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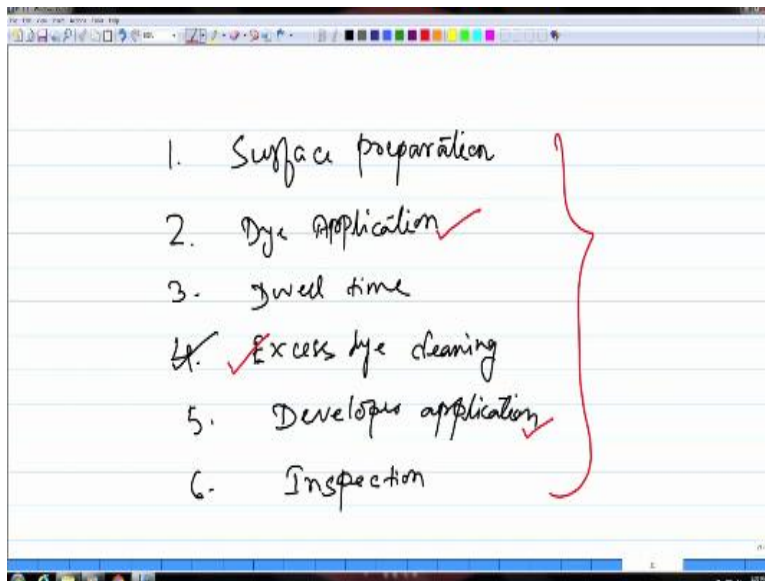
**Theory and Practice of
Non Destructive Testing**

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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 okay.

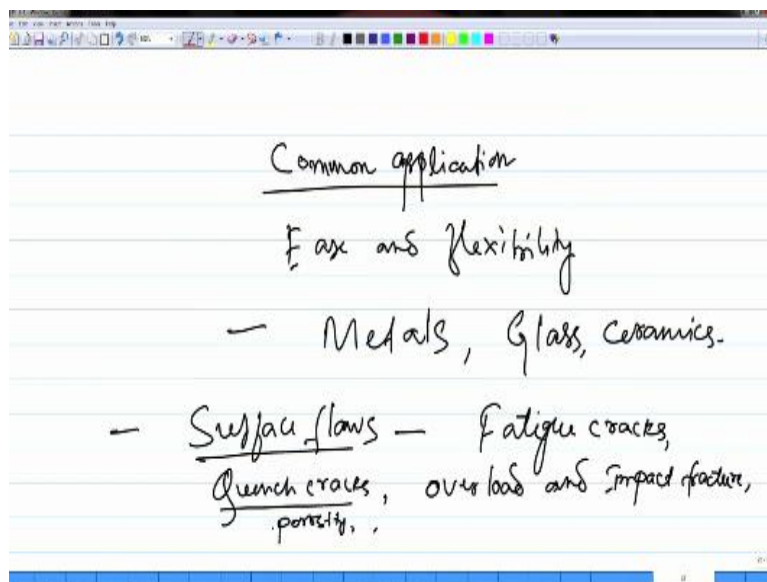
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So if you recollect finally this is what we have for this particular technique on dye penetrant testing so basically you have six different steps to follow as you could see from here beginning from surface by present to all the way to inspection which is the final step. And there are some steps like this as I would have told you before also wherein you need to exercise care you need to do it carefully.

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 okay, it can never be done with only one of them.

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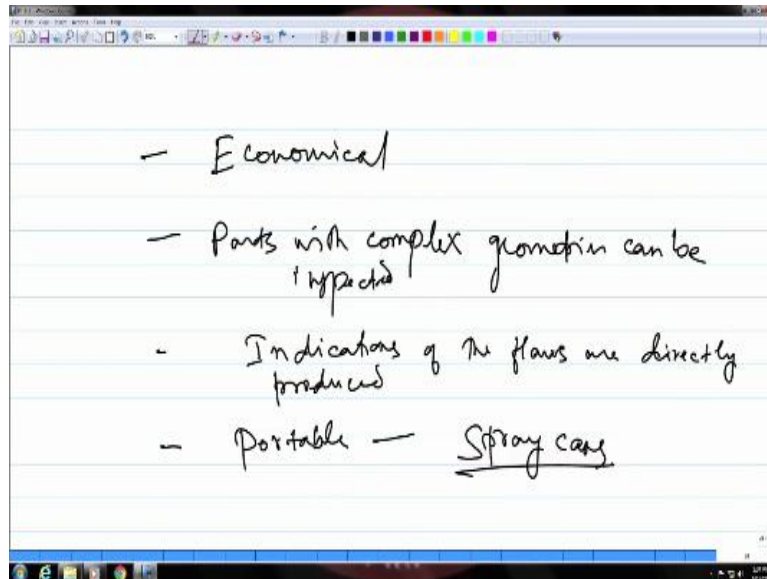
Laps, Seams, Pin holes in welds,
~~Low~~ Lack of fusion. Weld cracks

