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**Theory and Practice of**
**Non Destructive Testing**

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**PENETRANT TESTING – PART 3**

Hello and welcome back again. So, we have been discussing about the first topic among these NDT topics that we have lined up for this course. So, this is on dye penetrant testing that we have been discussing in last couple of classes. So, before we proceed today let us have a quick recap, what we did in the last lecture.

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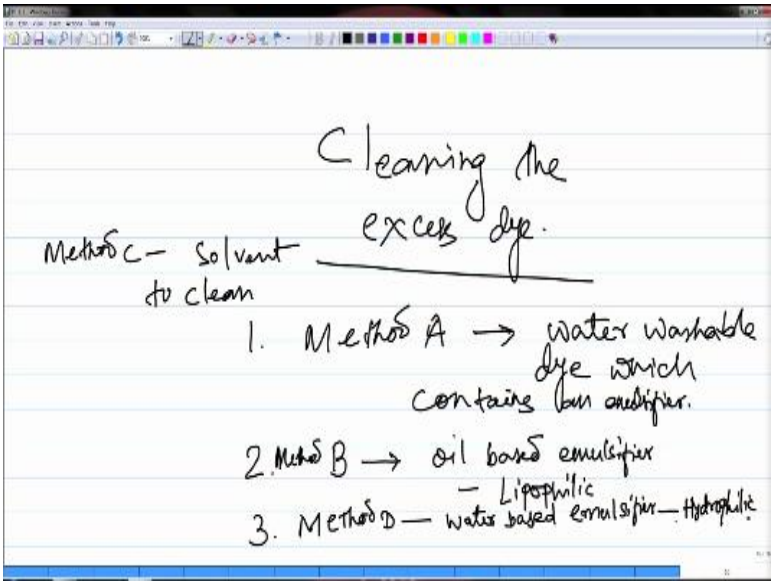

So, in the last lecture we talked about the cleaning methods for the excess dye. This is something that you need to do before you apply the developer, which is the next step that I am going to talk about today, to ensure that the surface is clean as it was in the beginning. So, we saw four methods of cleaning the excess dye; that is method A, this one is water washable dye which contains an emulsifier.

So, this already has the emulsifier. You do not have to add the emulsifier externally like what you do in case of method B and D. So, in case of this particular method if the dye contains the emulsifier then you can simply use water and washing. Method B is an oil-based emulsifier and that is why this is also known as lipophilic.

So, in this case you use an oil-based emulsifier to emulsify the dye and then clean it with water. Third one was method D. In this case you use a water-based emulsifier and that is why this is also known as a hydrophilic method. And then finally another method I talked about, which was method C, in which you use a solvent to clean the excess dye. So, in this case you simply take the solvent on a piece of cloth or on a piece of cotton and then you can clean the surface. So, these are the different methods by which you can clean the excess dye and keep it ready for the next step.

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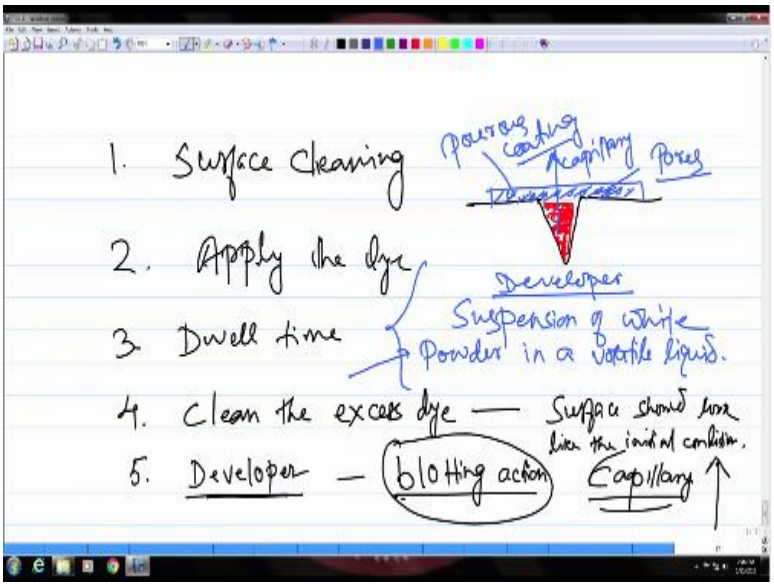


So, now if you go back and look at the different steps of this dye penetrant testing method; first is a surface cleaning, then you apply the dye, then you allow some time for the dye to go inside the flaws, if there are flaws and then clean the excess dye. This is what we discussed in the last class. And this would take the surface back to the initial condition.

