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Theory and Practice of Non Destructive Testing

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Radiography – 8

Hello and we will come back again we are on this topic of radiographic testing right now. And by now we have already learned most of the things about this particular topic as to you know how the image is formed, what kind of x-ray films are used, what are those parameters of the films and the source which control the image quality and we have also seen how exactly the image is formed okay.

And then in the previous lecture we discussed about my exposure also as to how the film is exposed how it is loaded into the exposure chamber and how the exposure time is decided for a particular material okay.

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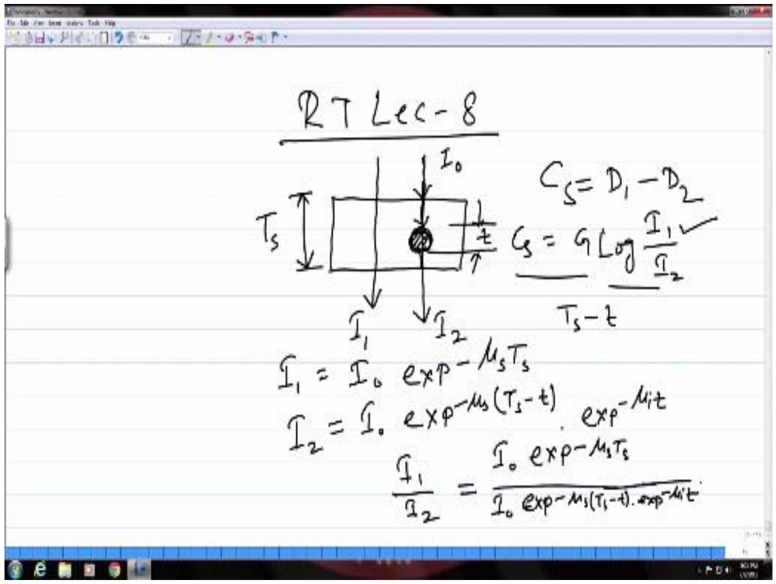

So today we are going to talk about some examples and see for a given kind of defect how the contrast is created okay, or I mean based upon how these x-rays are being absorbed by different features or different effects how the contrast is and what is the parameters which control the contrast from a particular feature okay.

So x-rays as you know are most commonly used for defects which are into the bulk and it provides you a 2d kind of shadow or a 2d for file of the defect that you can see on the x-ray film once it is developed okay. And this kind of defects like for example blow holes in a casting which are inside the casting or the component which is being cast this kind of defects are very commonly inspected by radiographic testing so that you can see them as a contrast on the radiographic film and try and understand how they are and you know what kind of size they have and things like that.

So you try and understand the typical features of a particular defect by taking an x-ray image for a for a particular component okay. And other kind of casting defects which can lie inside the volume of the component of the cost component are these nonmetallic inclusions for example, if you do sand casting many a times a sand particle can go inside the casting and that will be a defect as far as the quality of the casting is concerned.

So let us say you have a non metallic inclusion like this inside the casting, so for the disc casting which is exposed to x-rays in order to identify the defects when it is exposed to x-rays, the x-rays will go through the material and finally they will encounter the defect okay. So they will also have to pass through this particular defect okay.

And on the other hand where there is no defect they will simply go through the material. So you can expect at two different intensities coming out one from the parent material itself let us say that is I1 and the other from the defect which is I2 okay. And for the sake of understanding it let us give a size to this defect let us say it has a particular size is it has a thickness or a diameter of T and the sample thickness.

So we will call that as TS okay, so for this particular scenario let us see how will be the contrast generated and the contrast that you see on the x-ray film image it will depend on what parameters. So if you remember the contrast is given by this okay, so you want to understand that this contrasts how it will be for a scenario like this.

So this I1 which is the intensity coming out from the parent material this is the radiation intensity I0 so I1 will be I0 exponential where μS is the absorption coefficient for the sample and I2 which is the intensity coming out from the defect which is an inclusion in this case. So in this case you can see it is first going through the parent material and after that it is going through the defect or the inclusion.

So there are two components in this case one through the parent material of thickness TS-T so that much of a parent material which is this plus this part and then it is going through this inclusion also of thickness T okay. So for the inclusion let us say the absorption coefficient is μI so this will be μIT for the inclusion. So now if you simply take this I1 and I2 because that is what we need to get the contrast so on I1.

