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Theory and Practice of
Non Destructive Testing

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Magnetic Particle Testing - 4

We are on this topic of magnetic particle testing so far we have had three lectures on this particular topic and today will be the fourth lecture on this topic so it is continue where we left it from in the last lecture so if you recollect in the last class we discussed about the types of particles which are used.

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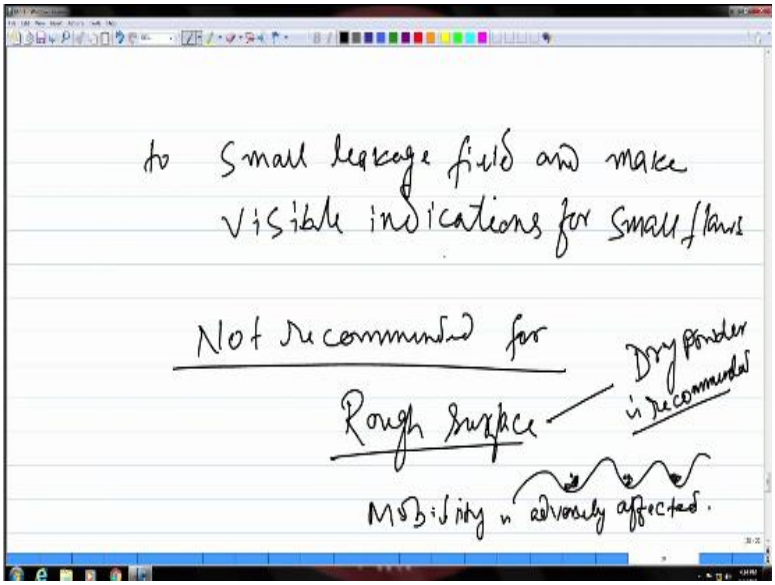

And the properties of these magnetic particles that are used for magnetic particle testing okay.

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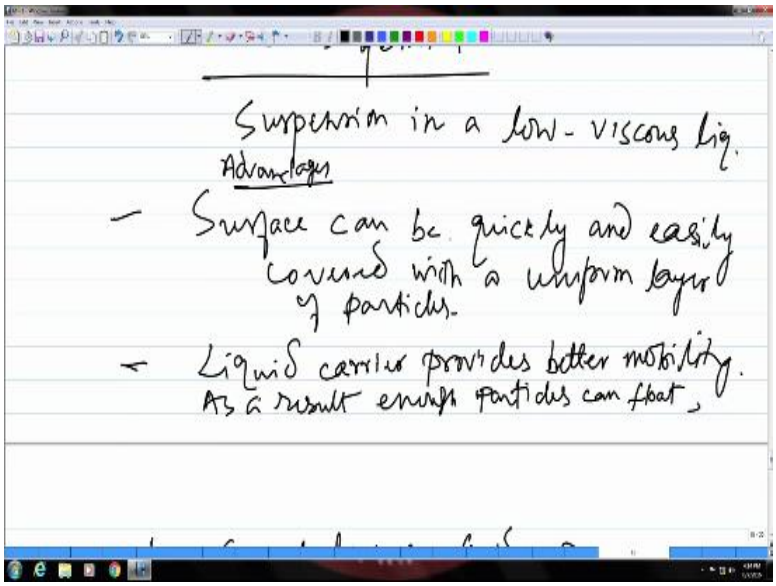

So let us take a quick recap as you always do before proceeding today.

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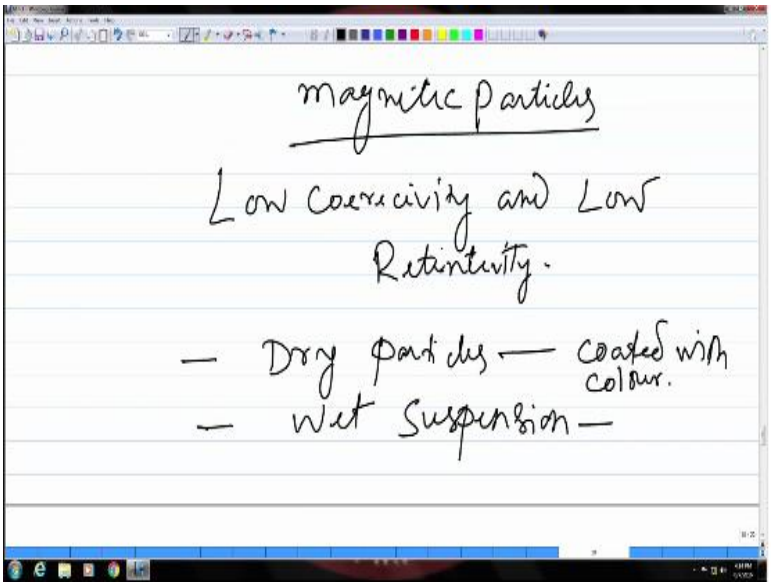

