Lecture-02
Colorants

So we are ready, for the next session, on this printing lecture. And what we have covered, in the last one,

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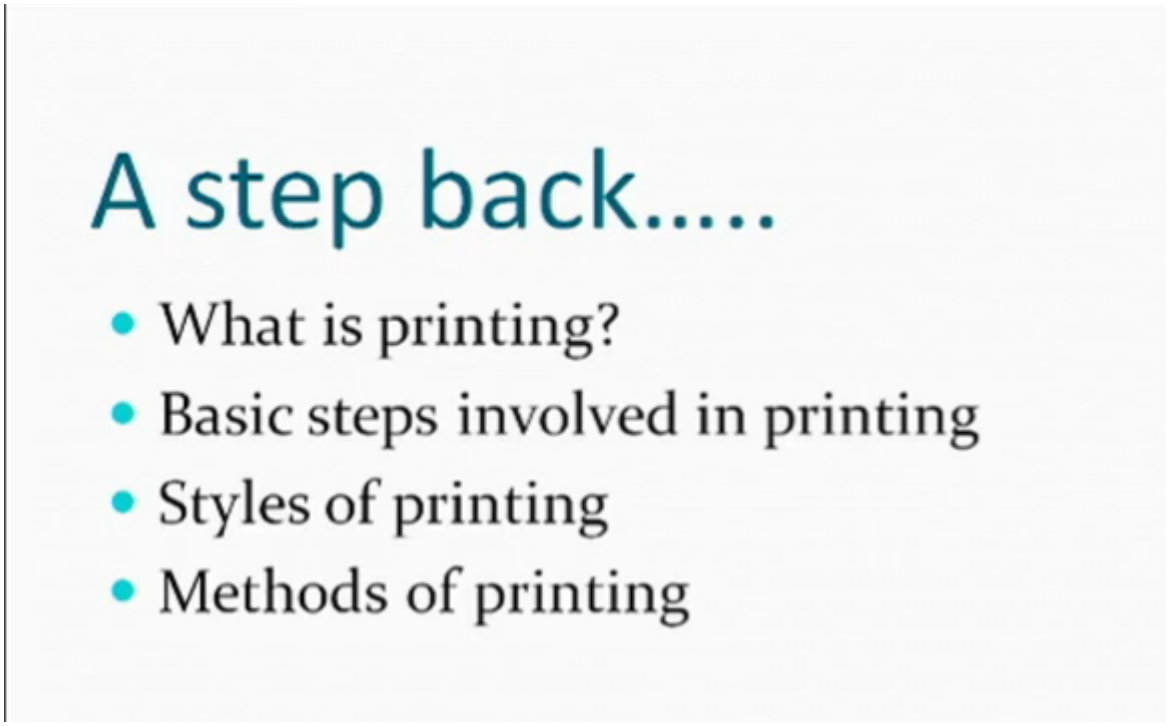

Is this, what is printing? How close it is from the dyeing? What are the basic steps involved? Like printing, drying, fixing, washing, styles of printing and methods of printing, this is what we revised.

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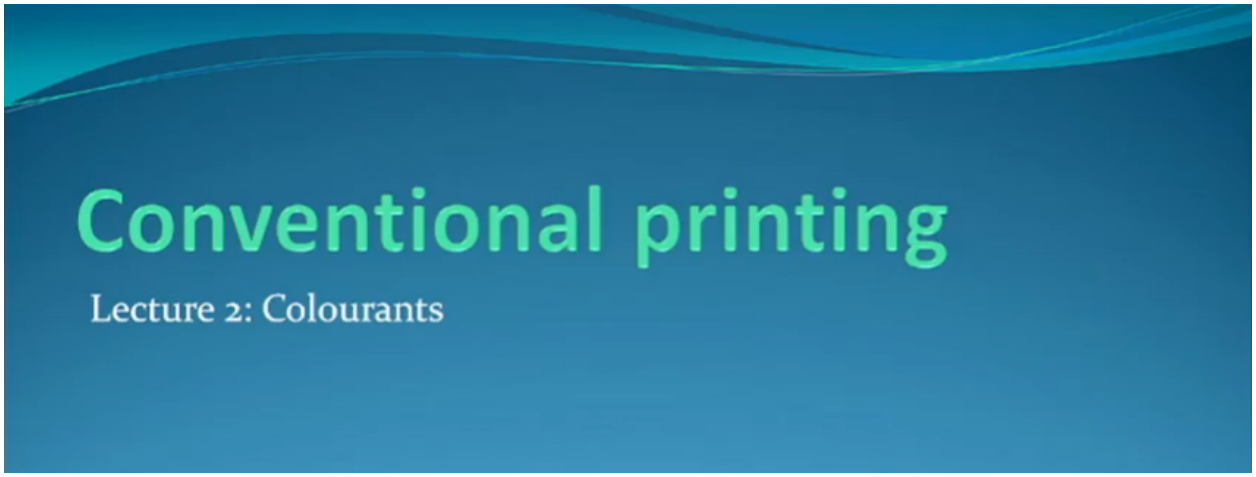

And now, in the lecture two, we will look at the essentials, ingredients of printing, paste and one of the essential obviously is the color, how many types of colors are there? What interactions that they have? All that is important from the point of view, of printing as well, like it was for dyeing. Right??

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So, if you look at the essentials, we have colorants, which as we said, of course it has to be supported by, what we call as a printing paste, to increase the viscosity, because you want to keep everything in the boundary, it is also sometimes known as thickening or thickening agent. Okay? This is how the life goes and of course, you would require a large number of auxiliaries, to support this printing process, alRight. Although we will not concentrate on, auxiliaries so much, we will spend some time, on colorants and just revise, as to what we had probably understood before, taking a printing class.

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So, in the auxiliaries. One of the auxiliaries, we are quite familiar is called the, 'Wetting Agent'. Right? the reason why we use a wetting agent, is to reduce the surface tension, mix things properly, because most of our, action is going to be aqueous, water-based and therefore, what you would require is, some amount of reduction in the surface tension of the systems. So, penetrations becomes easy ,they are also quite sure, that whatever we talk about, it is going to be a viscous paste and a viscous paste obviously, will have a difficulty in penetration, also we said there will be humectants. humectants are required again, as I said, it is a small area, small volume, concentrations are high, how do you get the water, because we have, already dried the fabric and so during the steaming process, during what we call it the fixation, where there is a dry heat superheated steam or atmospheric steam, you would get some moisture from, the environment. And that moisture is, going to be absorbed, as such or maybe the humectants are going to help them. The other important thing of course, could be solvents, particularly those dyes, which are not so much what a solubility, soluble or their solubility is slightly less, like a dispersed dye for that matter or where dyes for that matter, as ox so that matter and so, you may require additional solvents, which may help it to remain in solution form, as we said that, unless and until the dye is in a molecular form, it will be very difficult, for it to penetrate diffuse interesting. Unless and until, we are talking about, pigments. Other auxiliaries would depend on, what type of agent? What type of dye? that you actually, want to use, for example, if the dye, is acids dye, you may require acid, acids in the printing paste, if it is let's say, reactive dye, gets fixed in alkaline, alkaline medium, so we require alkalis, if it is actually, read you know, VAD dyes, so you may have oxidizing agents or reducing agents, as auxiliaries, which we required and the whole process of printing, if you're looking at oxidation colors, you may actually have some amount of catalysts, to be used and dispersing agents would be required, if we are using let's say a dispersed dye. Because, dispersed dye initially is dispersed and then of course, part of it gets