Now, your surface is completely clean. There is no dye at all but if there are flaws, then you know that the dye will be inside the flaws. So, let us say there is a crack, so, dye will be inside the crack. But now on the surface you do not see anything because you have cleaned up the surface. So, in order to make visible indications of flaws like cracks and other defects, you need to draw this dye out of the flaw and make it visible on the surface.

So, you need something which will draw this back to the surface and make visible indication. Now, if you remember when I talked about the early method, in which case they used to use oil as the dye and then after soaking in the oil, they used to apply some chalk dust. So, the purpose of using that chalk dust is to draw this dye out of the flaws and make it come to the surface so that you can have visible indications of the flaw.

So, that particular thing which will draw the dye back to the surface, like the chalk dust, is known as the developer, because this is going to develop the visible indications of the flaws. So, the fifth step, now once you have this clean surface, is to apply the developer and then wait for some time to see if you have any visible indication. So, if there are flaws and defects and if the dye is inside them, this developer will have a blotting effect.

So, by this blotting action, it will draw the dye out of the flaws and make visible indication. So, in this case also, as you could realize from this particular term, you need to suck it out. That means you need the same driving force which took the dye inside the flaws, that is the capillary force. But in this case these capillary will work in the reverse direction. So, in the first case it suck the liquid inside the flaws and in this case the same capillary force will work but it will suck it out, so it will act in the opposite direction.

And if you remember, I said for this capillary force to act, you need some kind of opening. Some opening on the surface through which this capillary will develop. That means this developer should have some porosity. So, it will provide a porous surface and because of the presence of these pores, again the capillary will act on this and it will draw the liquid out of the flaw onto the surface.

So, you need a porous uniform coating on the surface to be able to draw this liquid out of the flaws onto the surface. That is why you use a suspension of white powder in a volatile liquid and you can apply it through a spray can and so, the moment you apply it, this volatile liquid will quickly evaporate and it will leave behind a porous coating.

So, that is the purpose of using this volatile liquid, so that you can quickly dry it. That is the first objective and then it will also leave behind a porous coating because you need these pores for the capillary to develop.

So, as you know by now the dye color is normally red and that is why a white color powder is chosen as the developer so that you have a contrast. So, the moment you apply the developer and it dries off, if there are flaws on the surface you will see them, see their indications, as red lines

according to the geometry of the flaws. Let us say, if it is a crack, so you will see a red line on a completely white background.

So, that will give you a good visibility because these two colors are contrasting to each other. So, if you will see red color indications on a white background, so your visibility will be good and that is why these two colors are chosen as contrasting to each other. So, this is a porous coating which will help develop the capillary in the reverse direction and draw the liquid dye out of the flaws onto the surface.

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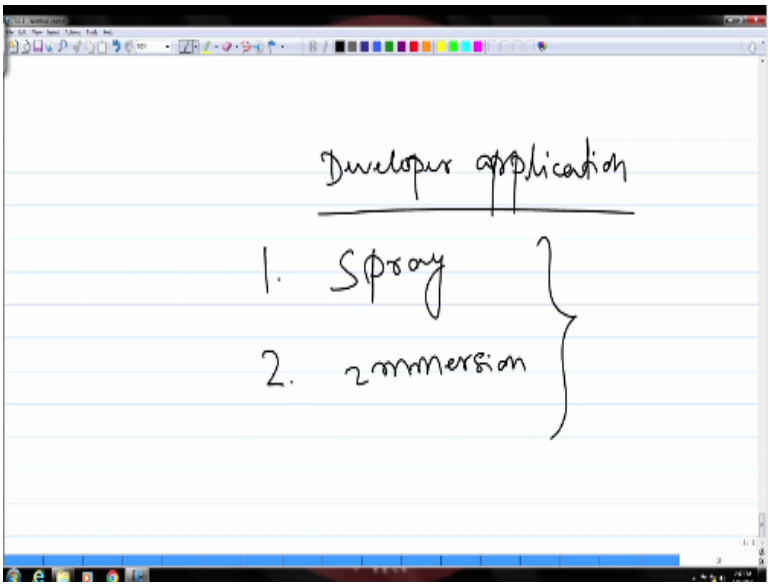


And you can apply the developer in two ways; one is, by spray, so you can have a spray can which will contain this white powder in a volatile liquid, and the other way, you can do it is by immersion. So, this depends on your requirement. If a spray can is sufficient for the part you have, then you can spray the developer. On the other hand, if you think that the spray can is too small for the part, then you can immerse it in a tank which contains the developer. But either way the function of the developer will be same.