So these are the typical properties that this magnetic particles would have any particles which have.

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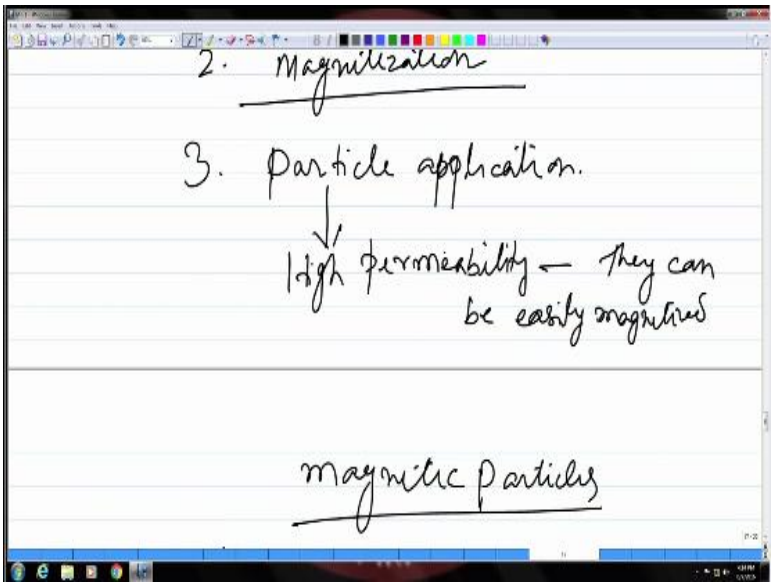

High permeability high magnetic permeability like iron particle for example can be used for doing magnetic particle testing apart from high permeability.

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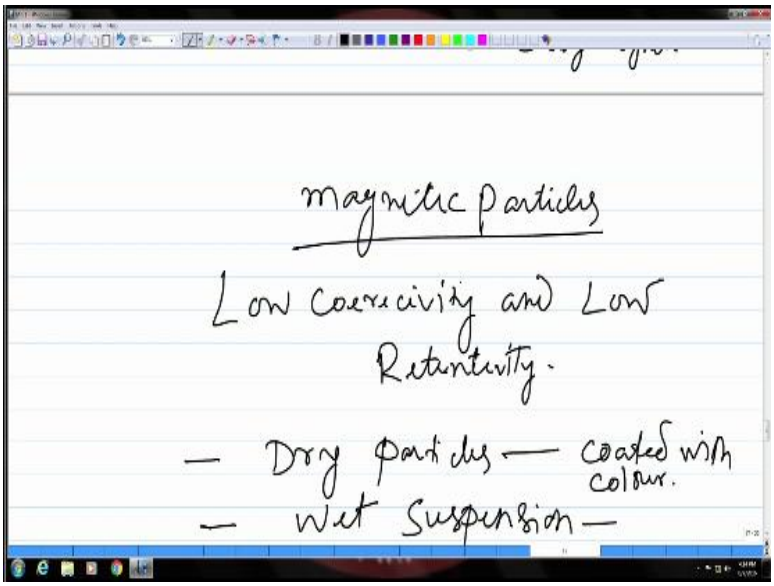

They should have low coerecivity and low retentivity also and the reasons behind this requirement these property requirements we have already discussed in the last class okay and then we saw that two types of particles are generally used either weight suspension in some low viscous liquid or these particles can also be used as dry powders depending on the surface condition okay.

