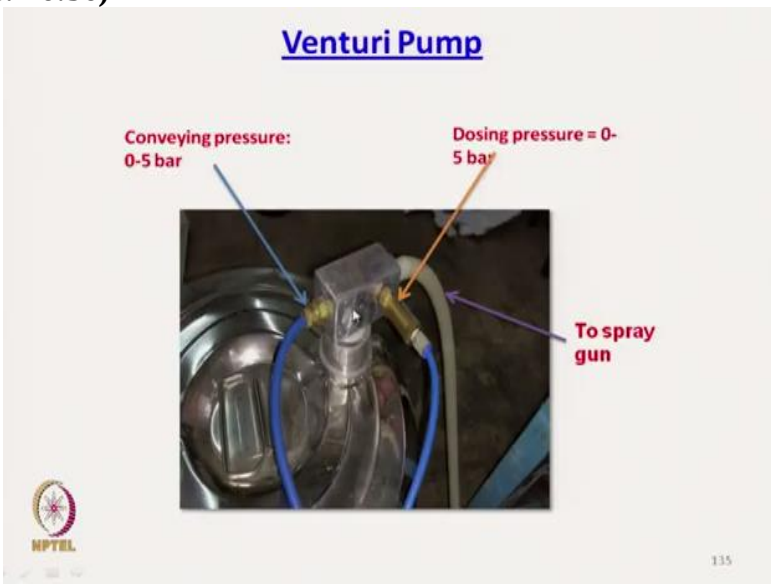


This is a venturi pump conveying air pressure, so this is the pressure range 0 to 5 bar dozing presser and it is going ultimately to spray gun. It has got 4 sources this is coming from this fluidizing chamber.

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And here it is an electrostatic spray gun where the particles are being charged. So, in this at the tip of the electrode it is actually creates 30 to 100 kilo volt charge is created depending on this charge the particles are being charged and clouds are formed.

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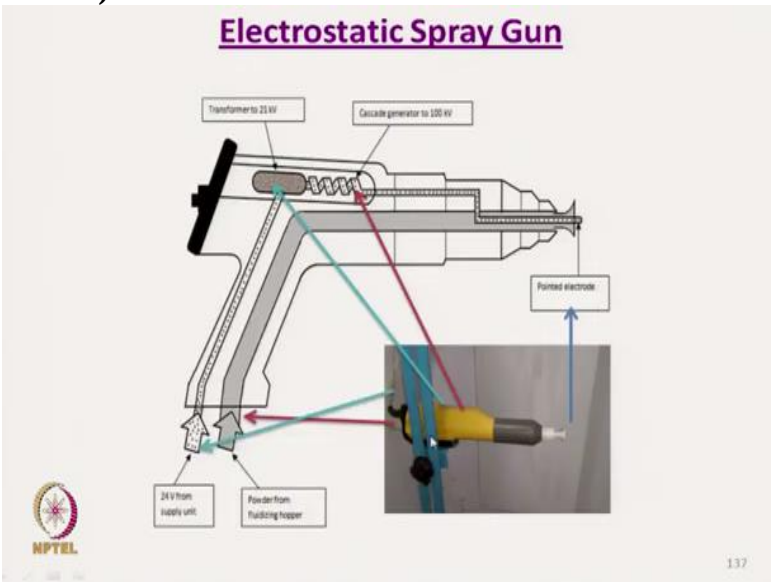


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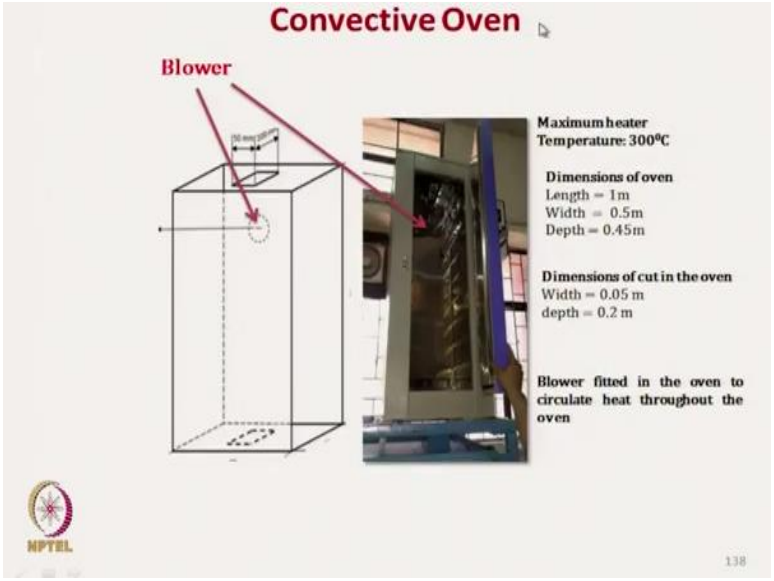


This is the internal structure of the spray gun. And the convective oven so, here maximum heated temperature is 300 degrees Celsius, the dimensions are given here length is 1 meter width 0.5 meter and depth .45 meter is the dimension. So, when the coated filament passes through this chamber so, powders are melted.