dissolved and then get diffused and you, you get, you know, the molecular form of the dye, which penetrates. Deforming agents, you know, form gets generated, because you have lot of studying being done. And it's a viscous system and if suppose lot of form gets generated, because you have a surface active agent, which is called the, 'Wetting Agent'. and you must have seen, whenever you do lot of agitation, in any liquid system and there is a soap or such detergents are available, lot of foam gets generated, it may not be the same situation here, but if the foam or the bubbles, get generated and they are trapped, in the paste and when you actually, do the printing and they would, burst at wrong time and then, the design will have issues. So, you may be using be foaming agents, so there are many, auxiliary which are definitely, required based on which type of a dye fiber system, you are going to be printing.

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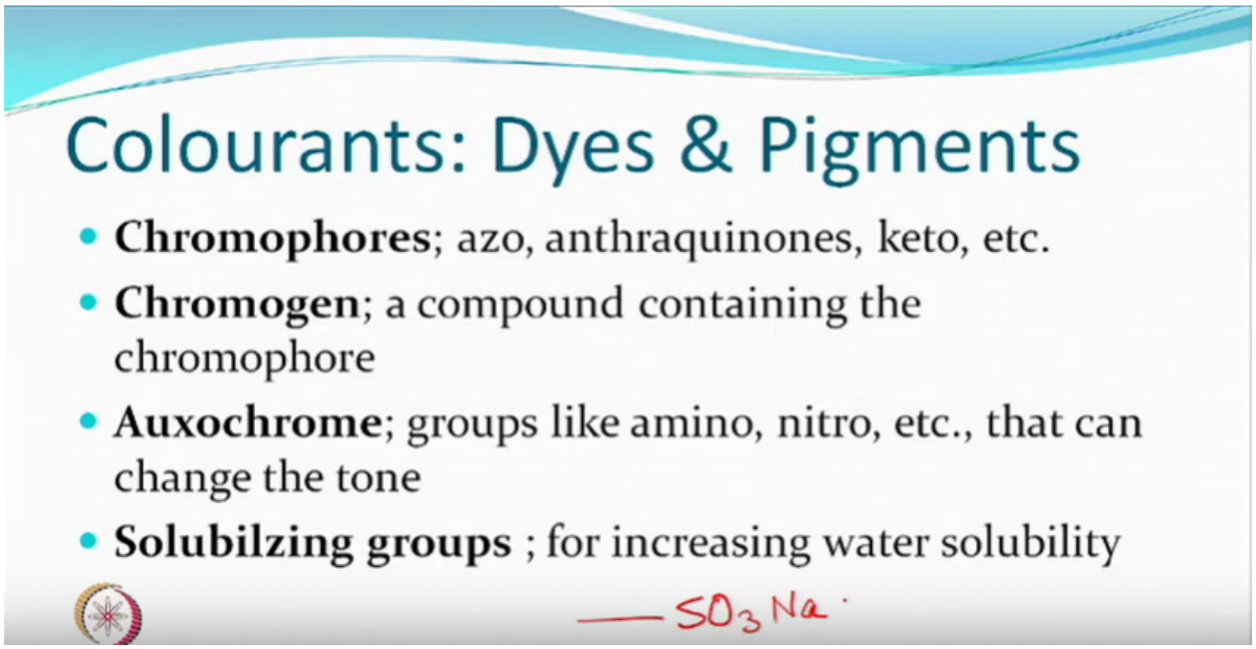

So, as I said, we will spend more time on colorants: because, they are our mainstay. So, when we say colorants, you have dyes and you have pigments. Now whether, this colorant has to be used, as a pigment, in that case you will be supporting its fixation by some other mechanism. But, if it is considered as a dye, it must go through, some dissolution process and therefore, its interaction is going to be important. Theoretically speaking, the same dye which is we used for dyeing and same dye fiber interaction, which is valid for dyeing process is valid for the printing process as well. If there are different requirements, let us see, if we can find them identify, what requirements are there? So, a colorant is a compound, which has, a group which we call as a, 'Chromospheres'. Some of the popular names here, you can see are azo, anthraquinones, keto and others, which I have not listed, you must have seen, before as well. So, this is the stay, the

color is because of chromophores, if the chromophores are not there, the compound is not colored. And that's one of the ways, we can see, when you reduce let's say a bad dye, the chromophores is broken and the color just goes off, in most cases it becomes pale, so major colors lost. So these are the, most important part of the colorant. Which let's say, it could be dye or a pigment. Chromogen; is another supporting compound, which obviously, contains the chromophores. Now, these type of the body, main body of the dye or a pigment, is the one which is which holds it, holds the chromophores. but also, with the fiber it must be interacting, that is whether it, when we talk about affinity towards, a fiber then some of these things can define, if you look at the size of a direct dye, if it is large dye, the most the molecule is not a chromophores, it is just a support system, it goes inside and does not come out, because it can form some bonds, let us say adorn bonds, with arkandable forces, with the fiber molecule and so, this type of a thing ,which is called a chromosome, is the body of the whole molecule, which supports the chromo 4, but also helps, in adsorption, absorption.

Then there are Auxochromes, which are smaller, functional groups. which can be attached at Parramatta positions, ortho positions, of a dye molecule, they can change, the tone let's say, a blue can be a different blue or a red, can be a different red, if we keep playing around with some of these groups, this whole science is called the, ‘Molecular Architecture’. So, a dye molecule has its own architecture and based on these groups, you can actually play around and actually synthesize a new dye molecule, which may have certain, interesting shade palette. And so, these Auxochromes are also very important, as well so, they will be part of our type. and yes, most of the dyes and also whether they are through printing or dyeing process, would be through, applied through, XP dye and so, these solubilizing groups are the ones, which help, they dye to get so realized in water, it is not that we any you can solubilize them in any solvent, but we are looking at groups like SO 3, Na. Which is sulfinate; so so, they are ionic groups, attached with dry molecules, so the solubility will depend on, how many such molecules are attached? What is the molecular weight of the dye? if the molecular weight is very large, obviously solubility’s are not going to be very high ,so you have more solubilizing groups and so you, do the play around, with the architecture of the dye molecule.