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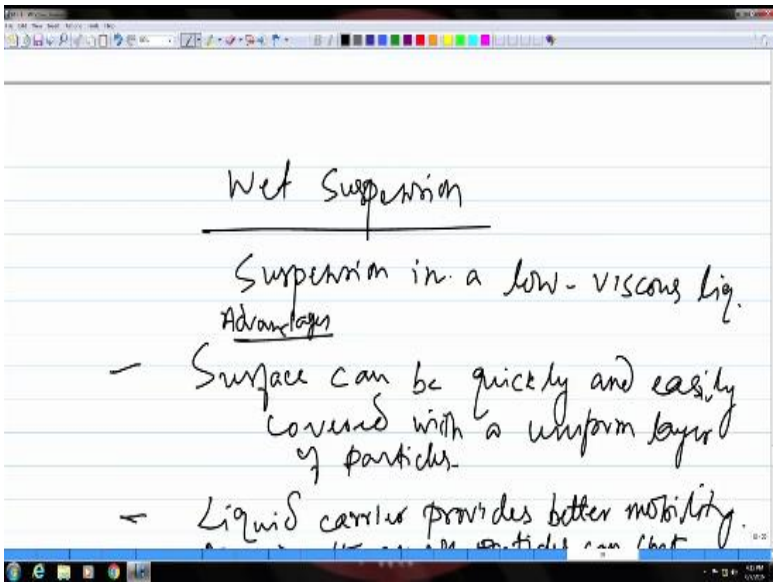

And these wet suspension we saw it has certain advantages over the dry powder and in certain cases where the weight suspension cannot be used like a rough surface in those cases a dry powder is recommended.

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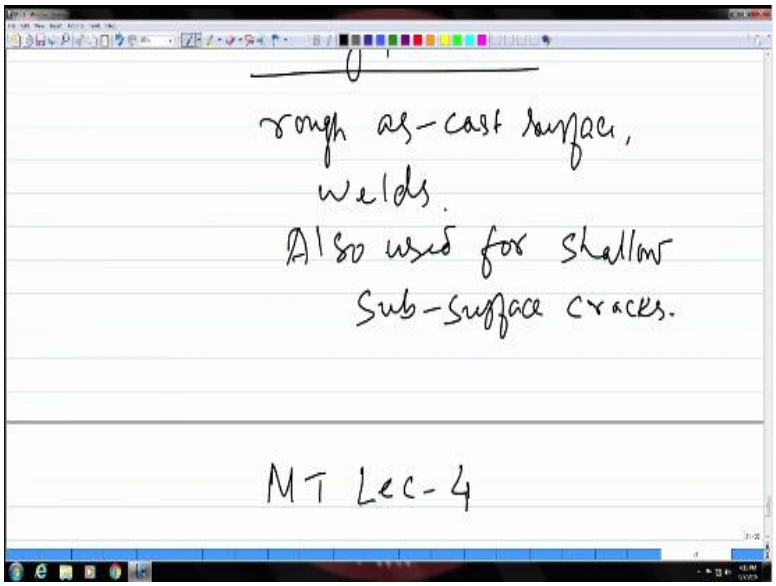

And the dry powder is also useful for doing shallow subsurface cracks apart from the surface cracks these dry powder can also be used for doing some subsurface inspection so let us continue today.

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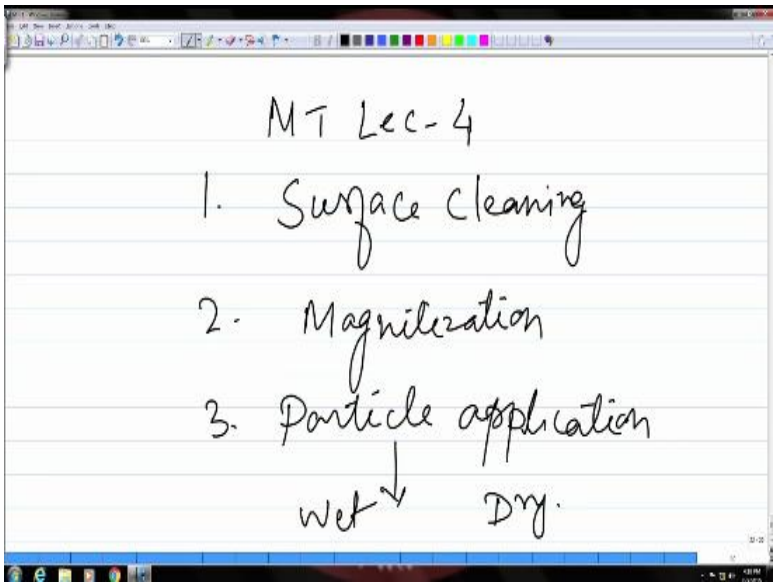

And if you remember we have so far covered these three steps let me highlight them once again surface cleaning then magnetizing and once the part is magnetized you apply the particles and in this we saw there are two types wet and dry which are used depending on the surface condition about how these particles are applied.

