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Theory and Practice of Non Destructive Testing

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Magnetic Particle Testing – 2

Hi my name is Ranjit Bauri so today we are going to continue on this magnetic particle testing which we have started in the last lecture.

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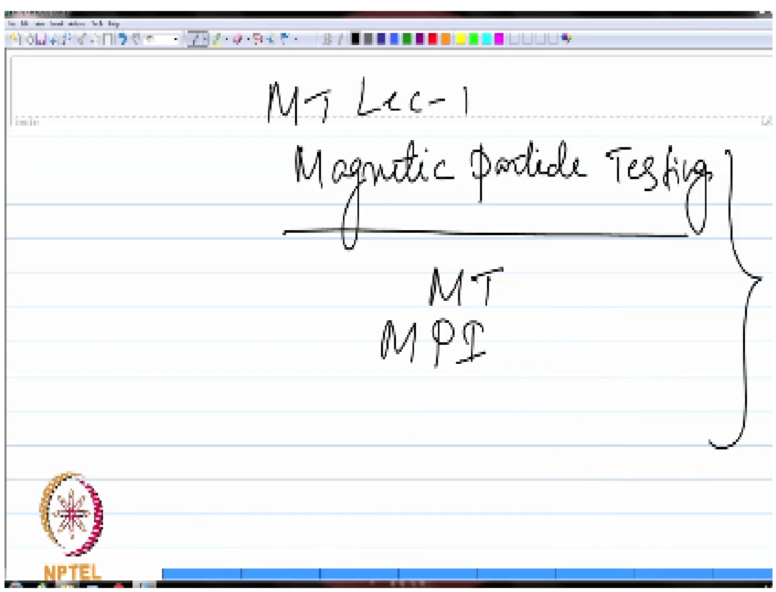

As part of this lecture series on entity so before we proceed today let us have a quick relook what we did in the last class we learned about.

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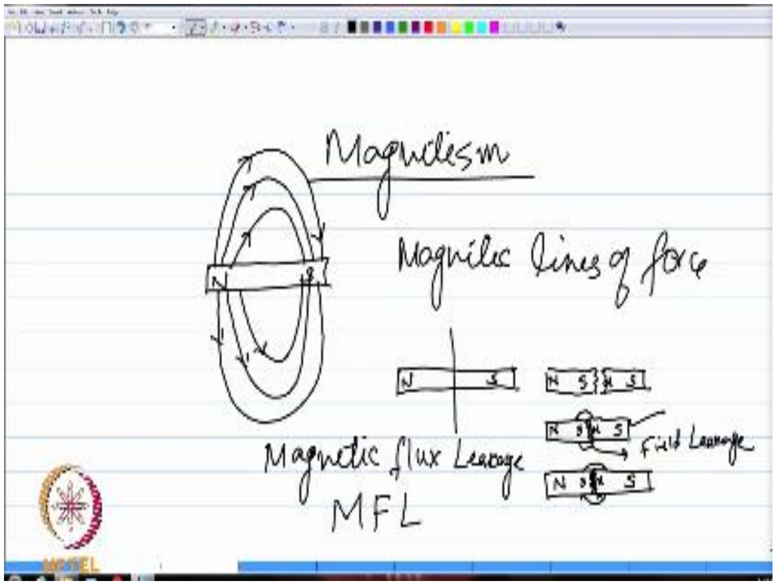

The basic principle behind this technique and we saw it is primarily the leakage field which comes due to the presence of a discontinuity on a magnetized surface due to that leakage flux or due to that leakage field it creates a small magnet along the discontinuity and then if you apply magnetic particles they will be attracted to this small magnet being created at the discontinuity and that is how it will be made visible by this magnetic particle testing okay so the main factor here or the main the basis for this is the magnetic flux leakage at a discontinuity.

