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Theory and Practice of
Non Destructive Testing

Dr. Ranjit Bauri
Dept. of Metallurgical & Materials Engineering
IIT Madras, Chennai 600 036

PENETRANT TESTING – PART 4

Hello and welcome back once again to this lecture series. In last few lectures we have been discussing about this particular topic on dye penetrant testing and so far we have learned about the basic principle behind this technique and we have also seen how the method is done and what are the different process parameters, which control this particular process.

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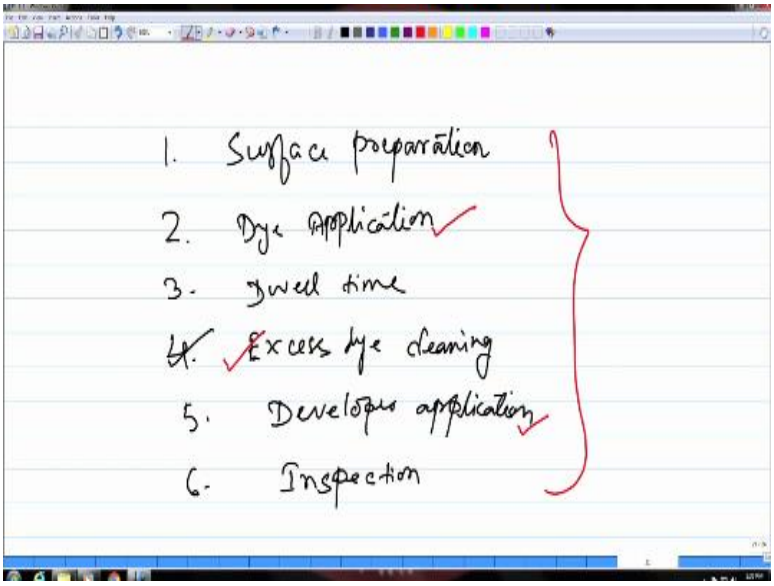

So, basically you have six different steps to follow beginning from surface preparation to all the way to inspection, which is the final step.

So, as a process if you look at it, you would have realized by now that, it is a combination of primarily these two things, the dye and the developer. It can never be done with only one of them.

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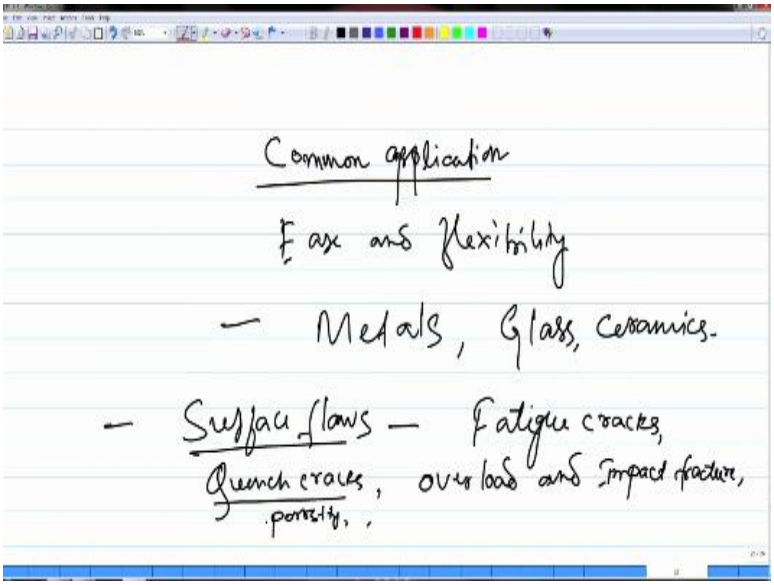

