SIntroduction to Materials Science and Engineering
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Lecture – 102
TTT diagram of hypoeutectoid and hypereutectoid steels

Till now we have seen the time temperature transformation diagram the TTT diagram for eutectoid steels. Now let us look at how the in this diagram how the TTT diagram we will vary if we consider hypo eutectoid or hyper eutectoid steel.

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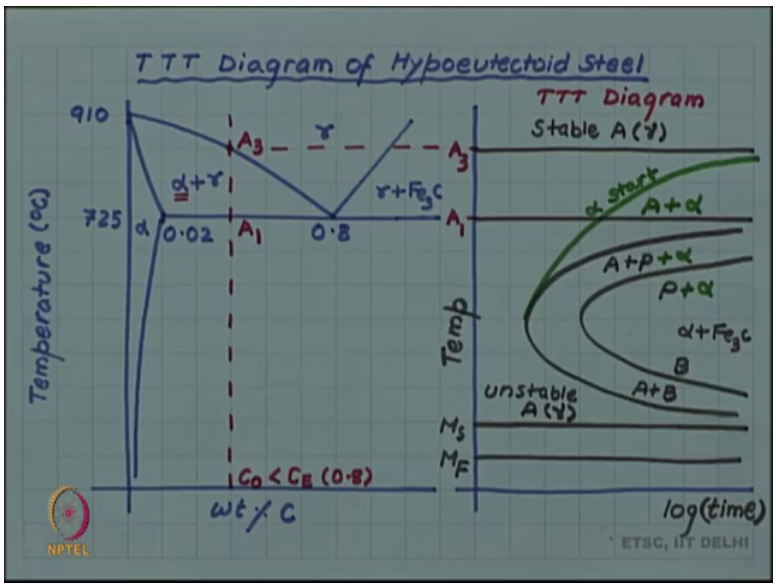

Recall that in the steel phase diagram in the iron carbon phase diagram this 0.8 weight percent carbon steel was the eutectoid steel. And this is what we have been considering till now any alloy with composition less than 0.8 weight percent is considered to be hypo eutectoid steel. So, let me take the composition, so let me take this composition. Suppose, we take a composition less than point A so, that composition is represented by this vertical.

So, my alloy composition C naught is less than 0.8 C naught is less than the eutectoid composition CE which is 0.8 to 8 percent carbon. So, for this composition that equilibrium transformation happens at the eutectoid temperature and also at this temperature where gamma starts transforming to alpha.

So, as we cool along this line in the single-phase gamma will enter into alpha plus gamma, which means; alpha starts precipitating. And you have seen that we call this alpha the pro eutectoid alpha. So, corresponding to this in the and these temperatures in steel literature quite often these came i have been calling this the eutectoid temperature and labeling this as TE conventional labeling A 1 is also used for me this temperature and similarly, where the composition vertical hits this gamma alpha plus gamma boundary that boundary temperature is known as A 3.

So now, you can see that there are 2 critical temperatures A 1 and A 3 for this alloy. So, this will reflect in the TTT diagram also. So, on the right i am going to draw the TTT diagram and i am now transferring these temperatures onto the TTT diagram. So, this is going to be the TTT diagram for hypo eutectoid steel. So, there is a horizontal line corresponding to A 3 and there is a horizontal line corresponding to A 1 and of course, lower down just like for eutectoid steel you will have a horizontal line for MS martensite start and MF the martensite finish. And then you have the C curves for the transformation and just like for the eutectoid steel you have 2 C curves for start and finish 2 alpha plus Fe 3 C formation. So, this is alpha plus Fe 3 C region.

And you know we have seen that about the nose we get pearlite. So, I write that pearlite both are alpha plus Fe 3 C, but microstructure are different and below the nose we get bainite. Similarly, between the start and finish we have austenite plus pearlite and austenite plus bainite, but stable austenite in this you can see single phase is stable austenite will be available only above A 3. So, we have their stable austenite and below A 1 of course, austenite is unstable.