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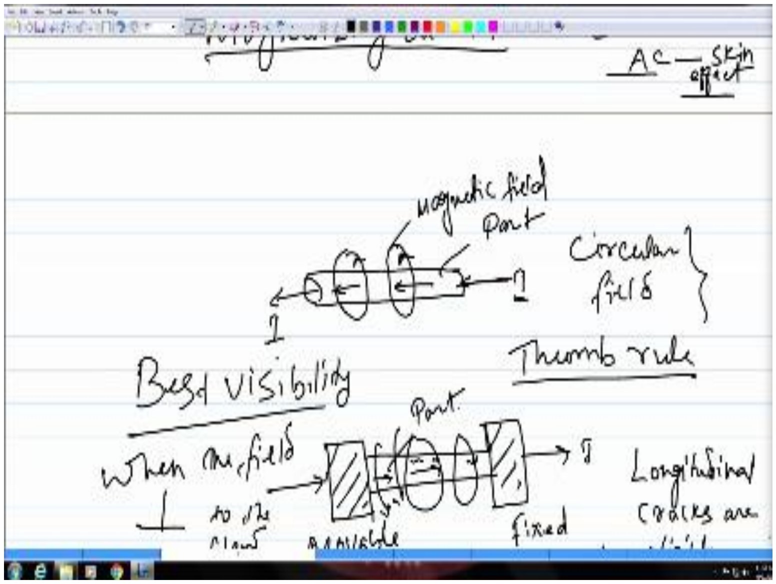

Then we talked about different methods of magnetization the first step in this case is to magnetize the surface and there are different methods which are available for magnetizing the part and depending on how you pass the current you can see the magnetic field how it is created and the direction of the magnetic field as I said before can be found by this right-hand thumb rule as you could see here ok so if on your right hand if the thumb be the direction of the current then the fingers will point towards the direction of the magnetic field okay.

So these are mutually perpendicular to each other as you could see in this case for example in the first one here so if you pass a current like this through this part it is being examined so the magnetic field will be created in this path so these are called circular magnetic field the direction of which is perpendicular to the direction of the current ok so this is what we saw and we also saw that the best feasibility you have then the field and the discontinuity are perpendicular to each other okay, this does not mean that other orientations will not be visible they will still be visible but the strongest indications will be obtained when the discontinuity is perpendicular to the field okay.

So this is what we saw and then they went ahead and saw different methods few methods by which you can magnetize the part and this was the first one using two electrodes and clamping the part in between these two electrodes so for clamping the part one of the electrodes is movable and the other one is fixed okay and then we saw the current requirement also for this kind of magnetization the magnetizing current is in there in this range depending on the size of the part.

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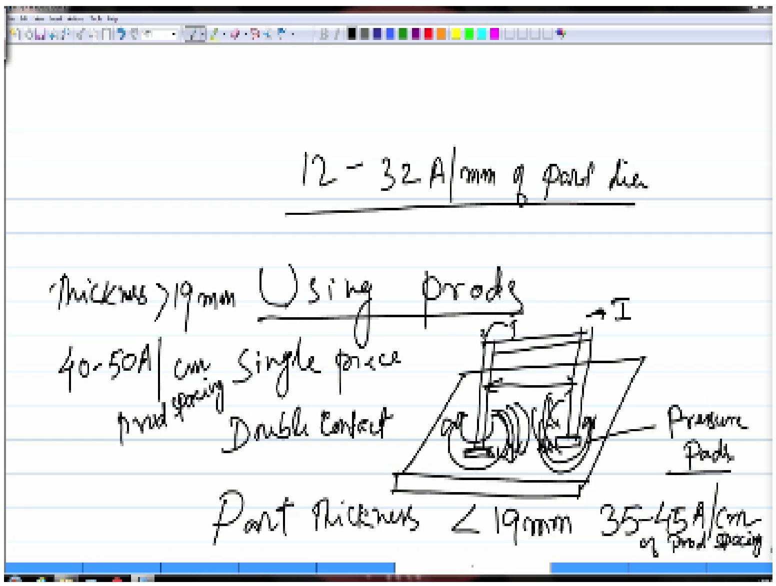

And then we saw another method we uses this kind of electrodes which are known as prods so you can either use a single prod or a double prod and in this case again when you pass the current through this part along this Prada skeins of you know circular magnetic field will be again generated like how you see over here and the defects around this magnetic field will be made feasible. So in this case one thing I should mention here the requirement of the magnetizing current when you are using prods it will depend on the thickness of the part.

