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Theory and Practice of
Non Destructive Testing

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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.

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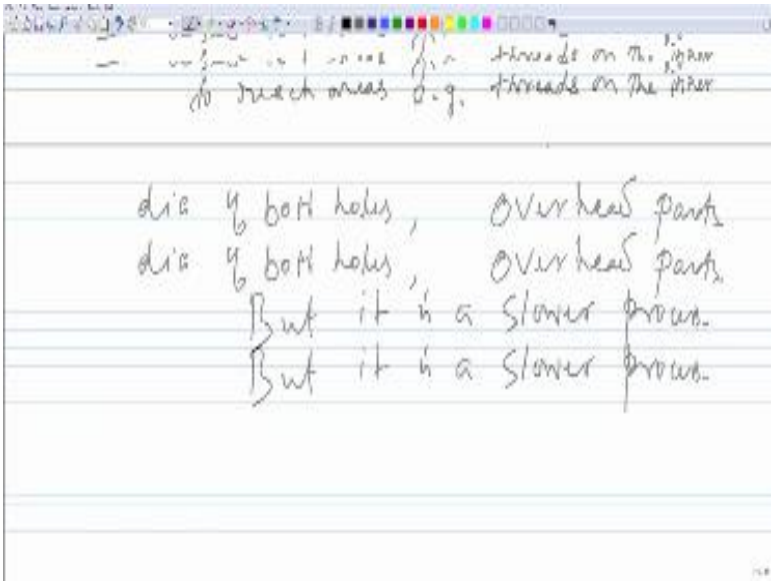

So let us see what we have done so far quickly.

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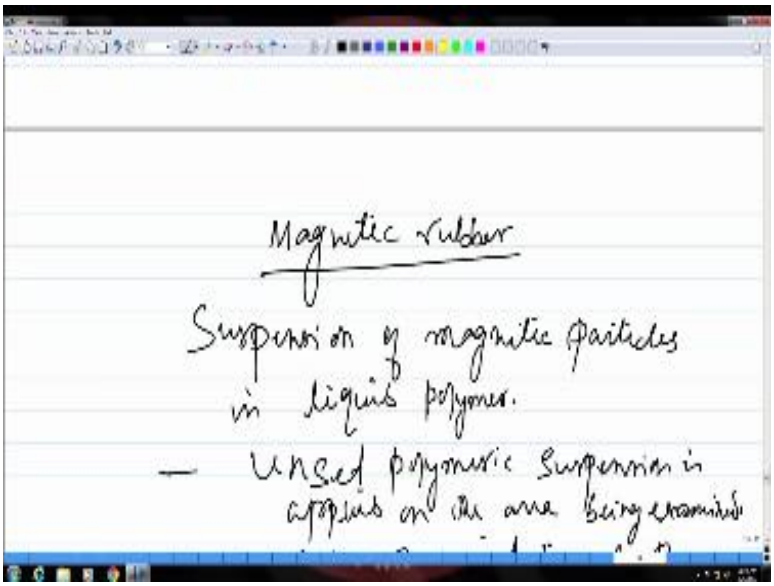

So we have talked about the magnetizing methods and then how the particles are applied what kind of particles you have and so on okay and we have also seen depending on the condition of the surface or the kind of part you have okay so depending on that you choose different kinds of powder either wet suspension and in the weight 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.

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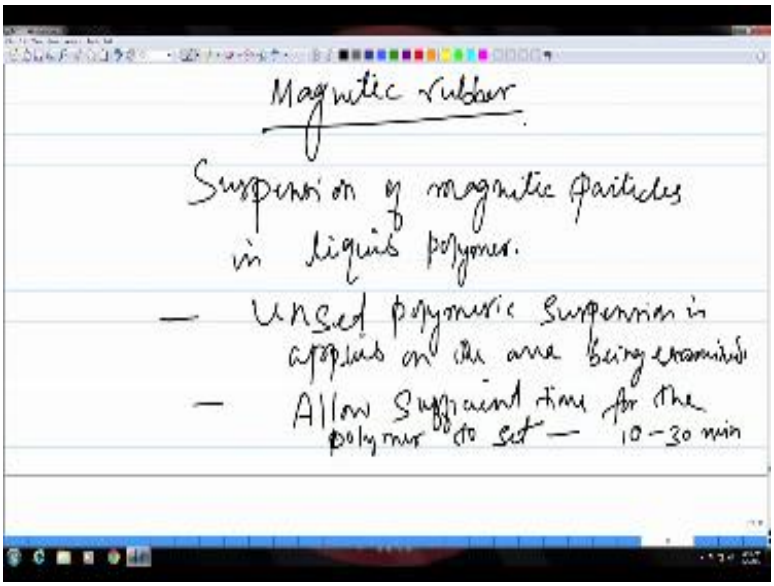

We saw that either dry or wet particles can be applied and there are different methods by which these are applied okay, yeah so today finally we will see how the inspection is being done which is the final step so we have started from again.

