Module 25 - Lecture 16
Inkjet Printing

So, we continue with, Advanced Textile Printing, in which, we are talking about exit printing.

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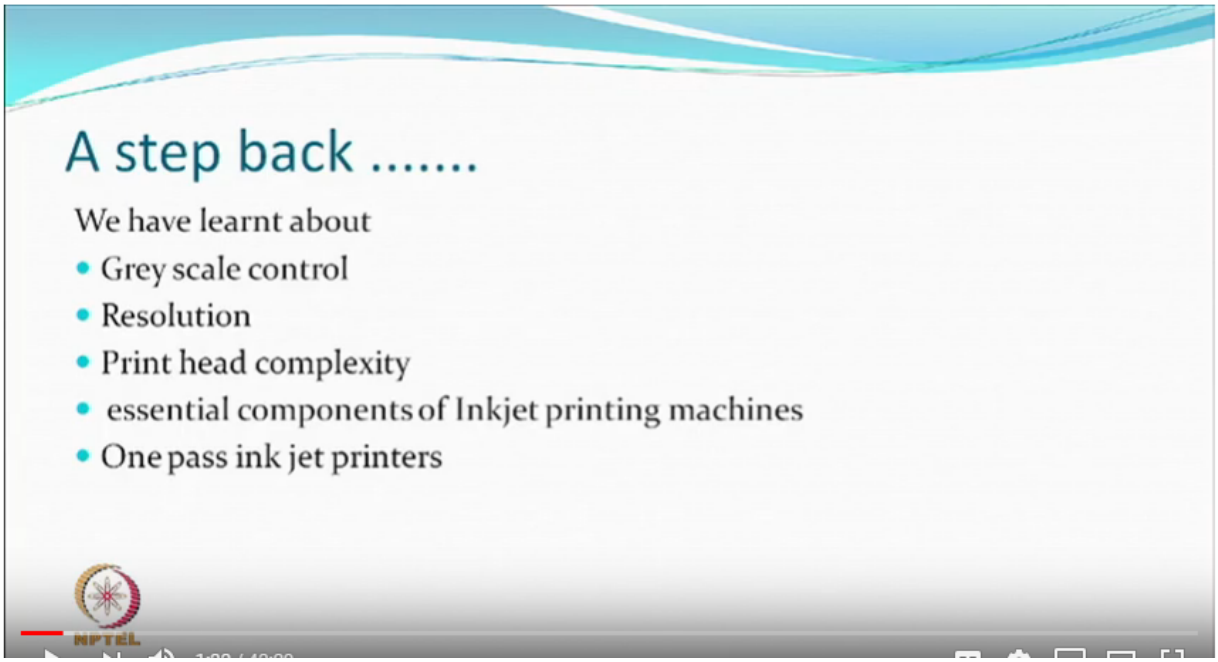

So, what we learned last time was that, the grayscale can be, controlled, by the size of droplet, resolution, is more dependent on the print head, design and the requirement that we have, printed by itself is very complex from electronics point of view from, the actuators that you use whether the thermal or piezo and we just saw that an normal exit printing machine, of course is a heart and main machine, but it is supported by, a feeder dryer and soon so forth and now we are looking at, the possibility, of one passing jet printers ,what it means is that your, printing head and the carriage, is going to be stationary and so, the speeds can be very fast, we'll spend some time, on the cost, of this printing.

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So, we say that the main difficulty, people have been facing is the cost, that we discuss in the early days that the percentage of production, happening where this technology, is quite low, we hope that it increases in coming future and one of the thing which has been responsible, is the cost, while as the speeds, of printing are increasing and if you look at, at one pass type of machines, then we may expect the cost to be very, very low or absolutely comparable to any, other technology and once that happens, then life and be different.

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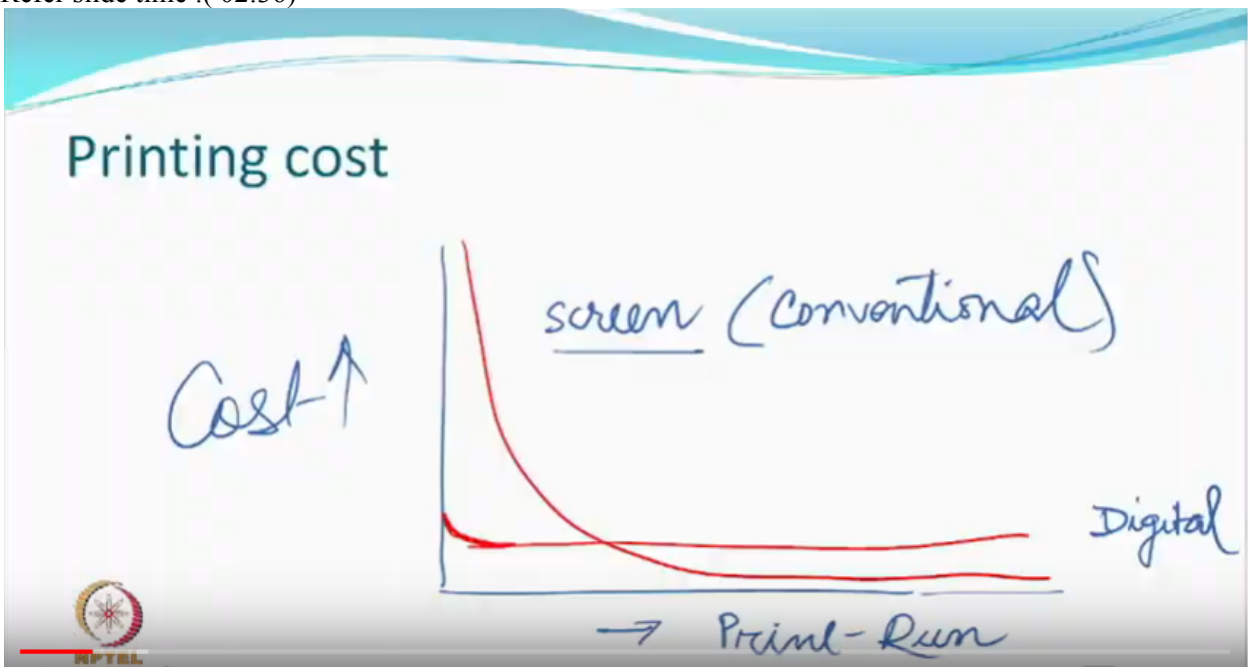

So, today the situation is that if you are having smaller print runs, 100 meters,500 meters, this is still cheaper, but when we have long runs, thousand five thousand ten thousand meters or more then a screen printing the convention, screen printing may be, cheaper because the investment, done to prepare design and screens and storages and so, on so, forth becomes compensated, it compound gets compensated the cost, of a digital printing system, which is mean the exact to the moment is basically constant. So, it was a very, very small, going a piece good then maybe it is little higher, but after that it doesn't matter. So, you print more or you print less, the Machine ink that is required is, based on the design, design remain constant, the ink cost of the ink may not change at all, of course there will be something, else to be considered also. So, that's the advantage of, this and if actual, speeds become high and the only thing which you want to compare, is the screen printing, the roller flatbed screen, not so, let's say attractive, rotary screen is definitely very attractive till now.

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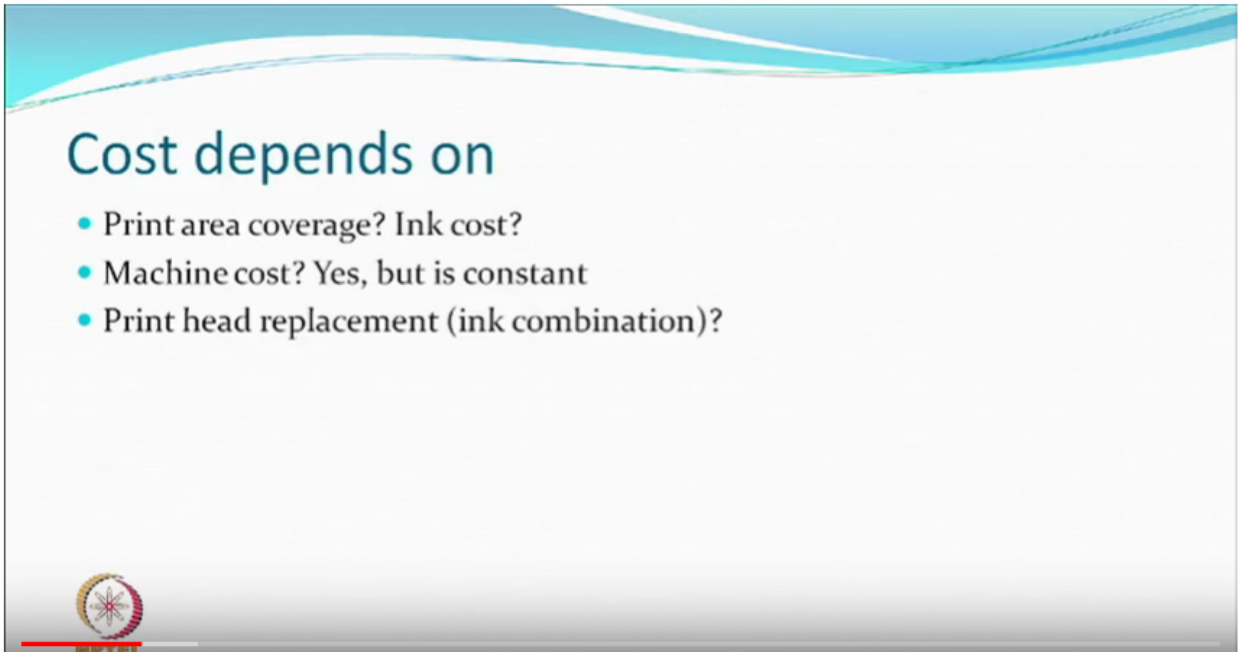