For example if the part thickness is less than 19 mm okay the current requirement for this case would be 35 to 45 amps per centimeter of brought spacing so it depends on the distance between the two lakes of the prod so it will depend on this distance so that means if you have a ten-centimeter distance for example then you would need for a part of thickness less than 19 mm you need the current in the range of 350 to 450 amps when the spacing between the prod legs is 10centimeter okay.

And for a part thickness of greater than 19 mm the current requirement would also increase so in that case it would be 40to 50 amps per centimeter of rod spacing okay so this is the requirement of the magnetizing current for this particular method.

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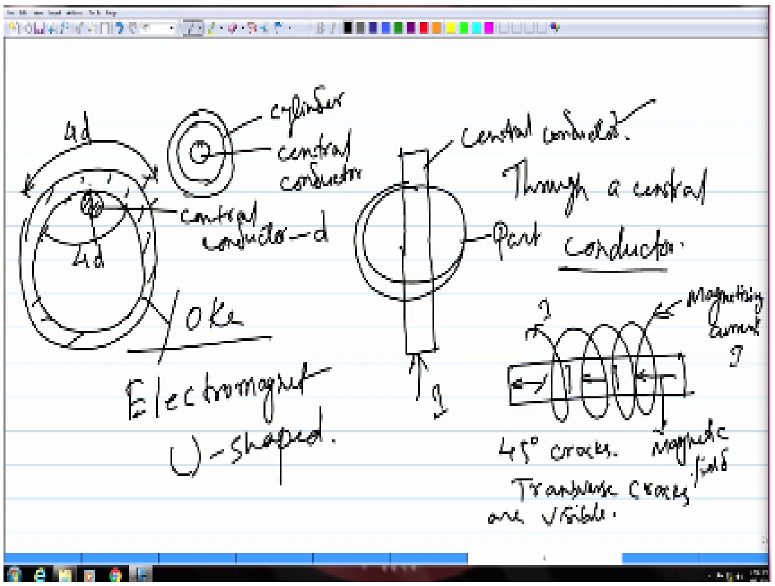

Then we talked about this also if you have a part which is hollow then in those cases you can take a conductor and pass it through the central hole so with the help of this central conductor when you pass the current through it you can magnetize the part by induction okay. Similarly you can use a coil and insert the part through it so in that case also it will 90 ties the part and in this case when you are sending the current through this coil let us say this is the direction of the current as you could see so here the magnetic field is not circular in fact in this case it is longitudinal.

So the cracks which are transverse that is perpendicular to the axis will be having the best visibility and cracks like this which lie along 45degree they will also have good visibility okay so when you have a central conductor depending on the size of the part you have to place it so if it is a small cylinder like this then you can place it at the center okay so this is the a cylindrical part that is being examined and this is the central conductor which is carrying the magnetizing current so if the part is small you can place the conductor along the center.

So that you can have a uniform magnetizing on the surface of the cylinder okay but if you have a bigger part let us like this okay, so in that case if you place the conductor along the center then the magnetizing will not be uniform across the periphery or across the circumference of this part so in that case the central conductor is placed in contact with the wall of the part in on one portion like this so this is the central conductor so you have to magnetize a particular portion of the part it is being examined.

So if the diameter of this central conductor let us say if it is d then in this case you would be able to cover a distance along this which will be equal to 4 d 4 times the diameter of the central part so that will be the effective distance of magnetization when you use a central conductor like this at a part which is bigger and the conductor is placed in contact with the wall of the part at a particular location okay. So this is how it will be if you see along the circumference the distance that you can magnetize in this case will be four times the diameter of the central conductor. Similarly when you are using this kind of coil.