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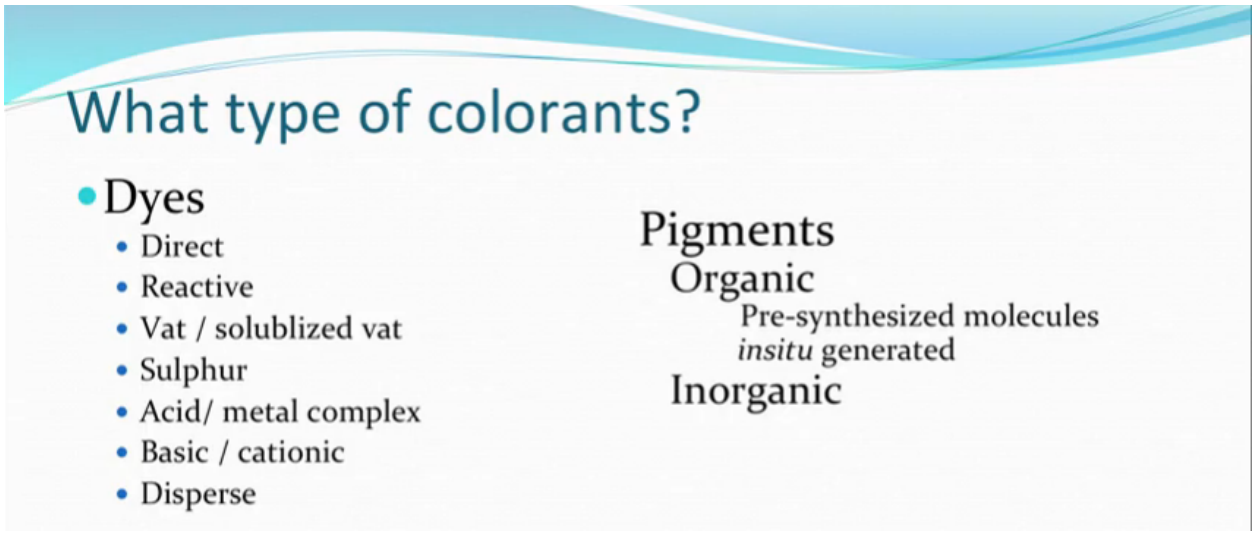

Now, this question is that what type of colorants are available, there are large number of colorants that are available, all of them theoretically, can be used, for printing as well, directs if we look at direct dye ,what is the problem with the direct dye? It was one of the easiest dyes to be dyed, generally for cellulosic material, but people are not very happy with it. Because, it was easy to dye and wash fastness was low is it to come out of the fiber as well, it is not that every direct dye has low wash fastness, but a large number of them have, low wash fastness and therefore, you may not like, to print, with direct dyes. Because, printing is a costly process, you have to do lot of exercise and at the end of the day, if anything wrong happens, then you know to be very happy. So, that's one dyed, unless and until, there are certain shades and certain types of dyes, which definitely are very important and very nice, Tello sign and based dyes for that matter. One can use direct dyes, but generally we may not. Reactive dyes, of course reactive dyes the name suggests, that they can react with the molecules, so the wash fastness is going to be high. Right? They make covalent bonds. Right? And so, they are good for us, definitely so people would like to use reactive dyes. Wet and solubilize wet, are two combinations, which people use, for printing purposes, wet is a good color.

Because, after you have done the whole process, it becomes insoluble and so, definitely wash fast in is high and other faster also very good. Sulfur sometimes because, cheap you might like to use but, it's also insoluble. But, most people may not like to use, sulfur as such sulfur is used for dyeing, but nobody can stop ,you for using that, a said is metal complex basic, that the cationic dyes and disperse dyes, are the ones which of course are used. And then, there are pigments, organic which are the like dyes, which are insoluble. So, they can be pre synthesized molecules, as a pigment, which will be fixed as a pigment or they could be generated in C2, while you are actually doing this whole process, the pigment get generated, that's one. and inorganic of course, you can use some of the inorganic compounds ,which give certain types of shade, which may not be easily available easily synthesized in the organic, particularly in some cases the fastness properties may be , also very good and so, you may like to use pigments.

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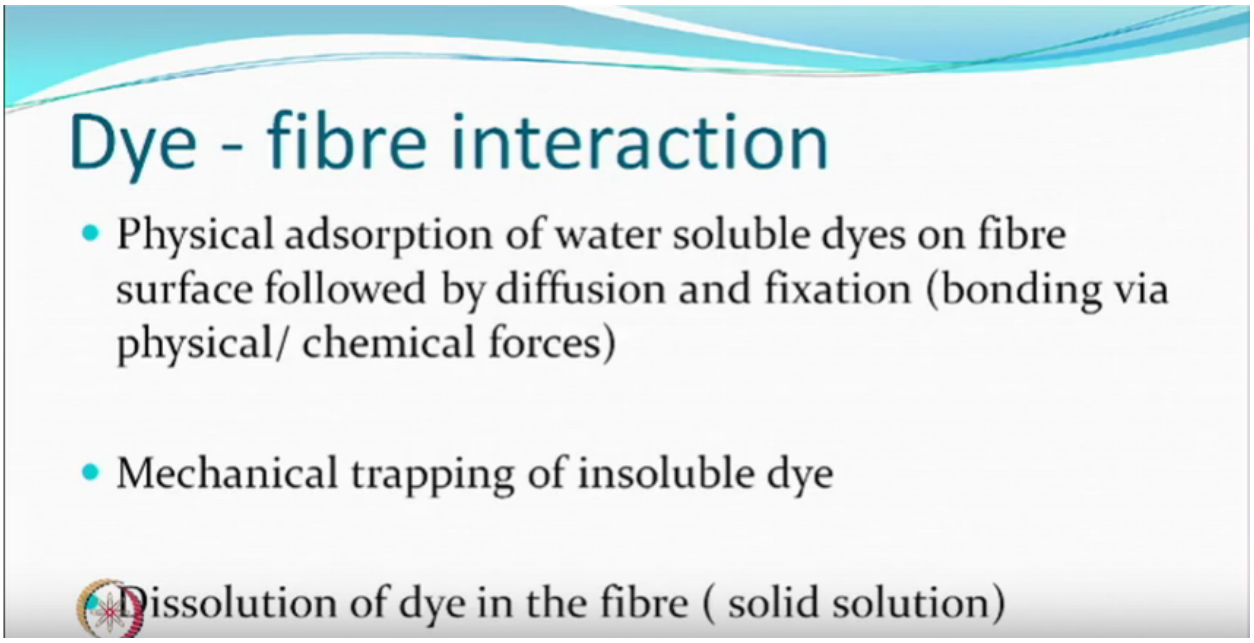

Let's first look at, our rewires, as I said this is a revision. So, normally what would be happening is that you dissolve the dye, inlet's say water, so we have water soluble dyes. So, in a normal case solution to the fiber surface, the dye goes and then once it reaches the fiber surface, that is governed by, shall we say, affinity, forces and once they reach the surface, then the diffusion takes place, depending upon the temperature, agitation and such conditions, in printing you have no scope for agitation, so you only believe, that the dye definitely likes the fiber and therefore, it just keeps moving in. Right? This is what's going to be more important. And then, of course fixation, download fixation, if it is a reactive dye we talked about covalent bond, if it is not a reactive dye, then it could just be Vander Waal forces Harden bonds and what-have-you, just like trapped inside the fiber and then doesn't have, a chance to come out. So, you could be trapping ,a big molecule inside the fiber, once it has gone in, it has got certain kinds of interactions and because of that ,it would remain within the fiber. There are some dyes like, disperse dyes and polyester, it just goes in, from aqueous medium, which was solution to a solid medium, which is also behaved like a solvent. It can be anywhere, you see the property of a solvent, but a solution, is that the concentration of a dye at any given point and any given place, is same. Right? That is what the solid solution means? that's the solution that means, the dye has no issue, it tends go, go anywhere wherever, there is a space this keeps moving and hopefully the spaces are also, uniformly distributed and therefore, dye also gets informally distributed, it behaved like a solution. But, in a solid state.