So, the cost of the printing, depends on the, print coverage area, 20% coverage, rest is plank, versus 60% coverage and that, has something to do with the ink cost, you will be using more ink, as such use very less amount of color, your wastage is very, very of anything else, most of it whatever is like a part of a drop, has some other solvents and chemicals, but mostly, it is ink and the ink is concentrated and so, it is used. So, it's effectively, based on average, the cost due to ink, ink by itself is costly that's one part, but it, it is required very less also machine cost, you bought whatever we are bought initial investment, that's one part and so, that remains constant and obviously some project, would be having break-even values, but it don't change, the only thing that one has to consider, as a recurring cost other than the ink is the head, the

print head can get damaged, the may require, replacement there's no repair actually, it's very difficult for someone to say, well that something has gone wrong with the print head unless the top connection, only what inside something has gone wrong, something is choked so you don't have a system, to clean orifices and then say well start using it again that's, unreliable. So, it's the replacement is the one which, people work and so, it's a print head and ink combination and some print head, it's good for a certain, type of an ink and if the ink and they are compatible, the life will again behind, if you use a ink which is not recommended, by the print head manufacturer, will you say well it's Okay?, what is there it's just a reactive dye and we can make, our own ink or somebody else, makes an awning can you say, I'll use this company thing. So, you may be lucky, if everything goes. Right? If everything doesn't go right, then this combination can also be responsible for additional, costs that you will be incurring, which is nothing to do of course something to do with the production, that after a certain amount of production, of a certain amount of use, something will have to be changed.

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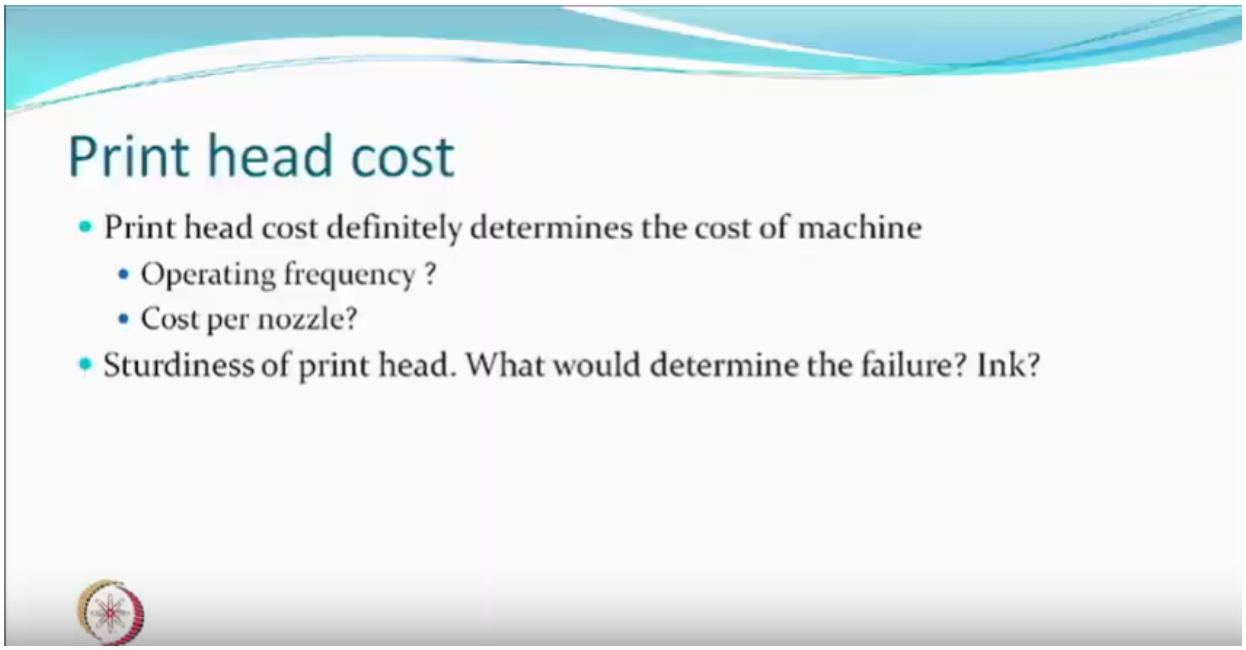

So, print head cost, determines the cost of the machine also, very sophisticated, things where everything is being controlled, how many nozzles are there and what operating frequencies, you work, all that makes the print head itself, a very costly item, how the ink is being fed? How many stations are there? Whether it'll stop sat left and right both or stops at eighty one point how many carriages are there? How many heads per carried you're carrying, all that becomes costly. So, actually is where they call it cost per nozzle, you have the operating frequency is very high, all of that actually is a substantial amount of cost and if you have to replace this so, it's not like replacing any small part of the machine, it's actually one of the bigger, part of this, this therefore becomes a garden and so, people would like to, buy things, from

very standard, companies and so, sturdiness of a print, would be always very important, why will it fail, it can fail for various reasons, maybe filtering is not good maybe, something else, has come up or maybe the ink and head combinations are not good.

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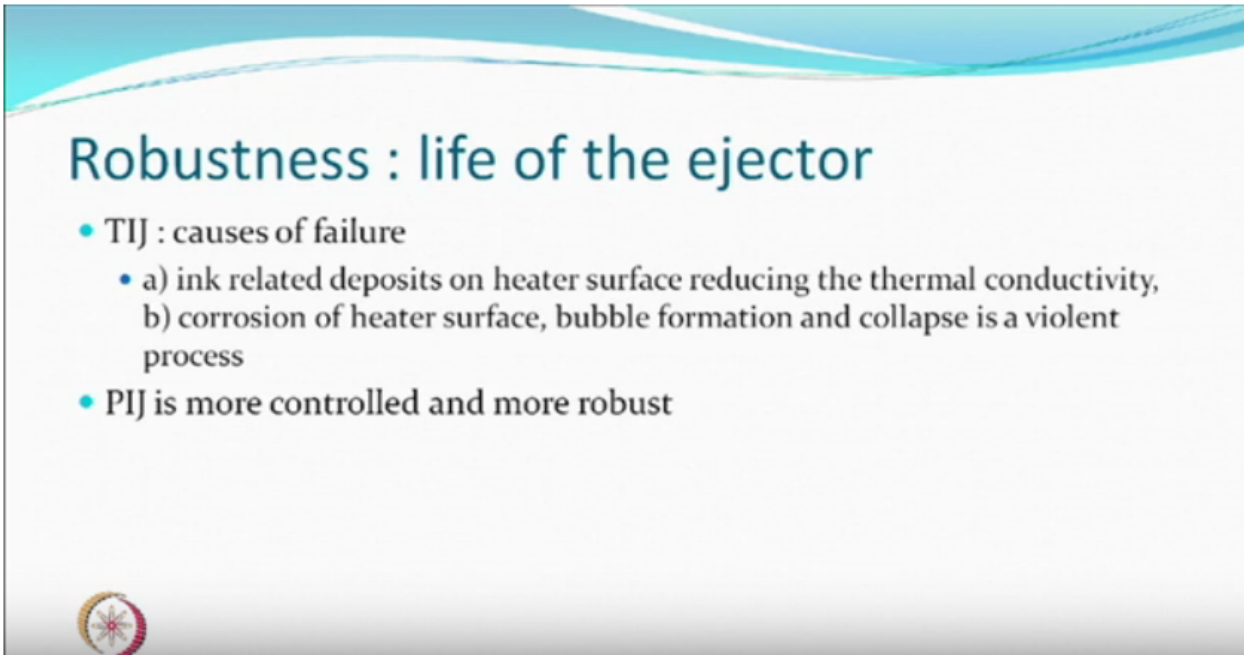

So, maybe we had talked about it before, that's like, thermal inkjet, it can fail because, there is a heater and for various reasons there may be deposits, on the heater surface, but that's part of the thing is it understood something will happen, if that's the only reason why it is there you will still be. Okay? Because once something had deposit thermal conductivity changes, are there is the corrosion of the heater surface, bubble formation and collapse, etcetera they can also cause failure, of the head and so, you may require, replacement on such type of matters the Pizzo based system, is more controlled, more robust frequency less but that also means maybe production, is also not as high and you would like to have something else, but this type of compromise, on one or the other technology people will be doing, you may not really be interested, in trying to save any cost on the ink, because ink used, is very, very, very efficiently is being use very small, but people may try and compromise, on these things depending upon, what is happening ?