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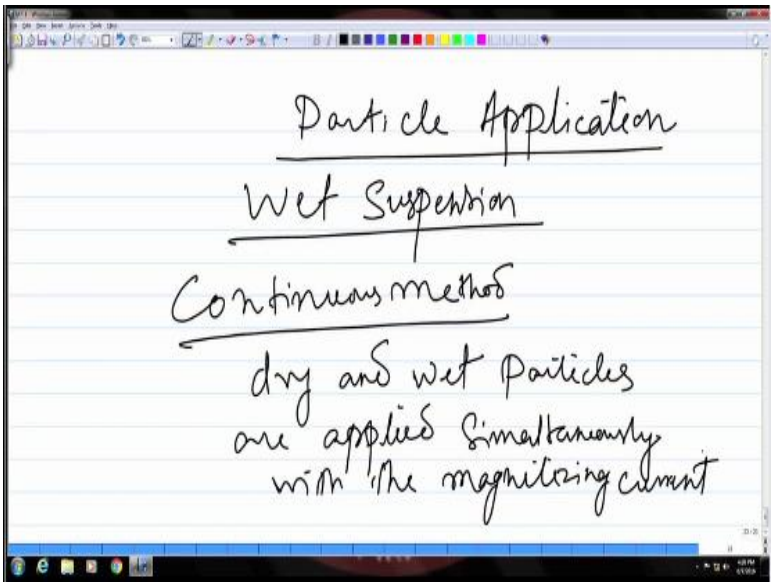

During the testing there again you have certain methods by which you apply the particles depending on what is the requirement in the test or what kind of part you have and so on okay when you talk about the weight suspension there are two or three ways by which you can apply depending on what exactly is the requirement first is continuous method and this can be used for both dry and wet so dry or wet particles are applied simultaneously when the part is being magnetized with the magnetic field or the magnetizing current okay.

So that is why this is known as continuous method because the particles are being applied continuously when the part itself is being magnetized or in the magnetic current is on you apply the particles simultaneously.

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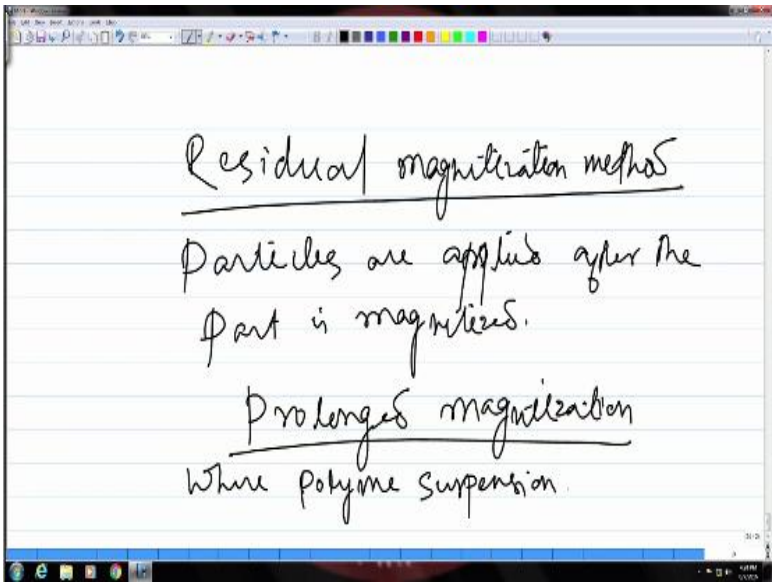

So this is continuous method next is the residual method so as the name suggests in this case it depends on the residual magnetism which is left behind once the magnetizing current is switched off okay so that means particles are applied after the part is magnetized okay so first you switch on the magnetizing current you apply the magnetizing current which will generate the magnetic field and magnetize the part once the part is magnetized then this magnetizing current is switched off and after that do you apply the particles okay so that means whatever residual magnetism is remaining on the part based on that these particles will be attracted to the surface and to the flaws okay.