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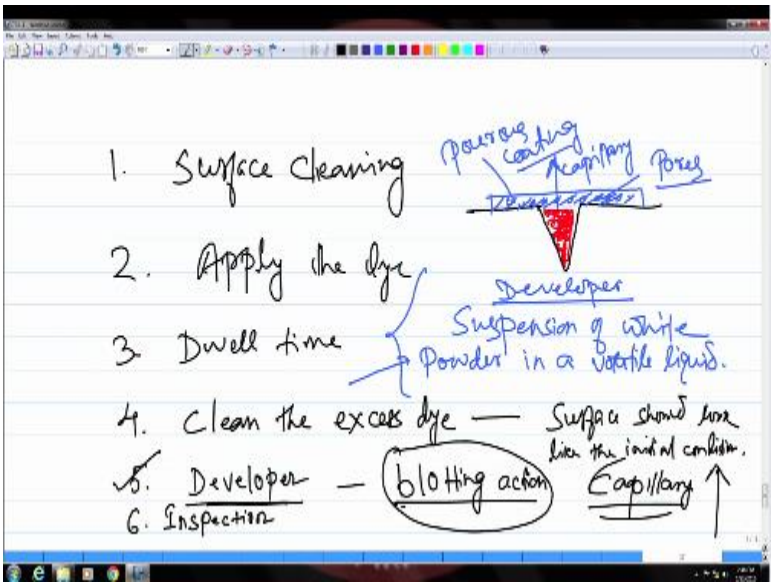


So, now we are in the fifth step, you apply the developer and then if there are flaws, you can see visible indications. So, the final step will be inspection. So, here are the six different steps of this particular method beginning from surface cleaning and going all the way to inspection.

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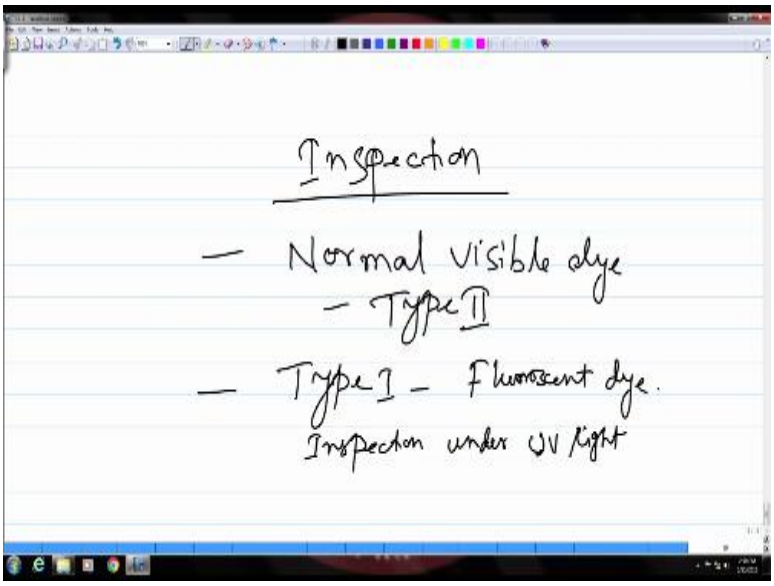


So, now you have applied the developer and then visibly you could see that the dye is coming out and making red color indications on a white background, as I said. So, you should take the part to a well illuminated area so that your visibility is good and then observe it and see if there are any feasible indications. So, this is how you do it for normal visible dye, which is also known as Type 2 dye.

If you remember, we have talked about this. So, in this case, you simply take it in a well-lit area and then see the visible indications, which may be there on the surface. And in certain cases you can also use this Type 1 dye, which is a fluorescent dye, so it contains a fluorescent material. So, in this case, the inspection has to be done under UV light, under ultraviolet light. So, once you apply the developer and all that, so rest of the steps will be same from 1 to 5.

But, in the final step, when you do the inspection, if you are using a Type 1, fluorescent dye, then you need to take it to a dark room and then do the inspection on the observation under ultraviolet light.

