NPTEL

NPTEL ONLINE COURSE

NPTEL Online Certification Course (NOC)

NPTEL

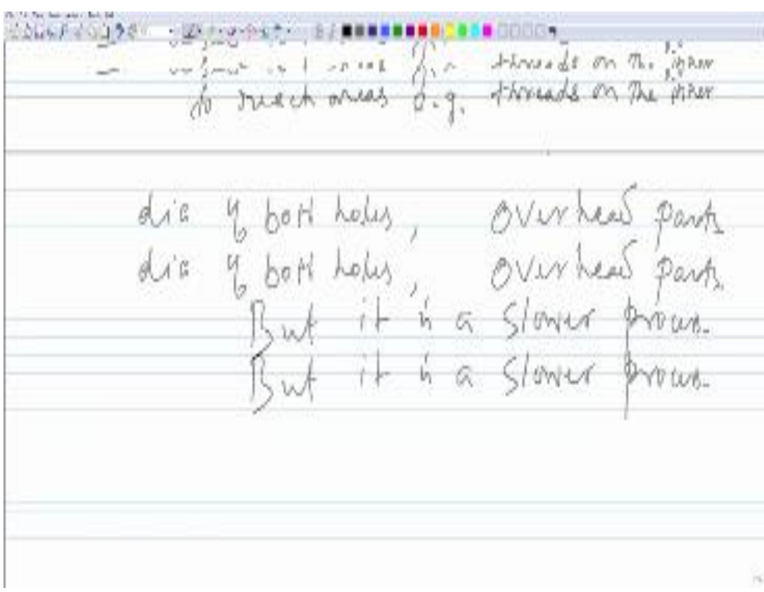
Theory and Practice of
Non Destructive Testing

Dr. Ranjit Bauri
Dept. of Metallurgical & Materials Engineering

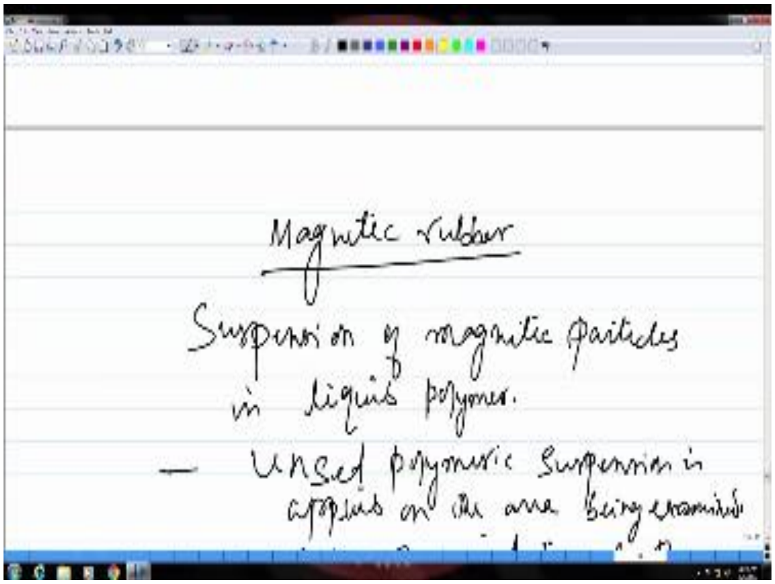
IIT Madras, Chennai 600 036
Magnetic Particle Testing -5

Hello. So, we have been on this topic of magnetic particle testing and in last few lectures, we have seen several aspects of this particular technique and learned about them. In today's lecture, this will be the fifth one and the concluding lecture on this particular topic, so, let us see, what we have done so far quickly.

(Refer slide: 0:36)

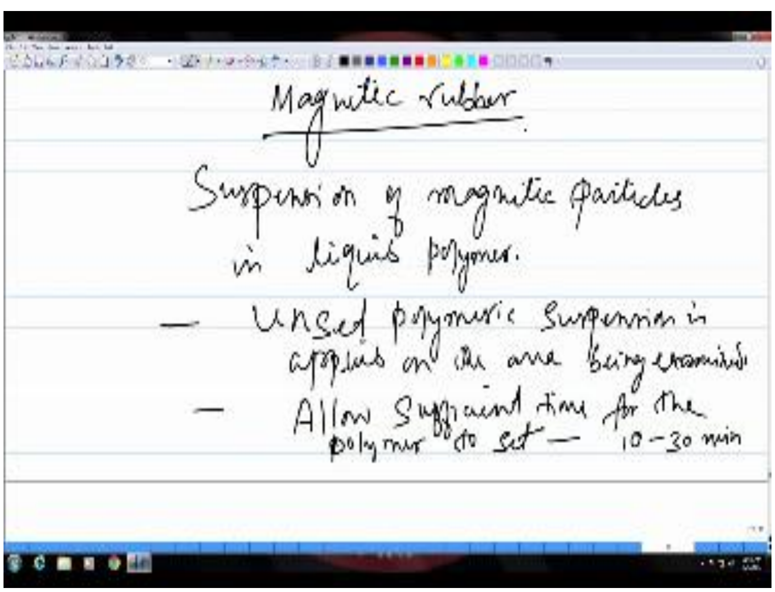


(Refer Slide Time: 00:44)



