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# Environmental Degradation of Materials

**Lecture – 28**
**Broad Subject: Intergranular,**
**Corrosion, Dealloying**

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So we see that two criterias are need to be satisfied in order to get say, in here to get chromium carbide precipitation along the grain boundary, one we have seen the carbon content, carbon percentage it should be beyond 0.02% and we have seen from the phase diagram that if this is my phase diagram this is temperature, this is percentage of carbon, and this is austenite plus carbide, and this is austenite zone, now they are in between there have we have gamma + alpha + carbide, now if the carbon content and this is around 0.02% and if the carbon content is around 0.08% then, and this is the solidus line and if we cool it, and during cooling let's say we are at this temperature around 700 degree Celsius, and the 700 degree Celsius the chromium carbide precipitation is possible and the amount of carbide that is to be formed will depend on the percentage of carbon that is available for carbide formation. And as you see that the equilibrium carbon content at this temperature is this much, but the amount of carbon which is excess in the gamma solution is of this much, so this much carbon is available for carbide formation and the carbide would form along the grain boundary since the grain boundary provides heterogeneous nucleating sites.

Now second case is now if somehow if we file cooling, if we cool it very fast and since carbide formation is a nucleation and growth kind of phenomena, so if we don't allow sufficient time to form carbide in this zone then of course the whatever carbon what is there in the solution at this stage will stay in the solution even at low temperature and the solution becomes supersaturated with carbon and if we have very rapid cooling we don't have sufficient time for carbide formation and we don't have the problem of carbide precipitation along the grain boundary, so time is important issue. The amount of time what we spent at this temperature zone around 600 to 800, 600 to 800 degree Celsius in this temperature zone the amount of time spent would be a critical criteria because if we spent lot of time then carbide precipitation would be possible, since the time available for precipitation, nucleation and growth.

And second issue is if somehow if let's say we are cooling it slowly up to this above 800 degree Celsius and then in this temperature zone we cool it very fast and then after we cross this temperature zone we see that we don't need much of cooling rate even if we go for a very slow cooling rate it is not possible for the carbide to precipitate out along the grain boundary, so we see that this temperature zone 800 to 600 degree Celsius is also critical so time and temperature. So time and temperature both are important in order to have carbide precipitation, and these temperature means the critical temperature zone which is 600 to 800 degree Celsius in case of 18:8 stainless steel with carbon percentage around let's say 0.08%.

Now another criteria could be there that is basically the other alloying elements, other alloying elements and not only other alloying elements, the alloying elements which are strong carbide formers, like niobium or titanium. See if we have these highly carbide forming elements and if their affinity towards carbon is more than the chromium then depending on whether then the possibility of having carbide precipitation which is the chromium carbide precipitation since chromium is important in giving stainless property so if we have these elements and if somehow we can take care of the excess carbon that is available in the material by forming niobium carbide or titanium carbide, so chromium carbide formation we don't have much of carbon left so chromium carbide formation would not be there, but that's what depending on whether this kind of alloying elements are present or not the sensitize of this carbide precipitation along the grain boundary would be decided, so these are the major criteria that are essential for carbide precipitation and preferentially chromium carbide precipitation along the grain boundary and leading to chromium depleted zone along the grain boundary and that would give rise to intergranular corrosion and that we have seen the mechanism we have already seen.

Now once we have these three criterias let us see when we weld a stainless steel 18:8, stainless steel let's say that stainless steel when we weld that time it doesn't have the problem of chromium carbide precipitation, now the point is whenever we have two stainless steel bar let's say the two stainless steel block and I need to weld in this zone, okay, when we weld that time we have to raise the temperature around more than 1650 or 1700 degree Celsius in order to melt this local zone, now this is also 18:8 stainless steel and this is also 18:8 stainless steel and let's say the carbon content is 0.08% and here also 0.08%. Now let's say this two particular blocks, stainless steel blocks they have no carbide precipitation along the grain boundary, so the intergranular corrosion in these two blocks individually they don't have this problem of intergranular corrosion because the chromium carbide has not form along the grain boundary in any of those blocks and the chromium always stays in the solution, and let’s say the heat treatment that has been followed would be such that the chromium carbide precipitation doesn't occur, how we can go for that heat treatment we can quench it rapidly so that the chromium doesn't form in this temperature zone, sorry chromium carbide doesn't form in this temperature zone, fine we don't have any problem.