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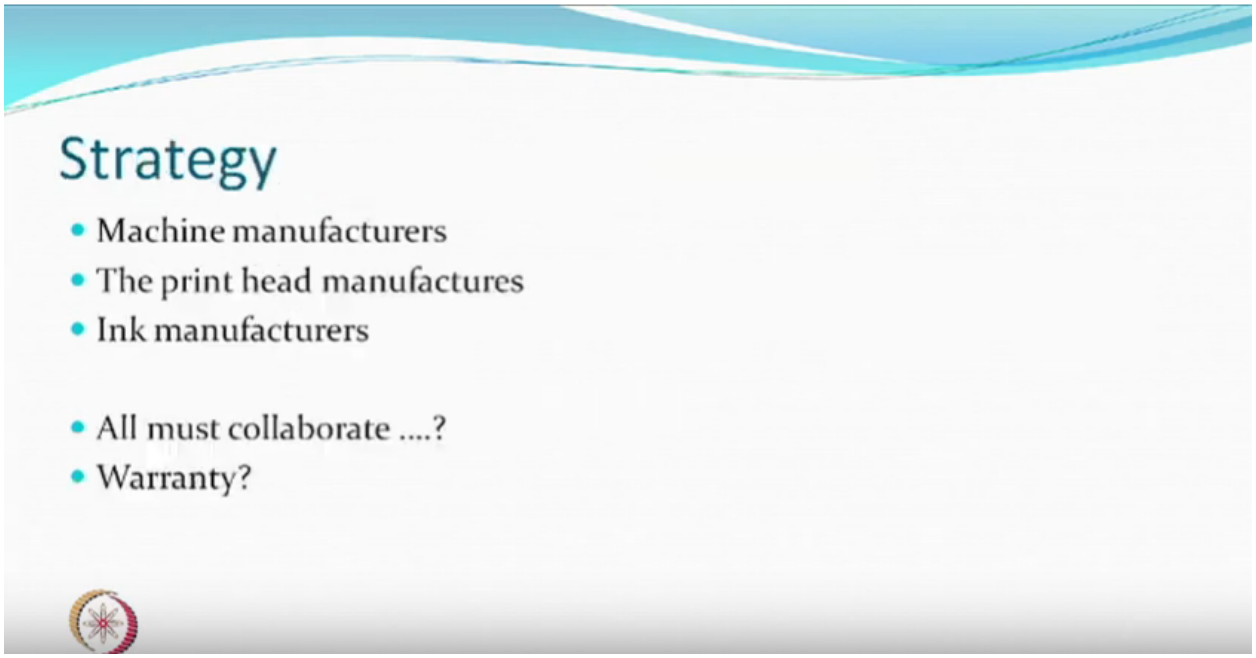

So, general strategy, is that the machinery manufacturers, may be different, than the print head manufacturers, because here the technology and complexity is much more, in a high print head compared to the rest of the machine, where you have tension control, feed a control, speed control, temperature control, that's something else, of course they appreciate, what is happening? Machine may have of course software's, which will understand, things. So, you and then the increment effectors, so, basically all the three, actually are collaborating, that if my printer has got this kind of a head, then this company will definitely has understood your requirement of the head. And so, it is not that it's a magenta, color it's actually suited, to this type of a print head technology and so, they exactly study each other, and they manufacture. So, it's collaboration, work and what it says of warranty in case, you are using somebody else's ink, then the print head guarantee may not work. So, you may call it monopoly, but it, it is called,' Collaboration', they use my ink, use my printer, use my machine. So, one machine, manufacturer uses one type of a company, which makes print heads and doesn't have to look give me any print, head I will just attach it and start using it, theoretically it's possible, but because the overall cost of the machine is high, we don't want to take such risks. So, whichever is the machine in fracture he or she open he that the company, has to make sure the arrangement with the print head and also recommend, what ink? And if you use all that then the warranty clauses are more meaningful.

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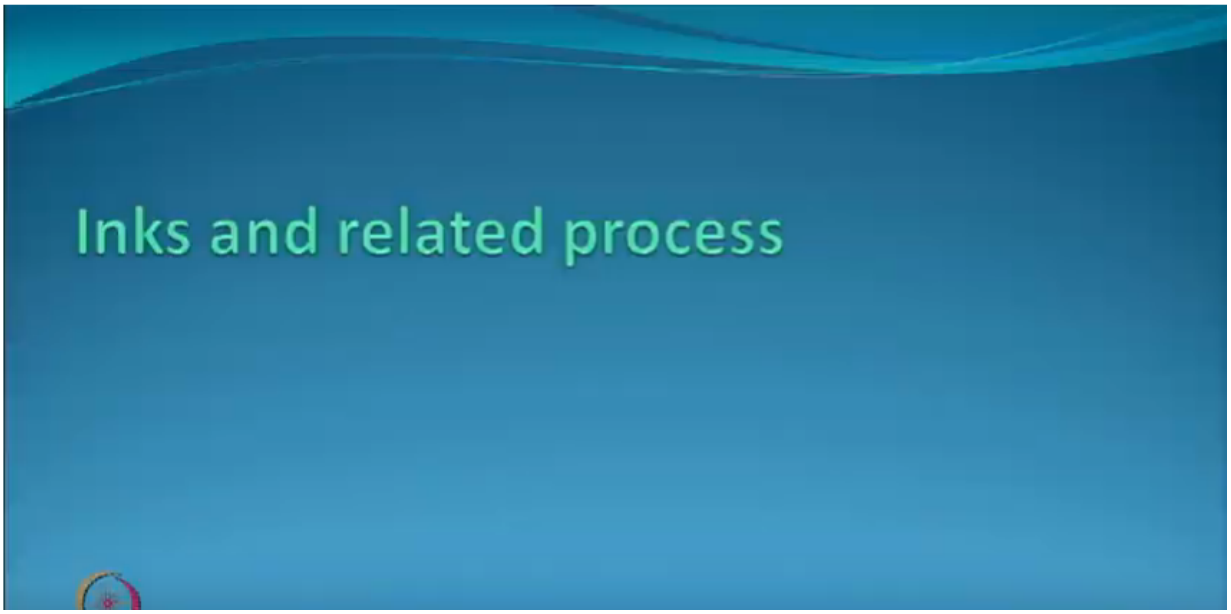

So, going further the ink and the related process

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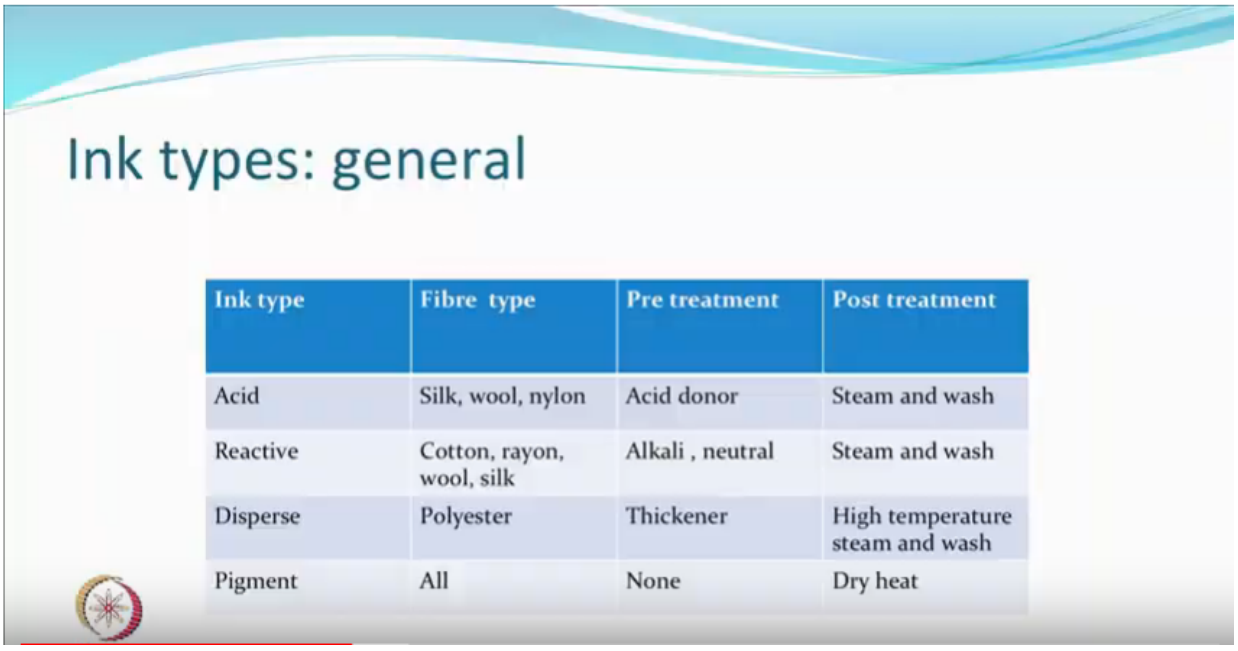

So, general the acid, type of an ink category, would be suitable for silk wool nylon, but may require a pretreatment, I made a quite a post treatment, in a pretreatment you may have some, acid latent or otherwise, being there in post treatment steaming, washing and of course drying, the reactive generally

initially were recommended for cotton and other cellulose, will but theoretically, we can use them for wool and silk and if they are being for cotton, you will be requiring an alkali and if you are only for wool and silk you may actually not require any alkali and a pretreatment and just you can still work, of course steam and wash, you may like to do, disperse for only polyester, but actually theoretically you can use it, for nylon as well, you may not use it, it requires just some kind of a thickener and possibly, some amount of dispersing, agent may be so, high temperature steam could be one of the ways in which you do it, the pigment, can be used for all types of fibers and actually does not require a pretreatment, but you may still, give some treatment, to make the surface better and most treatment, would be only dry heat for curing purposes, because there is a binder there.