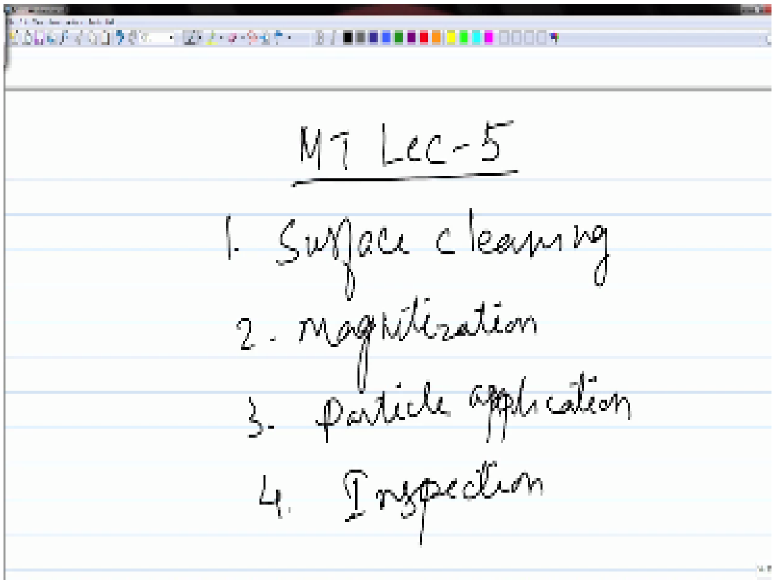
So, we have talked about the magnetizing methods and then, how the particles are applied what kind of particles you have and so on. And we have also seen depending on the condition of the surface or the kind of part you have, you choose different kinds of powder. Either wet suspension and in the wet method itself, we saw there are different kinds of suspensions, depending on what is the part being examined and then depending on the surface condition.

(Refer Slide Time: 01:24)



We saw that either dry or wet particles can be applied and there are different methods by which these are applied. So, today finally we will see how the inspection is being done, which is the final step.

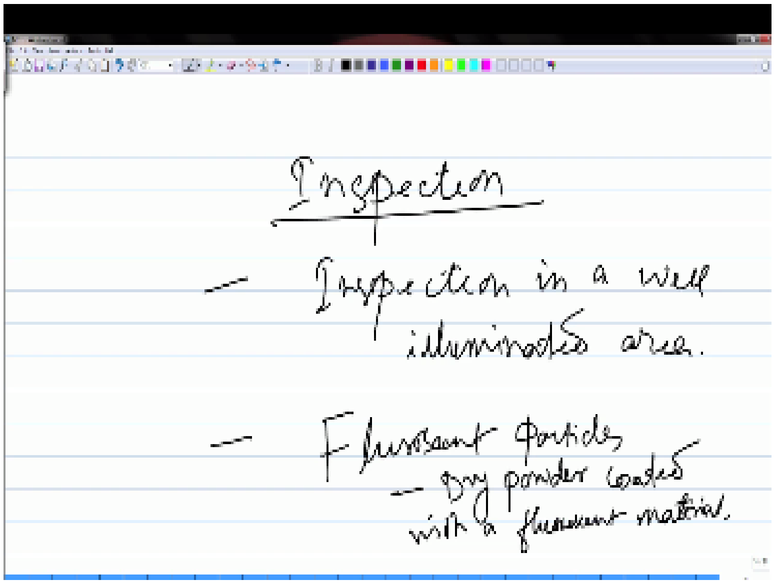
(Refer Slide Time: 01:38)



We have started from this and then finally once the particles are applied, then, we do the inspection. So, let us talk about this today and few more things. So, inspection, as you would have seen in the demo video that I showed you in the last lecture, you could do it in a well-lit area where you have enough lighting. So, that is for the normal particles that you use, what you saw in the video which could be either dry or wet particles.

So, that is what you do when you have normal, either wet suspension or dry powder, you take it to an well illuminated area and then see if you can see some visible indications of the surface flaws. The other thing that you can do in this case, as you would have seen in case of dye penetrant testing, in this case also, you can do fluorescent inspection.

(Refer Slide Time: 02:47)

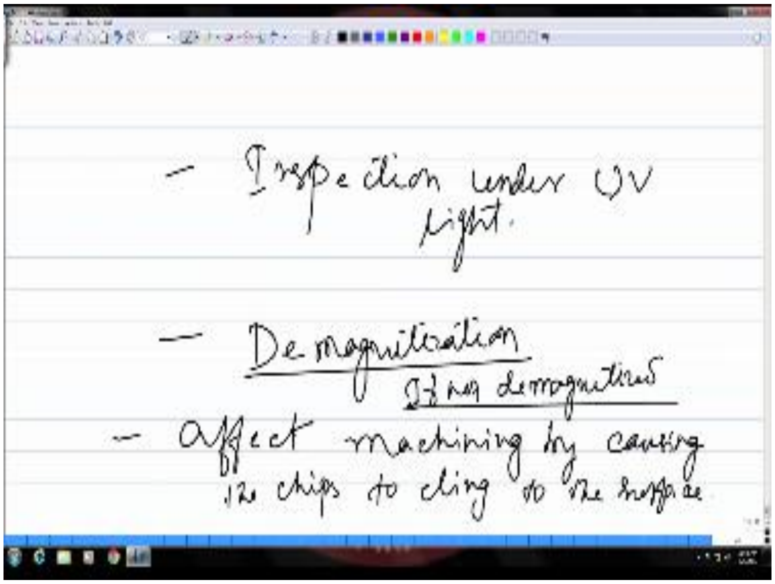


So, in case of dry powder, these powders are many time coated with a color. They can also be coated with a fluorescent material.