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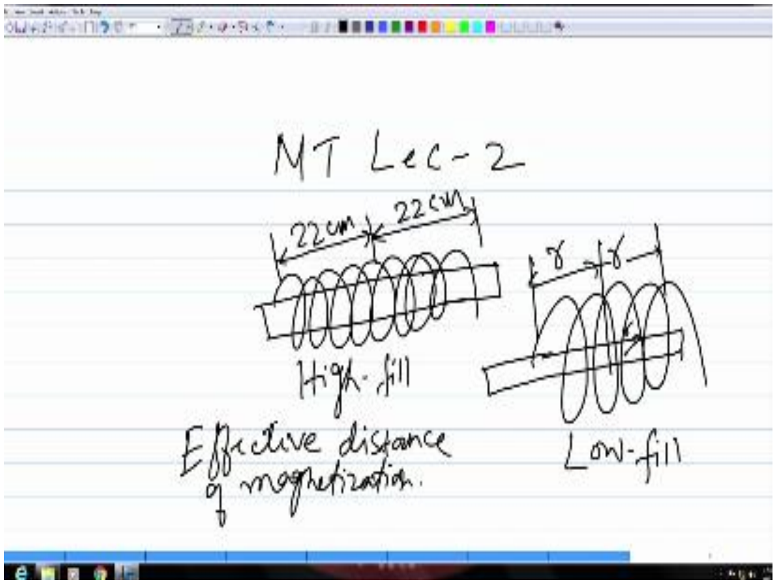

Depending on whether the diameter of this coil is tightly field by the part or the part diameter it is much smaller compared to the diameter of the coil then since this is highly field okay this is known as a high film and in this case you could see the filling of the coil is not that much so that is why this is known as low film in case of high film the effective distance of magnetization from the center of the coil is 22 centimeters on either side from the center and in this case the effective distance is our wherein r is the radius of the coil okay.

So in case of High field it is22 centimeter the effective distance of magnetization, so in case of High field it is 22centimeters and in case of low fill let us say is equal to the radius of the coil okay, so this is how it is in case of a coil or a solemn oil.

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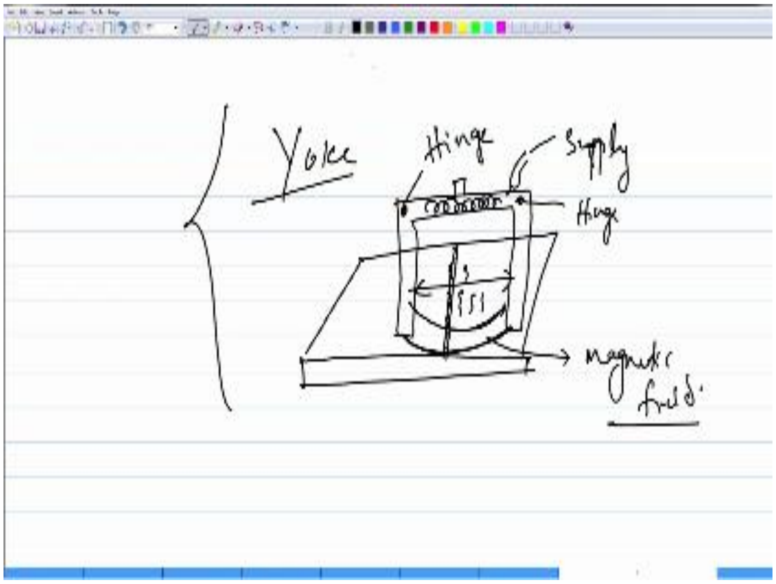

And then we talked about this also a u-shaped electromagnet which is known as a yoke that can also be used to magnetize the part and in this case the direction of the magnetic lines the magnetic lines of force are across this if you connect these two legs so along this line is the direction of the magnetic field so that means cracks which are lying like this perpendicular to this field will have the best visibility.

And in this case as I told you could have a hinge also like this that will allow you to move this legs and you would be able to adjust the distance between the legs so that you would be able to vary the effective distance of magnetization in this case so these are the different methods of magnetizing the part okay.