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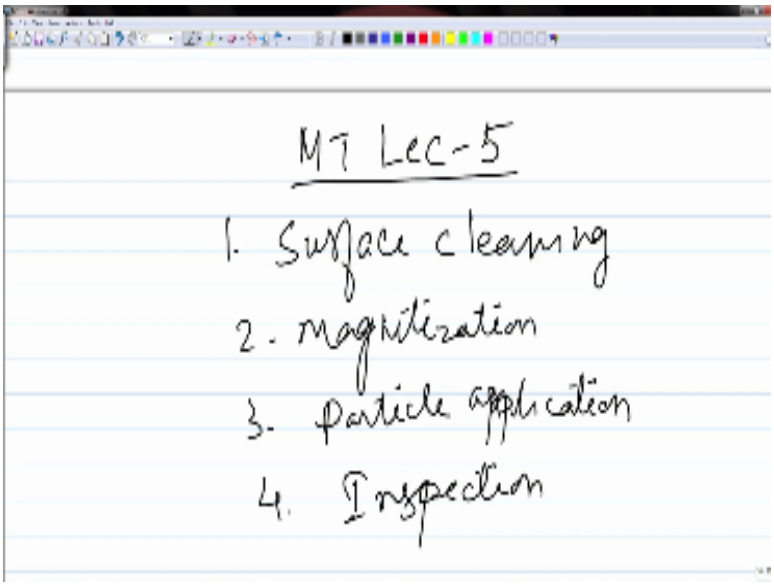

I will go back to this we have started from this and then finally once the particles are applied then we do the inspection ok so let us talk about this today and few more things so inspection as you would have seen in the demo video that I showed you in the last lecture you could do it in a well-lit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

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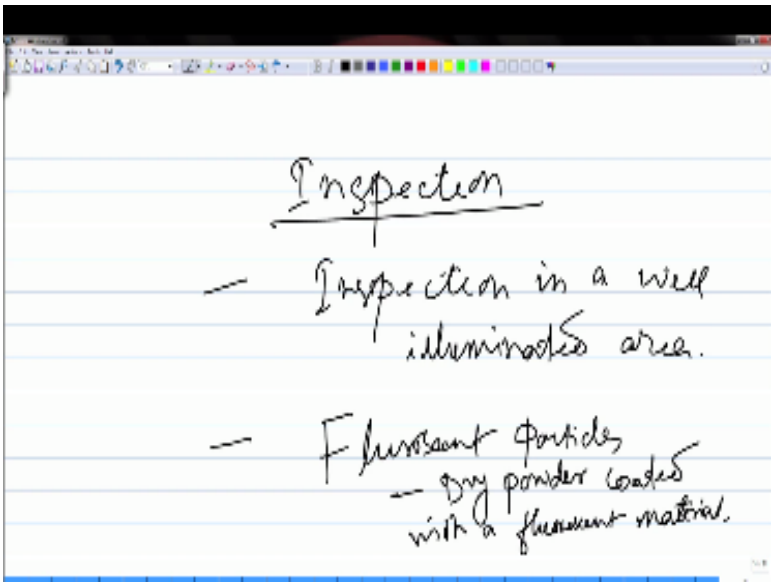

So that is what you do when you have normal either wet suspension or dry powder you take it to an well illuminated area and then see if you can see some visible indications of the surface flaws okay the other thing that you can do in this case as you would have seen in case of dye penetrant testing in this case also you can do this fluorescent inspection so in case of dry powder if you remember I said that this powder are many time coated with a la they can also be coated with a fluorescent material okay.

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

And if there are flaws and effects as I said they will oh they will fluoresce due to this exposure and that is how you will get the visible indications of okay, so these are the two ways of inspecting the part finally but there I one more thing remaining which apparently may not look like a part of this particular technique but once this inspection is over okay your part is still magnetized okay, so that is something which is not desirable because it could be a component which will be used okay if there are no flaws so in that case if it is still magnetized.