So, in that case, you would be able to do this inspection under UV light and the defects and flaws, if they are there, then these flaws will glow in a dark room, when they're exposed to UV light. So, this is something that we have seen before also. So, in case of dye penetrant testing, when a fluorescent material is exposed to ultraviolet light, then they emit light in the range of yellow to green, in that wavelength and you will see these defects and flaws glowing either in yellow color or green color or something in between them. So, that is what happens, when you do this fluorescent particle inspection. So, these are primarily dry powder coated with fluorescent materials. So, in this case, you need to do the inspection under UV light.

And if there are flaws and defects, they will glow. They will fluoresce due to this exposure and that is how you will get the visible indications of flaws. So, these are the two ways of inspecting the part finally. But there is one more thing remaining, which apparently may not look like a part of this particular technique but once this inspection is over, your part is still magnetized.

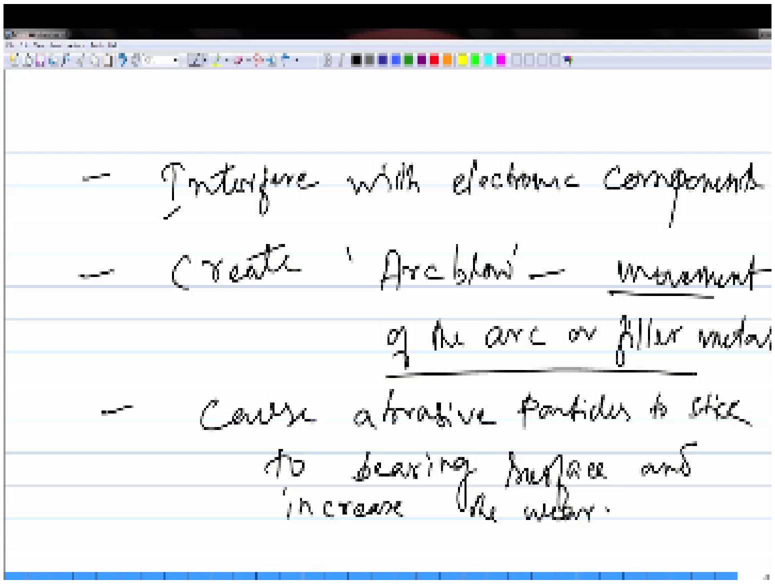
(Refer Slide Time: 06:31)



So, that is something which is not desirable because it could be a component which will be used, if there are no flaws. So, in that case if it is still magnetized, so, that magnetic field of the sample, of that component can affect its function, when it is used along with some other parts in a particular system. So, the last step in this case, then, should be to demagnetize the part before you wind it up. So, let us see what could be the possible difficulties, if you do not demagnetize the part after you do the inspection. So, if not demagnetized, then, let us say, this is, something, a semi-finished kind of part which has to be further machined to give the final size and shape. So, in that case it can affect the machining.

So, this we are talking about, if not demagnetized, what could happen. It will affect machining, by causing the chips to cling to the surface because of the magnetic field.

(Refer Slide Time: 08:53)

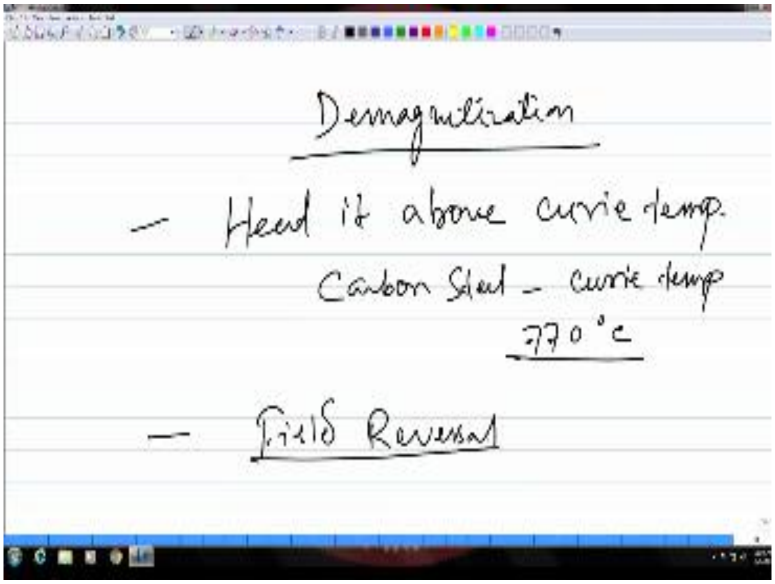


So, these chips will cling to the surface. Then, let us say the part has to be used in some kind of electronic system or some electrical system, then, it can interfere with some other electronic components because of the presence of the magnetic field, again, or if it is used in close proximity of some electronic component, it will affect the electronic components because of the magnetic field. And let us say, this part has to be welded for some reason to give it a shape or whatever reason, if this has to be welded and if you use an arc welding process, so in that case, this will create something known as arc blow, due to the presence of the magnetic field.