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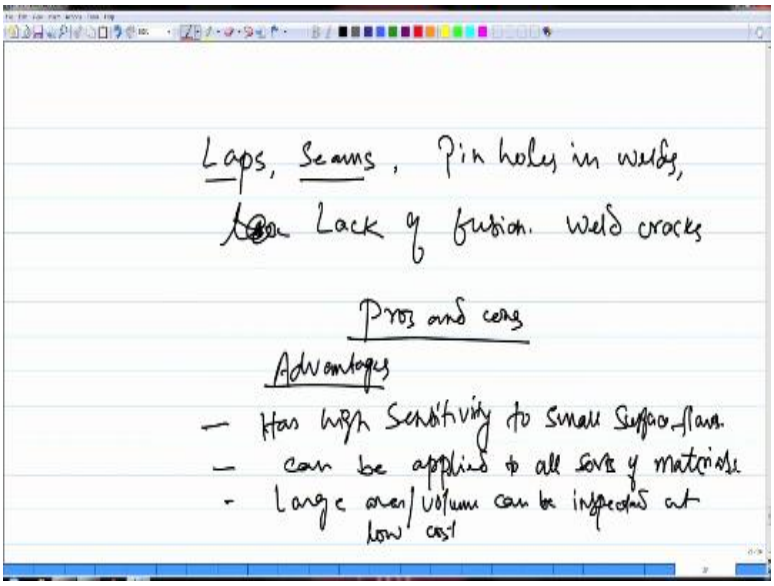

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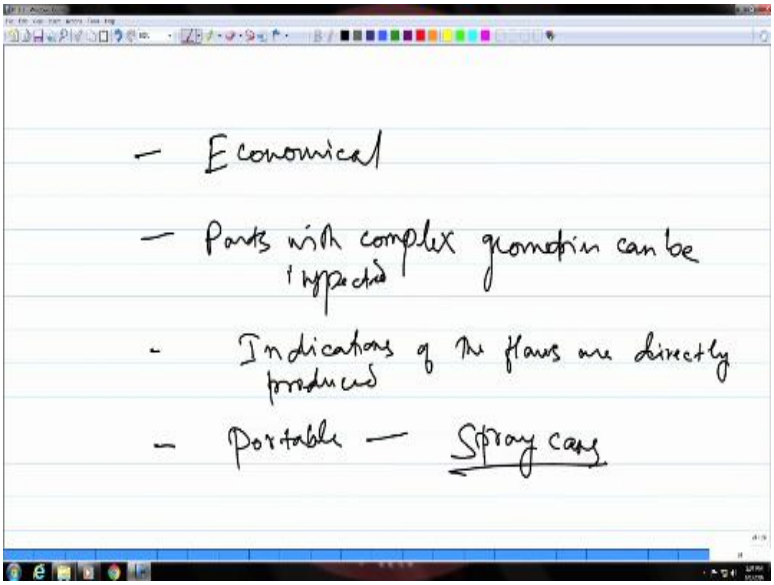

Although we have seen, the dye is the main responsible factor, which is going inside the flaws but even then only with the dye, it is not possible to do this testing because without the developer the dye will remain inside the flaws and will not come out.

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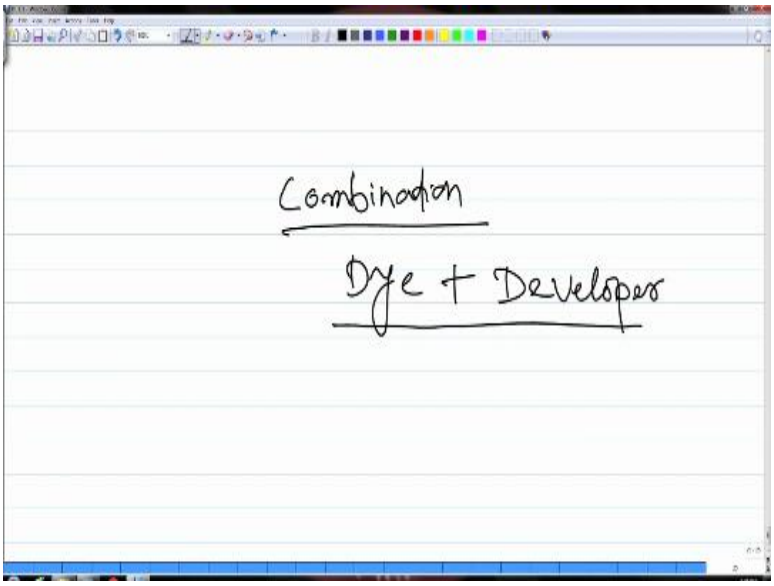