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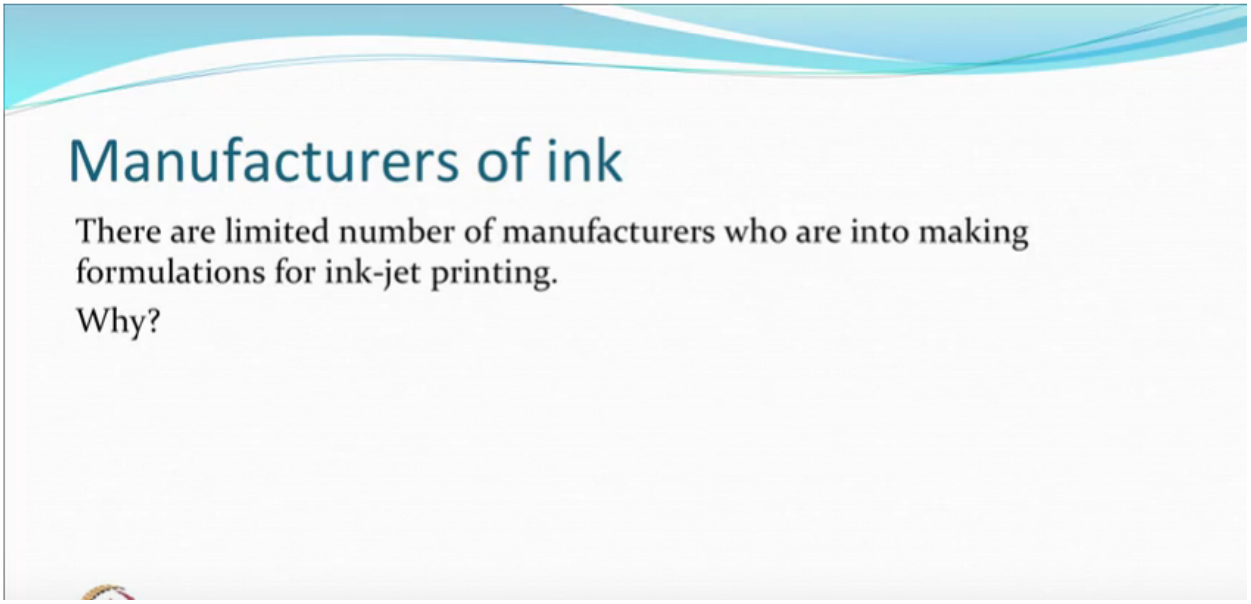

So, there are definitely less number of manufacturers, who do this formulation for example printing. So, all the dye manufacturers are not the manufacturers, for inkjet printing. So, other than the type of color, the chemistry of the colors, but there is a formulation, which as I said could be based on the type of print head somebody, is using and therefore you may be recommending that is why?

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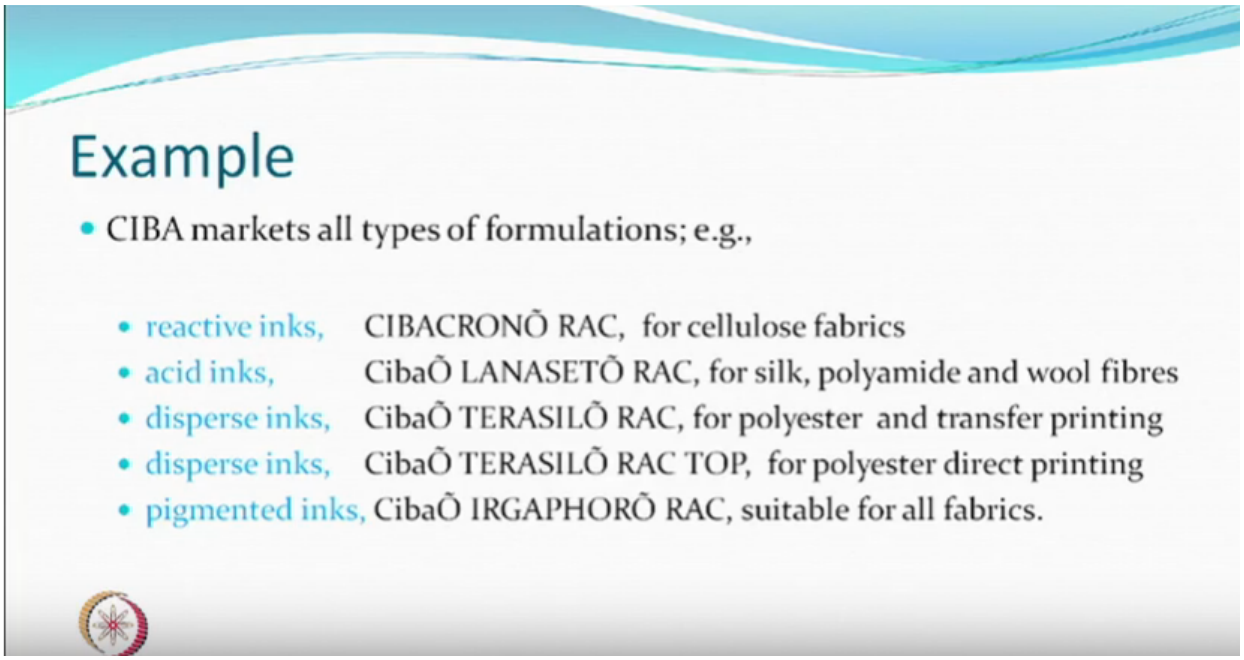

The some big companies would be making all types of inks. So, you can have reactive ink, for cellulosic soirée sir to the disperse, disperse for transfer printing because, transfer printing is not gone out, it's still there so, you print paper or directly you can print polyester or dispersed inks which are for polyester only and not for transfer printing and pigment inks. So, they all make this type of a formulation which will be available.

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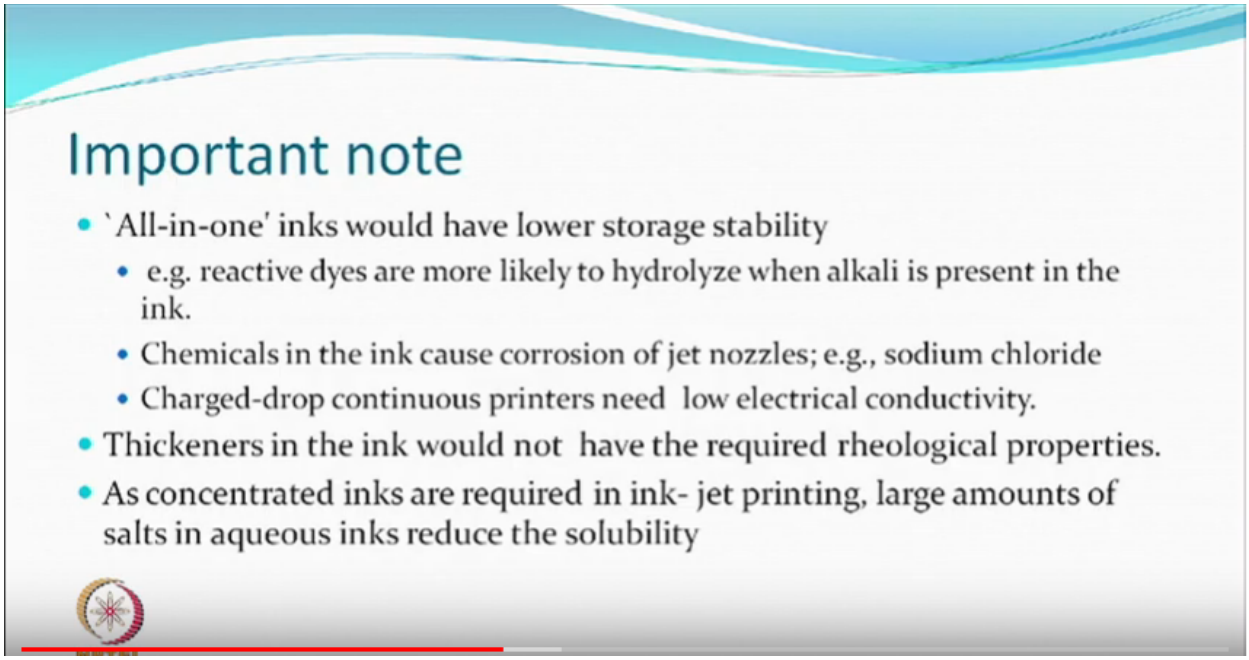

So, one thing which we almost realizing, is that all-in-one ink that means you add everything in the ink, likely to have a low storage, stability, that either you use it very quickly or don't use it throw ,that off like reactive dyes and alkali if they are present in the ink, together then there will be problem. So, you will not do that other chemical ink, you put it in the ink, could be corrosive like, global salt or sodium chloride and particularly when you are using a technology, this in continuous inkjet printers systems, we're drops are charged, they would require low electrical conductivity, if you have ions in the ink, then there will be problems. So, for various reasons you may not like, to put everything in the ink, thickeners in the ink, may not have the required rheology, because you require low viscosity. So, if at all you require some, way to control diffusion, then again, it's not a good idea to have, any of such thickness very easily, in the ink. So, realistically properties will be affected but, the rheology, which is required, is of low viscosity systems, but we still have to be controlled, as we mentioned earlier that the inks will be highly concentrated, solutions of tea or suspensions of the dye or a pigment. So, if salts are present other than corrosion and other thing, they reduce, solubility of the, dye and so, but will in the ecosystems. So, all in one, cannot be considered as a good idea.

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And so, we are working on what we call as a pretreatment.