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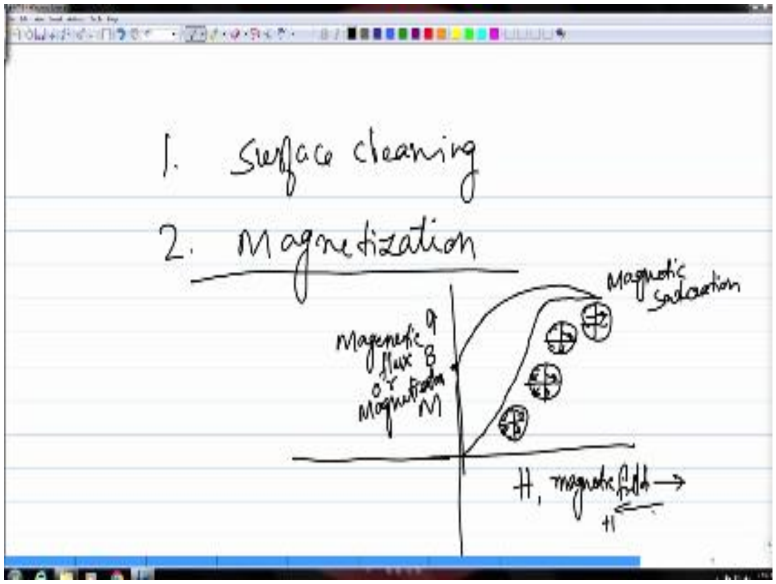

So let us continue on that in this lecture so first thing that you do you clean the surface of all dot oil grease and so on and then you magnetize the part okay by using one of these methods depending on your requirement and the suitability so when you magnetize we know what are the different methods that is all fine but when you are magnetizing the part how do you know what is the level of magnetic field which is optimum or which is good for magnetizing a particular part of given size okay.

So if you want to know that first you need to know a little bit about the theory of magnetization that means we need to go back and discuss a little bit about the basics of magnetism and then you have to see the magnetic properties of the material which is being tested okay so if you refresh your memory on the theory of magnetism let us say you apply a failed H in this direction so in the part which is being magnetized it will create a magnetic flux or it will magnetize it. So if you plot the magnetic flux or the magnetization on this y-axis magnetic flux many times is denoted by B or you can also use magnetization M along this axis.

So as you continue to increase the magnetic field the magnetic flux in the material would increase like this and finally it will saturate okay so that is the saturation magnetization so what basically happens here you may know that in a ferromagnetic material you have what is called as magnetic domains or magnetic dipole moments so this in the beginning when you do not apply any failed when the field is zero these magnetic dipole moments are random lee oriented like this okay.

And as you continue to increase the magnetic field in a particular direction then some of the dipole moments which are favorably oriented with respect to the direction of the field will grow in size it is this one at the expense of the other one so the other ones will reduce so as you continue to increase this direction will continue to grow the favorable direction and it will also tend to a line along the direction of the applied field okay.

So at this point when you reach this saturation point all the dipole moments which are favorably oriented along this magnetic field will be now aligned and they also grow in size at the expense of the others and they will be almost aligned to the direction of the magnetic field and that is when you reach magnetic saturation okay, now if you reverse the field okay if you change the direction of the field if you do field reversal then it will not while coming back it will not follow this same car rather it will follow a curve like this so now at this point although your field is zero okay.

But it is still having some magnetic flux it is still having some magnetization okay, so that means it is retaining some of the magnetization which was provided.