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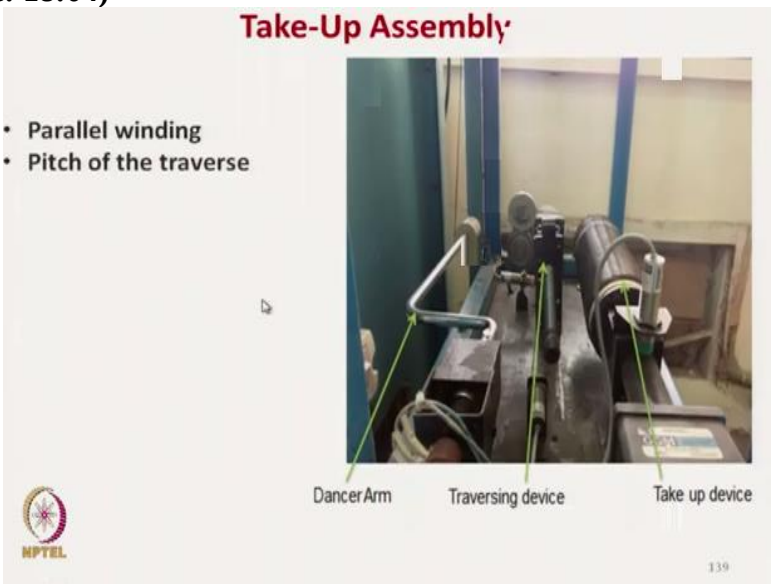


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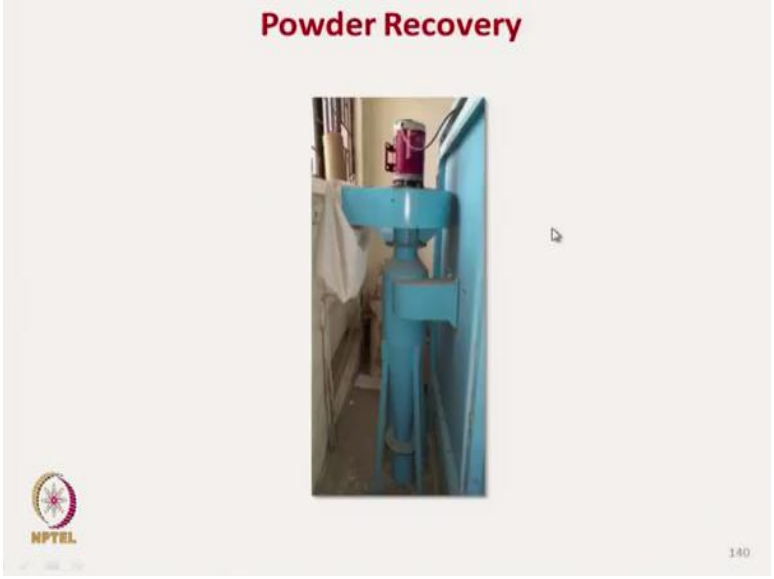


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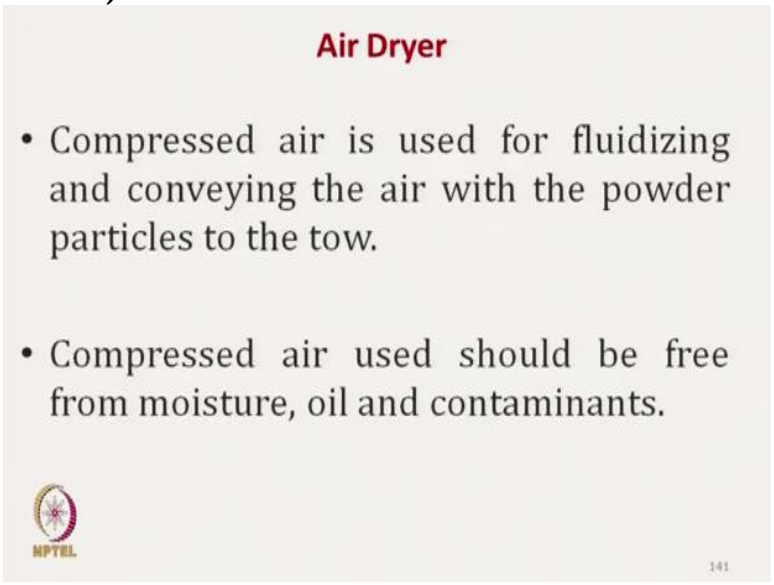


Here is the Take-Up assembly, the parallel winding, powder recovery. Air dryer is important because compressed air is used for fluidizing bed and conveying the air with proper particle to the tow, which is important the compressed air use should be free from moisture, oil and contaminant. So, if moisture is there in the air, then that will actually reduce the efficiency of charging or powder agglomeration may be there so, we need properly dry air.

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So, this is the total fiber powder coating setup.

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Let us see the running of the instrument, here this is the carbon tow, so the let-off arrangement is there and here it is moving here this is the coating chamber. Now, this is entering to the coating chamber, this is the spray gun. Now, as you can see clearly the cloud is being formed and the powder is coated by the powder. Filament is coated with powder and immediately after that it will pass through the heater where this will be melted, this is the heater chamber.

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So ultimately will form the towpreg and what has been observed this towpreg by this powder coating technology it is very flexible. Now in the next class, we will discuss another technique of composite manufacturing. It is a thermally bonded roving structure, which is actually the natural fiber, how from the natural fiber, we can develop unidirectional composite so, this technique I will discuss in next class. Till then thank you.