This arc blow is nothing but movement of the arc or the filler material, which is used for welding. So, this movement of either arc or the filler material is due to the presence of an additional magnetic field, which is in the part. So, this arc blow, again, is not desirable. If the arc moves then, your welding will be improper. It will create, some kind of uneven welding and things like that. So, there again this presence of the magnetic field on the part is not desirable and you need to demagnetize the part, before you can weld it, If you plan to use an arc welding process.

Then, it can also cause abrasive particles to stick to the surface. Let's say in a part like bearing, this will increase the wear. So, these are the different things which can happen, if you do not demagnetize the part. So, let us see how you can demagnetize and what methods are available for doing.

(Refer Slide Time: 11:52)



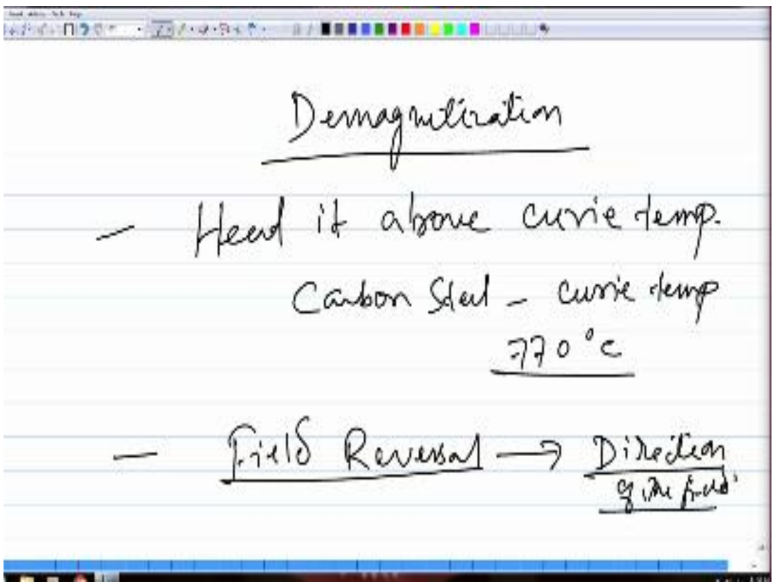
So, there are two ways by which you can do it. One is, you can heat it above the Curie point or the Curie temperature, this is a temperature above which a ferromagnetic material losses the magnetism and the reason behind that is the magnetic domains that are aligned in the direction of the field. When you apply a magnetic field, the magnetic domains in a ferromagnetic material align in the direction of the field when you reach saturation.

So, when you heat this ferromagnetic material, these domains again will misalign, because of the atomic vibration that happens due to the temperature, or due to the heat. So, due to these atomic vibrations, as you keep on increasing the temperature, these magnetic domains will again get misaligned and above a particular temperature all the domains will again be oriented randomly, like how they were in the beginning, when the part was not magnetized.

So, this is how, heating it above the Curie temperature will demagnetize it. But for this you need to have heating arrangement, furnaces and all that, because this temperature can go high, for example, for carbon steels, this Curie temperature is around 770 degree Celsius. So, you need a furnace, a heating arrangement, which can heat the part to this kind of temperature.

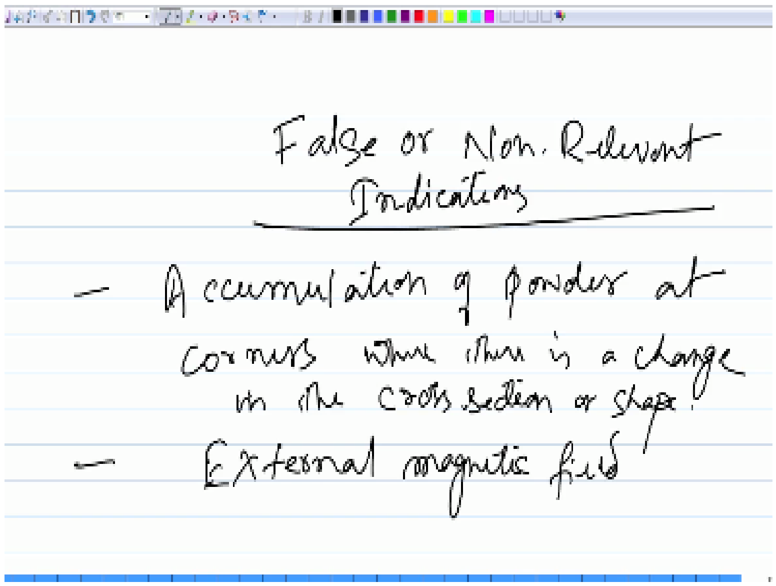
The other way of demagnetizing the part is, field reversal. That means, if you know the magnitude and the direction of the field which was applied in the beginning to magnetize the part, then you can apply a same magnitude of field but in the opposite direction. So, if you apply the field in the opposite direction, it will go through that hysteresis curve in the other direction and at some point when it reaches the coersive field, the magnetic flux in the material will become zero.