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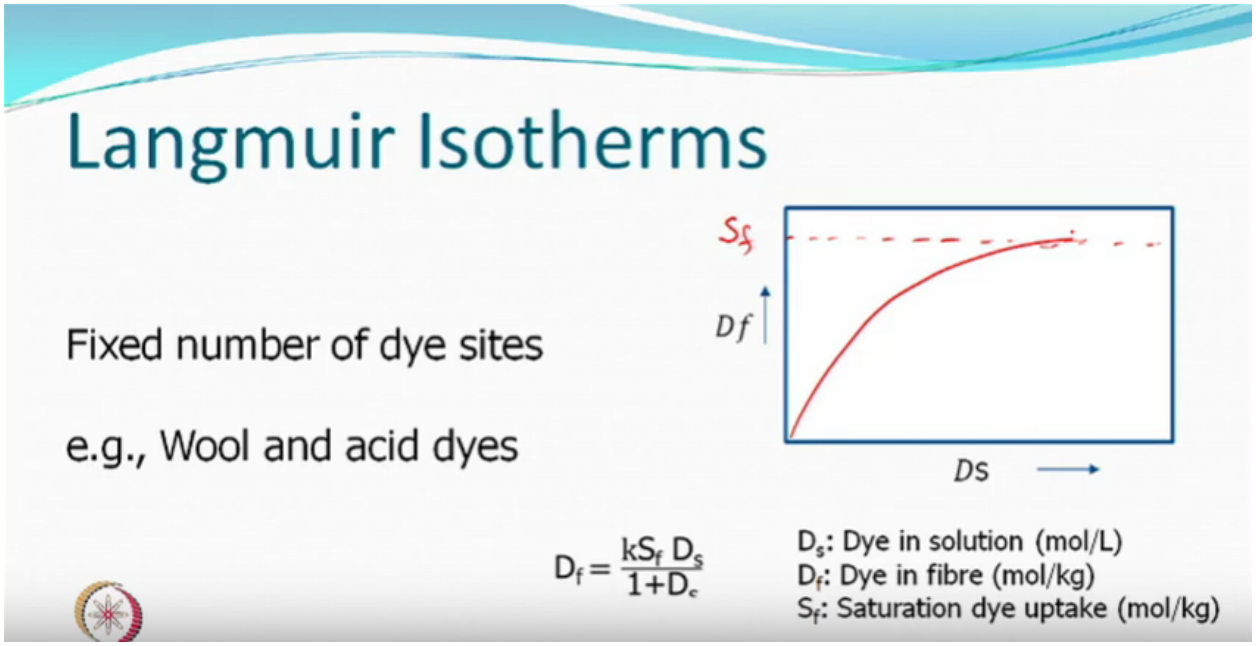

So there are some ways, in which these interactions have been defined, you can do quantitative analysis also, that how much dye, will go. And isotherm means, that at the same temperature, you are looking at, how the dye moves from solution, to the fiber, all Right. Langmuir isotherms are the ones, which are plotted, at a constant temperature. You know, like we're not talking about, the dyeing starting at room temperature, raise the temperature, to a certain degree, then hold it to a certain degree, for a certain degree, at a certain time and then drop it down. Those kinds of things on, it is a constant temperature .so, at a constant temperature, at the equilibrium position, how much the dye is likely to be there, in the solution, harm of the dye is likely to be there on the fiber, remember this is an equilibrium reaction, equilibrium reaction. So, this particular isotherm, Langmuir believes, that there are sites available on the fiber, where the dye is going to go, that means, if the sites are not there anymore, that I will not go. Right? So, this is the thing, like the example, we said is a wool, silk, even nylon, with an Ac dye. So, these are the amino end groups, where the dye is going to go, if the end groups are finished, the dye cannot go. This is what? This particular isotherm believes, this is the postulate. So let us say, you have a saturation point, let us we call it, ‘D’. Or what we have called here is, ‘S’. Which is saturation on the fiber and so this, will move and off sometime, it will not increase. Right? And so, the sights are finished and therefore, dyeing will not take place. And so it's got, from the kinetics, you can get to this type of equation, which will be valid, if such interactions are there.

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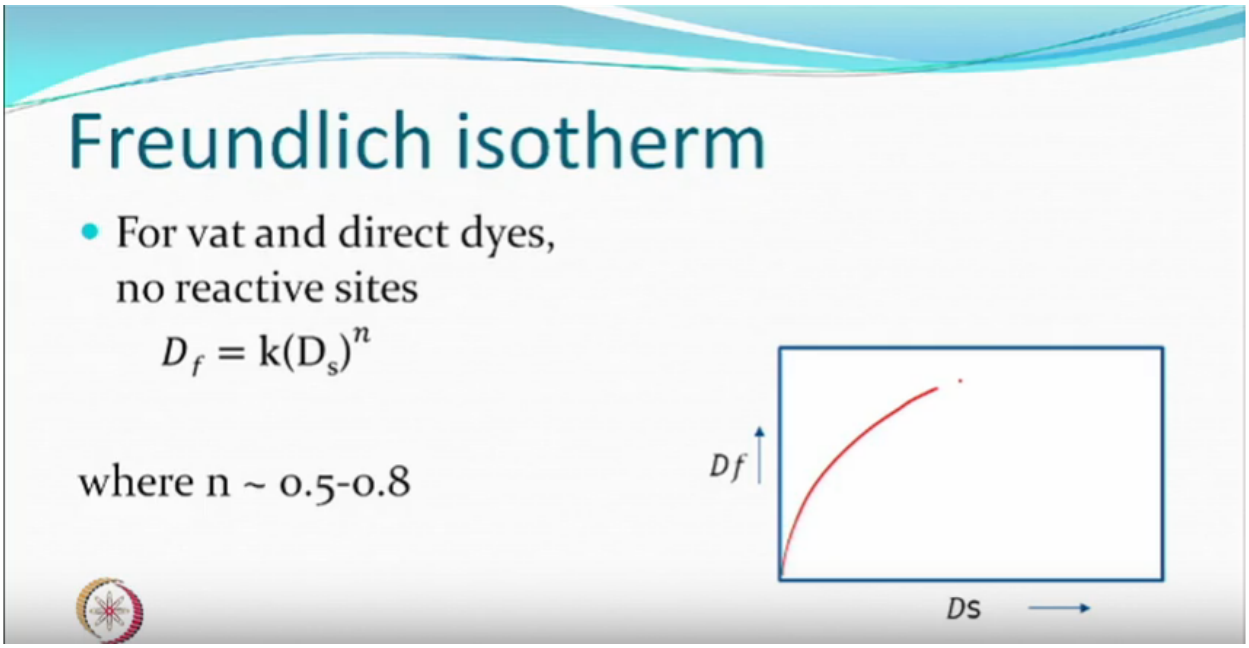