Now the point is if we weld, if we take the temperature to around 1700 degree Celsius and then if we have a section, different sections we can have a different temperature time profile at different sections, and depending on those profiles we will see some of the sections there we have sufficient time for chromium carbide precipitation as well as we can have this favorable temperature zone, and when we have let's say some zone, let's say in this block you have this section where we have sufficient time, sufficient time and the temperature zone is 600 degree Celsius to 800 degree Celsius so chromium carbide forms, in these zone only other zones we don't have any problem. And when this chromium carbide forms this is the grain boundaries and if the chromium carbide forms along this grain boundary zones along this zones okay, so you have this chromium carbide formations, this are the chromium carbide and you have a depleted zone, that time the steel is called sensitized, and the phenomena is called sensitization means where we don't have the problem of chromium carbide precipitation along the grain boundary that particular steel if we satisfy this situation sufficient time in the 600 to 800 degree Celsius zone we can reap, we can have the situation of re-precipitation of this chromium carbide along the grain boundary and leading to chromium depleted zone along the grain boundary keeping the rest of the system where, in face of the system intact where the chromium in solution would be 18% but along the grain boundary the chromium contained can go down to around 2% or less, so you have grain boundary or intergranular corrosion, and that time this is called sensitized steel and the process is called or the phenomena is called sensitization.

Now during welding of this too un-sensitized block that means there is no grain boundary precipitation of chromium carbide, let's see what happens and what would be the temperature profile or time temperature profile as we go from this zone the welded zone to the body of the, towards the body of this block. Now let's say this is my welded zone, let's say this is my welded zone, and let me what I can do I can perform an simple experiment, what I can do? I can mark all those points, I can mark all those points, let's say this is one point, this is one point, this is one point, this is another point, let's say this is D, this is B, this is C, this is B, this is A, and here you see the A is directly in the fusion zone, and the rest of the thing are basically the heat affected zone and that heat affected zone always is experience, we experienced while we do fusion welding.

Now since they are thermocouple fixed to this points so we can easily get the temperature while heating as well as temperature profile while cooling so if we see the, this is time scale, this is temperature scale, now we can have a different temperature zones let's say this is 1204 degree Celsius, this is 93, then you have 982, then you have 871, and this is in centigrade scale, this is 760, and this is 648, and let's say this is 537 and below that it's 315, so this is the temperature scale what we are interested with. Now when we see that the temperature while heating let's say we are heating from here and while heating if we employ very rapid heating generally the heat the temperature increases rapidly, so in case of A point, at this point of course this point would be the maximum temperature which is the center of this weld zone for the temperature go may be around 1600 to 1700 degree Celsius, but in the fusion zone at the end of this fusion zone we can have a temperature profile like this, temperature could be like this during heating. Now when it cools down since it's at the maximum temperature this would be that the maximum temperature compared to the other points during the welding process, so when it cools down it cools down like this.

Now let's say this is A the temperature profile for the thermocouple at A point, which is the boundary between the end of the fusion zone and the heat affected, start of the heat affected zone, now if you consider the what is the temperature time profile for the thermocouple B, thermocouple at position B we can have a profile like this, profile like this, this is for the case with B. Now then we have the zone, the thermocouple which is fixed at Point C we can also get the temperature profile like this, and then point D of course it would be the lowest one like this, so this is point D, this is Point C, now if you see this graphs carefully you will see the temperature the maximum when it cools down this is heating, this part is heating and this part is cooling, when it cools down that time the temperature the maximum temperature from maximum temperature and 1204 degree Celsius the cooling rate all would also be very steep, since we have a larger temperature so large temperature differences so the cooling rates rate also would be very steep. As you go down from the maximum temperature to this level, to this level to this level, that means as you go away from the fusion zone then you have the attainment of the maximum temperature would be, the maximum temperature would be less as you go down towards this side, so that's what you are seeing that B, thermocouple B so this is the maximum temperature that can be attained at this point and gradually if you go this way the maximum temperature also would decrease and as well as since you have the lower, a lower temperature gradient you have sluggish cooling rate as we go down like this.