So, therefore, this process is a combination of the dye and the developer and these two have been kept with the color, which are contrasting to each other, so that the visibility is good. So, I will demonstrate this today with a small video, how this combination work and in that video you would be also able to see the other steps from step one to six, as we have discussed so far. So, let me show you this small video which will give you some idea as to how exactly this process is followed.

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So, this is a video that we have captured in our own lab, our NDT lab at the department of metallurgical and materials engineering.

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So, here let me first tell you what part we have that we are going to examine. So, if you see this part, this is an automotive exhaust valve, which is used in the engine. So, what he is doing right now, he is cleaning the surface, as I have told you, the first step of the process to clean the

surface nicely and as you could see he has taken a small piece of cloth and in that he has taken some solvent and with the help of that he has cleaned the surface.

So, this is the part as you could see, this is an automotive exhaust valve and apparently as you could see right now, on the clean surface, apparently it does not really show any defect. It looks like a sound good quality part but let us see once we do this dye penetrant testing on this, what can we see on this, whether it is a good part or a defective part.

All you need are couple of cans; one for the dye that you could see over here, the red color dye, one is for the developer and the one more you may have as a solvent to clean the surface. Now, this is the second step to apply the penetrant. So, he is making sure that the surface is absolutely clean and now it is ready for the dye to be applied.

So, this is the spray can, which contains the red color dye, which is going to be now applied on this part. So, take it and apply it nicely all over the surface, nicely and uniformly. Now the surface is fully covered by the red color dye, the dye is all over the place. And now, if there are any defects or flaws this die is supposed to go inside them, but right now, as you see, you cannot do the inspection because the whole surface is fully covered by the dye.

So, this is the excess dye that we talked about which you need to clean and make the surface clean again as it was, before you could apply the developer and do the inspection. So, we are going to allow some dwell time because that is also necessary after we apply the dye, we will leave it for some time, let us say about three to four minutes for this particular part.

And now, we have to clean the excess dye which is there on the surface. The surface would go back to the initial condition, as I would have said before also. So, you can see that he is taking a piece of cloth, which is having some solvent. So, this means the method that he is using for cleaning the excess dye is, yes you guessed it right, this is the method C that he is using right now to clean the excess dye from the surface.

And he is making sure that the surface is again absolutely clean, no dye or nothing is sticking to the surface. It has to go back to the initial condition as it was. So, he is making sure, he is cleaning it again and again to make sure that no extra dye is sticking to the surface, but he is careful enough, so that he does not remove the dye from inside the flaws. So, look at the surface now, it looks like as it was in the beginning, as if there is nothing and nothing has been applied.

But once the developer is applied, as we are going to see now, you could see a magic, if there are flaws. The surface looks good and ready for the developer. So, he has taken the can and shaking the developer can and now he is applying that white color developer on this and as I said, immediately you could see something is happening. Some red line you can see. So, this is almost like a magic, there was nothing on the surface as it was looking absolutely clean and free of defect.

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And now, you see the moment he applied the developer, you could see a big long crack from here all the way going up. So, that means this part is defective. There is a big crack across this handle and here near the base also, you could see over here, there is a crack. Let us see, if we could see any more defects. So, this is a closer view we could see. You would see the crack, some indications over here also, so that means there could be a crack in this portion as well.

