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Review on Fundamentals of Quenching

Prof.M.N.Lahoti
H.O.D, (Mechanical) Sanmati Engineering College (2nd Shift Diploma), Washim
milindlahoti18@gmail.com

Abstract
Quenching is the one of important part in heat treatment process the actual hardening process is depending upon quenching and quenching time, quenching media .Quenching is nothing but a process of heated metal cooling in specific time, in which all internal phases and internal structure of metal changed and improves hardness and mechanical properties of metal.
Keywords: haradning, quenching, pearlite, bainite,austenite, martensite

I. INTRODUCTION

Heat treatment can be defined as an operation or combination of operations involving the controlled heating and cooling of metal in the solid state for the purpose of obtaining of specific properties. There are many type of heat-treating process available fulfilling a wide variety of hardness and mechanical properties requirements? This paper is concerned with the principles and practices of the quenching processQuenching of steel involves the rapid cooling of austenite to transformed it into the hard structure – martensite. This is generally achieved by cooling at a sufficitiently fast rate to avoid the formation of soft constituents in the steel (perlite and bainite) these reaction can be represented on a continuous cooling transformation (CCT).diagram (fig.1)

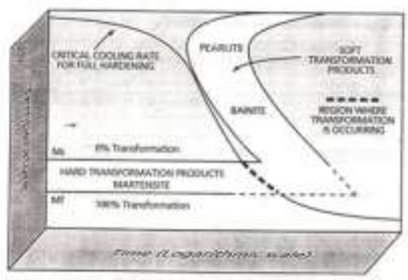

Fig. 1. Continuous Cooling Transformation diagram illustrating the critical cooling rate for complete martensitic transformation.

For a given steel composition and heat treatment condition, there is a critical cooling rate for full hardening at which all the high temperature austenite is transformed into martensite without the formation of either partite or bainite. The steel begins to transform at the Ms Temperature and is fully hardened at the Mf temperature. The Ms Temperature decreases with increasing carbon content of the steel as shown on the Table1.

Table 1: Carbon contents

Carbon content	MS temperature
0.2%	430 c
0.4%	360 c
1%	250 c

In practice however ,when a steel components is quench the surface cools more rapidly than the centre this means that surface could cool at the critical cooling rate and hence we fully hardened ,where as the enter cools more slowly and forms soft peritic structures fig-2

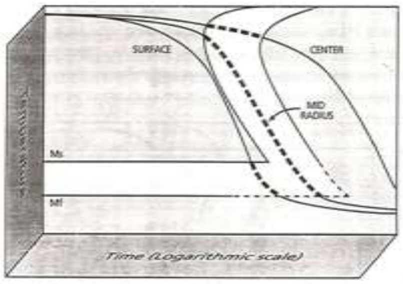

Fig. 2. The effect of component section thickness on cooling rate.

Lack of through hardenighning can be overcome by one of two methods

a) By increasing the hadenability of the component by the use of steel with higher alloy content. This usually causes a delay in transformation, illustrated by a shift to the right in the CCT.

This reduces the critical cooling rate for martens tic transformation producing fully hardened components with maximum hardness and mechanical properties (fig 3).alloying element can however be expensive and may not be beneficial to other processes i.e. machining, forging, etc.

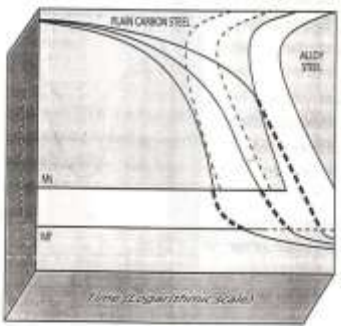

Fig 3: The effect of alloy content on steel hardenability

b) By increasing the quenching speed so that the cooling rate at the center of the component exceeds the critical cooling rate. This can be achieved, for example, by changing from a normal speed quenching oil to a high speed accelerated quenching oil (Fig. 4) or , if using a polymer quenchant, by reducing the concentration of the solution.