Now you see that in case of B we have a particular temperature let's say this is my 800 degree Celsius, this is my 800 degree Celsius, and this is my zone, this is 600 degree Celsius, now the material of this zone and C is basically the start of this 648 zone, so this zone actually, this zones is staying in the sensitized temperature zone which is 600 to 800 degree Celsius for the maximum duration, for the maximum duration if you see that this is the amount of time that the material is spending in this critical temperature zone where we have sensitization, but if you see the A case the amount of time that the material is spending is only this much, only this much, so the amount of time that is being spent in the critical temperature zone which is 600 to 800 degree Celsius temperature zone when we have the thermocouple at this point that is only this much time, and if you see in case of D that is not at all reaching to the temperature zone which is 600 to 800 degree Celsius, so that means we are bound to get more and more or possibility of having chromium carbide precipitation in case of this material of this zone, in this zone we have more and more possibility of chromium carbide precipitation along the grain boundary, and here though we have spent some of the time in this 600 to 800 degree Celsius temperature zone but the time is so short it will not allow that chromium carbide to form at the same time, it will not allow the chromium carbide to grow, so we see that in this zone we have the possibility of sensitization and this material in this zone will get sensitized, this is the region where we have intergranular corrosion when it is exposed to corrosive, and rest of the material and same way the other side also you can experience a particular zone where we have sensitization, so these zone and this zone would be susceptible to intergranular corrosion and rest of the zone will not be susceptible and there will not be any problem, so the failure would occur along this zone and this is called, this particular section generally is called weld decay, this particular process is called weld decay, weld decay this particular process is called weld decay and this weld decay means the creation of sensitized zone, sensitize zone in the stainless steel which is not sensitized when it was, it was not sensitized during before welding, so before welding there was no sensitization problem and after problem because of this temperature time profile we have a zone which is developed and this is basically the area of weld decay and here we have intergranular corrosion and rest of the cases we don't have any intergranular corrosion, so that's what it is very important to have the time temperature phenomena, and in case of stainless steel we always prefer arc welding over gas welding and that is also understood from this picture if we have gas welding the heating rate would be very slow as well as cooling rate also would be slow, and there would be a large heat affected zone so we can have more and more area which would be susceptible to intergranular corrosion and sensitization would be possible or weld decay would be possible, but if we employ arc welding the heating rate would be very sharp at the same time cooling also would be very sharp as well as the heat affected zone would be narrow, so the effect of sensitization or weld decay would be minimized.

Now let us see this is the problem with a welding of stainless steel, and if the stainless steel is not sensitized before welding and after welding because of this phenomena sensitization can happen which is called weld decay. Now let us see how many ways we can avoid this sensitization, there are major three processes by which we can avoid sensitization let us get into that processes how we can prevent sensitization, one is this is prevention or control of sensitization of austenitic stainless steel and mainly stainless steel, so first process is since we have seen that if we can decrease the carbon content in stainless steel less than 0.02% we will not have any problem of sensitization, and sensitization is related to the chromium carbide precipitation along the grain boundary, and if we don't have sufficient carbon which can be left out by the austenitic lattice during cooling in the temperature zone of 600 to 800 degree Celsius chromium carbide cannot form because if there is not much of carbon left for the chromium to take up those carbon and form chromium carbide, so if we can go for very, very low carbon percentage, and if we can take the carbon content less than 02% or around 0.02%, so that is basically low carbon austenitic stainless steel, so we don't have much carbon to form, much carbide to form, so very, very low carbon, so this is one way but this is a costly affair since we need to employ secondary steel melting process where we can get rid of carbon in the steel, and it increases the cost of the material, but another problem with this let's say we have a very, very low carbon content in stainless steel so that means I don't have any problem of sensitization, we can easily cool slowly in this temperature zone, so if we cool very slowly in this temperature zone and if we have a very low carbon then we don't have chromium carbide precipitation and sensitization process, but the point is if we let's say go for oxy acetylene gas welding then since it's a very low carbon the system can have a tendency to pick up carbon from the gas welding process itself, okay, so when it picks up carbon from the gas welding process that means the flames that time the carbon content again goes up to beyond 0.06% or 0.05%, so little bit of carbon which is left out and the same process would happen and there could be a possibility of sensitization of weld decay because if this carbon pick up.

Now second case is we can have suitable heat treatment, suitable heat treatment means somehow if we can, as we have seen the temperature time or phase diagram so that case if we can cool it very fast in this temperature zone, if we cool it very fast we don't have much time to form chromium carbide, so there is no problem of sensitization, so suitable heat treatment.

