Effect of diameter on Properties of steel

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Abstract

A 4130 steel was used to study the effect of diameter on properties of steel .in this paper the effect of the diameter on properties was studied .Same heat treatment cycle was applied to different diameters. All mechanical properties were evaluated, tension test ,Hardness Evaluated to study the effect of diameter on properties .The results were compared and reasons were discussed

Keywords*: Tensile strength, yield strength, elongation impact energy, hardness, heat transfer,quenching.*

Introduction

Once steel composition and deformation were fixed and completed than there is only one way to alter the properties of steel. Heat treatment is a multi parameter process those parameters are selection of Grade and Quenching medium and conditions, Heating rate ,Atmosphere, soaking time ,Temperature all are important parameters in that section size and shape are also play crucial role in heat treatment and further processing .the sample was quenched from high temperature to room temperature in that process we are creating high dislocation density due to formation of martensite by shear process . quenched sample has high energy which is thermodynamically unstable in order to stable that tempering was carried out to reduce the dislocation density and energy .

In each step heat transfer rate play major role which depend on section size and shape in this paper we studied about how the properties are varied by changing section size.

Quenching is one of the most important parameter in heat treatment it involves heating the sample to desired temperature and allow to soaking for a specified time followed by suitable quenching medium quenching allows formation of martensite and bainite. In quenching heat transfer plays major role which is depend on section size and shape. During quenching in liquid media with boiling temperatures far below the initial temperature of the body , three stages of heat removal occur. These are refer red to as (1) the film boiling or vapor blanket stage, (2) the nucleate boiling stage,and(3) the convection stage(see Figure 1).In the vapour blanket stage a blanket of quenchant vapours forms over the specimen surface. This avoids physical contact of specimen with the quenchant. heat transfer in this stage is mostly through radiation. As the temperature drops, the vapour blanket becomes unstable and collapses, initiating the nucleate boiling stage. Nucleation and collapse of bubbles at the specimen surface causes turbulence at the surface, improving convective heat transfer ratesHeat removal is the fastest in this stage, and continues till the surface temperature drops below the boiling point of quench medium. Further cooling takes place mostly through convection and conduction[1].

Apart from this heat extraction from specimen depends on section size in small diameters heat extraction is very easy compared to heavy sections which results uneven properties.

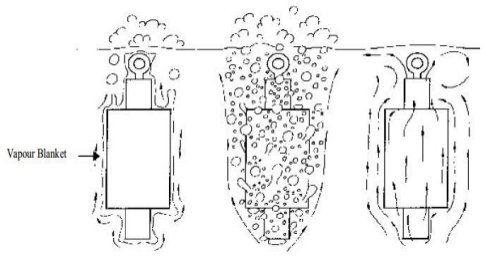

Fig 1 the stages of cooling during quenching of a steel.

EXPERIMENTAL WORK

80,100,120,160,200 mm Φ 4130 steel were produced by Electric arc furnace.The compostion of the steel was tabulated in table 1.Samples were heated upto 870^{o}C and allowed to soaking three hours at 870^{o}C followed by water quenching. After completion of quenching samples were tempering 5:30 minutes at 630^{o}C.than samples were section out. The tension test was carried out by using Shimadzu displacement controlled machine. In Brinell Hardness test 3000kgs load was applied and The Charpy impact test also carried out.

Fe	Cr	Mn	C	Si	Mo	P

97.	0.80	0.40	0.28	0.15	0.25	0.035

Table 1: Chemical composition of 4130 steel

RESULTS AND DISCUSSION

As increase in diamtere Hardness,Yeild Strength and Tensile strength were dicreased and %Elongation and Reduction in area were increased(see Figure 2). It is clear that as the section size increases the strength drops and ductilty increases It is because, the cooling rates for varying section size is different which can be correlated to CCT diagram.

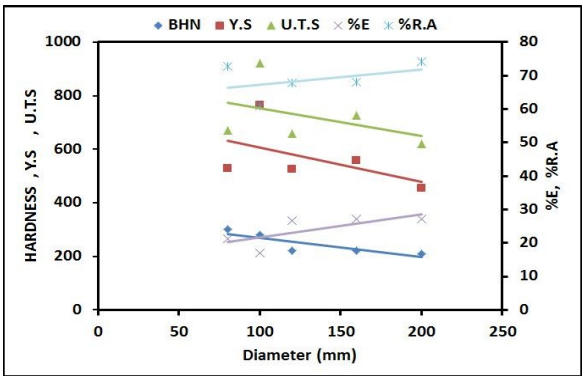

Figure 2 : Diameter Vs Mechanical Properties .

In quenching process surface cools faster than center,in this condition surface transfer to hard martensite and center was still has higher heat content so it transfroms pearlite. In case of samll daimeter it is easy to extract heat from center to surface and have uniform properties and microstructure , where as increase the section size it is diffictult to extract heat from center to surface. From the figure2 it is clear that increase the section size difficult to get martensite in uniform from center to surface.With increasing the section size cooling rates are vareid[13].

The influence of cross-sectional size when quenching the same grade of steel under the same quenching conditions shows Steeper hardness decreases from surface to core and substantially lower core hardness values result from quenching a larger cross section(see Table 2)

Diameter	*Surface(Hardness)*	*Center Hardness*
80	*286*	*279*
100	*273*	*258*
120	*240*	*235*
160	*233*	*217*
200	*235*	*207*

Table 2 : Hardness Results for different diameters

CONCLUSION

For same steel grade with Different diameters were applied to same heat treatment cycle.From this we conclude It is easier to get martensite in small diamter than big diameter.In case of small diamter properties are uniform from center to surface where as increase the section size properties were non uniform from center to surface.Increase the section size dicrease strength(Yeild Strength,Ultimate Tensile Strength,Hardness) and increase ductility due to formation pearlite.

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