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Properties of Materials Laboratory

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Introduction:

The hardness of steel with low carbon content can be enhanced through the addition of carbon under a certain form of heat treatment, we refer to that as Carburizing.

Carburizing is a procedure that hardens metal surfaces while letting the metal underneath remain soft. This leads to the formation of a thinner and harder layer of metal known as the surface case. This takes place as the metal undergoes heating with the presence of materials that contain carbon, like carbon monoxide and charcoal.

The purpose of this process is to make the metal harder and manageable, as well as having the metal gaining more resistivity against corrosion

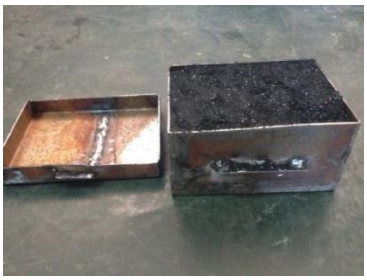
In this experiment we will be hardening the surface of steel (carburizing it), then using Rockwell method of hardness measurement we determine the hardness of the surface with distances from the specimen's center to its edge.

Materials and Equipment's:

1) Heat furnace

2) Carbon (Charcoal)

3) Steel Box



4) Rockwell Device

5) Timing Equipment
6) Clay

Experimental Procedure:

Through this experiment, we will increase the percentage of Carbon in a low carbon steel by carburizing it to harden the external surface of it.

- We filled the metal box with black coal called carbon powder.
- We buried the specimen, which was a low carbon steel with a 15% carbon, inside the carbon powder, we added energizer, we covered it with mud to maintain the gases throughout the carburizing process and then we closed the metal box with a metal lid.
- We put it in the oven at 950 degrees for 2 hours.
- After the specimen is taken out the oven, a case hardening process is implemented by using another oven at a 780 degrees for 30 minutes. After 30 minutes in the oven, the specimen should be cooled down using oil or water.
- After it's cooled down, the specimen was cut in the middle into tow halves. The first half is going to have a microscopic examination and the other half is going to be used to take hardness measurements using the Rockwell C-scale (HRC). We used the Rockwell C-scale because it is a hard metal.
- To take the hardness readings, we set the Rockwell device on 150 kg force, the indenter (diamond coin) at 12 mm. We put the specimen in the device and we set a timer of 15 seconds for 3 rotations. Once the time is up, we take the readings off the edges then we add 2mm and

take it from the middle, in the next round we add 4 mm and we take the reading from the middle and so on. The readings are maximum at the edges.

- The readings obtained were :
  - At a distance of 0 mm, the HRC was 38.5
  - At a distance of 2 mm, the HRC was 30.1
  - At a distance of 4 mm, the HRC was 23.3
  - At a distance of 6 mm, the HRC was 21.1

Discussion:

In the beginning, we grabbed the specimen of steel and put it down in the box which contains solid carbon powder, we put this box in the furnace on 950 c for two hours.

During this period of time, carbon monoxide must be developed through the existence of solid carbon and oxygen in entrapped air:

$2c + O2 \text{ --------} \rightarrow 2CO$

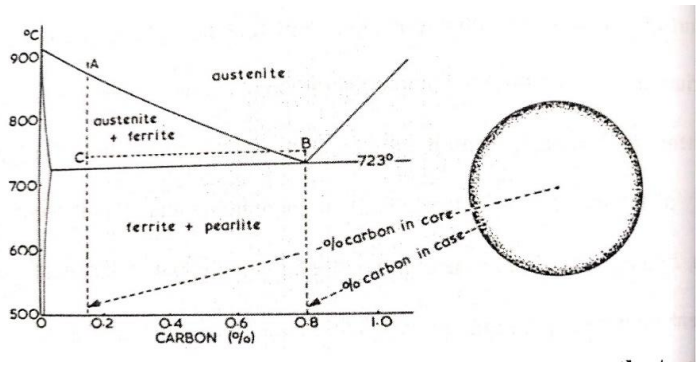
At the surface of the work piece this carbon monoxide releases carbon atoms:

$2CO \text{ ----------} \rightarrow CO2 + C \text{ gas}$

The carbon atoms so released are dissolved interstitially at the surface of the steel.

Then, we switched off the furnace and took out the box containing the specimen then we took out the specimen from the box and put into another furnace at temperature 780 c for 30 min, then we cool it in water or oil, then we cut the sample into two halves, we use one of them in microscopic examination and we use the second in a hardening test experiment - Rockwell test -.

The case component which we heated to 760 c, the coarse martensite of this case changes to fine-grained austenite. Quenching then gives a fine-grained martensite in the case.

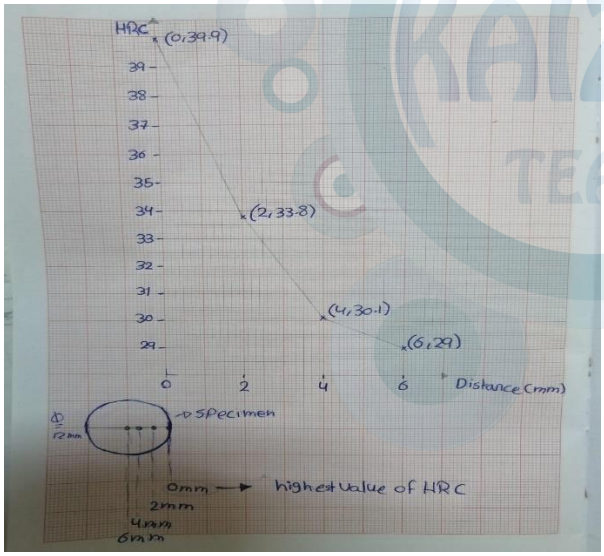


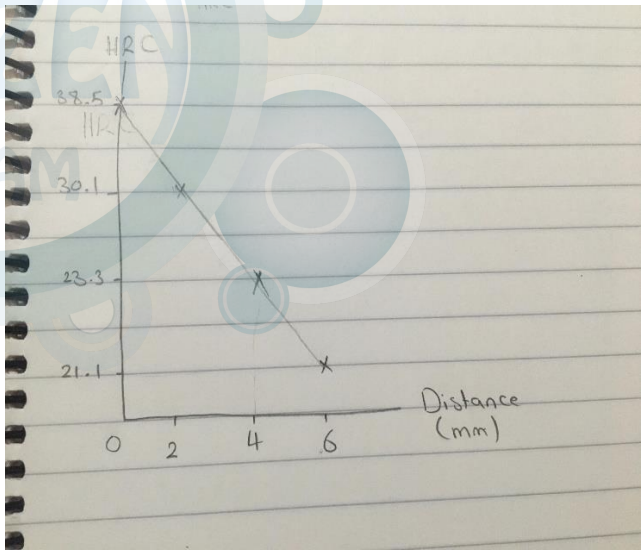
Conclusion and Results:

In this experiment we used the (pack carburizing) on a low carbon steel with suitable core properties, thus our steel has become harder and more resistant to corrosion (wear resistant surface).

After measured the hardness of our specimen by what we learned previously about measuring the hardness, we got these results:

Distance (mm)	0	2	4	6
HRC	39.9	33.8	30.1	29





1) As the distance increases the HRC decreases.

2) The depth of the carburizing level increases with increasing the time of carburizing.

3) The greatest reading of HRC at the edge of the specimen.

References:

Properties of engineering materials lab manual

YouTube videos

Corrosionpedia.com

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