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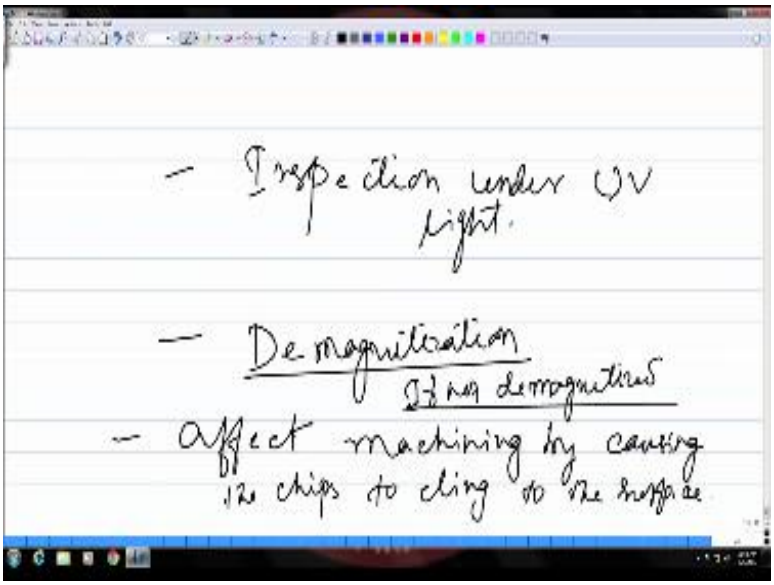

So that magnetic field of the sample of that component can affect its function when it is used along with some other parts in a particular system okay so the last step in this case then should be to demagnetize the part before you wind it up so that is the last thing that you need to do if you do not demagnetize as I said there are problems so let us see what could be the possible difficulties if you do not d magnetize 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 okay so in that case it can affect the machining so this we are talking about if not demagnetized what could happen ok it will affect machining by causing the tips to cling to the surface because of the magnetic field the machining chips which are generated will stick to the surface which will affect the machining operation so this 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.

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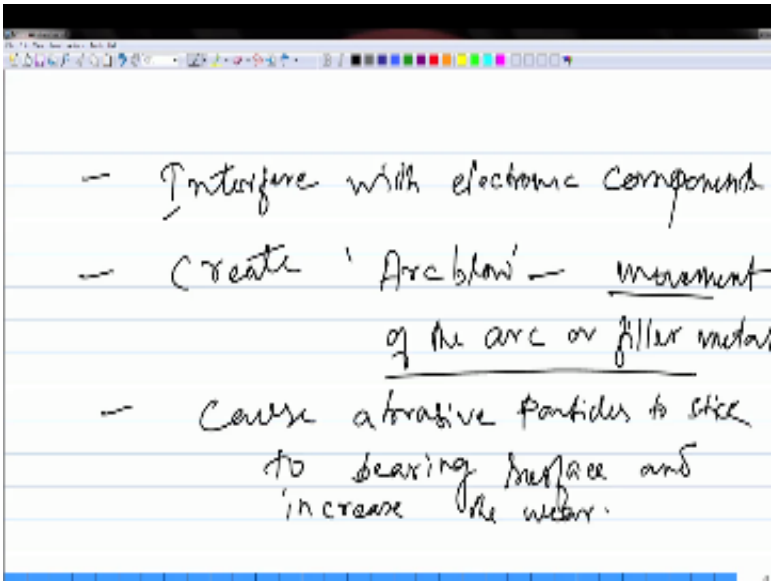

Then it can interfere with some other electronic components because of the presence of the magnetic field again or if it is used in close proximity of some electronic component there again it will affect the electronic components because of the magnetic field and let us say this part has to be welded 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 the magnetic field of the part will create something known as our blow due to the presence of the magnetic field.

This is our flow is nothing but movement of the arc or the filler material it is used for welding okay, so this movement of either dark or the filler material is due to the presence of an additional magnetic field which is in the part so this is arc blow again is not desirable if the arc

moves then you are welding will be improper it will create you know 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 if you plan to use and arc welding process then it can also cause abrasive particles to stick to the surface let's say in a part like bearing.

And this will increase the wear okay, so these are the different things which can happen if you do not demagnetize the part and therefore as I said as a final step you need to demagnetize the part before you close this process so let us see how you can demagnetize and what methods are available for doing.