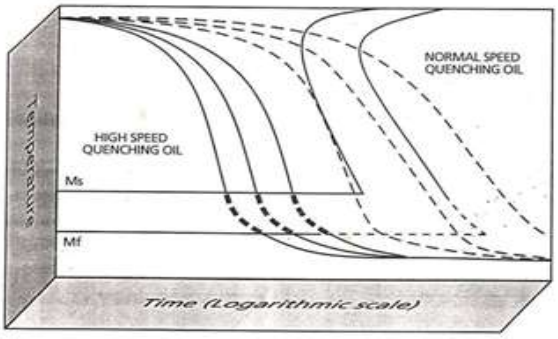

Fig 4: The effect of quenching speed on hardness end mechanical properties

The influence of quenching speed on hardness and mechanicalproperties can be illustrated by comparing the cross-sectionalhardnesses achieved in a 10mm diameter bar of 0.4% carbon steelquenched into different types of oil with normal speed oil, hardness decreases rapidly below thesurface due to the formation of pearlite and bainite. With high speed oil, the critical cooling rate is exceeded to a much greater depth below the surface, resulting in an improved hardness profile. Therefore, steel composition, component section thickness, and type of quenchant all have a major influence on the properties obtained in the heat-treated component.

II. THE MECHANISM OF QUENCHING

It is important to understand the mechanism of quenching and thefactor which affect it, since these can have a significant influenceOn quenchant selection and the performance obtained from the quenchingprocess regardless of the type of quenchant being used, cooling generallyoccurs in three distinct stage, each of which has very different Characteristics. The cooling characteristics of a quenchant can be measuredusing probes instrumented with thermocouples. Various techniqueshave been used including both cylinder and spherical probesmanufactured from a variety of metals including stainless steel,Silver and nickel alloys. One of most widely used and acceptedMethods is based upon the use of a 12.5 mm diameter cylindrical

Probe manufactured from inconel 600@ alloy as specified in theWolfson heat treatment centre (WHTC) Engineering groupSpecification recommended by the international federation for heatTreatment (IFHT) AND ADOPTED BY THE INTERNATIONAL Standards Organization (ISO 9950).

Results obtained by the different test methods vary depending upon the material, geometry and surface condition of the probe. Cooling Curves produced in this way illustrate well the three stages of Quenching and demonstrate the influence that factors such as Agitation, quenchant temperature; contamination and degradation have upon quenching performance.The cooling characteristics can either be shown as a graph of Temperature against time or as a graph of temperature against

Cooling rate for both normal speed and high speedquenching oils. Such cooling curve information is valuable since it can theoretically be superimposed upon CCT diagrams to predict Heat-treatment response.The duration of the vapor phase and the temperature at which the maximum cooling rate occurs have a critical influence on the ability of The steel to harden fully. The rate cooling in the convection phase is also important since it is generally within this temperature range thatresidual stress, distortion and cracking.However, cooling curves produced under laboratory conditions must be interpreted carefully and should not be considered in isolation. Results on used quenchants should be compared with reference Curves for the same fluid.

Quenching characteristics are influenced significantly by the degreeof agitation, for normal speed quench oil undervarying degrees of propeller agitation. It can be seen that increasing the degree of agitation reduces the stability of the vapor phase and Increases the maximum rate of cooling.The performance obtained from a quenchant in practice, therefore, depends upon actual conditions in the quench tank. For this reason, it Is highly desirable to measure quenching characteristics on site Specialized, fully portable and self-contained equipment has been developed for this purpose by IVF (The Swedish Institute of ProductionEngineering

Research). This equipment conforms to widely accepted industrial standards of quench-rate testing (IFHT and ISO) and Enables cooling characteristics to be determined on site under actualoperating conditions.

III. Conclusion

To summarize therefore, steel composition, component section thickness, and type of quenchant and quenching rate all have a major influence on the properties obtained in the heat treated component.

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