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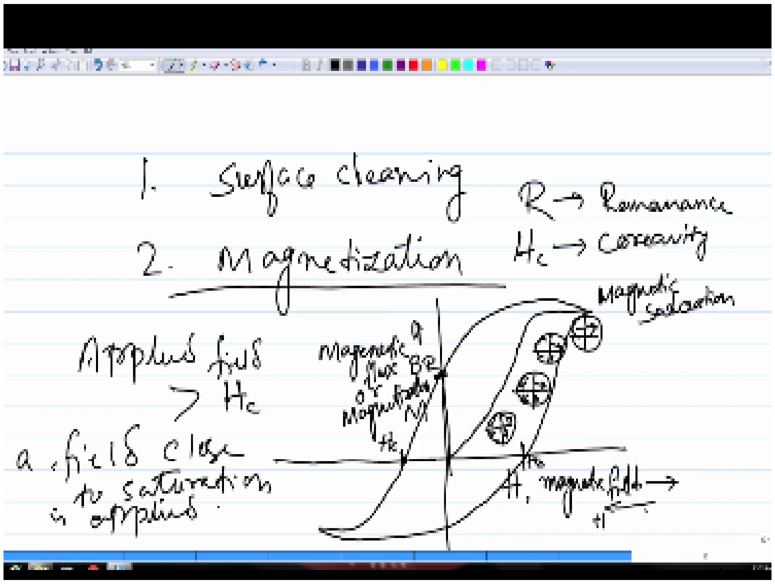

In the beginning and that is why this point is known as remnant so if we denote that as our okay and then if you continue to reverse the field then it will finally saturate on the reverse direction also and now at this point it is the magnetization is becoming 0 so to take it back to the zero magnetization you have to apply a field in the opposite direction and this particular point the field H corresponding to the point when the magnetic flex is becoming 0 is known as the coercively so again this is a property of the material and now if you increase again on the same direction then this hysteresis loop develops.

So this is the magnetic hysteresis that we all know okay, so now coming back to this as to what should be the level of the magnetic field that we apply to magnetize the part okay, so as you could see in any case the applied field has to be greater than the query field so it must be greater than the where it's a film which is this one so that it is the magnetization is not zero it is some positive value it is more than zero in most cases a field close to saturation is applied so that when you remove the field you have enough magnetic flex remaining okay.

So theoretically this tells you what should be the level of the magnetic field that you apply to magnetize the part but when you actually do it this theory is fine because this gives you the idea as to how much you should have lie but when you are practically do it and as you apply the field you do not know what is the exact magnitude of the field which is being applied okay so that means during doing it practically you need a reference okay or something which would at least indicate if not tells you the exact value of the magnetic field which you will at least indicate that the field which is being applied is good enough to magnetize that particular part okay so that is where these field indicators come into picture .

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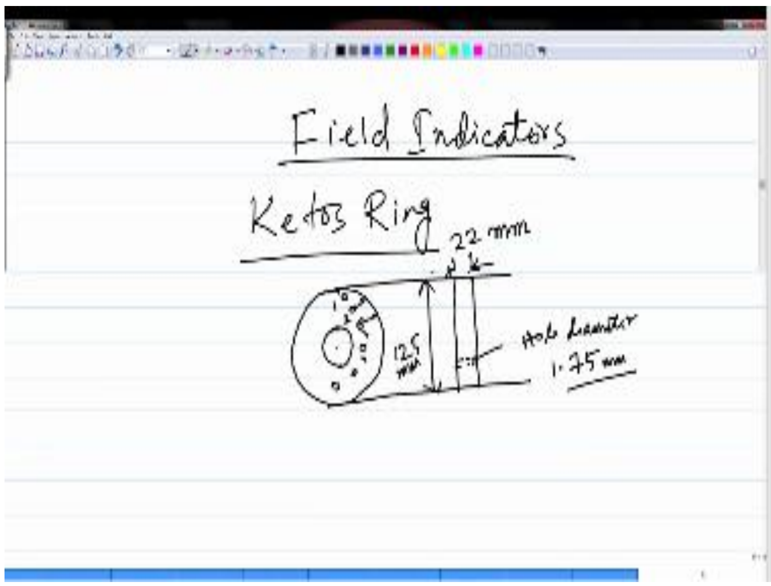

As the name suggests this will indicate the level of the magnetic field of course in a qualitative manner whether it is optimum or whether it is enough to magnetize the part or not okay , so there are different types of field indicators depending on what kind of part you have which can be used to indicate the level of the magnetic field being applied and one of them is known as ketosis ring o this is basically a ring like this with a hole at the center okay and then along the periphery you have some smaller holes at different distances from the edge like this so as you go on this distance from the edge increases okay.