And there are some indications on the base here. So, this portion also was looking absolutely clean and there was nothing, but now you could see the red color dye, which has come out and making this visible indications. So, this is how the combination works, the combination of the dye and the developer works to make visible indications of surface defects. So, I hope this video will be a good practical exercise for all of you.

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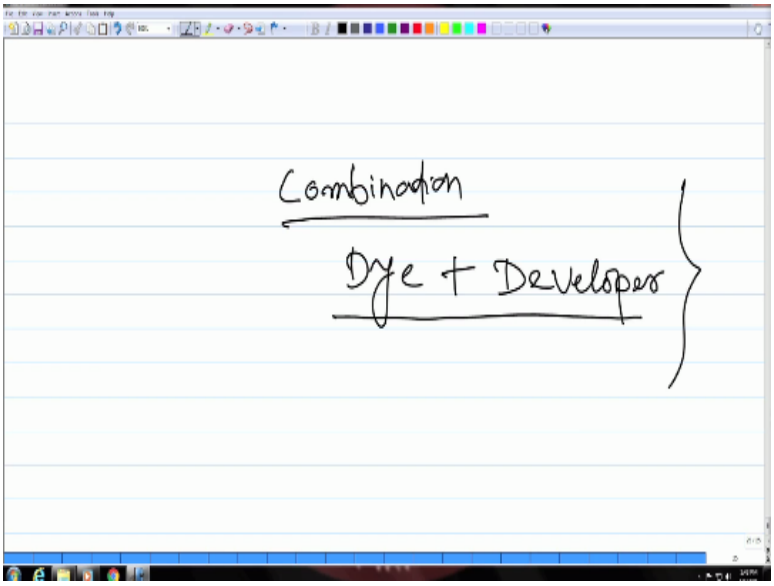

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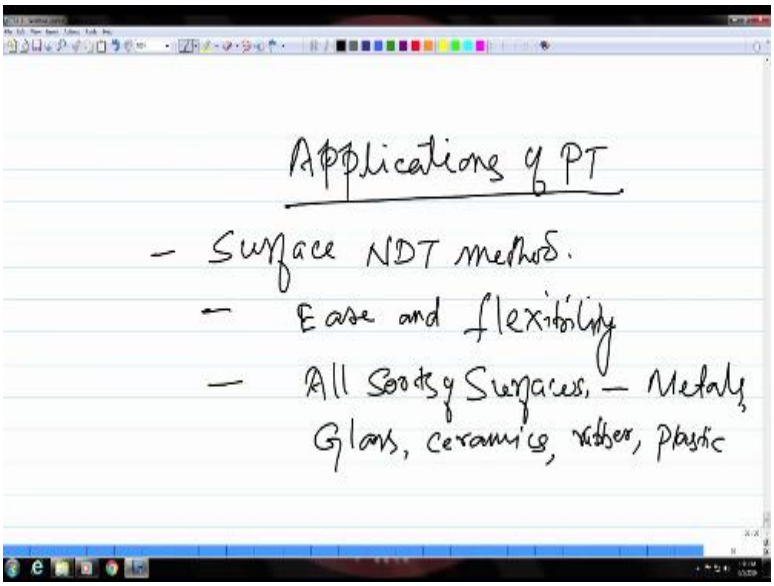

And now, let us go ahead and see what are the application areas of dye penetrant testing. As I said before this is a surface NDT method and anything to do with surface and surface flaws, this particular technique can be applied. In fact it can be applied on all sorts of surfaces; metal, nonmetal, ceramic, glass, almost any kind of surface provided the surface is not too porous.

If the surface is too porous, for obvious reasons, you cannot use this method, otherwise for every kind of surface, this method can be applied. And this is also easy to do and quite economical, as you would have seen in the previous video. All you need a couple of cans to do this. And this can be done anywhere. You can do it inside the lab or outside the lab or in fact you can do it on the site also, if you want to examine any part or a component of the system.