Pros and cons

Advantages

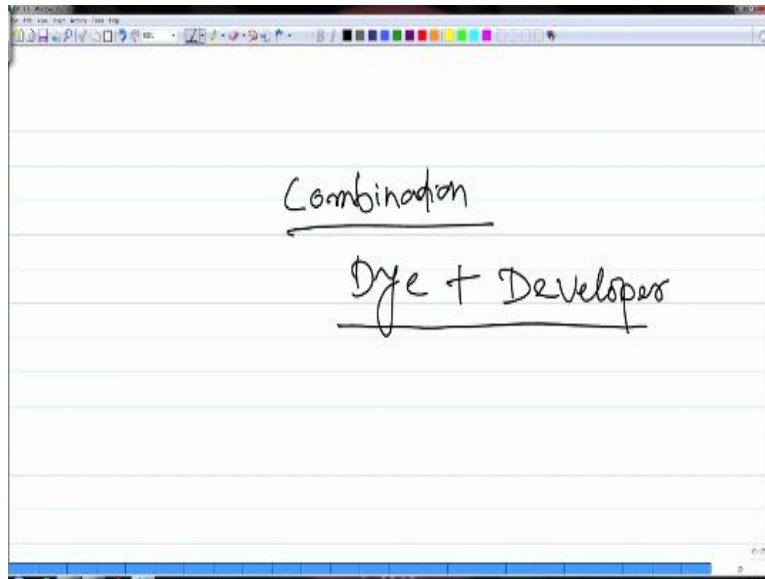
- Has high sensitivity to small surface flaws
- can be applied to all sorts of materials
- Large area/volume can be inspected at low cost

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

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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 have you know contrasting to each other so that you 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 so 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 okay.

So this is all you need as I would have told you before also this is a very simple process all you need are couple of cans one for the dye that you could see over here the right 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 okay, so this is what we have done. Now if you remember as I told you now the surface is fully covered by the red color dye, the dye is all over the place okay. And now if there are any defect or flaws this dye 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 okay.

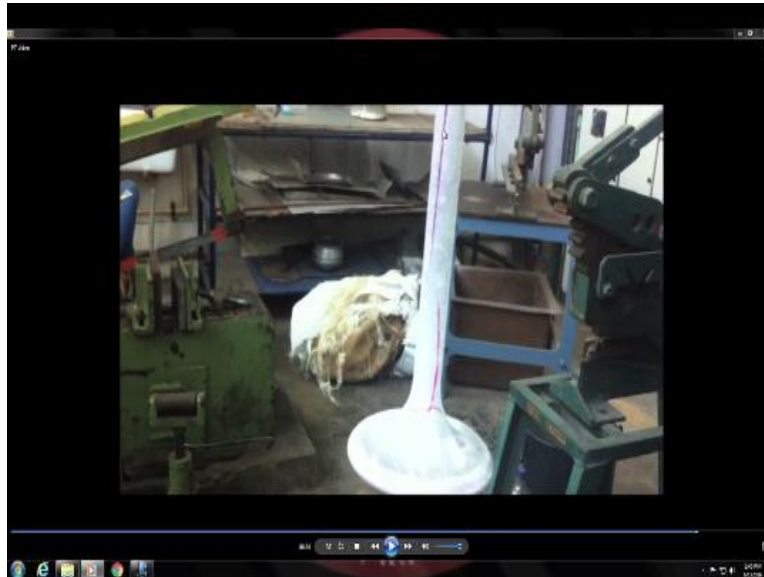
So this is the excess dye that we talked about which you need to clean and make the surface clean again as it was before you could apply the developer and do the inspection. So now what we are going to do we are going to allow some dwell time because that is also necessary after we apply the dye will allow some time 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 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 okay if there are flaws good, the surface looks good and ready for the developer. So he has taken the can and shaking it 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 okay. So this is almost like a magic there was nothing on the surface as it was looking absolutely clean and free of defect.