And third is addition of carbide formers like niobium or titanium, what they will do? Let's say the carbon content is 0.06% in the austenitic stainless steel, now these elements when it is basically made, these elements are added and these elements are very, very strong carbide formers and those can take up those excess carbon and it will form carbides and that carbides may also form along the grain boundary no problem, it can form inside the grain boundary inside the grain at the same time it can form along the grain boundary and so once the carbide forms, these carbides forms so the carbon content in the solution or in the lattice goes down or the iron lattice goes down and then the carbon which is required for chromium carbide to form would not be available, so then we don't have chromium carbide precipitation on the grain boundary or sensitization affect.

Now the point is as we are saying that as it is said that the titanium carbide or niobium carbide they can also form along the grain boundary but still we are not experiencing much a problem with the sensitizer, much a problem with the grain boundary attack or intergranular corrosion, the main thing is in case of stainless steel 18:8 stainless steel the corrosion resistance is coming from chromium, so somehow we have to keep chromium in the solution so even if this are forming along the grain boundary but still since the around the grain boundary zone also the chromium percentage is more than around 18% or close to 18% we have complete protection, so this is one issue. And now when you add these alloying elements and form carbides and take care of those carbons available for carbide formation, chromium carbide formation so this process is called stabilization, this process is called stabilization.

Now other two cases they are not stabilization, the stabilization whenever we say that the sensitized steel is stabilized it always means that somehow the niobium our titanium carbide titanium are added and we have the formation of titanium and niobium carbide in the steel and these titanium and niobium carbide when they form they don't allow the chromium to form chromium carbide because not much of carbon is left out in the system to form chromium carbide, so this is called stabilization and these are the control mechanism in case of stainless steel in order to avoid sensitization, so there are two important issue in case of stainless steel, one is sensitization, another one is stabilization, so we can have this three protection mechanism.

Now the point is even if sometime the material has low carbon, even if the material is let's say the moderately low carbon it says 0.05% or 0.04%% carbon and also we have niobium and titanium presence there, so the material the stainless steel is stabilized steel, but still we can come across sensitization phenomena, so we will see one example that is the classic example why the sensitization can happen even the material isn't stabilized so that can happen in case of stainless steel, stabilized stainless steel drum which handles fumaric nitric acid, so let us see that example it's basically the sensitization of stabilized austenitic stainless steel. So now if we have a drum let's say this is the drum which handles fumaric nitric acid and this is handing HNO3 acid and this is a thin sheet drum, and the drum is welded like this, this part is welded and the drum can experience a very, very localized intergranular corrosion very, very localized intergranular corrosion and there could be failure of the drum along the welded zone we can have a very sharp intergranular attack and the drum can fail or break into pieces, so this particular process a sharp crack formation due to intergranular corrosion in case of stabilized stainless steel drum that is called this particular attack is called knife line attack, this is called this particular attack is called knife line attack, and that happens in stabilized stainless steel and this is the problem which is associated with welding the thin steel sheet and then subsequently when we anneal this steel in the temperature zone around 600 to 800 degree Celsius we come across this knife line attack.

Now why does it happen? If it is stabilized steel it should not have happened, now this happens because of that after welding when it go for stress relief operation because it's a thin sheet and when we go for welding then there would be a lot of quenching strain and that quenching strain is to be relieved and when we go for stress relieving operation then we come across sensitization and that sensitization would lead to a very sharp zone which is sensitized and that section would be corroded due to intergranular attack and lead to knife line crack formation or knife line attack.

So let us see situation what is happening there? Now in case of this particular situation generally this has been experienced in case of 347 stainless steel which is 18:8 stainless steel with niobium addition so since niobium is added which is the carbide former, strong carbide former that's what we have the stabilization property. Now if you come across, if we come across a particular sematic plot so we see the knife line attack happens in case of stabilized stainless steel of this nature 347 variety, which is 18:8 niobium containing steel, now if we see a different levels where the carbides different carbides can form, let’s say this is the level which is around 1230 degree Celsius where chromium stays in the solution and niobium carbide forms. Now if you come to 790 or let's say 800 degree Celsius in this zone we can have a situation where if there is a chromium carbide, there is chromium carbide in the system like this so chromium steel it remains in solution or even if the sensitized steel let's say the sensitized steel is heated to high temperature beyond 800 degree Celsius that chromium carbide which can dissolve C6, and of course sorry, there is a small change beyond this temperature niobium carbide also dissolves and it means that chromium always will be in solution beyond this temperature and let's say if the steel is stabilized that means the stabilized steel already has niobium carbide so if we heat beyond this level existing niobium carbide will also dissolve.