Freundlich, does not take into account, as to that there are limited number of sites and therefore it cannot go, so I believe that, there is an amorphous region, where it will keep going, amorphous region and the crystalline regions, are inter dispersed. Uniformly and therefore, that I would keep on going. But, the rate of diffusion would depend on, how much the fiber initially, has the dye? And how much the solution has a dye? Therefore, the concentration of the cell the dye, in the solution and the dye on the fiber ,are defined by a power equation, which basically would give you, some curve, of a parabolic type, the value of K and n would differ from fiber to fiber, like dyes which do not actually, depend on any site. So, fiber has many sites or areas amorphous, this is diffuse and enter there. So, as I said, some of the dyes will behave like this, but when the concentration become too high, the, the formula may not really fit, the way, we want them to fit. But, nevertheless mostly it is going to be true.

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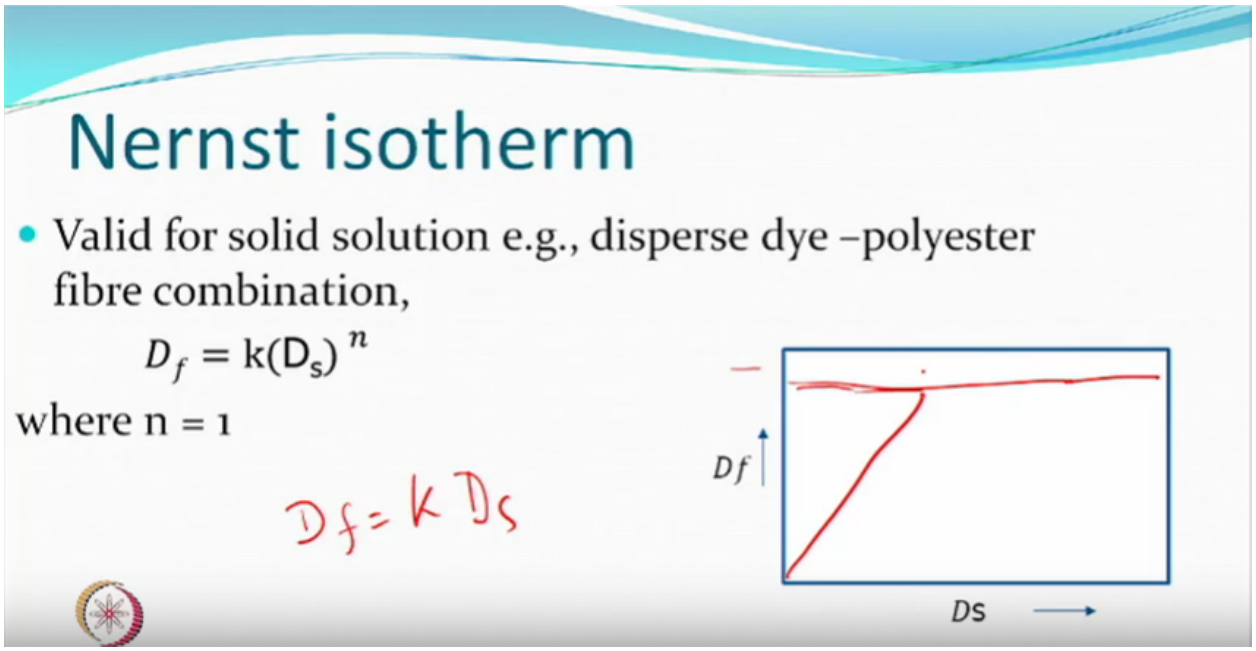

The same power isotherm, when the value of the n becomes 1. So, it just becomes D F is equal to K, D s. So it also, has a saturation limit. But, it goes trace a straight line, so based on what type of dye, that we have, which does not depend on, what is inside? What is outside? it just depends, it does not get governed by the inverse flow and so, the dye as long as, there is a space it just keeps going, more is the dye in the solution, more will be the dye on the fiber, in a linear way. So, when the N is equal to 1, so this formula, therefore for you, will be and this is the limit, after this there is no space, whatever the voids, amorphous they're also filled, till that time we'll keep doing and follow the straight line. And this is, what is we call as a, 'Solid Solution'. So, you'll just keep falling and after that, it'll become flat. The previous one is,

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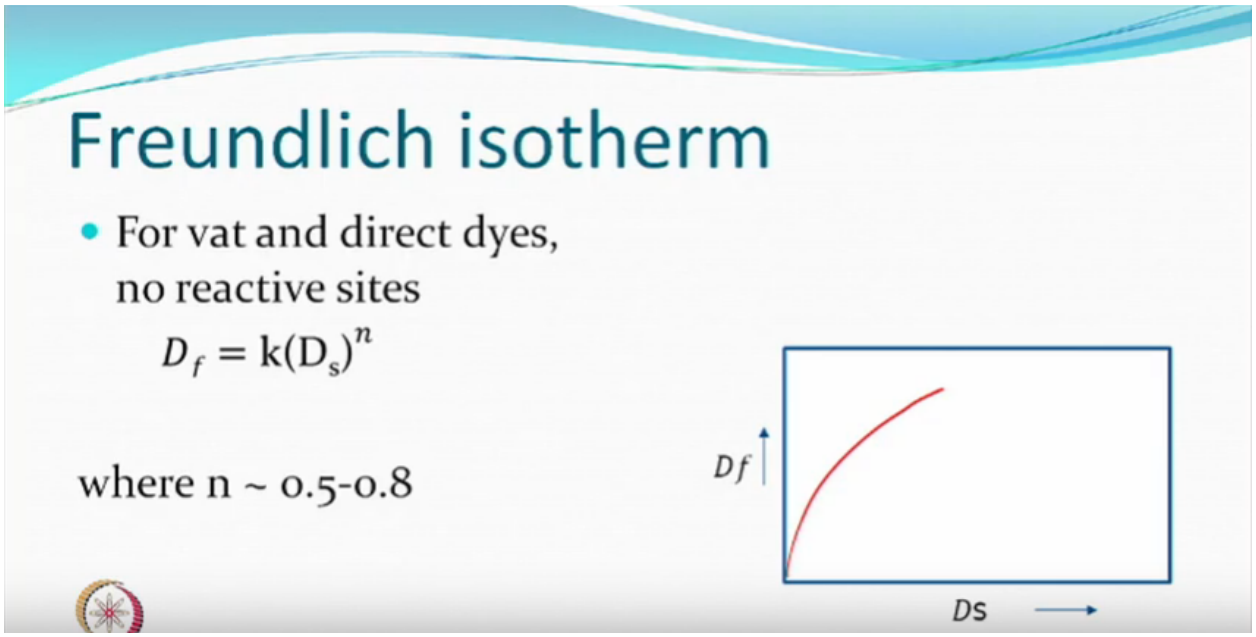