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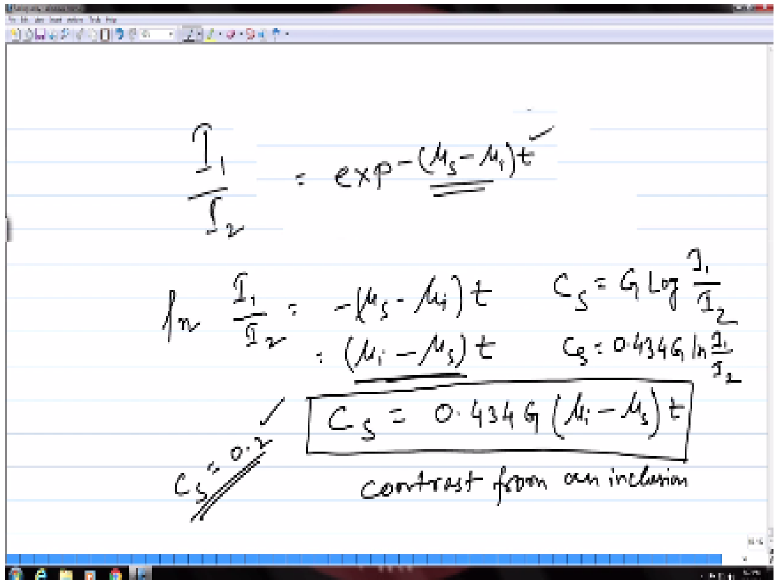

So this will give you and living behind finally this expression okay. So you can see here that this I1/I2 it is primarily the difference between the absorption abilities of the material and defect and the thickness of the defect okay. So now if you take this Ln I1/I2 then it becomes it simply becomes, and we know that CS is this. So if you convert this in terms of Ln it will be this is the factor which will come.

And we have already derived Ln I1/I2 is this, so the contrast from an inclusion will be equal to this okay. So from here you could see that the contrast from an inclusion is not going to depend on the thickness of the parent material, but it will depend on the thickness of the defect or the inclusion okay. So you simply have to see whether this contrast is enough or not and accordingly you have to choose those exposure parameters for getting a C_S value which is easily visible to human eye and if you remember I said that a contrast a minimum contrast a point to is needed for it for good visibility on the radiographic image, okay.

So in this case you simply have to see that for a given condition whether this I_1/I_2 which is basically this difference of the absorption abilities of the inclusion and the parent material whether that is giving you a value which is more than 0.2 or not okay, so for those exposure conditions which include your exposure time the tube current and the tube voltage if you get a value of C_s greater than 0.2 then you will be able to see this inclusion on the radiographic image which is captured, okay.

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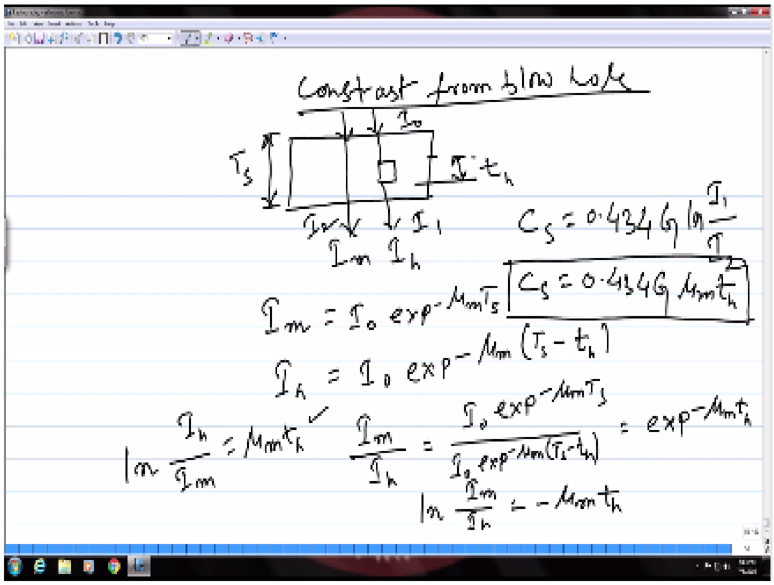

Similarly, you could also get the contrast from a blow hole, so here again we will follow a similar approach let this be the sample thickness and this is the size of the blow hole that you have, so let us indicate that as t_h, okay so in this case again when you expose this to x-ray radiation of intensity I_0 it will go through the parent material like this one only through the material and in the other case it will encounter this blowhole also, okay.