So, it provides you that flexibility and ease. So, let us see the common applications of this method. So, ease and flexibility are two aspects which make this technique very popular for inspecting surface flaws and the other aspect is, of course, you can inspect all sorts of surfaces like metals, non-metals, glass, ceramics, rubber, plastic. It does not matter what kind of material you have. So, all these aspects make this method very very popular for surface NDT.

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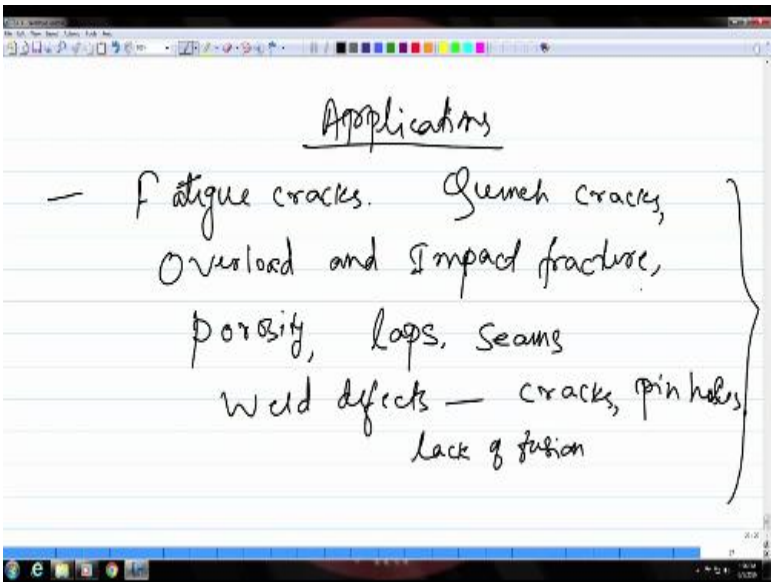

These are the typical applications in which you can apply this method. So, any flaw which is limited to the surface for example, fatigue cracks can be detected. Fatigue is a process which always starts at a surface. The fatigue crack initiates at a surface. So, these fatigue cracks will be limited on the surface and that is why this technique, the dye penetrant method can be used for examining fatigue related defects or fatigue cracks.

Then, quench cracks. Again during quenching a metal part from high temperature, these cracks can develop on the surface because the surface cools very fast and thermal shocks due to that can develop, which can lead to surface cracks. In fact even before this technique was used as NDT method, these blacksmiths noted that after quenching metal part, this quenchent liquid is seeping out of surface cracks, right. So that is how, probably it was first time observed that liquid can go inside surface cracks and flaws like that.

Then other kind of damages, like overload and impact fractures. So, not only cracks but this can also be used for other defects, for example, porosity. Then in metal forming, you could have some surface defects like laps and seams. The laps, for example, is a rolling defect, which happens due to a small part on the metal surface is folded during rolling and that folding is being rolled along with the metal. So, it will form a small folded part, which is rolled over the surface.

So, this is not desirable. So, this will leave behind a defect on the surface. So, this kind of surface defects apart from cracks can also be inspected by this particular technique. Then you can also inspect welds. So, weld defects like cracks, weld cracks, then pin hole, lack of fusion. This is a very common welding defect, where the metal does not fuse completely leaving behind a gap at the root. So, this is again a defect, right.

So, these are some of the defects. There could be many more. As long as the defects are located on the surface, this technique can be used. And finally let us see what are the pros and cons of this particular process. Every process, every method, has its own pros and cons, has its own advantages and disadvantages. So, here also, let us have a look what are the advantages and what are the disadvantages of this process.