this one you're talking about, this actually does not believe, it believes that the rate of absorption, will keep going down, as they dye and the fiber keeps increasing .and because, it still thinks, that there will be some bonding of hydrogen bond, will formation or some kind of affinity, things will be there and so, rate of diffusion will keep dropping down, this one says no, if there is space and just go without bothering as to how much dye is already present, till the time, when nothing is available. So, it's a question of for example, students entering, through this room, from this gate, there are enough seats available, it does not matter, whether 10 students are inside and that the eleventh world will say ok let's not go. Because, there are 10 students inside, oh there are space, I just go, no resistance. So, it will just keep doing, approximately like this, of course this slope of the curve is telling, as to whether the dye loves the fiber more or the water more. Right? This, is also one of the reasons, although dispersed dye is not soluble in water, but still, you dye from water. So, why do you dye from water? You could have dyed from a solvent, where the dye is soluble. Why do you need to dye it from water? where it is not soluble, other dyes are water soluble, so it's very good, here you don't want, because the water solubility was the one, which was responsible initially, that the new fibers like, acetate fiber, polyester fiber, when they were synthesized or manufactured, those earlier dyes, would not go in, when they found their more hydrophobic, so they have to have hydrophobic type of dyes, it's not a zero solubility but, very little solubility in water. Okay? So, if suppose we say tomorrow, you want to dye , from a solvent. Where the dye is soluble and then dye the way you dyed, let's say from organic solvent like hexane. Then you'll find the dye goes, but the dye, fiber interaction again is the same solid solution, all Right.

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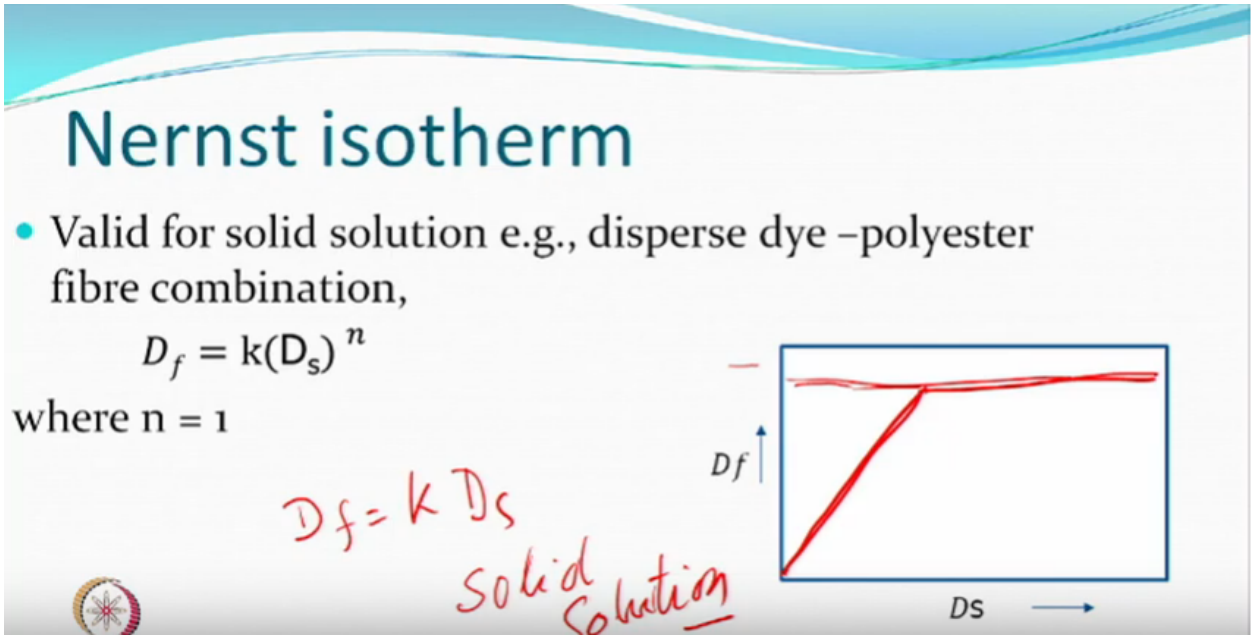

So it will go, sit in the fiber. But, what you find is, the dye because it is soluble in a solvent, is like the Solvent more. So, the partition coefficient will shift, towards the solvent and not traverse the fiber. And that's the reason, why although disperse dyes are not water-soluble, we still would dye from aqua systems. Right? So it, is its good that, more dye goes, into the fiber rather than, it stays, in the solution.

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Now, this the same type of colors, I'm not talking about pigments at the moment, can be used for printing. How should they be different? one many colors are being used, in the same system, there of course, mixtures are being used yes, the fastness of the dyes in general, has to be on the higher side, particularly the wash fastness, should be on the higher side . Okay? And therefore, it will not be so much important, that you have a faster rate of reaction, what will be more important is, that it is uniform and properly, diffused into the fiber. And proper diffuses, at least 50% of the fabric or a fiber cross section, has been taken care of. And also, the difficult part as we've said already.

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The fastness of each of the mixture, that you are using, of the dye, should be similar. They'll be very difficult to be exactly same, because definitely, cool is different, so theoretically you can expect, that every different molecule will have a different property. But, if it is in the range, we always talk about, some range, acceptable range, acceptable limits, and then it will work. So, you will have to depend lot on the datasheet, of the manufacturer and then select the mixtures and not arbitrarily, because this Patrol gives such a beautiful shade, let me use it, later results would not be so nice. So, we just saying the same thing, light fastness also because you're going to be exposed, you know, the certain portions of the garment, are exposed fully, certain portions of the garment are exposed less. And if the, fading is not happening at the same rate, then the shade chain takes place. and if, the shade chain takes place, then you can be quite sure, people can find out, there is a change of shade, it doesn't look the same and so, we would have to because such a, costly process we would like to, select such dyes, where light fast is the high, of course and also similar, you know, so it's not easy. But, you can try to find out, that said that how, the fading takes place, in your own ways, whether if the dye fades, these fabric will get affected. But, I gets affected anyway, but do you think there are dyes, which will affect the fabric, can try and find out, there are some wear dyes, which were stopped, the manufacture was stopped, at Sam's. Whether the substrate, affects the fading, whether the substrate affects the fading. So, this is an important thing, one of the interesting case, is there and you can appreciate, in the light fastnesses, you absorbing certain amount of energy, this energy is absorbed by the molecule, which is called the dye. It has in, any way absorbs, the otherwise nothing will be seen, but you have UV light also, but not just the visible. So, if you absorb certain energy and that energy, changes the molecule, damages the molecule, then obviously fading takes place. If suppose the energy instead of the molecule, actually changing itself, passes on this energy to the fiber. Because, the linkages are such that, can actually transfer the energy, so fiber if, suppose some