So in this case now if you see these intensities let us say we call this as the parent material and for the hole I_h so I_m is straight forward and for this I_h so in this case it is going through the parent material only but the thickness which is lower by the thickness of the blow hole, okay as you could see from this diagram. So, now if you take this ratio which is the ratio that you want for calculating the contrast, so in this case ln $I'm/I_h$ will be simply $-\mu_m$ t_m okay, and so ln I_h/I_m is $\mu_m t_m$ okay.

So the contrast from the blowhole in this case is again the same equation here so in this case I_1 is this one which is coming out from the blowhole am I_2 is this okay, so if you replace this over here the contrast from the blow hole becomes, okay. So here again you could see that the contrast from the blowhole also does not depend on the thickness of the material or the thickness of the sample it rather depends on the thickness of the blowhole other defect, right.

So this is how in this case you can calculate the contrast from the blowhole if you know the size of the blowhole and if the material is known then the μ_m is also known so there again now you have to see whether C_S is greater than equal to 0.2 or not so when you get the value of C_s based upon this blowhole will be clearly visible on the radiographic image for the parameters which are used to capture that particular image.

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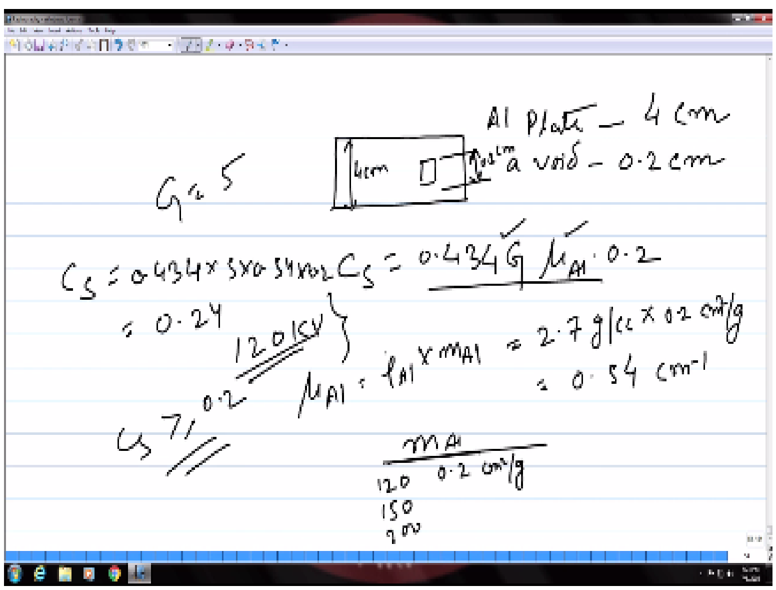

We can take an example to see this let us say this is aluminum, so in an aluminum plate you have a void which is 0.2 centimeter and the aluminum plate is 4 centimeter in thickness, okay and you already derived what will be the contrast for this G is the gradient which is known for a particular film, okay. So now let us say you are using a tube voltage of 120KV so the question here is whether this blowhole will be clearly visible on the radiographic image or not at a tube voltage of 120kilo volt, okay.

So for that you simply have to see at 120KV what is μ_L and you put the value of μ_L for here for a known G and then see whether C_S is more than 0.2 or not okay, so tables are actually available for the mass absorption coefficient rather than the linear absorption coefficient so for different voltages the mass absorption coefficient for a particular material can be obtained from this kind of available data. So for aluminum let us say if it is that 120 if it is let us say if it is 0.2 cm^2/g so μ_L we know will be this for aluminum the density is 2.7 g/ccx 2.2 cm2/g this will give you something around 0.54 centimeter inverse.

And now if you put this value over here, let us say we consider g=5 so your contrast for this will be around 0.24 which is greater than 0.2, okay. So for a voltage of 120KV, if you expose the sample this blow hole that you have why it will be clearly visible because the contrast is greater than 0.2, okay. So this was an example how you get the contrast from different kinds of defects at a particular exposure condition okay, and with this we come to the end of this lecture also so I will stop here today I will see you next time, thank you.

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