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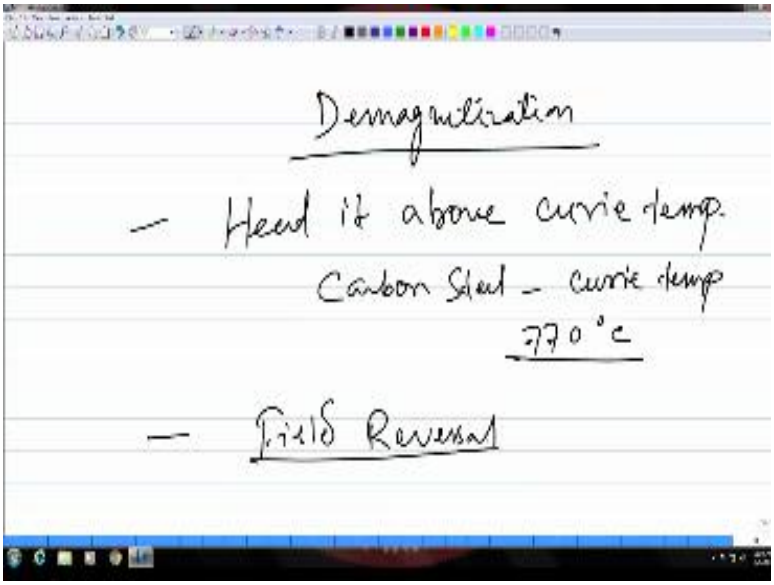

This so there are two ways by which you can do it one is you can heat it above the Curie point or the curie temperature this is a temperature as you might know above each a ferromagnetic material losses the magnetism and the reason behind that is the magnetic domains that you had which you are aligned in the direction of the field if you remember we have talked about this when you apply a magnetic field the magnetic domains in a ferry magnetic material align in the direction of the field when you reach saturation.

So when you hit this ferry magnetic material as we increase the temperature these two men's again will misaligned because of the atomic vibration that happens due to the temperature okay, or due to the heat so due to this 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 okay.

So this is how hitting t above the curie temperature will demagnetize it okay but for this you need to have heating arrangement furnaces and all that because this temperature can high for example for carbon steels this Curie temperature is around 7 70 degree Celsius so you need a furnace a heating arrangement which can heat the part to this kind of temperature okay so if you could afford to have heating arrangement a furnace then you can take the part and heat it above the curie temperature and then demagnetize it.

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 okay so if you apply the field in the opposite direction it will go through that hysteresis curve in the other direction at and at some point when it reaches the passive field the magnetic flux in the material will become zero. So let us see what we have done so far quickly.

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But for this you need to have heating arrangement furnaces and all that because this temperature can high for example for carbon steels this Curie temperature is around 770^0 Celsius so you need a furnace a heating arrangement which can heat the part to this kind of temperature okay, so if you could afford to have heating arrangement a furnace then you can take the part and heat it above the curie temperature and then demagnetize it.

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 okay. So if you apply the field in the opposite direction it will go through that hysteresis curve in the other direction at and at some point when it reaches the passive field the magnetic flux in the material will become zero okay, so there again in this case knowing.

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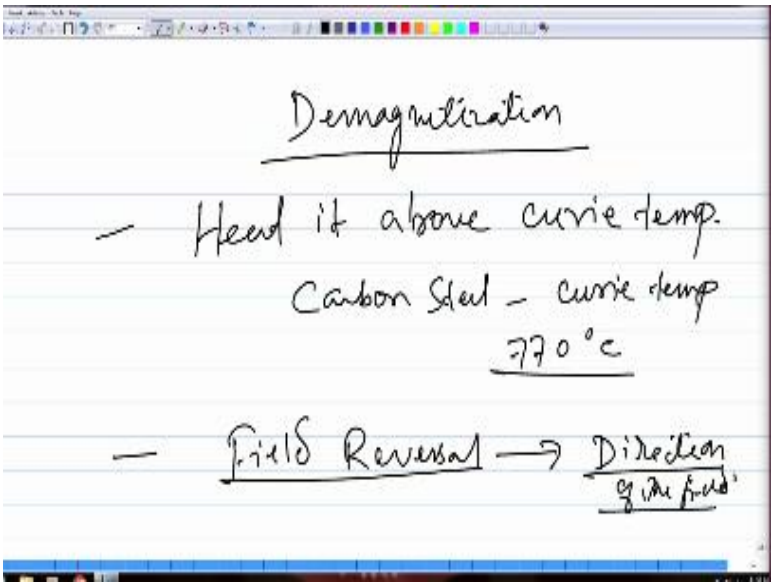

The direction of the field helps you so this is the another advantage if you know the direction of the magnetic field okay the other advantages we have already seen like the orientation of the defects with respect to the direction of the field the visibility of a defect to depend on that okay, and the other advantage you have if you know the direction is this when you finally come to this step if you had known the initial direction of the magnetic field.

Then now you can apply the same field the same magnitude field in the opposite direction and then at some point when you reach the coercive field you can de magnates the part okay so these are the two methods these are the two ways by which you can t magnetize the part okay.