damage takes place, will take place. But, fiber being a large, volume large mass, it may be smaller, the dye is a small molecule, just sitting somewhere, on the surface and trying to do whatever, particularly surface, the fading will be felt on the surface, the dye which is inside the fiber deep, is not even visible, so you will not see whether it is faded not and most probably, it's not even faded. Right? So, we're looking at surfaces, printing is based absolutely on surface, you know, surface interaction with our own eyes and that is how the printing takes place and so, one case for example, the cationic dyes, you can dye them on, cotton also through a mordant, you can similarly print also, you can have those same dyes, on acrylic fibers . Okay? Now, generally it was felt and it may have been, you remember also, the light fastness of the basic dyes on cotton, were found to be relatively poor, compared to when direct dyes, you know, light fast I'll be talking about. But, the same dye, if applied on acrylic fiber, has shows higher dye, higher light fastness. Because, you make an ionic bond there, it is easily, relatively more easily able to transfer the energy to the fiber and I feel safe, and so, fiber dye interaction can actually play some role, in the fastness, defining the fastness, light fastness also, to wash fastness you understand very easily, there is a bond made, less bonding, more bonding, covalent bonding, ionic bonding, they will all play a wash fastness role in determining, what is the wash fastness, but light fastness also, gets affected. You can read, more about it. The wash fastness of course, is important. Higher the wash fastness, better it is as far as the printing is concerned.

But, you would be also very much interested in staining, resistance, staining resistance is important. Because, when you wash some of the dye solution, during washing will flow over, the areas where you don't want it to be there and this you must remember, stain is generally difficult to remove, easy to happen. Because, the equilibrium is in the favor of the staining, because the color is more in the solution let us say, and there is no color, on the fiber although temperatures of course are different, you are not giving the right pH, you are not giving catalysts, anything else, therefore we don't expect so much to happen, but stain is a stain and that's what you have to worry about. And so, one would like to have such dyes, which do not stain easily, you know, you would have to wash sometimes also, when you for worse the same. Same government, just got position which are white, a portion is a light and so, anytime that I can get exchanged.

So, the staining is an important part, you will like to choose, perspiration fastness of course, are important, because and rubbing as well. So, if you have dyes which are not soluble, which have not reacted, which after process would be available in particles, even small or dimmers, trimmers and larger things, which become insoluble iced, after the process is over, they may have a tendency to get out also, because they may be in the surface. Let us say, as awake like, they may remain on surface and so, the problem. Or the indigo for example, you know, you know, the denim. So, affinity is less, does not penetrate more, but you like it anyway and so, rubbing fastness, unless and until this a fashion, it may not be very good. in the case of disperse dyes, you should be bothered about, a sublimation fastness as well, see, the same reasons, the sublimity and fastness is not very high, the wash fastness may be good ,because this first eyes are not water-soluble and let's say you have done, the printing with disperse dyes on I'll on, which you can do, when you store also, at temperatures which are not very high, but let's say, go up to 50 degrees in some cases, you may see sublimation very low, but it is there it'll good enough to stain. and that's

it, your print is over, the problem is not that Hamid I you lost, you've lost the whole fabric or a garment ,which you may have paid for so, did the general questioner, they do the dyes have all these fasteners very good, they're not, sometimes the shade here to compromise. Because, the shade desires that such dyes must be used, otherwise you will not obtain then, you have to compromise. But, everything not being same and not in your favor still, you have to work around, if you have the choice, you better exercise, the choice that's how we would like.

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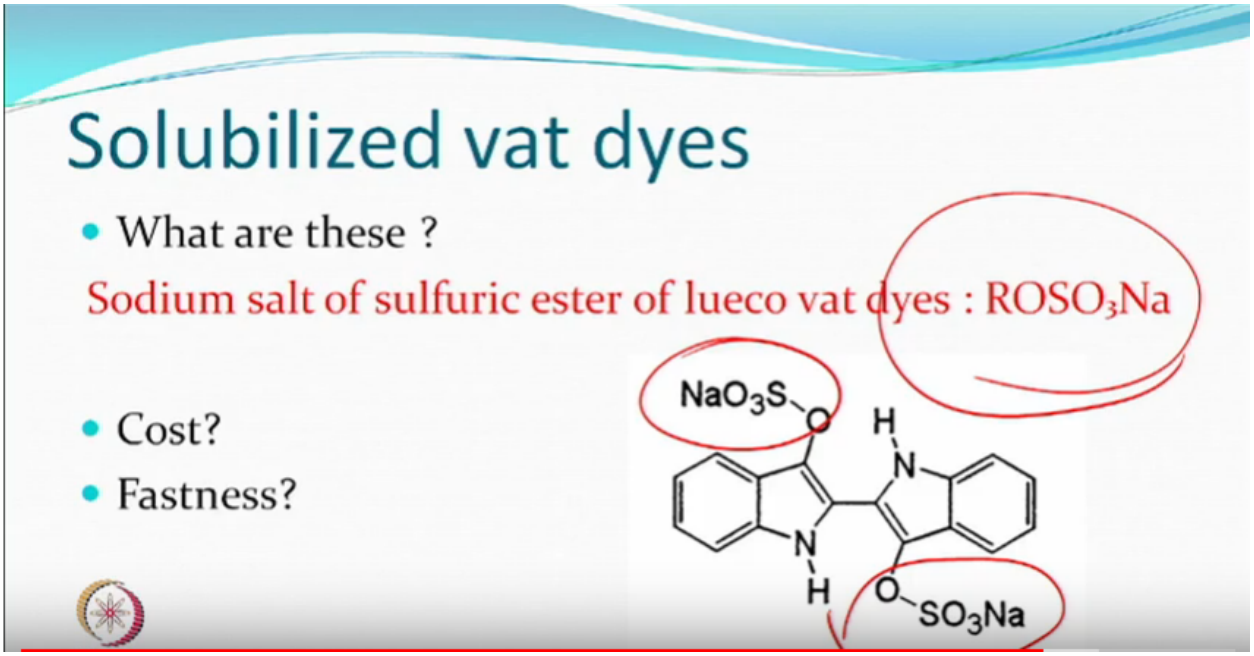

So let's say, Vat dyes. We they generally use for printing, without any doubt. Okay? Why, they have all kinds of fastness, which are very good. Very important from the printing point of view, we look at the worst fasteners, you look at light fastness, all kinds of fasteners, they are very nice dyes. But, they are expensive, so you can appreciate anything, which does everything Right? Will be expensive, not just as a dye ,but also the whole process, you have reduction, oxidation, all that has to be done. So, they're good for printing, cost is high, so no problem ,you should be able to use them. Which type of a fabric fiber, fabric can be printed, with red dyes, this give me some answer, what type of fiber fabric? Cellulosic. Okay? Very good, so this type of a dye, the way it is, can be used for cellulosic cotton viscose, etcetera. If suppose somebody says, I want to use it for wool and silk, is the dye has a problem with the wool and silk. So, what is the problem? Alkali and the process is a problem. Right? If suppose you can solve this problem, then you should be able to dye, that's why people made, something called a, ‘Solubilize Vat Dye’. The same dye as observed change, that you have now, groups attached ,they make the dye soluble. So, these are sulfuric esters and sodium salts, of sulfuric acid because every time you make,

these compounds, you got to make a salt, so that they remain ionic and so water soluble. So, the same guy as before, just that, is the structure has changed.
So, because of this particular group, that has been added, you are now here, this is the change from the previous dye and suddenly, this dye can be used, on any fiber. Which is, which is hydrophilic ? Okay? So, you can go on the silk, you can go on cotton, you can go and rayon, you can print on, nylon, no shoes but why should you that's a separate question, cost is very high. fastness you would like to have any questions, on the fastness, do you think the fastest will be different, it should not be, this is the same molecule, if the molecule because at the end of the day, this will become the same dye, after final, little, oxidation cycle. They're the same dye and so, this is what we call it the engineering a molecule, to your own advantage. But, cost is high and of course, the pellets that are available, color palettes that available, pellet that is available, is not as large as wide, as the where dye. But, cost is quite prohibitive, but printing purposes if you really want it, they are, there. So, all substrate can be used.