So in this case particles are applied after the part is magnetized okay so these are very similar type of methods only differences in one case the magnetic current is on and in the other case when you apply the particle so the magnetic current is not on and then there could be cases wherein you may have to use a different kind of suspension which is more viscous for example if you want to inspect some overhead parts right in those cases you may not be able to use a low viscous liquid because it will not stay on an overhead part.

So in cases like that where low viscous liquid cannot be used then you have to use a viscous liquid which can stay on an overhead part okay so since in that case the viscosity is high and the mobility of the particles is low you need to do the magnetism for a prolonged time okay so that is why that method is known as prolonged magnetization wherein you use highly viscous suspension like a polymeric suspension.

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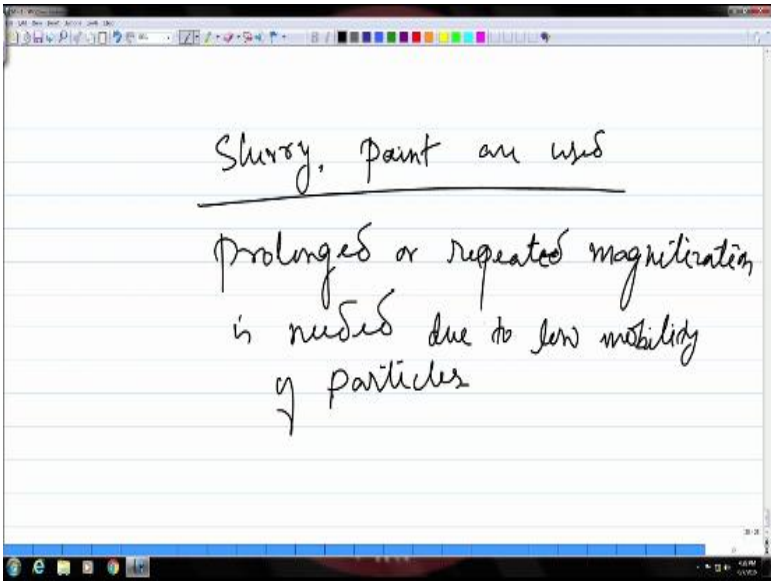

Or some slurry paint etc are used okay so this slurry paint or that polymer that will contain the magnetic particles so this is a suspension of the magnetic particles in a highly viscous liquid like a polymer or a paint okay so since the mobility in that case is highly limited you need to do the magnetization for a prolong time that is where this prolonged magnetization method is used so in all such cases prolonged or repeated magnetization is needed because of the low mobility okay.

So this is the third method that we have for wet particles and the first one we have seen which is the continuous method that can be used for both weight and dry.

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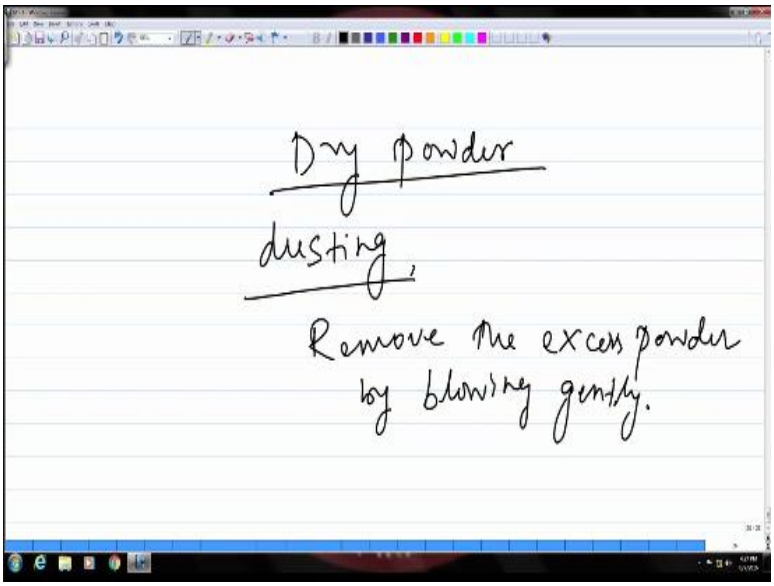

Now if you talk about the drive particles as such they can be applied by dusting okay so you simply take the powder and dust it over the surface and then you should in this case since you do not really have too much of control on the dusting so there could be excess powder on the surface so it is better to remove the excess powder by gently blowing it so that you have a uniform layer of powder so you should remove the excess powder by blowing gently okay so you can use those small handheld blowers we are in one side you have a small rubber palm kind of thing which can be pressed and once you press it you can blow it.