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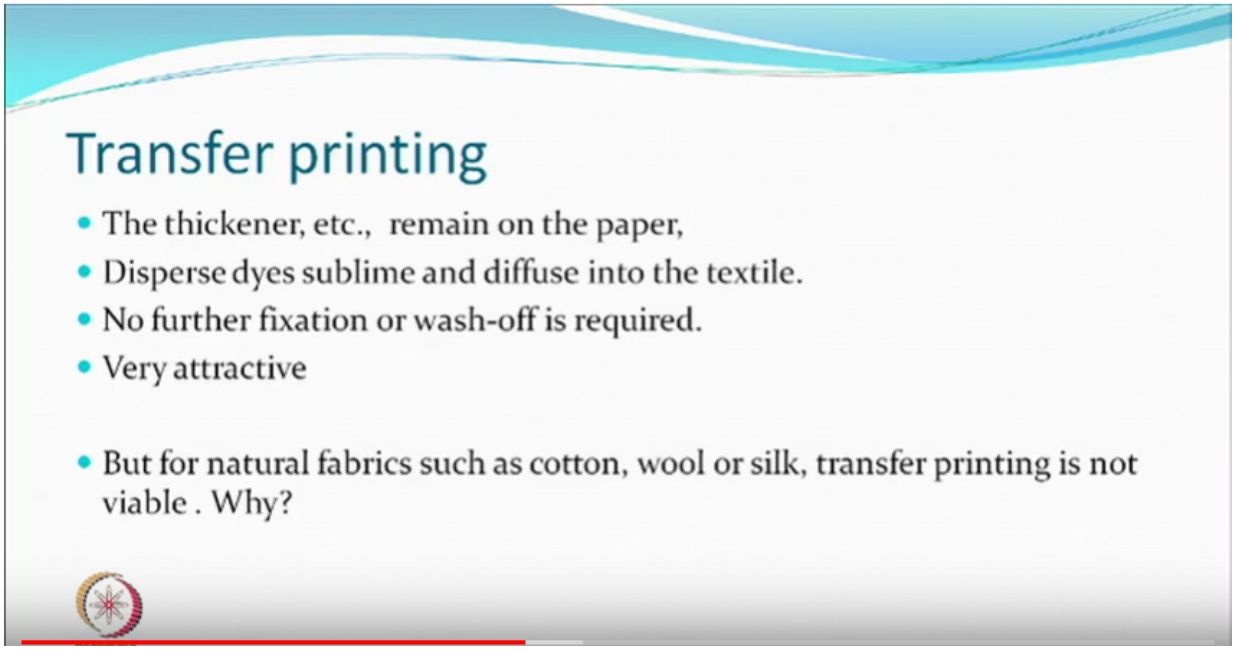

So, we remember that from, the inkjet point of view photo image, point of view the transfer printing, was a clean technology, that means, the thickener was on the paper, nothing to do with the fabric, dispersed dying would sublime diffusion to textiles, no further fixation or wash off is required. So, very attractive except that the cost of the paper and what to do with after using the paper was the issue. And another issue of course, that natural fiber fabrics such as cotton, wool silk the transfer drinking was not viable of course, we thought about wet transfer printing, but commercially has not been very successful and most of us use, all types of fabrics and therefore this is not a good situation.

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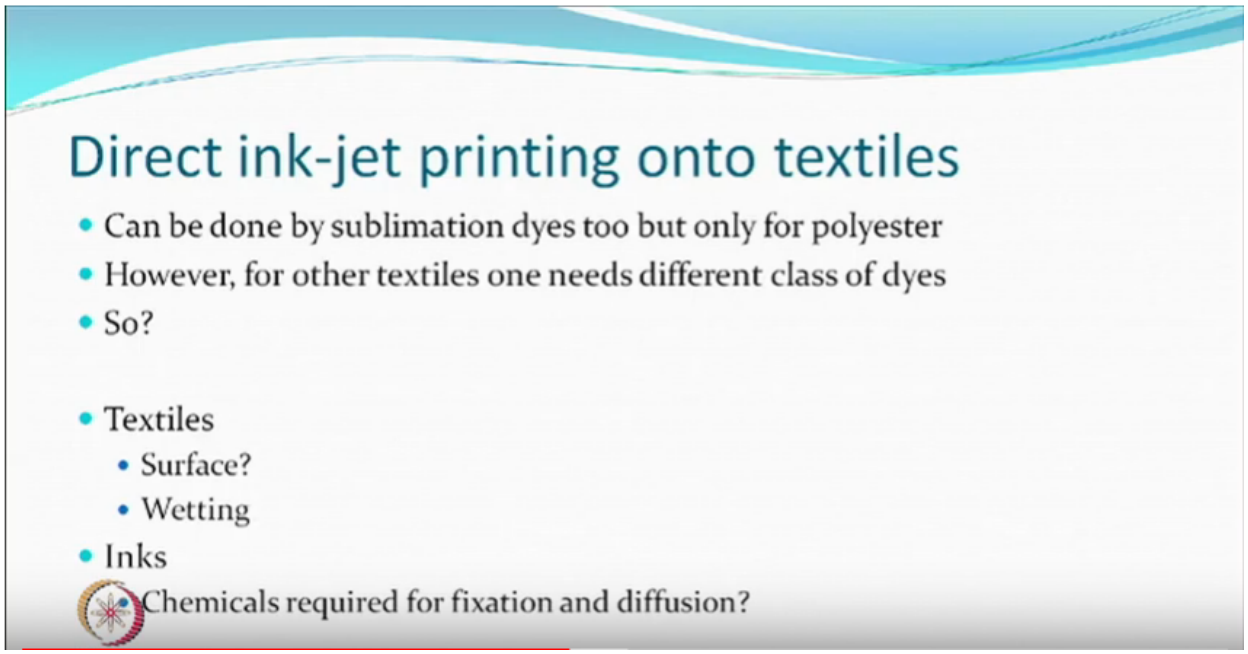

So, direct inkjet printing onto textiles, can be done by sublimation dyes also, but again on polyester and so, as we understood, that for different other textiles, you may require different class, of ties and that would mean, that you have to modify things, that's where the fabric is concerned, you will modify the surface. So, it becomes smooth, because a rough surface, it has been scoured bleached and maybe mercerized and so, the wetting is high which obviously, was required initially, but for printing purposes you still have to control, the diffusion of color, in transverse direction, if it goes in inside the fiber and into the fabric, you don't mind but if it goes literally, then there is an issue and this is because, of whatever capillaries and soon so, forth we have and in some sense, was a good idea, for printing you had to control and you require, for different things chemicals, etc for fixation and diffusion and so, you would require, what we?

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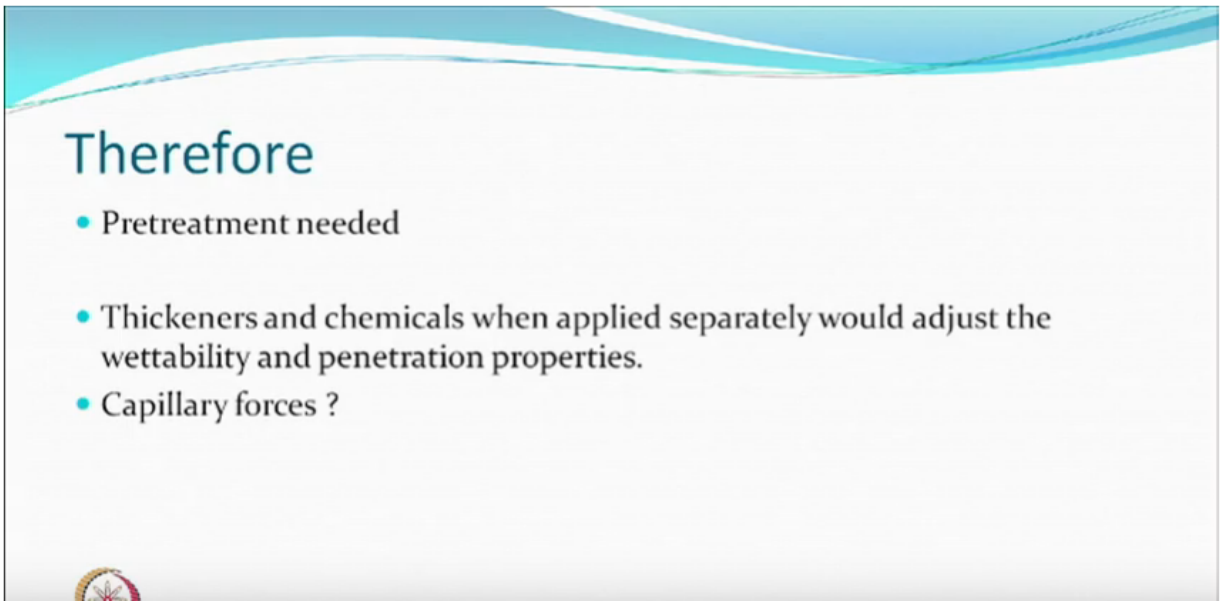

Now understand is pretreatment. So, this is obviously making this process, not as clean as the transfer printing. So, everything is to be done it can be very complex also, other than the except that some beautiful designs, cannot be produced by any other technology and therefore all complexities you would like to, tolerate that if it's a simple design, some checks and some dots to be printed, you might just say well this is as complex, you first do the pretreatment, then you do the thing and they knew the post-treatment, why should I be interested in this technology. So, that's one, of the reasons also its complex. So, thickness and chemicals, when applied separately are expected, that they would control, the wet ability and penetration and so, your designs, are going to be there so, that is one reason, you may like to use thickeners, even for pigment printing, pigment inks. So, capillary forces are going to be controlled, by some kind of a thick net layer, which you apply, onto the textile.

