JOMINY HARDENABILITY TEST

Objective

To study hardness as a function of quench rate and investigate the hardenability of steels.

Introduction

The hardenability of a steel is defined as that property which determines the depth and distribution of hardness induced by quenching ftom the austenitic condition. The dependence of hardness upon quenching rate can be understood ftom the time-temperature-transformation characteristics of steel, and, for a particular steel, can be estimated from the T-T-T diagram.

A part may be hardened by quenching into water, oil, or other suitable medium. The surface of the part is cooled rapidly, resulting in high hardness, whereas the interior cools more slowly and is not hardened. Because of the nature of the T-T-T diagram, the hardness does not vary linearly from the outside to the center. Hardenability refers to capacity of hardening (depth) rather than to maximum attainable hardness.

The hardenability of a steel depends on

(1) the composition of the steel,
(2) the austenitic grain size, and
(3) the structure of the steel before quenching.

In general ,hardenability increases with carbon content and with alloy content. The most important factor influencing the maximum hardness that can be obtained is mass of the metal being quenched. In a small section, the heat is extracted quickly, thus exceeding the critical cooling rate of the specific steel and this part would thus be completely martensitic. The critical cooling rate is that rate of cooling which must be exceeded to prevent formation of nonmartensite products. As section size increases, it becomes increasingly difficult to extract the heat fast enough to exceed the critical cooling rate and thus avoid formation of nonmartensitic products. Hardenability of all steels is directly related to critical cooling rates.

Procedure

Sample of medium carbon steel machined to the shape shown in Fig.2. It is a cylindirical bar with a 25 mm. diameter and 100 mm. length. The specimen is placed in the furnace at 900 ^{0}C for about $^1/_2$ hour. The water flow rate is adjusted so that the water column is approximately the distance 50 mm above the end of the pipe, when water is flowing freely.
After the sample has been austenitized, it is removed from the furnace and placed directly into the quenching apparatus. A jet of water is quickly splashed at one end of the specimen. After the entire sample has cooled to room temperature, the scale oxidation is removed; two opposite and flat parallel surfaces are ground along the length of the bar. Rockwell C hardness measurements are then made every 2 mm and these readings are recorded.

Results

Plot a hardenability curve of Rockwell hardness vs. distance from the quenched end. (Fig. 3)

Discussion and Questions

1. Evaluate the hardenability of the steel used in this experiment using the plotted hardenability curve.
2. Predict the microstructure of the steel all along the bar in correlation with your hardness measurements. What is the ***ideal critical diameter*** and can it be determined with a Jominy test.
3. How is the role of carbon and various alloy elements on the hardenability of steels (Give examples of different hardenability curves).

References

1. Shackelford, IF, Introduction to Materials Science
2. Smith, W.F., Principles of Materials Science and Engineering 3. ASM, Heat Treater's Guide

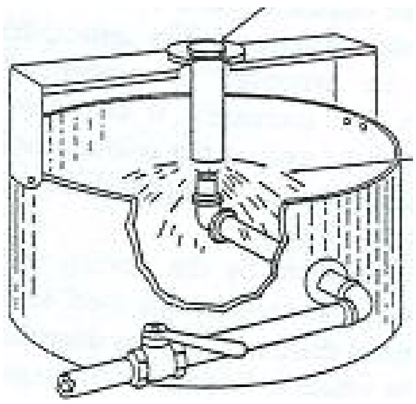

Fig.1 Schematic illustration of the Jominy end-quench test

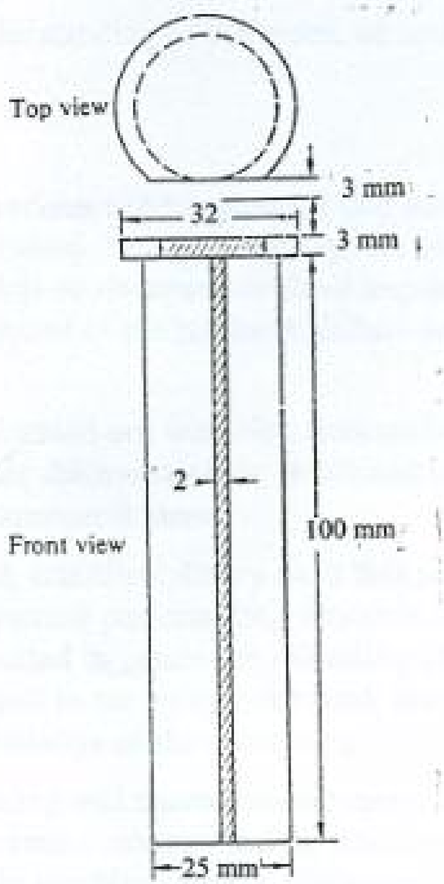

Fig.2 Standard-size sample.

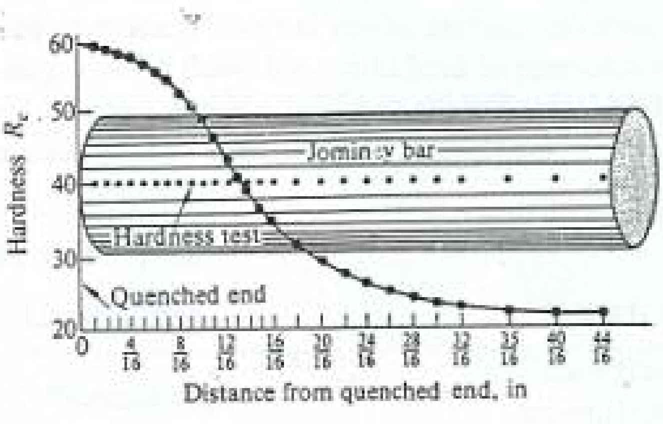

Fig.3 Position of hardness test points along the bar.