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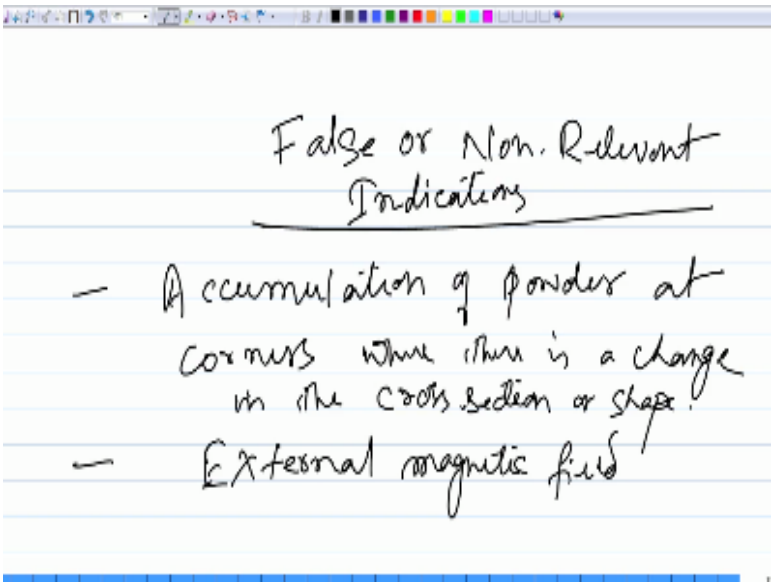

So this is how the process works now finally let us see what are the applications of this particular method and then like what we do for every process will also see what are the advantages and disadvantages but before that one thing that you should always remember whenever you do entity not only for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

So this may look like a defect it may give an impression like a defect but it may not be a defect okay the indications that you see okay this kind of false are non-relevant indication they may look like a defect on the surface but actually they may not be okay 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 okay.

So let us see for this particular technique for magnetic particle testing what are the reasons for feet you can get you can end up with false or non-relevant indications, accumulation of powder act corners where there is a change in cross in the cross section of say 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 they are a defect but actually the reason is the change in the cross section or the shape not really the presence of a defect okay then if you have an external magnetic field present around the part okay so there again because of this external magnetic field close to the sample okay this can also generate false indications or non-relevant indications.

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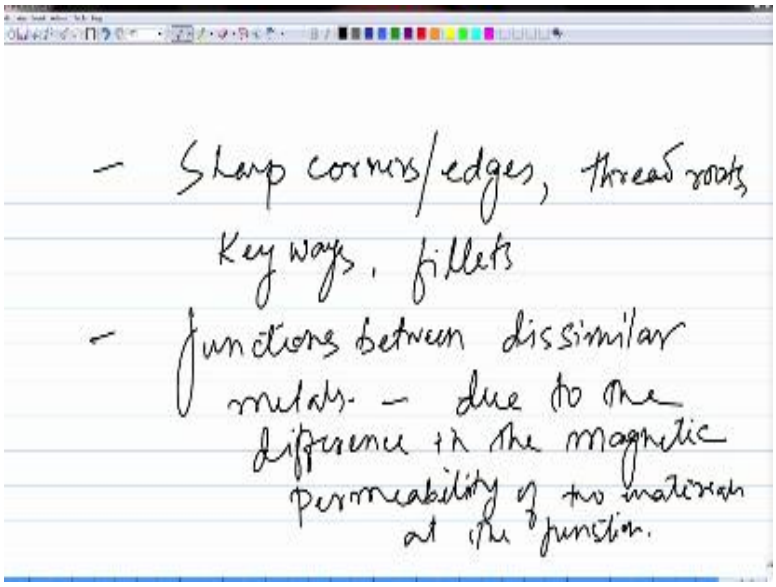

Then if you have sharp corners or edges in the sample or in the part being examined so these are the areas where the particles tend to segregate or the particles tend to accumulate then you could you could have this kind of areas also like thread roots key ways fill it okay so these are the areas where 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 okay 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 this two different materials two different metals that 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 so you should be careful when you have this kind of dissimilar metals joints if you examine them by magnetic particle testing.

So this is due to the difference in the magnetic permeability is between the two materials at the junction okay, then if you have subject the part.