Now these temperature zone means chromium will be in solution but if we have a situation like this weld decay phenomena there we have this zone where we have chromium carbide precipitation, beyond this temperature zone the chromium carbide will dissolve also, and in this temperature zone there is one more phenomena that is niobium carbide will form, niobium carbide forms, beyond this temperature niobium carbide dissolves, below this temperature and up to 800 degree Celsius chromium stays in solution and if you are heating a stabilized steel beyond this temperature there will be dissolution of existing chromium carbide but if there is now being presence in the steel the niobium carbide again will form in this temperature zone.

Now let me get back to this graph again if we see that I have plotted 800 to 600 degree Celsius, I have said in case of B this is the time frame where I can have chromium carbide formation and these timeframe is very large so chromium carbide formation is possible. Now there is a small change this one should be like this, why? I have changed from here to there so if we raise the temperature in the B point beyond this level so this process would happen the chromium carbide would dissolve, but if we have the temperature, maximum temperature around 800 degree Celsius then we'll definitely have this much the timeframe where the system temperature remains in this sensitized temperature zone, but if we consider in case of A, why we are considering that this much time is basically the small change so time would be, this much would be the time, so this much would be the time, this match would be the time, where the A point is existing in the sensitized temperature zone, and this is a very short time in that temperature zone, we will not have any chromium carbide precipitation.

Now if the system has niobium carbide and then if we hit it like this up to 1200 this point niobium carbide will remain as niobium carbide, and if the niobium carbide remains as niobium carbide and beyond this temperature zone chromium carbide would dissolve if there is any chromium carbide, so that means if the steel is heated beyond this temperature zone, niobium carbide would dissolve and chromium also would remain in solution and if we are in this temperature zone chromium would be in the dissolved condition and if there is any trace of chromium carbide that would also dissolve and niobium carbide would form and if the temperature zone is 600, in this temperature zone if we cool it very slowly so dissolved chromium would again form chromium carbide, but if we already have niobium carbide then chromium carbide would not form, because we don't have any carbon, don't have any carbon to form chromium carbide, and below this temperature zone no reaction.

So let's see what happens in case of stabilized stainless steel, in case of stabilized stainless steel we have an niobium carbide + no chromium carbide, so this is my condition. Now I have, during welding I have heated the material from room temperature to the melting temperature or beyond melting temperature, and once we take it to the melting temperature everything dissolves, because we see that beyond 1230 niobium also goes into solution, chromium also goes into solution, so everything would be in the dissolve condition, so whatever advantage what we had due to the formation of niobium carbide would not be there since everything has gone into solution so the carbon is available for chromium carbide formation, but of course the steel has to go through these temperature zone where we have possibility of carbide formation, chromium carbide formation.

Now since this is a very, very thin sheet of metal and if we go for arc welding the cooling rate would be very, very fast and if the cooling rate is very fast during cooling, so during cooling it will go like this and if the cooling rate is very fast in this zone niobium carbide will not form, so if niobium carbide would not form then I don't have the stabilization because of niobium carbide formation but the point is since the cooling rate is also very fast so in this zone also cooling rate would be very fast, so that means very short time would be, the material would exist in this temperature zone, so no chromium carbide formation and the steel has gone to this place where we have no niobium carbide and plus no chromium carbide, so if the steel, even if the niobium is present in the steel because of this very rapid cooling due to the, due to a very thin cross-section of the stainless steel plate we have no niobium carbide, no chromium carbide, the system will not experience any intergranular attack, why? Because we don't have the situation where the chromium depletion is happening, so we have no chromium carbide formation and no chromium depletion, so this is not a sensitized steel, not.