(Refer Slide Time: 15:09)



So, there again, knowing the direction of the field helps you. So, this is the another advantage, if you know the direction of the magnetic field. The other advantages, we have already seen, like the orientation of the defects with respect to the direction of the field. The visibility of a defect to depend on that, and the other advantage you have, if you know the direction, is this. So, these are the two methods. These are the two ways by which you can demagnetize the part.

(Refer Slide Time: 16:07)



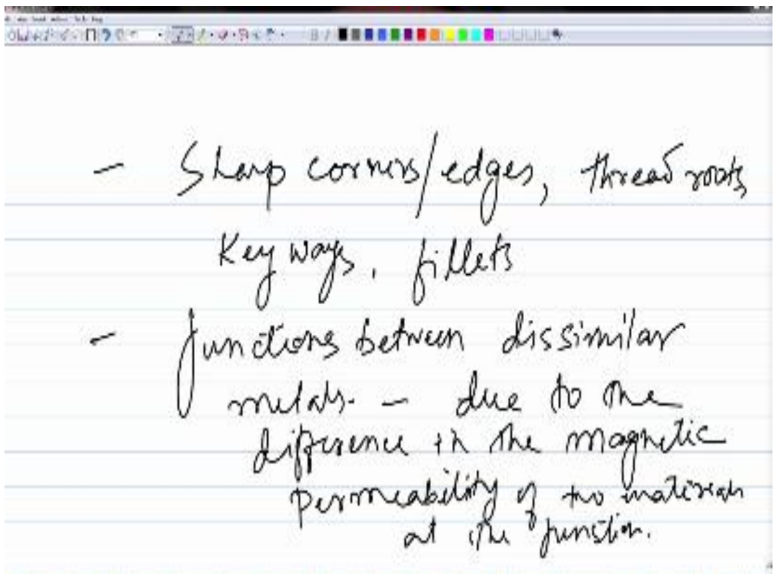
So, this is how the process works. Now, finally let us see, what are the applications of this particular method and then, like, what we do for every process, will also see what are the advantages and disadvantages but before that one thing that you should always remember, whenever you do NDT, not only for this method, but other methods also, are false or non-relevant indications which could arise due to various reasons.

So, this may look like a defect. It may give an impression like a defect but it may not be a defect. The indications that you see, this kind of false or non-relevant indication, they may look like a defect on the surface, but actually they may not be. So, while doing NDT, you should be always aware of this kind of non-relevant indications, so that you do not make a false call.

So, let us see for this particular technique for magnetic particle testing. What are the reasons for which you can get, you can end up with false or non-relevant indications, accumulation of powder at corners, where there is a change in the cross section of sample. So, if the part is not very regular, if there is a little bit of complexity in the geometry, let us say around the corners, there is a change in the shape or in the cross-section. So, along those areas, because of this change, the particles may accumulate.

And it will look like that this accumulation is because of a leakage field. So, it will give an impression that along those areas there a defect but actually the reason is the change in the cross section or the shape, not really the presence of a defect. Then if you have an external magnetic field present around the part. So, there again because of this external magnetic field, close to the sample, this can also generate false indications or non-relevant indications.

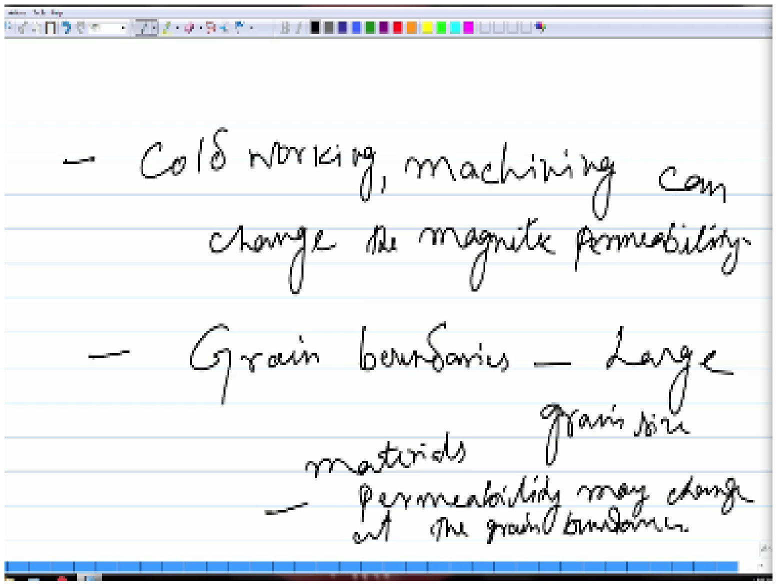
(Refer Slide Time: 19:51)



Then, if you have sharp corners or edges in the sample or in the part being examined. So, these are the areas, where the particles tend to segregate or the particles tend to accumulate. Then, you could have this kind of areas also, like thread roots, key ways, fillets. So, these are the areas where due to this geometry itself, the particles would tend to segregate and then it might look like that around these areas there are defects because particles are getting accumulated over there. But this is again due to the geometry and not really due to the presence of a defect.