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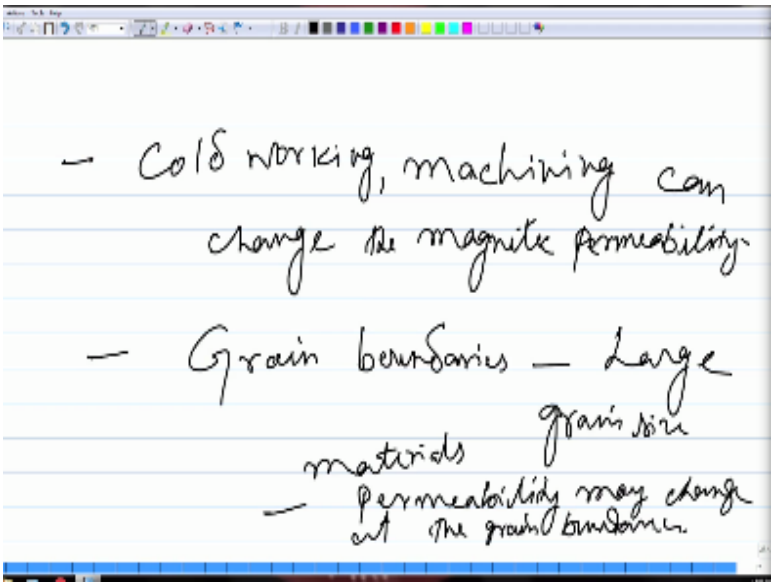

To some kind of cold working or machining so it has gone through some kind of plastic deformation due to these processes and due to that the magnetic permeability can change and you may end up with non-relevant indications because of this change okay so there again if you know that the part which is 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 okay.

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.

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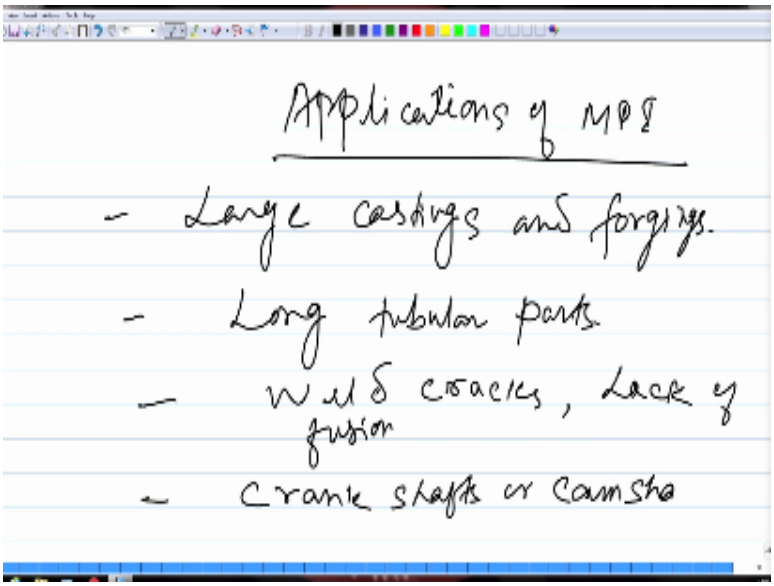

And finally let us see what are the applications of magnetic particle testing okay so this can be applied for large castings and for things for inspecting the surface flaws can also be used for long tubular parts Weld cracks then in welding lack of fusion it is a welding defect that can be inspected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

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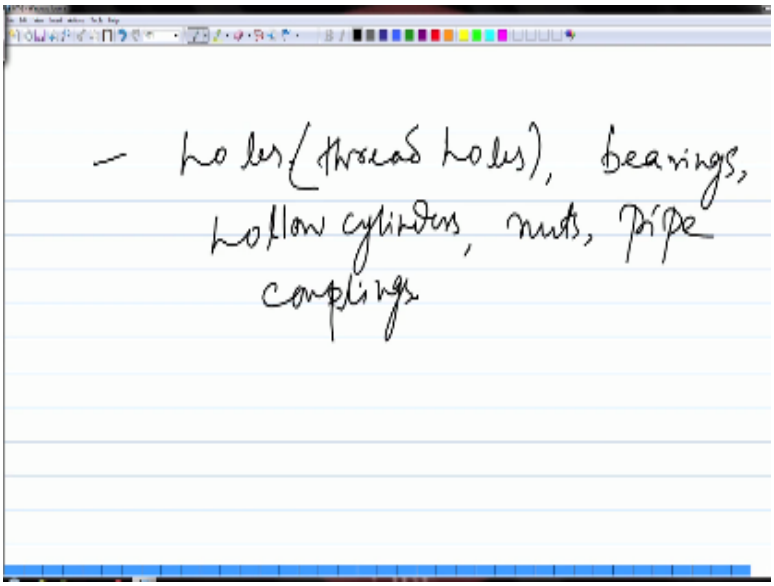

Then hollow parts or holes we have seen this before also while discussing about particle application if you have hollow parts what kind of particles you can apply you can apply a slurry or magnetic paint kind of thing or a magnetic rubber okay, so like holes in thread holes then other part like bearings hollow cylinder nuts and pipe couplings so this is some of the applications of magnetic particle testing okay. And finally let us see what are the advantages these particular technique offers.