Now the point is since this is a thin sheet metal so after welding we always go for stress-relieving operation because there will be a quince teen stress so if we go for stress relieving operation in this temperature zone, so in this temperature zone we see that even if niobium is present niobium carbide cannot form, so in this temperature zone niobium carbide cannot form but chromium carbide can form, so once we have chromium carbide formation and the chromium carbide always will form along the grain boundary so the material would become sensitized. So once we take it to this level for stress relieving operation, stress-relieving operation will come across chromium carbide precipitation along the grain boundary and we can, the material the steel would become sensitized and where? In the narrow zone, in the narrow zone of that welded part would become sensitized and there would be a sharp intergranular attack and a sharp crack formation which is nothing but knife line attack, so it's actually this process this entire process which is the knife line attack situation is basically happening due to sensitization of stabilized stainless steel and the stabilization, the sensitization is happening because the niobium carbide and chromium carbide both dissolves and because of the rapid rate of cooling niobium carbide doesn't form in this temperature zone when the material is cooled down in this temperature zone and chromium carbide even doesn't form but due to stress relieving operation after welding we always come across this chromium carbide formation if the stress relieving operation is carried out in this sensitized temperature zone, so we can experience chromium carbide formation and the grain boundary and the material would be susceptible to intergranular attack and that attack would be very sharp in nature because of gas welding or because of the welding process what we are carrying out that is the arc welding process that means the heat affected zone would be very narrow and the situation this weld decay portion would arise very close to the weld decay zone be very close to the welded zone as well as this section would be very sharp because we have a very rapid cooling and only this part, this section would experience this sort of chromium carbide formation. So this is happening and that time even if we have niobium we don't get any advantage of niobium. So this is a typical condition for sensitization of stabilize stainless steel. So this is about intergranular corrosion of stainless steel 18:8 stainless steel, this can happen in other material also as we have already cited some example, for example impurity segregation that is iron segregation along the grain boundary of aluminum alloys or zinc enrichment along the grain boundary in case of brass, and there could be the possibility of sensitization in case of stainless steel and weld decay and the weld decay we have already explained how weld decay happens and the heat affected zone, the narrow band of metal where we always experience the temperature, the material is in the temperature zone which is basically most critical in terms of chromium carbide precipitation for a longer duration and that time we experience chromium carbide precipitation along the grain boundary and we have chromium depleted zone and that chromium depleted zone would go for preferential attack along the grain boundary and there could be a possibility of intergranular corrosion, so this is about intergranular corrosion.

Now let us get into one more process or one more form of corrosion that is called dealloying process really or there are different names or selective leaching or dezincification in case of brass or graphitization or denickelification like that, it means that let's say you have A and B, these two elements are mixed and they are in solid solution, and when they are in solid solution and if it is exposed to corrosive solution that time depending on the electrochemical potential of individual elements or the nobility or activity of any of the elements, the noble metal will stay back in the solution in the material and the active metal would go into solution preferentially. So that means if B is active metal and A is noble, that time B always tries to go to the solution or electrolyte preferentially leaving A in the material, so this is basically the preferential dissolution of B, like that in case of brass let's say alpha brass which is 70:30 copper, 70 is copper percentage and 30 is zinc, copper zinc alloy, we experience that for a long exposure of this alpha brass to potable water that time we experience that some portion we have a reddishness, the reddishness of the some portion of that particular material increases and if we do composition analysis of that part we will see that zinc content has gone down even it can go down to less than 5% and the copper content in that around that zone this is zinc, this is zinc, this is copper, so copper content can go beyond 90% from 70%. So here we see the zinc is dissolve being preferentially leaving the copper in the material, so copper content increases and zinc content decreases and the system over the surface we will see the reddishness increases, so that redness or that becomes the surface become more and more red colored and also if we see the structure of it, that structure becomes porous in nature, porous in nature. So this is a particular example where zinc dissolves preferentially leaving copper in the material in the brass, so this is called dezincification.

And graphitization is another phenomena which can happen in case of grey cast iron this can happen in case of grey cast iron, grey cast iron where iron dissolves leaving the graphite flex in the body of the grey cast iron, so this is graphitization this is a sort of misnomer, graphitization means that graphite formation from purring, in case of cast iron composition graphite formation is basically the graphitization and then denickelification is nothing but in case of copper nickel system we can experience nickel dissolution preferential, dissolution of nickel and copper content in the alloy increases, so this is basically the dealloying which means the one of the element goes into solution preferentially or selective leaching that means one of the material is leached out, one of the elements in the alloy is leached out because of this process, corrosion process or dezincification zinc goes into solution preferentially, denickelification nickel goes into solution preferentially or graphitization iron goes into solution preferentially leaving the graphite flex in the body, this is about, this is basically the Dealloying or selective leaching.

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