So, we have unstable austenite. I am writing austenite a you can write gamma also i have used gamma here now you should be familiar with both these symbols and; however, as you can see that since pro eutectoid alpha can form independently of Fe 3 C between A 1 and A 3 a corresponding line of the TTT diagram is required to represent this transformation. And that line starts from the nose of the C curve and goes asymptotically to the A 3 temperature. So, this is we can call this alpha start pro eutectoid alpha.

So, this is an alpha start curve, and the phase in here between this line and this line is austenite plus alpha that pro eutectoid alpha and the pro eutectoid alpha will continue

here. So, we will modify this with austenite plus pro eutectoid alpha plus pearlite and the final microstructure also you will get pearlite plus pro eutectoid alpha.

So, this is how the diagram gets modified you can see that in the modified diagram there is no extension of the pro eutectoid alpha line below the nose. So, if I quench a steel hypo eutectoid steel below the nose and hold it isothermally I will only get bainite I will not get any pro eutectoid alpha, but if i quench and hold above the nose then initial transformation will be to pro eutectoid alpha and then for the pearlite will form.

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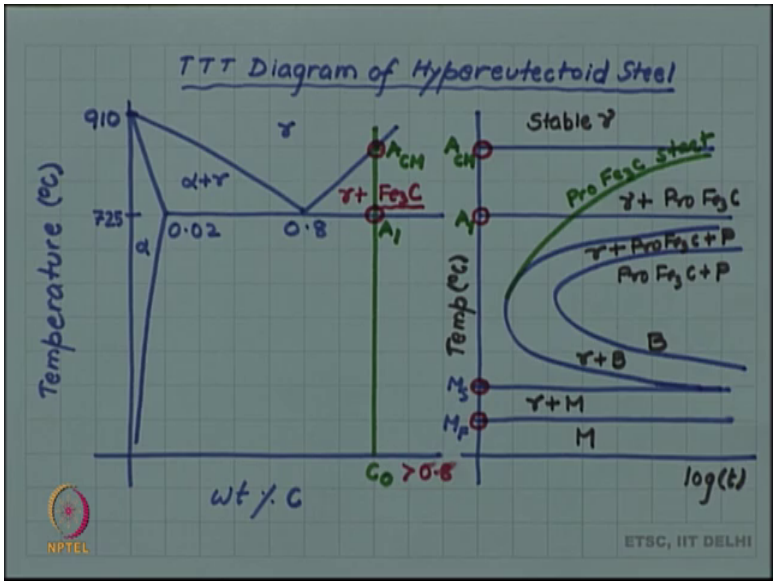

Now, exactly similar situation is therefore, hyper eutectoid steel. Hyper eutectoid steel you should note our steel with composition greater than. So, C naught is greater than point 8 the eutectoid composition. So, the composition vertical is on the right-hand side of 0.8 and the there phase is gamma plus Fe 3 C. So, the pro eutectoid phase which you form is cementite just like we had called this boundary the temperature corresponding to this boundary A 3 in a steel literature you temperatures corresponding to this boundary are known as ACM.

So, I have 2 critical temperature A 1 which is independent of composition and ACM which will depend on composition. So, I transfer this on the temperature axis of the TTT diagram. So, I have A 1 here and ACM here and i have the 2-corresponding horizontal line again you have horizontal lines for MS and MF as well. And you have the start and finish line for pearlite and bainite, but at the same time you have a line representing the

start of pro eutectoid cementite. So, this is pro Fe 3 C start this goes as if he starts with the nose and goes asymptotically to the ACM temperature. So, if we write the phases we have stable austenite, then we have here austenite plus cementite.

Here we will have austenite plus pro Fe 3 C plus pearlite and finally, we will have pro Fe 3 C plus pearlite, but just like in the hypo eutectoid case if you quench below the nose there is no formation of pro eutectoid Fe 3 C it is totally suppressed and you will get only bainite. There will be no pro eutectoid Fe 3 C this; obviously, is gamma plus martensite and this is martensite. So, this is how the diagram changes for hypo eutectoid and hyper eutectoid a steels.