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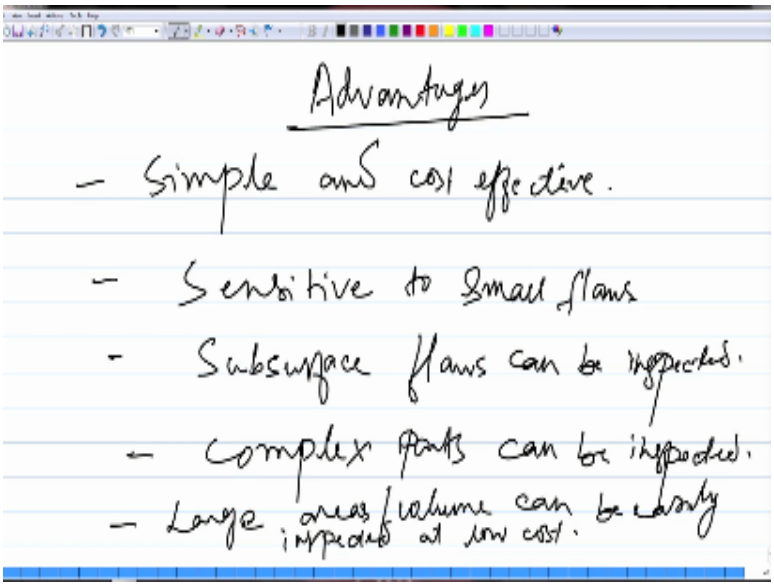

And if there are any limitations also this is a very simple process as you would have seen and also cost effective in terms of the consumables all you need is some magnetic particles like you can use iron particles and a liquid which could suspend it sensitive to small flaws and one of the biggest advantage 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 be you could inspect at the subsurface level as well, so subsurface flaws can be inspected complex parts again is not a problem for this complex parts can be inspected and large areas or volume can be easily inspected in at a low cost okay. So these are the advantages that this process offers but like any other process this will also have its own disadvantage also.

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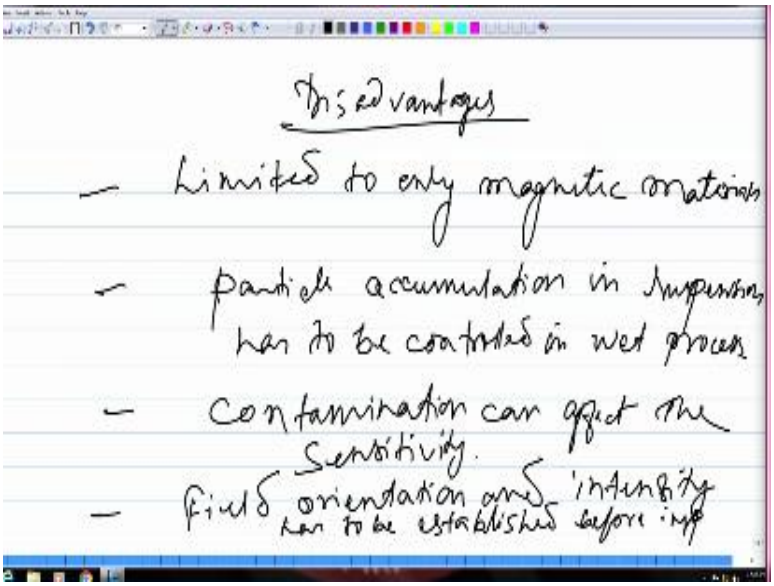

So let us have a look at them so this is limited to only magnetic materials it cannot be used for non-magnetic materials because the whole thing is based upon magnetism that is the major limitation of this process particle accumulation in suspension has to be controlled in the weight process and if you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