Then if you have junctions of dissimilar metals, so, these two different materials, two different metals their magnetic properties are different. So, across this junction, across this interface, the magnetic permeability will change. So, due to the change in this magnetic property across the interface, again you could end up with some non-relevant indication.

(Refer Slide Time: 22:54)

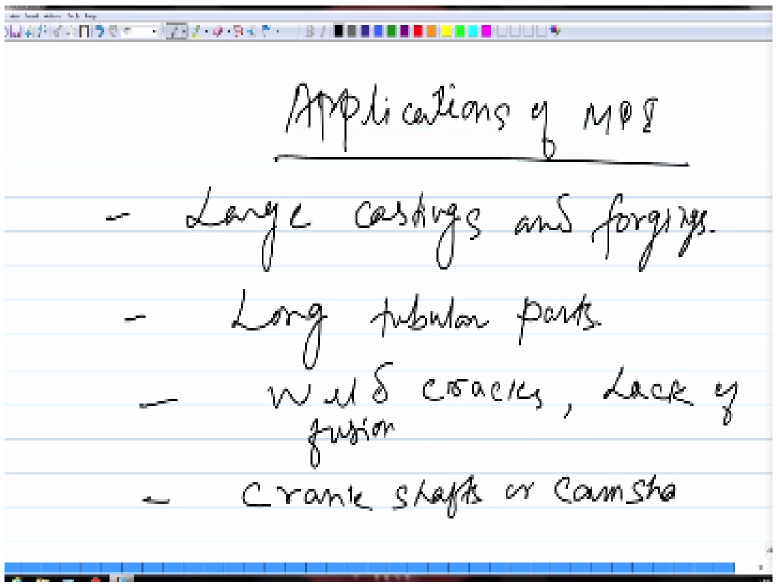


Then, if you have subjected the part to some kind of cold working or machining. So, it has gone through some kind of plastic deformation due to these processes and due to that the magnetic permeability can change and you may end up with non-relevant indications, because of this change. So, there again, if you know that the part, which is being inspected, if it has gone through a cold working or machining kind of process or some kind of plastic deformation process, there again you should be careful about the non-relevant indications.

Then, in polycrystalline materials, in polycrystalline metals and alloys, you have a large number of grain boundaries. So, they can also be a source of non-relevant indications, particularly in large grain size material. Across the grains, when you encounter the boundaries, there could be change in the magnetic permeability. So, for such materials where you know the grain size could be large like, for example, in castings, where the grains are generally large. So, there again you should be careful about this non-relevant indications.

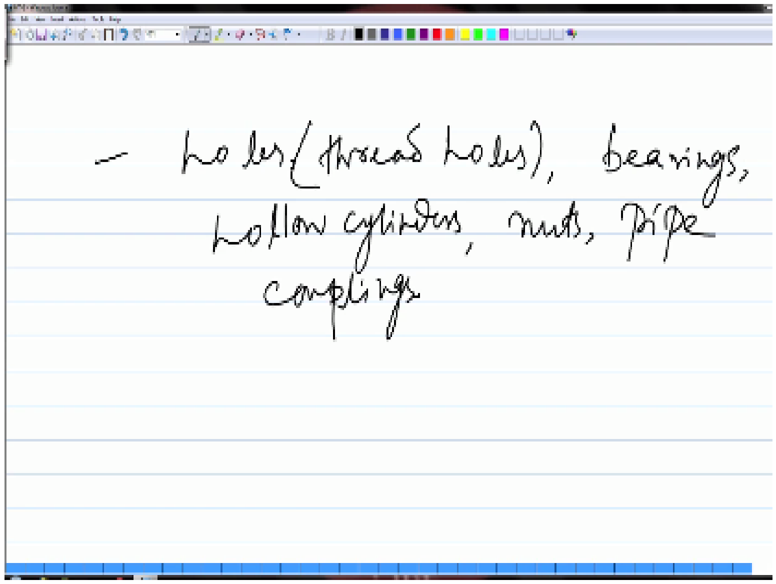
So, these are the different reasons due to which you might end up with non-relevant indications, in case of magnetic particle testing. So, you should be careful about all this, when you do this testing.

(Refer Slide Time: 25:25)