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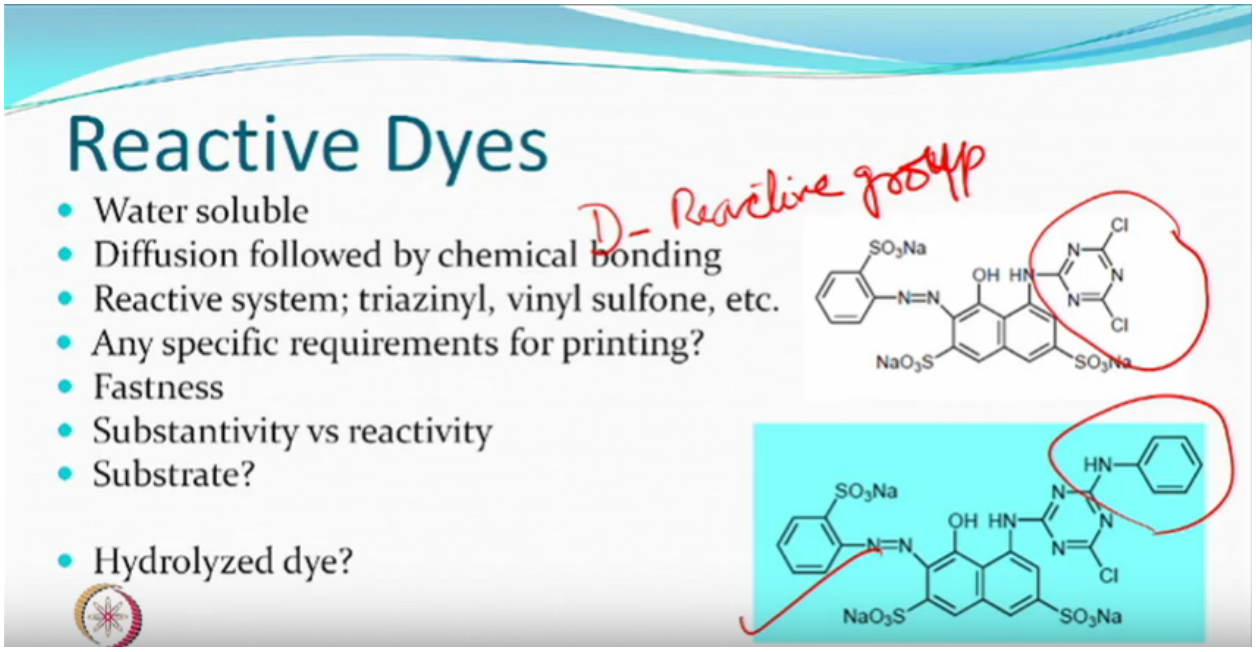

Reactive dyes became very popular. Right? And also, for dyeing as well as for printing. Because, you have let us say, something called this, so you have a dye and a reactive group, of course, there would be a bridging group and everything else, there is a chromophores, you can see, this also will behave like one. And so reactive dyes, everybody loves them, so we spend, some time here, before, we they are water-soluble? No issues on that, because they have, various kinds of groups with Sulphonic acid groups is attached. So, what is the process? The process will be first you dissolved ,then you make a paste, after making a paste, you do whatever and then it must

bond. So, you must provide a condition, at the Right time. If you provide the condition, of fixation is the wrong time, they look at the wrong results. So, the let's say it requires alkaline condition, the alkaline condition must be, provided at the time of fixation, if suppose the alkaline condition. Right alkaline condition, is provided in the paste itself, a paste is stored for a long time, it's not made every minute, they're not easy to make also requires energy. And effort and therefore, what will do? You will provide alkaline conditions at the right time. This particular dye, is called a, dry dichloride, try the Nile system, sometime known as the M type of reactive dye, this is not used for printing generally. It's too reactive, lot of wrong things will happen, Right thing will happen later. so you want to create a condition, let's say, it will fix at sixty to eighty degree centigrade, then at room temperature, it will not fix. so whatever kind of material that you have, whatever anything else that you have, they will not nothing will be happening at that time, it happen at the time.

So you might prefer the this dye, where one of the chlorine has been, substituted by an amine. So, reactivity has gone down and time required, temperature required will be high, but for printing it's a good idea, saving time is not a good idea. so these are, some of the reactive groups, as we said the reactivity should be less, fastness obviously will be high and this would two things, which we know, quickly talk about the fastness, if the reactive dye has reacted with fiber, it makes covalent bond, so should not have any fastness issue as for the wash fastness is concerned, but if it has not reacted, then you have a problem. So, if you're looking at cotton ,where does it react to they had two hydroxyl groups ,whenever there is a water, there is a hydroxyl group. So, it will react with water also, if it reacts with water, those let's say, one chlorine in a mono chloro triazine type of a dye, was there they say react with water and I will not react, it will just be there, you wash it it'll come out. so fastness property, would depend on how have you actually proceeded ,whether most of the dye has reacted or most of dye is not reacted or reacted somewhere else, or in some other form, then you have a problem, then this question of substantively versus reactivity. So you want it reactive, again moderate ,like you said I don't want at dichloride, substantively also moderate, then if at all it has hydrolyzed and available when I do good amount of washing, it should come out ,so there the customer does not complain, it should come out ,while you're processing. if it is high substantive dye, then it will have different ways of bonding other than, the covalent bonding also, like and it will stay and keep coming out, every time you wash and so, the wash fastness sometimes, reported may not be five, it will be less than five. How can you have, reactive dyed, less than five means what? It means ,you have done bad job, dye has reacted with water and is available on the fiber and so the new molecules, will have moderate reactivity and moderate subtend ability, so that can come out. Which substrates can be printed with, let louder, with substrate, yeah. Cellulose, of course they were designed for them, but wool, silk, can be and you do not really have to go to the alkaline, ph also, they can react and so hydrolyzed dye issues, will also not be faced, with silk and woll , so they are one of the best, actually in India also, a large amount of self printing is done by reactive dyes. and so, they actually have, show better fastness, they can react with free amine, amino groups and groups, that are present, in approximately neutral medium ,you can do an acidic medium, but neutral is the best and so, no hydrolyzed dye .because, had hydrolyzed dye is

formed in alkaline medium, I think today, we will like to stop here and next time when we meet, take it further. Right? Thank you.