So you have different holes like this at different distances from the edge and this holes are given numbers like this 1 2 3 4 and so on as the distance from the edge increases this number also increases okay and if you see the typical dimensions of this particular indicator this is like this so the diameter is 125 mm okay, and it's thickness is 22 mm and this series of holes that you have the size of the hole the diameter of the holes is around 1.75 millimeter.

So this is what you have now what you can do you can through this central hole okay, you can put a central conductor and pass the magnetizing current then as you pass the current this will be magnetized now depending on how many holes are visible or how many holes are being indicated by the magnetic particles so you first magnetize this ring and then you apply the magnetic particles and then see how many holes are being indicated by the magnetic particles clearly okay so it will depend on what is the level of current.

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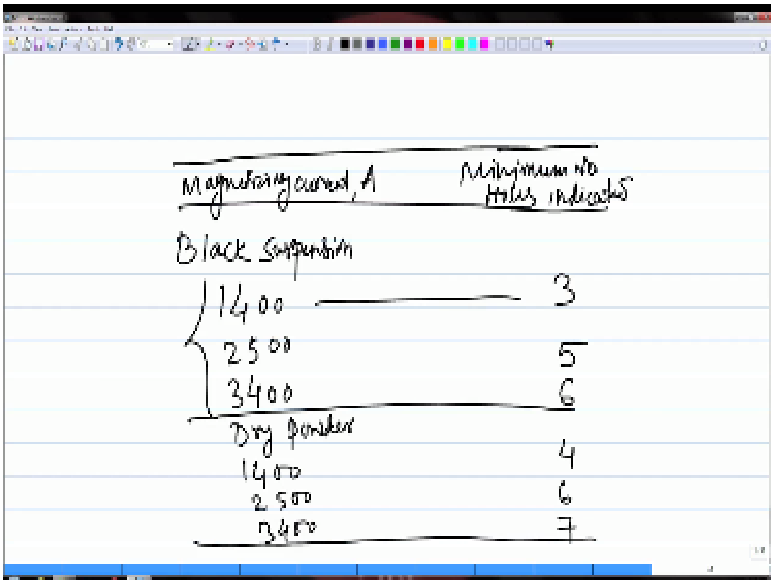

You are using and what kind of magnetic particles are being used so if you see this table for example which is the magnetizing current which is being applied to magnetize, magnetize the part and the minimum number of holes indicated by the magnetic particles so this magnetic particles can either be used in a suspension in a low viscosity liquid that we'll talk about later in little more detail or they can also be applied as dry particles okay.

So let us say you are using a black suspension and in that case the number of minimum holes that should be indicated that would depend on what is the magnetizing current which is used so let us say for these black suspension these are the levels of current then for this for each of these currents the minimum number of hole that should be indicated for 1,400 amperes it should be 3 then 4 2500 amperes it should be 5 and then for 3400 amperes it should be 6 okay, so this is how this key toasting would indicate that you know.

The magnitude of the magnetizing current which is being applied whether it is good enough or not okay, so if you are applying for example 1400 amperes and then if you see three holes are clearly indicated when you apply the magnetic particles then for that particular current for that particular scenario this much current is enough okay so this is how it will be for black suspension and if you use dry powder for the same level of current this number should be 4,6 and 7 little high okay.

So this is how depending on what kind of magnetic particles are being used and how many holes are being indicated by them the optimum level of the magnetizing current can be found okay so this is how these ketos rings is going. To indicate whether the magnetic field or the magnetic or the magnetizing current which is being applied whether it is optimum or not so this is one of the methods one of the indicators by which you can do it there are two or three more methods which we are going to discuss little later.

But I think we can take that in the next lecture because today this is all I have so I will stop here today thank you for your attention and I will see you next time.

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