



## Materials Science and Engineering

### Laboratory Session II: Heat Treatments.

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#### AIM

To know the effect of cooling steel processes on different physical and mechanical properties, as well as on the metallographic structures.

#### MATERIALS

- Steel samples with 0.45% C for Jominy and Charpy tests.
- Gloves, tweezers and protection elements against heat.
- Metal bucket with water.
- Broaching machine to notch the probes.
- Ovens at 850° C.
- Charpy pendulum.
- Jominy equipment.
- Polishing machine with sandpaper 180 grade.
- Hardness tester with slide table.
- Optical microscope

#### EXPERIMENTAL method

##### Operating process of Jominy test

Take a standardized steel sample and put it in the oven designed specifically for the test which is at the austenitizing temperature. After the required time the sample is removed and situated in a support in order to come into contact with a vertical water jet at constant rate for 10 minutes. Once this time is over you must cool it completely in water.

After cooling the probe, the two existing planes are sandblasted measuring the hardness in one of them (Rockwell C scale). The position of the measurement points should be made in a way that allows the construction of a representative curve of hardness variations vs. the equivalent length.

##### Operating process of Charpy test

To perform the test on the pendulum, the sample must be notched first using the broaching machine, taking care in not leaving chipings in the brush before and after the process, so that the notch is perfect.

Put the sample on the supports so that the notch is perpendicular to the ground and on the opposite side to that in which the pendulum will impact. Then, raise the pendulum through the steering wheel and place the needle dial in 30 kpm. Free the pendulum releasing the pawl

on the rear side, taking the utmost care and standing out of the trajectory of the pendulum to avoid shocks and braking the pendulum.

This test shall be performed first with a sample without notch to demonstrate the effect of stress concentration that occurs in the notch. Then a test must be done with a tempered steel sample (do the notch before tempering) and with a normalized sample. The value of the energy absorbed by the probe is the toughness. It is also important to note the aspect and shape of the fracture surface.

**Ductile-brittle transition curve:** To determine the full transition curve it is necessary to measure the toughness at different temperatures, which is a time-consuming process. Therefore only the toughness at two temperatures will be measured in the laboratory: room temperature and 300°C. The starting material is hot rolled steel and cooled in air (normalized).

2 samples must be notched with the broaching machine. The first is tested at room temperature. The second is put into the oven at 300 °C for 10 minutes. The standard indicates that the time between getting out the sample from the cooling bath or the oven should not exceed 5 s., so it must be tested quickly. The results of both probes will be compared as well as the fracture surfaces.

Thermal treatment effect: In order to observe the effect of the heat treatment, another notched sample of the same steel will be tested, introducing it in the oven at 700°C, and then tempering it in water. The effect must be analyzed by comparing the results of this sample with the normalized one tested previously.

#### Metallographic observation

Already prepared steel samples containing ferrite, pearlite and martensite structures will be observed under the optical microscope.