So using that you can blow the excess powder from the surface there is one more thing that I should tell you hear.

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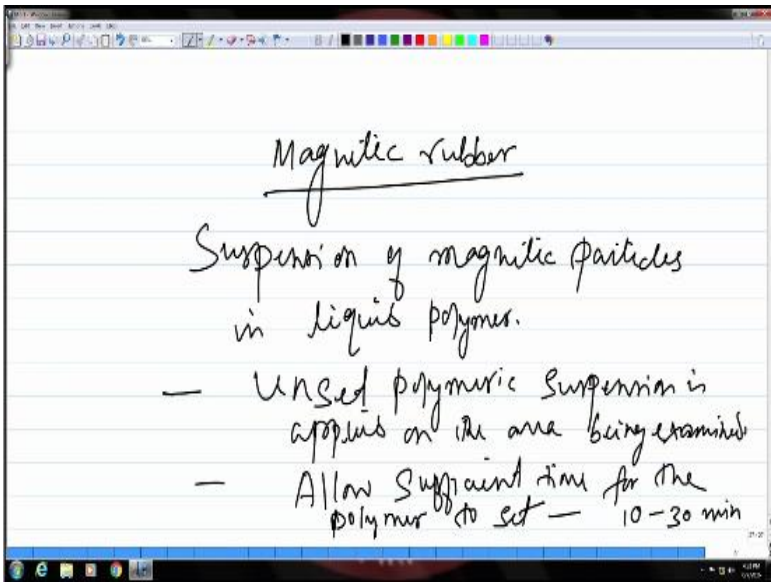

Something known as a magnetic rubber so just now we talked about a thick viscous liquid which is sometime used for parts like overhead parts and things like that okay in certain other cases where in the inspector does not have direct physical access okay to the part which is being examined okay where the physical access is limited for example if you want to inspect the inner diameter of a bolt-hole so in those areas you do not have direct physical access and hence you cannot apply the magnetic particles like the way you do it on an external surface okay.

So in those kind of cases you need to use a suspension which is known as a magnetic rubber and this will help you out you know to inspect this kind of areas where you do not have physical access so let us see how does this work and in what way it helps you in examining those kind of areas this is basically a suspension of magnetic particles in a liquid polymer.

So like the magnetic slurry or the magnetic paint that we talked about before this is a highly viscous slurry highly viscous suspension so this has this liquid polymer which contains the magnetic particles in a suspension okay so now this liquid polymer you can apply it on the part on the inner diameter for example that you are going to examine and allow some time for this liquid polymer to cure or to set okay so unset polymer is first applied unset polymer which

contains the magnetic particles you apply it fast on the part is applied on the area being examined then allow sufficient time for the polymer to cure.

So this setting time or curing time this depends on you know what kind of part geometry huh or what is the size of the part that is being examined and it can vary anything between 10 to 30 minutes depending on the size of the part now once you allow this time this polymer will cure and it will make a replica of the part on which it is applied okay now since this polymer contains the magnetic particles also so if there are any flaws these particles will be attracted to those flaws so this replica which is formed out of this set polymer will contain the impression of those flaws it will contain the visible indications of those flaws due to the presence of the magnetic particles in this polymers okay.

So that is how it works it makes a replica and once this liquid polymer is solidified it will also contract and because of this contraction it will easily separate out from the part so you can easily take it out and then inspect that replica instead of inspecting the part itself so that is how you overcome the difficulty of physical access by making this replica okay yeah.