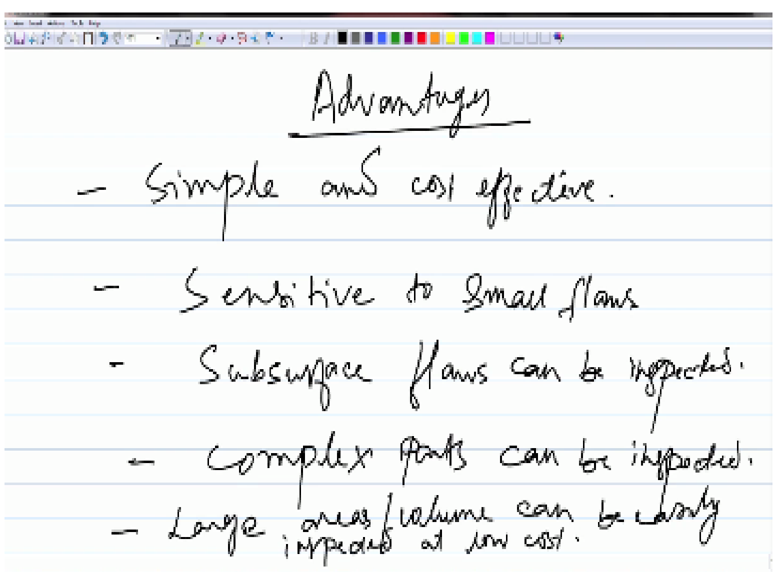
And finally, let us see, what are the applications of magnetic particle testing. So, this can be applied for large castings and forgings for inspecting the surface flaws. It can also be used for long tubular parts, weld cracks, then, in welding, lack of fusion, which is a welding defect that can be inspected, then, parts like crankshafts or camshafts can also be inspected.

(Refer Slide Time: 27:01)



Then, hollow parts or holes. If you have hollow parts, what kind of particles you can apply. You can apply a slurry or magnetic paint kind of thing or a magnetic rubber. So, like, in thread holes, then, other part like bearings, hollow cylinder, nuts and pipe couplings. So, this is some of the applications of magnetic particle testing.

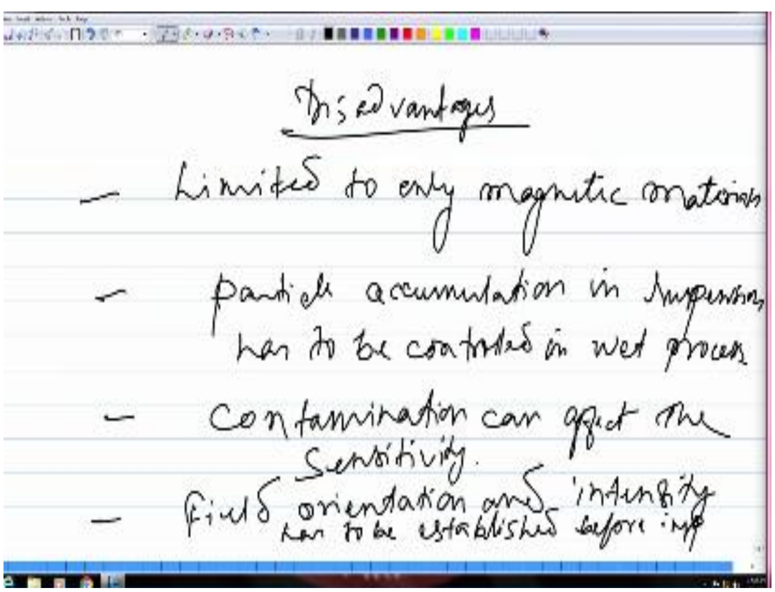
(Refer Slide Time: 28:12)



And finally, let us see, what are the advantages, this particular technique offers and if there are any limitations also. This is a very simple process, as you would have seen and also cost effective. In terms of the consumables, all you need is some magnetic particles, like, you can use iron particles and a liquid, which could suspend it. Sensitive to small flaws and one of the biggest advantage that this process offers is subsurface, you would be able to inspect subsurface in this case, which was not possible in case of other surface NDT methods, like dye penetrant testing.

So, in this case, you can go little below the surface also. So, you could inspect at the subsurface level as well. So, subsurface flaws can be inspected. Complex parts, again, is not a problem for this and large areas or volume can be easily inspected at a low cost. So, these are the advantages that this process offers, but like any other process this will also have its own disadvantage also.

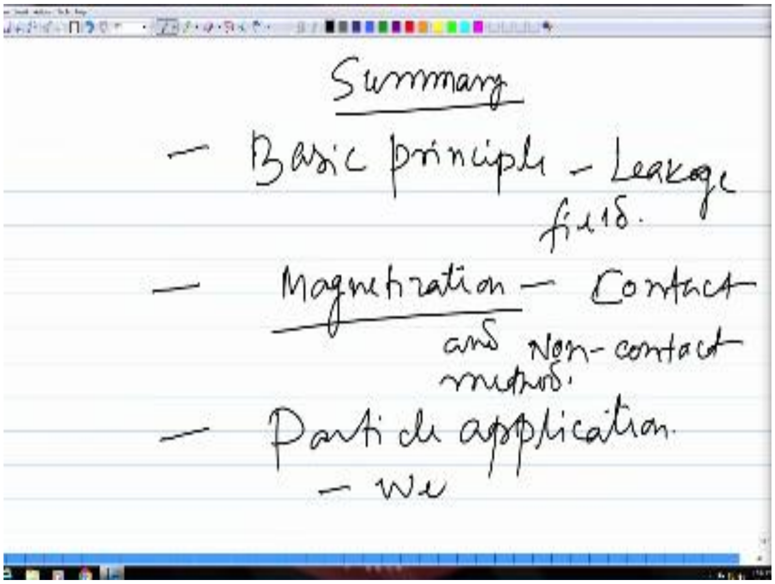
(Refer Slide Time: 30:34)



So, let us have a look at them. So, this is limited to only magnetic materials. It cannot be used for non-magnetic materials because the whole thing is based upon magnetism that is the major limitation of this process. Particle accumulation in suspension has to be controlled in the wet process and if you have contamination, then it can affect the result or the sensitivity and as we have seen field orientation, that is the direction of the field, and field intensity, has to be established before inspection.