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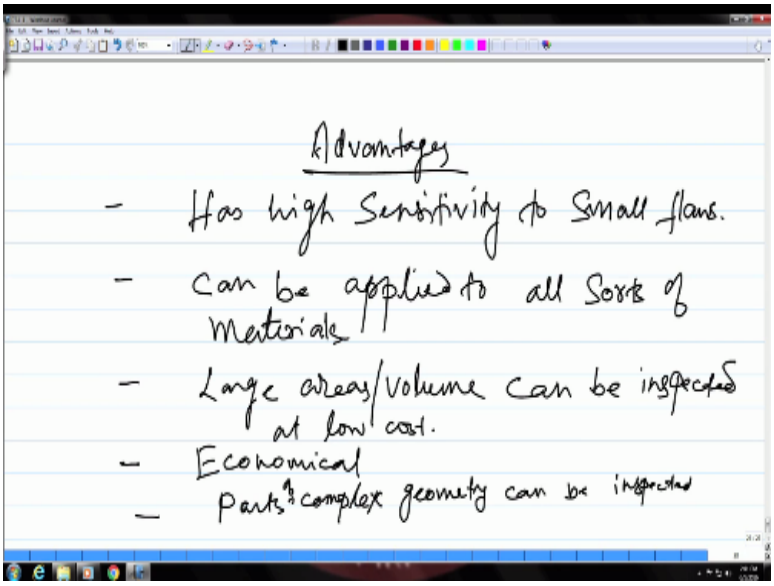

And with that, we can close this particular chapter. So, let us first have a look at the advantages. It has high sensitivity to small flaws. So, you will not miss out on smaller defects. Then it can be applied to all sorts of material, as I said before also. Then, if you have large parts or large areas or volumes to be inspected, you can do that with low-cost. So, cost effectiveness is one more

important aspect of this technique, it is very economical. Then, parts with complex geometry can also be inspected. So, the complexity of the part is not an issue for dye penetrant testing.

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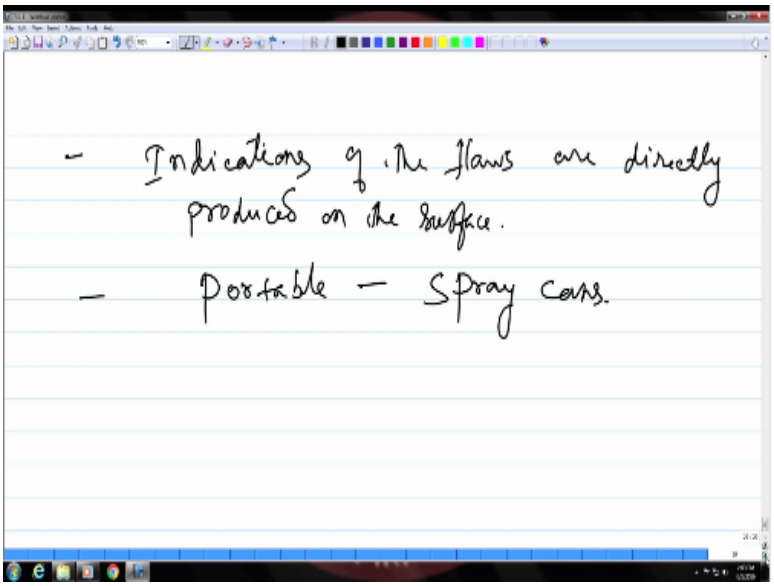

Then the indications that you have, are all direct unlike some of the other NDT methods, wherein you need to interpret the results to know whether the defect is there or not. But in this case, the indications are direct, you see the cracks directly on the surface. Cracks or other defects as you have seen in that demo video, you would be able to see the defects visually directly on the surface.

So, indications of the flaws are directly produced on the surface and it is portable, you can take it anywhere, you can do it anywhere you want. All you need, some spray cans and you are ready to go. So, although this process is very good to use for surface flaws but it also may have some disadvantages.