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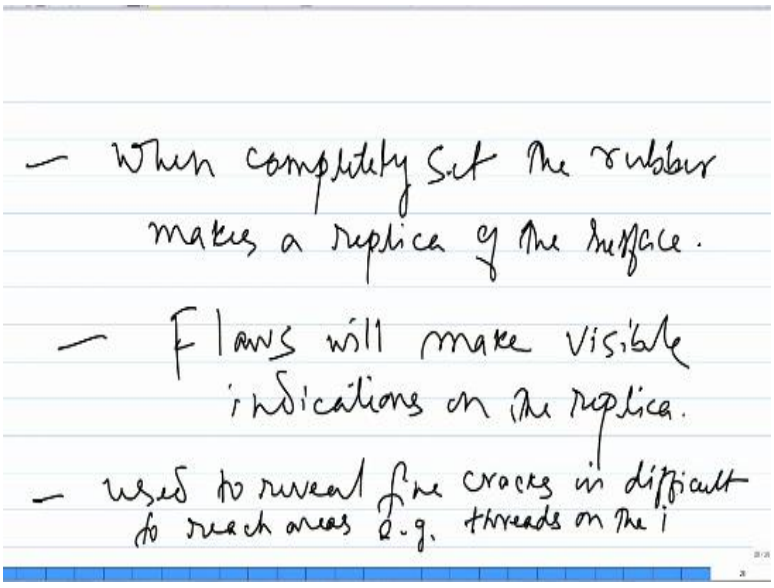

So when completely set the rubber or the polymer makes a replica of the Surface and flaws represent will make visible indications on this replica okay so this is how this magnetic rubber helps you out in cases where the physical access is limited so by forming this replica as I said you would be able to overcome that difficulty and instead of examining the area itself you can now come in and inspect this replica and if there are flaws they will be visibly indicated by this replica itself.

So this technique is useful for fine cracks in difficult to reach areas like I mentioned, for example threads on the inert about holes.

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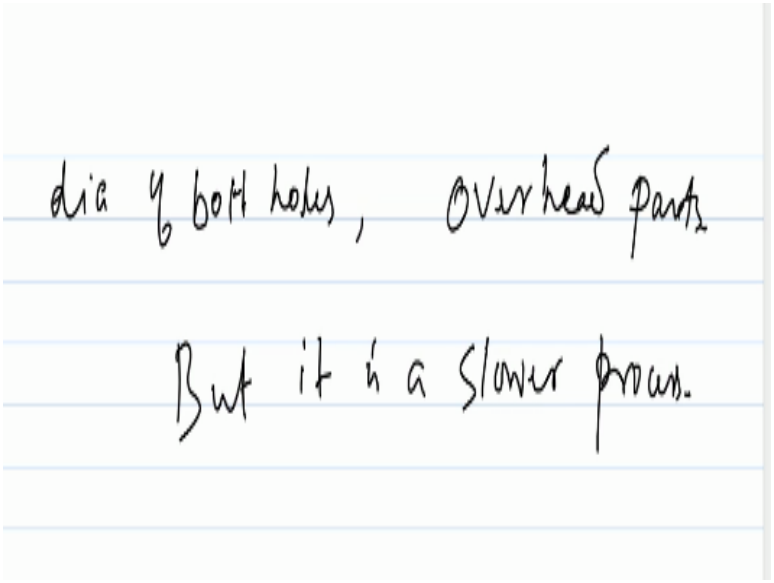

And also parts where a normal low viscous liquid will not stay like overhead parts there also it is useful but this is a slower process as you would have realized because of the presence of a highly viscous liquid and the low mobility of the particles due to that so it is a slower process, so that means that prolong the magnetization again comes into picture in this case as well okay. So these are the different ways by which the magnetic particles can be applied and you can choose one of them depending on what kind of surface you have what kind of parts you are talking about.

And what kind of areas in terms of physical access you want to examine and so on okay so depending on your own requirements one of these methods can be chosen now let me show you a small video to demonstrate how this process works. So this will again give you a practical feel of the whole process as to how it exactly works and what is done during the process so this video again we have captured in our NDT laughs at the department of metallurgical and materials engineering at IIT madras so let me show you that video.

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So here it comes okay so if you remember we talked about a device an electromagnet called yoke so this is what it is this is a u-shaped electromagnet having two legs and in this case you could see the legs are adjustable so you would be able to access the angles and the distance between them so that provides you more flexibility and there is a red switchover here okay which the examiner is pressing right now to switch on the magnetizing current and then continuously he is also applying the magnetic particles.