So, these are some of the limitations that this process has, but nevertheless this is a very useful process for doing surface and subsurface inspection on magnetic materials. So, this will bring us to the end of this particular topic and before we close this, let us take a moment to summarize.

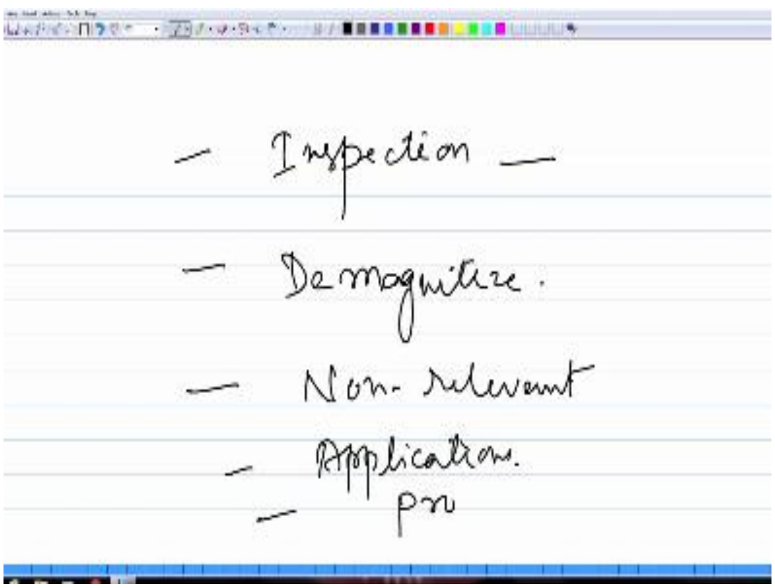
(Refer Slide Time: 33:04)



So, we learned the basic principle of this particular technique and we saw that it is due to the leakage field at a discontinuity. So, we learned about that and then we talked about different methods of magnetizing the part. So, in this, we saw contact and non-contact methods and we also learned about, the direction of the field depending on the direction of the magnetic current, how the field direction will be, that also we have seen.

The next step was particle application. So, there again we saw there are different methods by which the particles can be applied and then, we saw there are two types of particles, which can be used, one is; wet, which you use in a suspension and the other one is; a dry powder, which can be coated with either a color or sometime it is also coated with a fluorescent material and in this case, we saw, how this wet suspension is applied, depending on the part geometry or the type of part, like we had normal suspension in a liquid and then we have some highly viscous suspensions for particular applications like overhead parts and things like that.

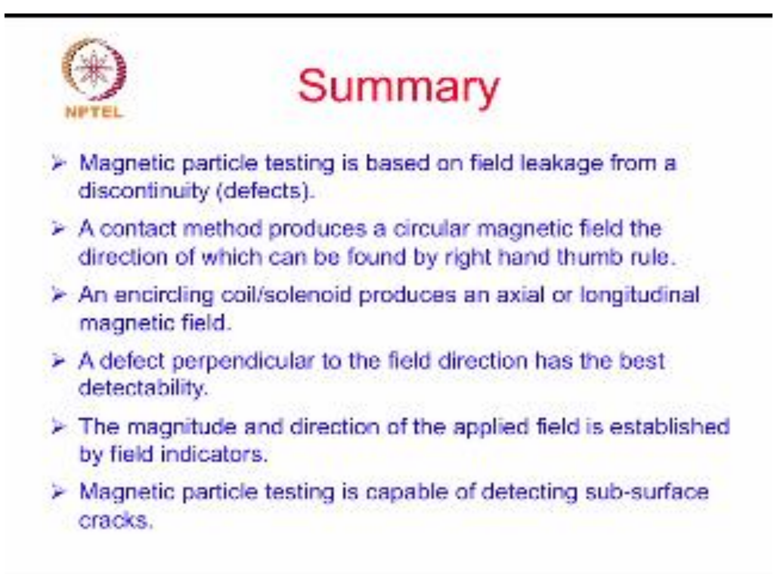
(Refer Slide Time: 35:15)



And finally we saw how the inspection is done. When you are using normal magnetic particles either in dry or wet suspension, you do it normally under visible light or sometime if a fluorescent material is used in a dry powder, then, it has to be done under ultraviolet light, that also we saw. So, there are two types of inspection, which can be done depending on what kind of particles are used and then finally we saw that once the inspection is done, you need to de-magnetized the part because that is also important.

And then, we talked about non-relevant indications and the causes for them, in this particular technique and finally we saw some applications of this method and the pros and cons of this particular technique.

(Refer Slide Time: 36:21)



So, this is all we had in this particular technique of magnetic particle testing and this is all I have for today and I will see you next time with a new topic. Thank you for your attention.

IIT Madras Production

Funded by

Department of Higher Education

Ministry of Human Resource Development

Government of India

www. nptel. ac. in