A Critical Review on Quenching and Partitioning on Commercial Steels

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ABSTRACT

To increase the ductility and hardness we mainly focus in our experiment to convert BCC structure into FCC from BCT structure and avoid formation of BCC structure after cooling which is called as formability. Here atoms are in BCC structure when we austempered energy is absorbed by carbon atom and bonds with another matrix and forms FCC structure. While quenching carbon atoms are constrained so they form BCT structure which increases its hardness. Where partitioning plays an important role in creating a smooth surface which is time dependent and temperature also, In partitioning constrained carbon atoms will get some heat due reheating and some part will escape from BCT to FCC so we get what we needed i.e. part hardness and part softness. Since it is so easy and simple to make this process is used in automobile industries to reduce the weight of car bodies for good flexibility and to absorb a good amount of shock loads.

Keywords: Commercial Steels, BCC, FCC, BCT, TRIP, AHSS, AC3

I. INTRODUCTION

High strength ferrous alloys containing significant fractions of retained austenite have been developed in recent years, and have important commercial applications. In sheet steels, for example, carbon-enriched metastable retained austenite is considered beneficial because the TRIP phenomenon during deformation can contribute to formability and energy absorption. In gear and bearing surfaces, austenite is considered to provide damage tolerance in rolling/sliding contact fatigue applications. In thicker section structural applications, retained austenite may provide enhanced resistance to fracture. Similarly, austempered ductile cast iron materials develop favourable property combinations through a microstructure of fine ferrite plates in combination with carbon-rich retained austenite.[1,2] Steels with substantial amounts of carbon-enriched retained austenite are typically produced by transforming at low temperatures, leading to a microstructure containing "carbide-free bainite" that consists of bainitic ferrite laths with interlath retained austenite.[3] Alloying additions such as Si or Al are made to suppress cementite precipitation that usually accompanies bainite formation. Recently, an alternative processing concept, "quenching and partitioning (or Q&P), has been developed for the production of austenite-containing steels, based on a new understanding of carbon partitioning hypothesized between martensite and retained austenite[4].

Steels place an important role in day to day industrial life due to its availability and mechanical properties which is especially useful to manufacturing industries for reducing the weight and increasing formability and so they developed (AHSS) ADVANCED HIGH STRENGTH STEELS technique in which is developed in full scale in three stages (1G-AHSS) in this technique they mainly focused on increasing the dominated ferrite micro-structure. But it was not fully achieved its potential then the (2G-AHSS) was came into focus here they concentred on alloying, but due to high alloy costs so it was a failure.so they thought of another way i.e. (3G-AHSS) QUENCHING AND PARTITIONING[5]
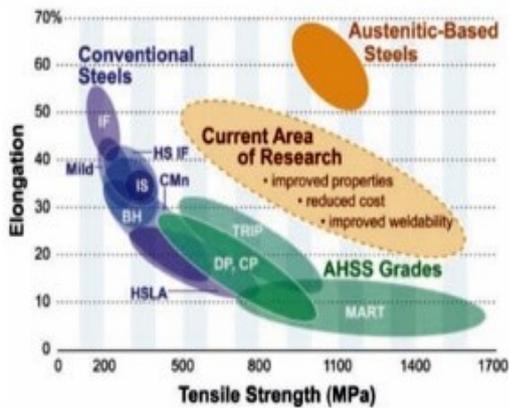
Figure 1. Representation of Elongation versus strength of steels

Figure 2 Iron – Carbon Phase Diagram

Here they reheat the steel up to austensite temperature and quench it (rapid cooling may be water or oil) and partitioning (again heating) to get enriched austensite carbon as a soft surface so it is hard from inside and soft from outside[6,7]