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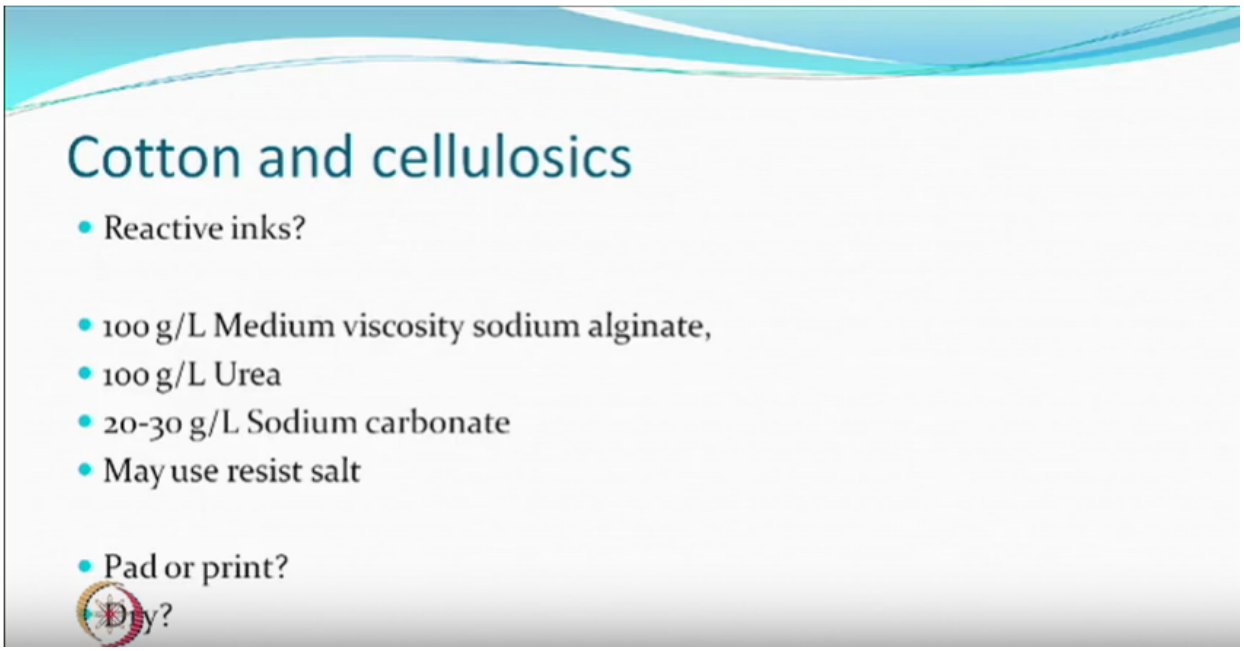

So, generally for cotton and cellulosics, reactive inks, would be suggested, just typically, this may contain, sodium alginate we know that any other thickener is not good for reactive dyes. So, you may use that urea may be required as a humectant, to ensure that while you are processing, when everything is dry there has to be a moisture and so, diffusion should take place and some alkali, when this alkali is there, on the fabric then the dye comes hopefully, this is the only one which will be, worried. So, at a concentrated, area alkali will be available. So, hopefully a reaction, would take place only with the fiber, you may use it as this salt, which is a mild oxidizing agent you know, during the fixation process, then you are going to be using steam, you should be able to, control any damage, due to reduction. So, what you do you can pad through this type of a solution, the fabric or you can over print, that if you know if the thick fabric and you don't want. So, much chemical, to views, you can just put it on the surface that's no problem, but padding is cheaper and of course you dry, I mean you're not going to be taking, a wet material, inside the digital printing system. So, all this is important so, whatever cost it has and whatever complexity, you have to do it.

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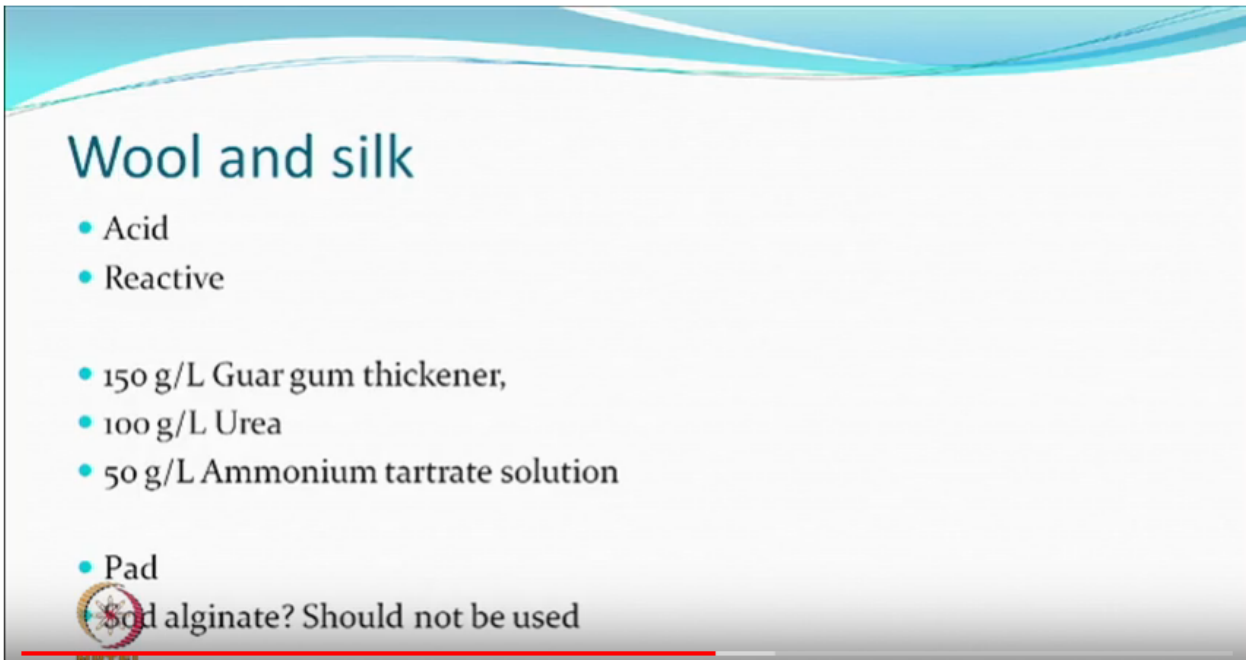

So, wool would require can be dyed, by the acid dyes, which is normal case, wool and silk, because the color gamut that is available looks pretty good, although reactives also can give similar effects, but acid inks are available, specifically for wool and silk, if you do the acid, you will not use obviously, else any cassette or alginate, because in the acidic environment, it correlates and you can have difficulty. So, one of the interesting technology obviously remains, as a guar gum which is. Okay? You do control molecular weights in a manner that, during washing later, should not have difficulty. So, the only thing which you would be concerned is now the thickener is everywhere, in a normal printing, the thickener is only in the printed area and now signal is everywhere. So, its wash ability has to be good and it shouldn't not obviously change, the handler remains some percentage of thickness not been washed. So, that means it's going to dead, the acid normally obviously in these cases, you may not be using mineral acids, sulfuric acids and so forth. So, organic acids could be used, in this case the example, in some sense a latent acid, since an ammonium salt of a tartaric acid, which at the fixation stage the otherwise the money, I will go and tartar case, will be there to do all the job adding obviously, can be done and said alginate should, not be used.

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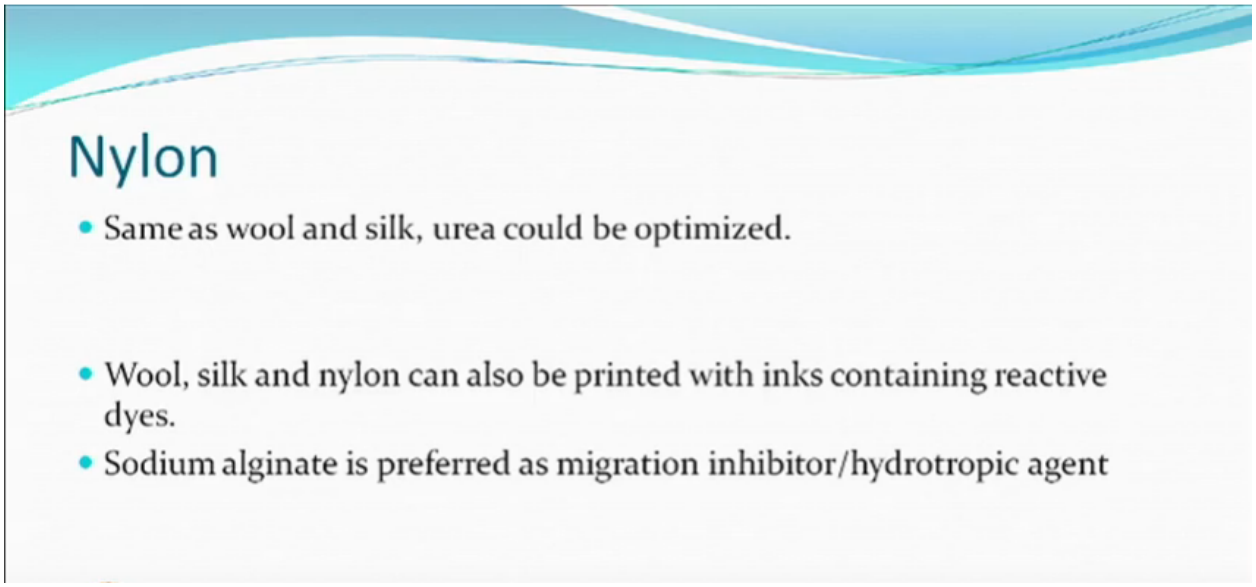

Nylons can be printed, in the same way, as the wool and silk, say Mesa dyes can be used, here some optimization, because of the diffusion rate, into the nylon versus, into the silk and wool which are more hydrophilic, will have to be done, but that is one part of it. So, will signal on can also be printed with, inks containing the active Dyson. So, you do a pretreatment, with them so, if you use reactive dyes an alginate will have to be used, which is in some sense have been call it migration inhibitor, ink will not be allowed to go beyond, the boundaries and so like whatever reason you had, for using this ungodly active.