So this is a block weight suspension you have in this case which is being applied okay right so this is a reference block which has some slots already marked over it so this we have etched out this slot in a particular pattern so this can be used to find out or this can be used as afield

indicator like what we have discussed before to know whether the field that is being applied whether it is enough or not and this can also indicate the direction of the field.

Because you have a particular pattern and you would be able to see in each particular direction the majority of the particles are going and accumulating so the perpendicular direction to that will be the direction of the field okay so this is what you could see here I could see that in some of the slots in a particular direction majority of the particles are trying to go and lying beside this over here this one if you remember we talked about this also this is the PI gauge which is like a coin.

Which can have six or eight sides so as you could see and you have this kind of slots which are cut out precisely on this surface and the others are other side of this is completely flat so these slots when you magnetize this pie gauge we lacked as artificial flaws and on the other side you could see their indications as we are going to show you now. We are yet to use any sample as of now we are just trying to establish the magnitude of the magnetic field and the direction also by using this field indicators okay.

And you can see the part is sticking it is being attracted to the electromagnet because it is big magnetized okay and now you could see majority of the particles are going into a particular direction and now if you see on the other side which is completely flat right but still you would be able to see the same pattern that you have on the other side once it is magnetized and you apply the particles now you see the same pattern which is etched out on the other surface can be seen on the flood surface also okay.

And in this case you could see yeah as I showed by that finger that is the direction of the field and most of the particles are going in a perpendicular direction okay so that is what indicates that the best visibility you have when the orientation of the flaw is perpendicular to the direction of the magnetic field, so here also a little bit of surface cleaning is needed as I would have mentioned before in the beginning to ensure that the particles have good mobility on the surface.

And now he is magnetizing this pi gauge so this is the flat side where you do not see any slot but as you magnetize and apply the particles you would see the indications of those slots which are cut out on the other side other side okay but you can clearly see them on this side also so this indicates that the magnitude of the field which is being applied through this Yoke is enough and you could see some of the slots are filled more compared to the other slots in a particular direction.

So that again indicates the direction of the field which will be perpendicular to the particular slot which is having majority of the particles sitting inside it, now I will pick up some kind of part which we know is defective and then we will show you how this surface flaws are fed surface defects are made visible by this magnetic particle testing okay so this is a piece of a steel plate some big cracks you could already see but that is not our concern right now.

Because they are already visible by the naked eye we want to see if there is something else which is not visible by the naked eye, so it is being magnetized right now and continuously we apply the particles also so this is a continuous method of particle application so those big cracks you can see again but apart from that now on this closer view you would be able to see a lot of other cracks for example here which was not visible by the naked eye.

And again I would like to show you the orientation of this particular crack so this is one leg of the Yoke and the other leg is over here and if you remember I told you if you connect these two legs by an imaginary line like this okay so that will be the direction of the field and now you see this crack is perpendicular to that direction okay and it is giving a very strong indication so that again tells you how the orientation of a crack and it is how the visibility of a crack depends on its orientation and the best visibility you have when it is perpendicular to the direction of the field.

So there are a lot of cracks on this particular piece and we will also magnetize it from other directions also so that we would be able to make visible indications for cracks which are oriented in so many other direction so it is always advisable that you magnetize the part from different directions so that you do not miss out on any crack which are differently oriented in different

directions and now it could see as we have changed the direction of the field lot of other cracks also are coming out.

So it is advisable to magnetize the part indifferent directions you could see lot of cracks in different orientation this is differently oriented compared to this then you have a big one over here and then again a perpendicular crack like this and then you have cracks which are at an angle close to 45 degree like this okay so that is why as I said it is always better that you magnetize the part from different directions, this is another small part again the same thing you could see being magnetized and the particles are applied.

And what you could not see by naked eye now you could see again you could see the directionality okay so this cracks are all in this direction which is perpendicular to the direction which is connecting these two legs so this is the direction of the magnetic field a line connecting these two legs and these cracks are all perpendicular to that direction and that is why you get very strong indications of these cracks, okay .So this Yoke is a very useful device to magnetize parts like this and it is very flexible and easy to use as you would have seen okay, so this is how the whole thing is done I hope this gives you a practical field as to how the whole process is done okay and this is what I have today so I stop here today, thank you.

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