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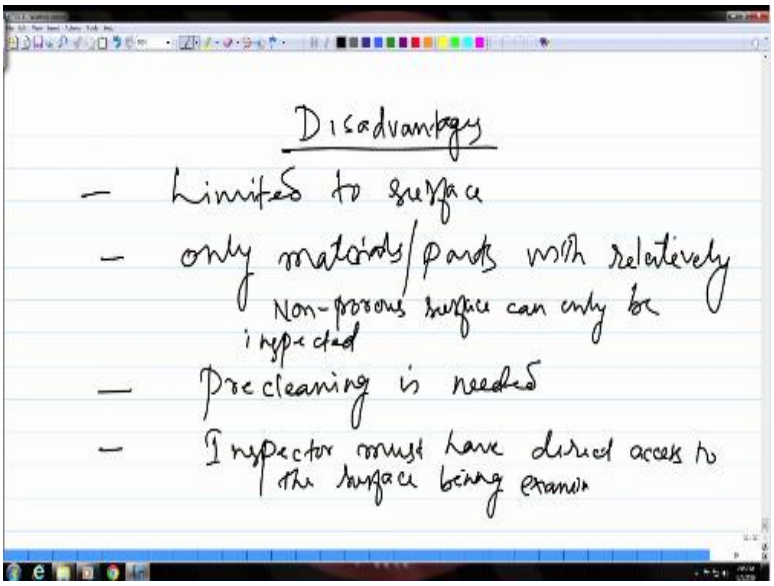

So, let us have a look at them also. So, this is limited to surface only, you cannot go below the surface into the bulk and then only materials or parts with relatively non-porous surface can only be inspected. If it is porous, for obvious reasons, you cannot do it. Pre-cleaning is needed, as we have seen and the inspector, who is doing the inspection, must have direct access to the part, to the surface being examined.

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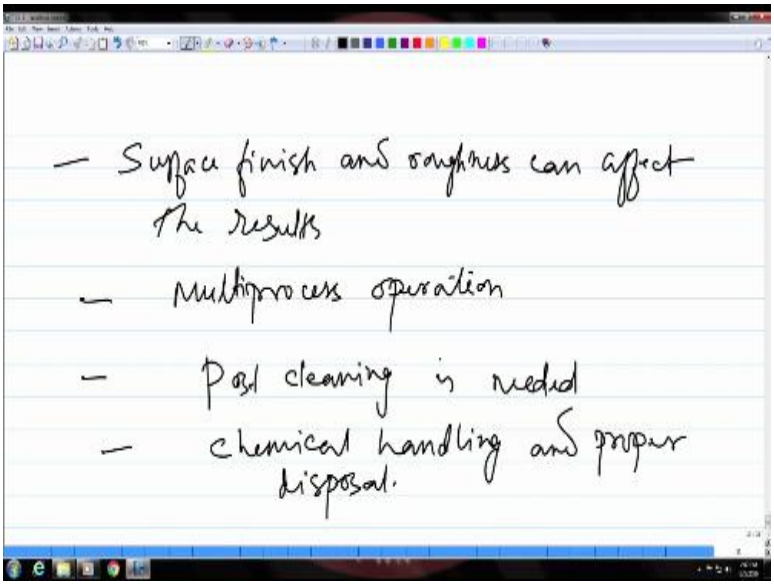

It is a surface method. So, surface finish and roughness can affect the results. Multi process or multi-step operation, as we have seen and you also need to do post cleaning, because the surface is entirely covered by the dye, as well as the developer. So, if you want to now use that part, let us say the part was not defective, there you did not find any defect, so you need to do post cleaning. Even for the defective parts also, for some other reasons, you may have to clean them. You are using some chemicals, in terms of the dye, the solvent and the solvent which is there in the developer. So, you need the proper chemical handling and disposal.

So, this has some limitations, but in spite of that, this is a very popular technique for detecting surface flaws and it is also very economical and flexible and that is why it is very commonly used for most of the surface defects. So, this is all I have for this particular topic. So, we have learned about the first topic, that we have lined up for this particular course. So, I will stop here today and then in the next lecture, we are going to pick up one more topic and then we will learn about that in more details So, today I will stop here, thank you.

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