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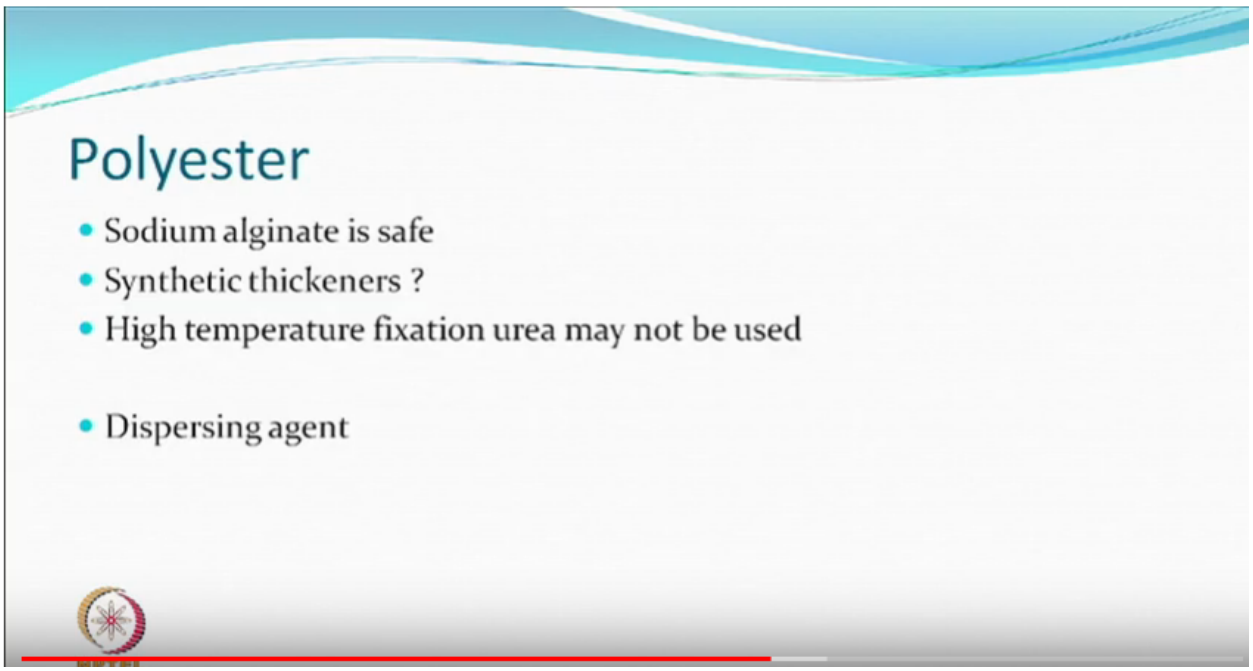

Polyester theoretically anything can be used, as long as you're quite sure, they're going to be washed, generally the pH is safe, synthetic nurse synthetic thickness can also be used as, long as, you are able to control, their viscosity. So, because you're going to be using high temperatures. So, because of urea, vapor is going here and there and what kind of things you may use or may not use you at all or use very less, although there should be some dispersing agents, in the ink itself, but you may put something during this padding processes, where?

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If you have blends so, as of now a mixture of, disperse reactive inks, is not available the reason, is you don't know what blend you are going to be working on? What ratio you should be making? And then of course there will be differences. So, the best thing of course, I mean if you are very looking at blends, this pigment and if you're wanting everything to be nice, because the fabrics could be very thin, could be very thick, could be very rough could be knitted or woven and all those kind of things. So, some want of taken air may be required to make sure the fabric dimensions are controlled and so, that you may still do, even with the pigment some amount of padding and drying scores, no a bad idea, because binder will not be washed, off and so the, the, the handle of the whole of the fabric is going to be changed. Alright? So, pigment has a binder, inside and therefore the ink head, print head technology that you will choose, will be such that does not, get a problem for example thermal, inkjet you not like to use with pigment inks and you may in such cases, have the catalyst, which maybe outside. Right? But as far as the binder, you don't go to pair the fabric, with a binder that not be done because that that's a limitation, we anyway are not very happy padding everything with the sodium alginate where the print is not to be there if 20% of the coverage is there and you're still printing, the or printing or padding the whole of the fabric the thickener, there's a waste in some sense, but it's very difficult to do anything otherwise. So, this is a challenge, I mean this challenge is not finished, to this extent today you 'redoing it, tomorrow if you can have any

other better system. So, the only thing you will say given, what is required is no longevity is required you just pad bring to the printer finish it off and wash it. So, washing capabilities, should be higher and so, there may be a relatively low molecular weight compound that will be preferred, anything theoretically you can use anything, does matter as long as you are saying, this is listens harm anything the cost of this is almost, anything could use, go outcome can, be used no shoes.

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So, we just not go into details, of this too much, today we discuss some, aspects and then we'll stop for today, the pigment inks are relatively, but one of the more popular ones, to begin with because, this actually gave the real advantage, of printing, with inkjet even, if you do not pair they can still print, you can take any fabric in just print as long as this is under tension and no way it will touch, the print head if that can be ensured, you can print and after, that you only have to dry which of course you have to cure, the pigment that's the only thing, but you don't have to wash it. So, after wash is not required so it is almost like, transfer printing but in slightly different ways and the other thing was that you didn't have to bother which fabric, blend are you worried, a lot of people ,have been used this for garments, peace goods and just take it print finished. And so, pigment had been very popular and one of the first inks, which were designed, were these the only thing was, you had to design, the binder, which had very low, let's say glass transition temperature. And would not very easily clog so, it had to be dispersed very nicely, in the ink, the binder as we said, cannot be used outside, this had to be inside. So, technology had to be decided, which of course was on-thermal visa based system and binder. So, that is the difficulty which people, die manufactures an ink manufacture face that you not only have to make a good dye, but you have to make a good formulation, which will suit up a new technology and so became more and more complex. So, because of the heat, this is a type of a monomer ready to be polymerized. So, if it polymerizes within the ink because or around that heater, even if little bit and then goes chokes tea nozzles. So, your head goes.

So, when we are referring to transfer printing, we are referring to polyester and dispersed, because the others have not really become very popular commercially. So, if there is any competition, between inkjet, this is with the disperse polyester combination and not with because they are not there, on the other hand, inkjet is now available, for acid reactives and pigment novices discussing. So, technology wise, people feel that this is more versatile, complex better versatile, but it can give you results, with other technologies you may not be able to give you at all and so, there is an interest that we look at it.

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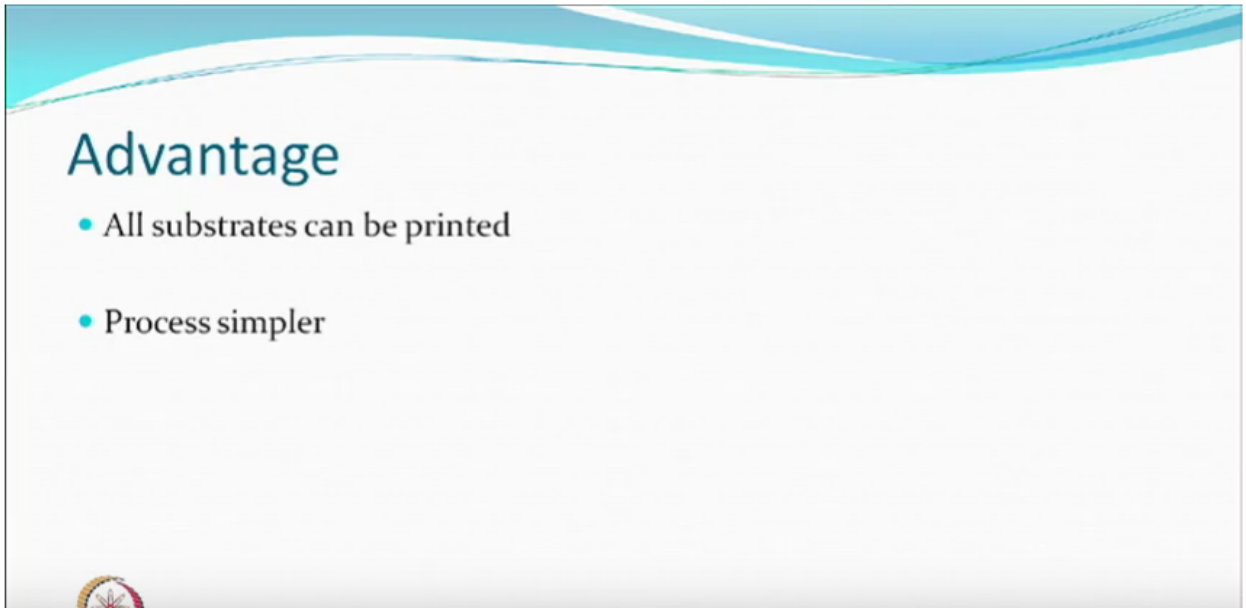

So, this is we start with an advantage and not look at the disadvantage first. So, all substrates and simpler process, these Goods garments, everything, can be printed through a pigment ink.