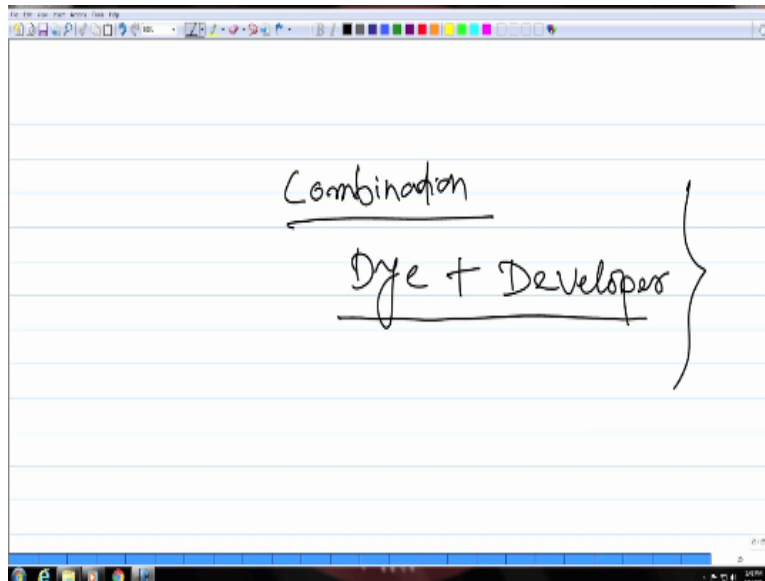
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And now you see the moment he applied the developer you could see a big long crack from here all the way going up okay so that means this part is defective there is a big crack across this handle and here near the base also you could see over here there is a crack. Let us see if we could see any more defect yeah. 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.

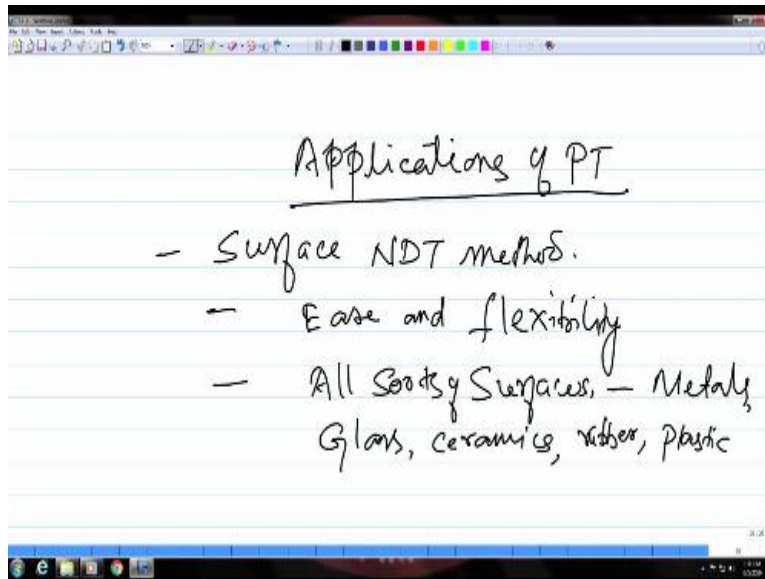
And there are some indications on the base here okay, so this portion also was looking absolutely clean and there was nothing but now you could see the red color dye which has come out and making this visible indications okay. So this is how the combination works okay the combination of the dye and the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

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And now let us come back to this okay. So this is what we saw and we also saw the other steps as we have discussed.