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

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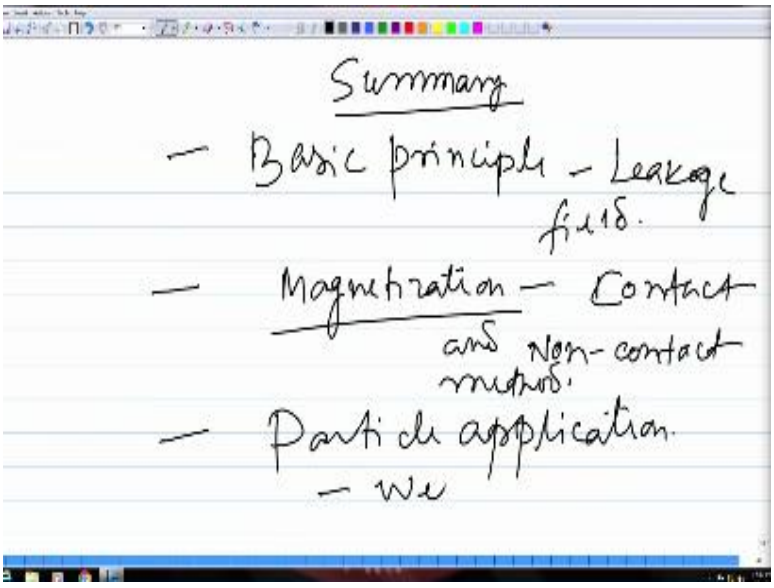

So we learned the basic principle of this particular technique and we saw that it is due to the leakage field at a discontinuity. So we learned about that and then we talked about different methods of magnetizing the part, so in this we saw so contact and non-contact methods and we also saw we also learned 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 red 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 weight 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 okay and finally we saw how the inspection is done.

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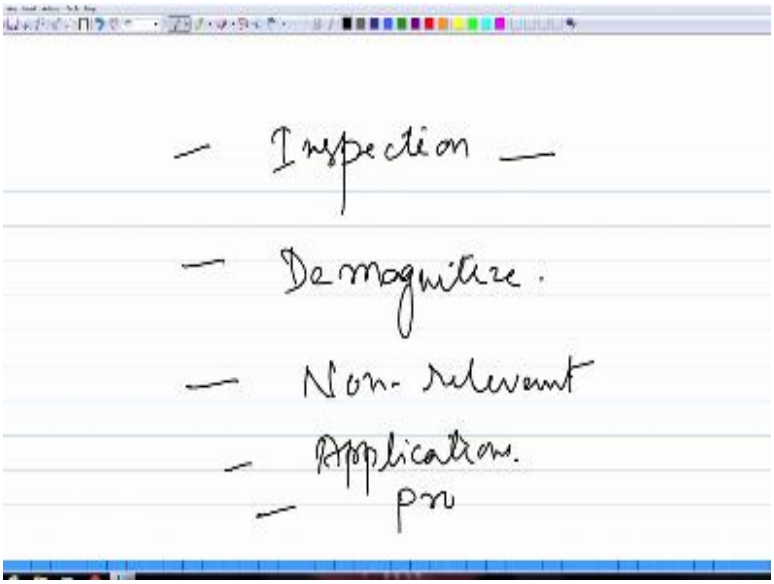

When you are using normal magnetic particles either in dry or wet suspension you do it normally under visible light or sometime if a fluorescent material is used in a dry powder then it has to be done under ultraviolet light that also we saw so there are two types of inspection which can be done depending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

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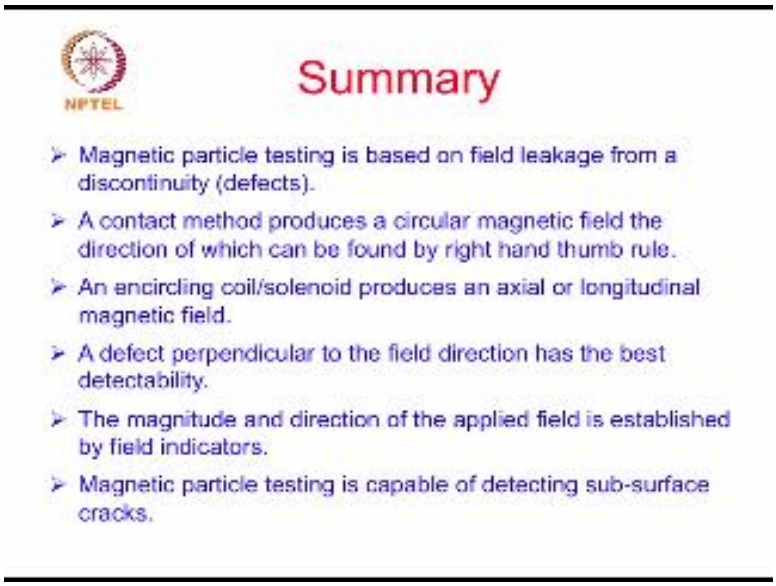

So this is all we had in this particular technique of magnetic particle testing and this is all I have for today and I will see you next time with a new topic thank you for your attention.

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