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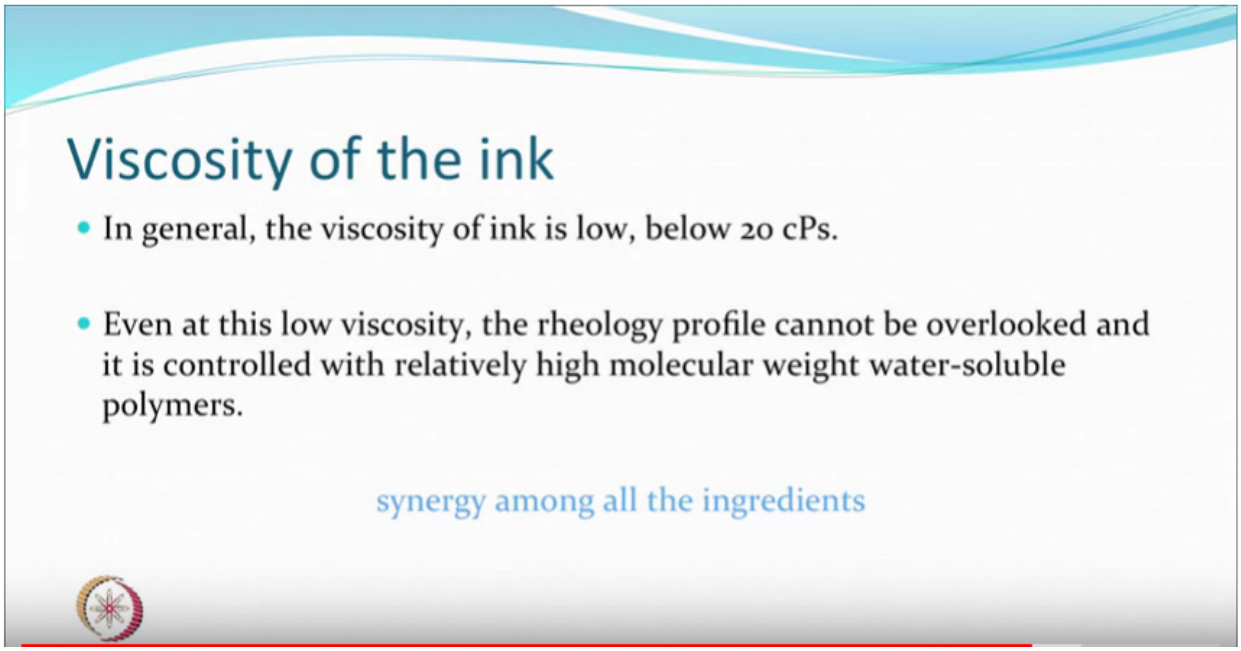

So, this ink, also on all other inks, will be working at low, viscosities. So, that is one part so, whether you make a suspension, out of it, it will still have to be low viscosity but what it means, is that even at low viscosity, this liquid is going to behave, in certain manner under stress, it's going to come out of a nozzle, that has to so, you will still be adding, other chemicals which will be able to control, the rheology, of this ink. So, whichever technology, it still has to pass, through and stop when there is nothing, no push pull, then stop and it should not, keep dripping. So, if you just say tomorrow they give well we use no other chemical, just a dispersion and think you might find that you're not able to control, your pushing but after that also it keeps coming out, then it will be difficult. So, you need some control, of rheology by using some high molecular weight, water-soluble polymers. So, this is an additional, thing which you may not require after printing, because they are water-soluble. So, they'll be washed off, but during this process, while it is stored, while it is being used during printing process, the rheology control, is required. And so, mu server is doing this formulation must calculate determine, all the properties, that you have and ensure that all such chemicals R's have some synergy, between each other and with the technology, of the print head as well equis paced system, normally maybe there because that's easy.

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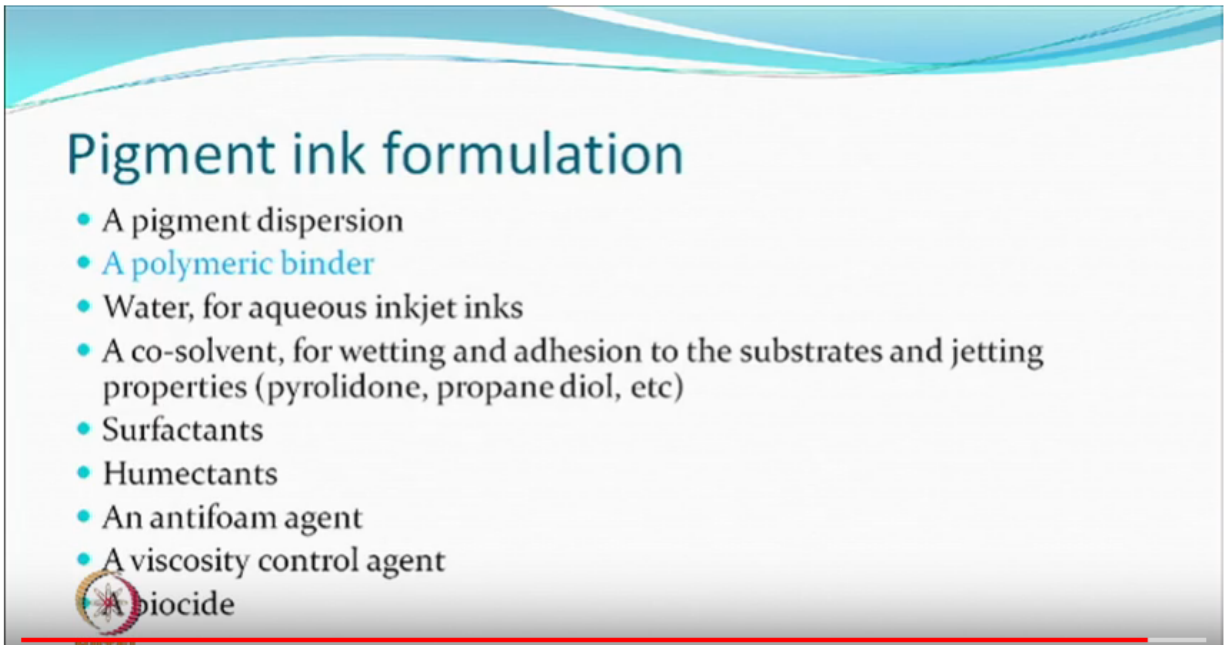

So, just last information for today. So, while we are saying that it is a very specific type of a ink or a pigment which is so, specific, that everything that you see on a monitor, would be correctly reflected, onto textiles. So, that's one typical part of it that's the whole chemistry estimates and which is pretty much researched and not every molecule can do this job. But so, you have a pigment dispersion you can very happy that I have a dispersion which I am going to be using is calling an,' Ink', just the viscosity has to be controlled, but one get surprised that these formulations, can have many things, a polymeric binder as we said which is the most important thing. And they're a type of a binder, which is not going to, do any choking of the nozzles and the print head, is a good amount of research, input of course for water or equis paced, inks you will have water, which is a dispersion you are creating, in addition to that, they may be using some Co solvents, wetting in addition to the substrate. So, it doesn't go very easily there itself, it stays there and also for controlling, jetting properties. So, additionally so, surface tension control weighting control, some examples are here with different companies may like to use different things.

So, you have a co solvent, you may obviously saying dispersant, dispersion and so, there is perfect inter, whose job will be making sure self attentions are nice and also when you are not using the printer, what is happening? Ink is still inside, you're not allowed to very easily, dry when you're not printing, because otherwise again you have to do cleaning. So, normally what would happen is that when you stop printing, the underside of the head is cleaned automatically, not dependent on, whether the person, who is in charge is remember doesn't remember. So, that is one cycle, which has to be done so, that underside is clean inside of course is liquid. So, that part is there so, surfactants may be there to do various job humectant also, may be there so, that again for similar purpose, to make sure that, while the surface surfactants are doing dispersions, controlling surface tension and so, on so, effect and we'll be providing enough moisture. So, drying, doesn't take place again, now this is outside, this is inside the ink and not on the fabric. So, you so, it means you're not finding so, many things are being added. So, this formulation is not simple, then you may add an anti foaming agent, some silicon based systems or otherwise or some polymeric base, because at the frequency that you're talking about, in case there is , which is a surfactant

also there and there are form or any, such thing generates within this small chamber also, then transfer of the so called force for ejection purposes may not be doing the job. Right? So, this is very answer it's quite possible, that one chemical may do both the jobs like, if you have a large molecular weight, molecule it can act like a surfactant and also maybe, act like an T forming also, but you do require something, whether a separate chemical, like a silicon-based chemical or any other chemical that you will require that. So, this caustic control agent means again some solvent, may be additionally there which would also mean a polymer, would be there again, we are saying it's a low viscosity system, but you still have to control the viscosity. And maybe a biocide means, you may want the ink to be stored for months together. So, whatever you can have aerobic or anaerobic growth, which you must not have. So, while this type of a thing may be required for a normal printing process also, but there you are looking within a week you will be able to finish it off for now, here you may say well no, somebody has made the ink and expect the storage there and it'll keep it using, whatever your strategy, may be there and it must be everything must be. So, they are all in sync, that the technology that, you are using they don't interfere with that and so, everything is so, very carefully selected and its purity also has to be. Right? So, the question that was that here, that bio site for example tomorrow, I decide well I'll use some copper coupon, in a normal thing, which will be washed off later, you can use it or another compound which is very effective a cationic agent, which is effective beside large molecular, weight doesn't matter but here function, may be same, the durability required, is much larger, the printing pace that you make, invariably, you may not finish in a day, but it is within a week you will be finishing. Here you are looking at maybe, six months, to one year. So, requirements are very different. So, there we are we, stop here and we'll pickup, next time when we meet, this type of ink and further other inks.