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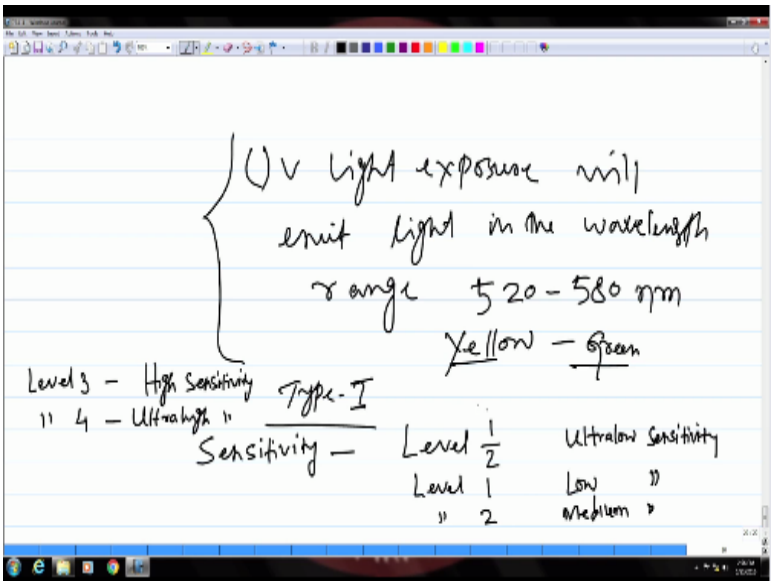


So, this contains a fluorescent material and when you expose a fluorescent material to UV light, it fluoresce. That is why this is known as fluorescent. So, UV light exposure of this fluorescent material will emit light in the wavelength range of about 520 to 580 nanometer, which is in the range of yellow to green or green to yellow. So, that is why these fluorescent lights, most of the time, you see as yellow or green color or something in between. Because when a fluorescent material is exposed to UV light, they emit light in the range of 520 to 580 nanometer wavelength, which falls in the range of green to yellow.

So, this is how you will see, if there are defects and flaws, they will glow. They will fluoresce green color or yellow color light and you would be able to see them glowing in a dark room. So, this is how, this is done, in case of Type 1 dye. And the visibility in terms of how far you see this fluoresce, I mean to what extent these flaws are glowing, depending on that visibility a sensitivity is assigned and there are four or five levels of sensitivity depending on how visible it is, under UV light.

The first one is, level half and the visibility in this case or the sensitivity in this case is ultra low. So, that means sensitivity for level half is not good, in fact very low. Then you have level one that is low sensitivity. Then you have level two, which is medium sensitivity. Next is level three

and in this case, this is high sensitivity and finally you have one more sensitivity level, which is level four and this is ultra-high. So, this is how the sensitivity levels are specified for Type 1 dye.

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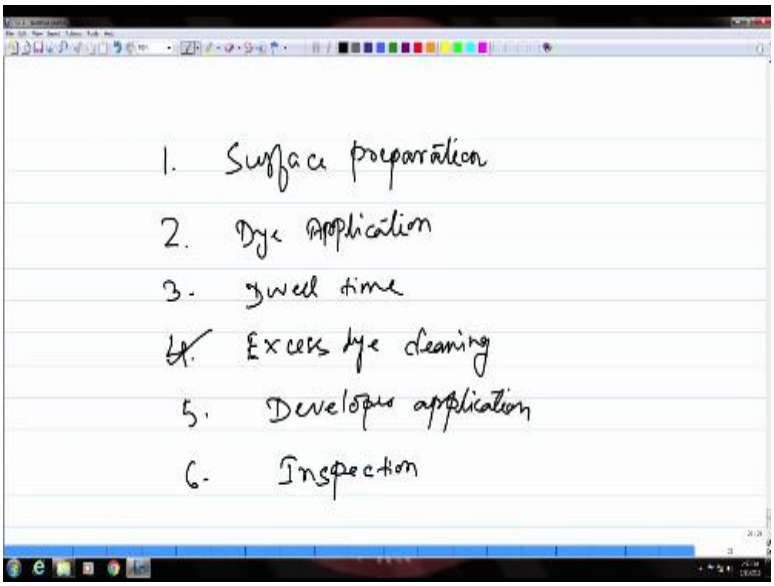


So, let us have a quick recap about this process, about the steps that you have in this particular process; surface preparation, dye application, dye dwell time, excess dye cleaning, developer application and finally inspection. So, this is a fairly simple method, if you follow these steps properly, particularly this step number four. As I have told before also, you need to be little more careful in this case, so that you do not remove the dye from the flaws while removing the excess dye from the surface.

So, if you follow these steps methodically, you would be able to do NDT using a fairly simple technique like this. This is all we have today. So, I will stop here today. There are a few more things about this particular process that we will see in the next lecture. Thank you for your attention.

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