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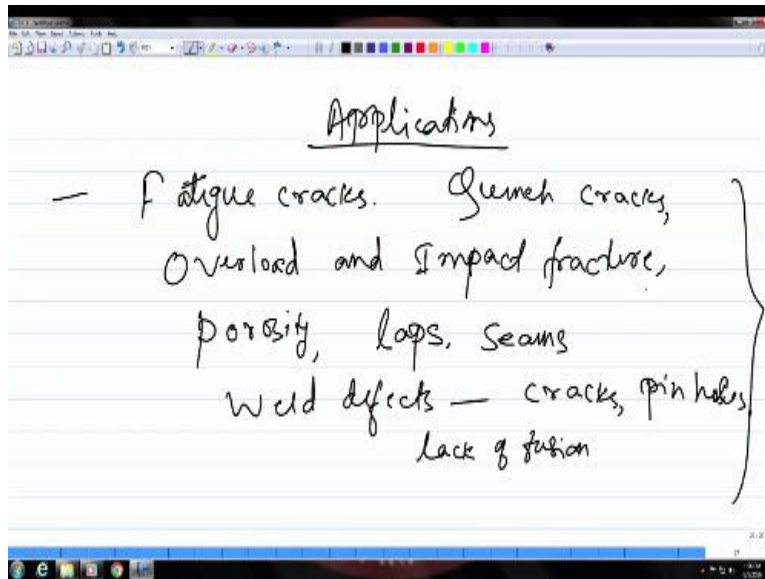


And now let us go ahead and see what are the application areas of dye penetrant testing. As I said before this is a surface NDT method and anything to do with surface and surface flaws this particular technique can be applied. In fact it can be applied on all sorts of surfaces metal, nonmetal, ceramic 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 okay 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 side also if you want to examine any part or a or a component of the system okay.

So it provides you that flexibility and ease with each you can do it, so let us see the common applications of this method. So ease and flexibility other 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, okay so all these aspects make this method very, very popular for surface entity.

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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 like 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 is a technique the dye penetrant method you know can be used for examining fatigue related defects or fatigue cracks, then quench cracks again during a quenching a metal part from high temperature.

These cracks can develop on the surface because the surface is cold 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 methods these blacksmiths noted that after quenching metal part this quenching liquid is seeping out of surface cracks, right so that that is how probably it was first time observed that liquid can go inside surface cracks and flaws like that.

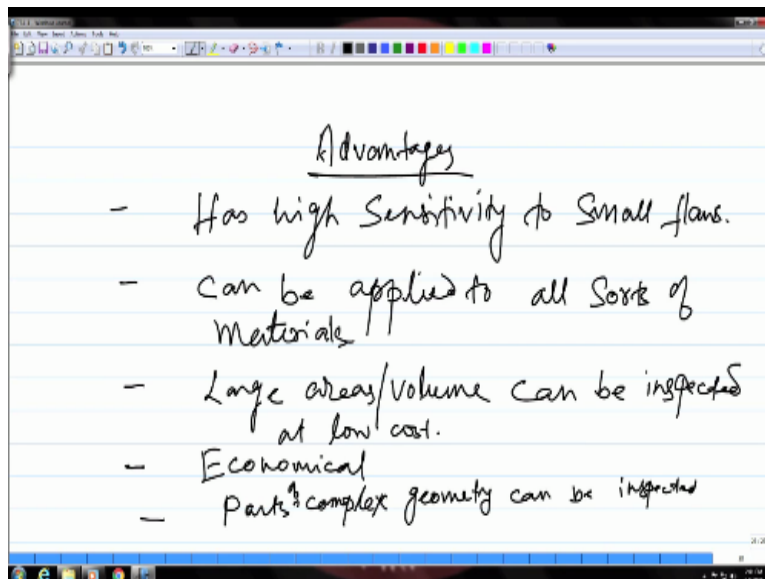
Then other kind of damages like overload and impact fractures then you have defects like porosity, so not only cracks but this can also be used for other defects for example, porosity then in metal forming you could have some surface defects like laps and seams the laps for example is a rolling defect 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 okay, 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 while 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.

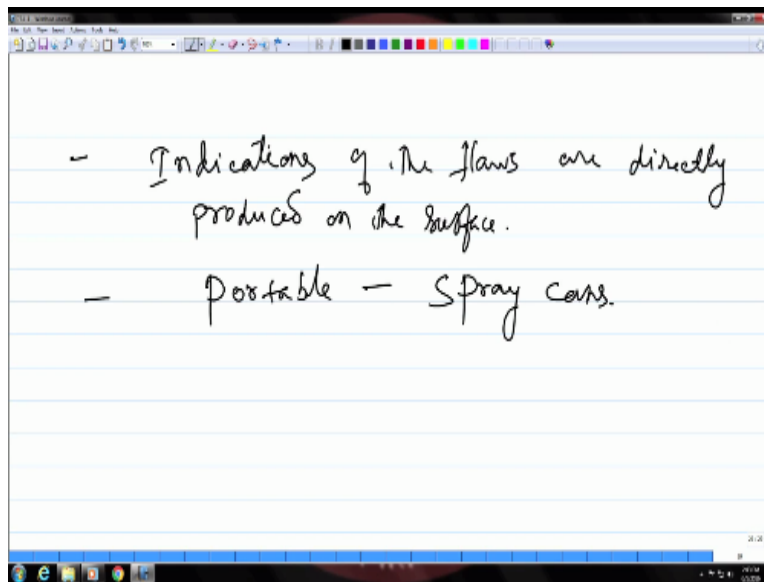
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And with that we can close this particular chapter, so let us first have a look at the advantages, it has high sensitivity to small flaws so you will not miss out on smaller defects then it can be