II. HISTORY

This technique was started just a decade ago but still plenty of research is going on carbon partitioning between Martensite and retained austensite is usually ignored and quenched steels, because the temperature is normally too low but it can be avoided by different mechanisms and formulation proposed by different scientist.[8] There are different methods and formulae for getting the temperatures of austensite, Martensite, formation and partitioning temperatures Different alloy materials will show different mechanical properties, but there are some disadvantages also just like precipitates and carbide formation and heat transfer in reheating.[9] They effect not only freeness of carbon but also helps in formation of bainite which is not useless in this procedure As for fe-c diagram we reheat the material up to AC3 temperature and we quench it down to perlite zone and we heat it up to ferrite zone so it gets, its soft phase
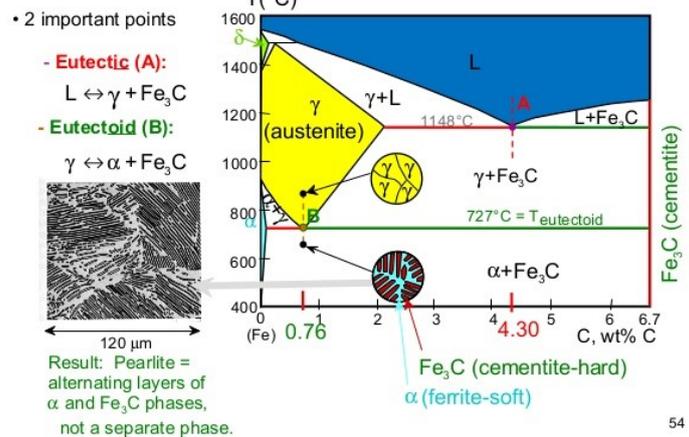
EXPERMENTAL PROCEDURE:

Many scientists were proposed different formulae to get AC3, quench (Martensite start and finish temperature, partition temperature) Here steels of known composition with different percentage of alloying is reheated to a certain period of time for good homogenizing to get ferrite microstructure this is to be assumed are calculated by known formulas which are proposed by different scientist by predicting the outcome through probability out of many some of them are quiet similar one is
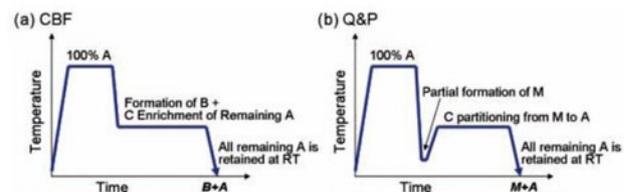

Figure 3

$Ms=539-423C-30.4Mn-7.5Si+30Al$
Was proposed by Mahieu for CM and (Si, Al) TRIP-steel compositions

$Ac3=910-203\sqrt{C}+44.7Si-30Mn-15.2Ni+31.5Mo$
(Austenitic start temp)

Was proposed by proposed by Mahieu et al., Andrews, and Steven and Haynes, respectively,

There are different formulas for different alloy's based on their composition and importance.

A. QUENCHINING:

Since our experiment has three steps quenching is the second step, here we cool steel in between Ms and Mf temperature (Martensite start and finish temperatures) The formula is mentioned above by substituting the values of composition we get values they might be in −ve temperatures also but with different formulation comes different values so we choose the best and do calculation here are some of the formulas for Ms Temperatures. The relationship between the Martensite start transformation and steel composition has been investigated by Grange and Stewart, Payson and Savage, Kung and Rayment, and Andrews. Andrews used the largest number of samples and he reported the following linear relationship:[10]

$$M s (C) = 539 − 423w − 30.4w −17.7w −12.1w − 7.5w$$

B. PARTITIONING:

Partitioning is the third step in the experiment. After quenching vapor blanket   is formed and
 carbon atoms are constrained so Martensite is formed hardness is achieved but ductility is what we need, here partitioning comes into play by conducting partitioning test. We accelerate carbon atoms by heating the material again to certain temperature (preferable).[11]

C. PRACTICAL APPROCH:

When it comes to real time work, things will be little different, because of the external errors and approximations. While asutentizing oxidation is a big issue it must be avoided, because it reacts with materials and forms a seal and prevents the heat transfer While quenching vapor blanket is forming due to sudden cooling so it prevents regular heat agitation is to be done After the heat treatment Martensite flakes are formed as the below picture
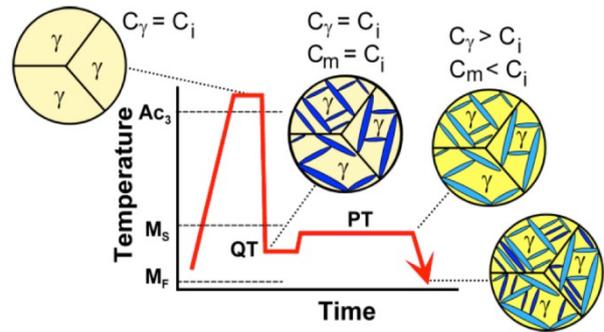

Figure 4

III. CONCLUSION

Now it is easy to estimate and predict the temperatures through chemical composition Though the process is long but is used to change properties as we wish by little variations Because of steels nature they can be used in many ways by changing their properties

IV. ACKNOWLEDGEMENT

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