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 the other advantages as I said it is economical. Then parts with complex geometry can also be inspected so the complexity of the part is not an issue for dye penetrant testing,

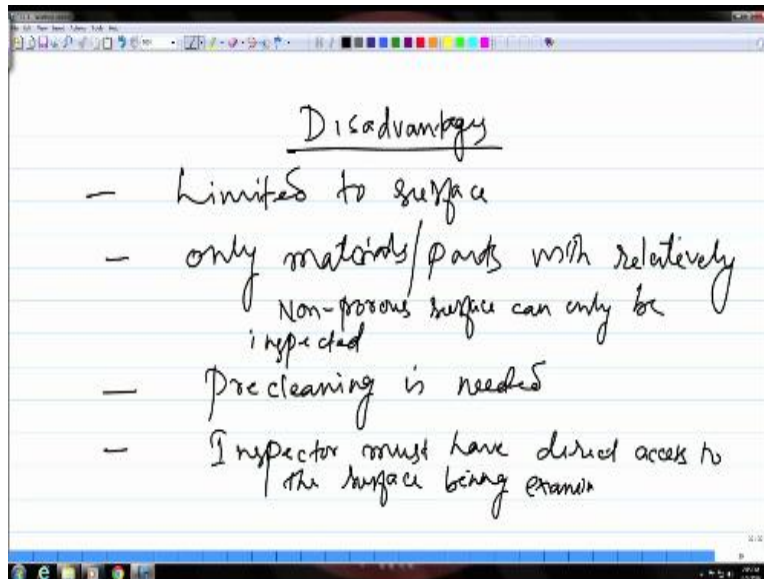
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Then the indications that you have these are all direct unlike some of the other NDT methods wherein you need to interpret the results you know to know whether the defect is there or not. But in this case the indications are direct you see the cracks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

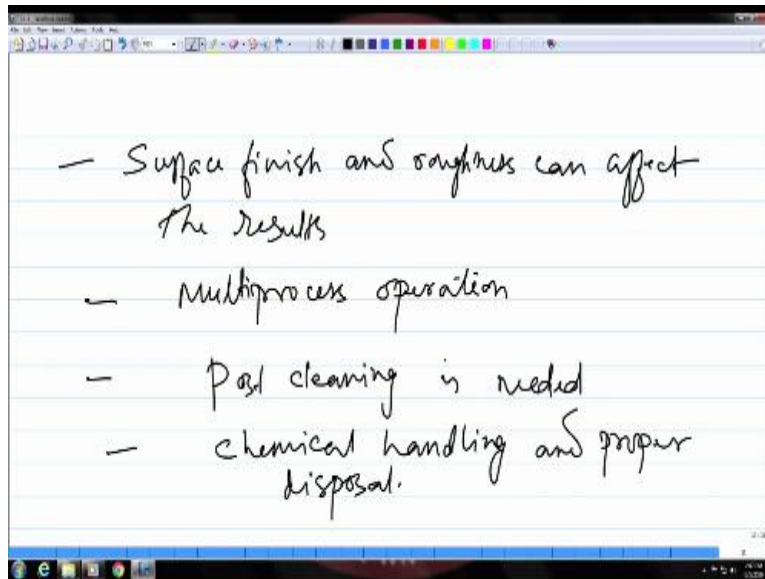
So indications of the flaws are directly produced on the surface and it is portable you can take it anywhere you can do it anywhere you want all you need as I said before also some spray cans and you are ready to go, but any process we will have its own disadvantage also so although this process is very 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 the relatively non-porous surface can only be inspected, if it is porous as I said before 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 okay, 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, okay.

So this has some limitations that this process has 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 learn about that method in more details so today I will stop here, thank you.

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