

## Experiment # 8

### Heat treatment

#### Experiment Objective

In this experiment, student will be able:

- To experience effect of heat on the material
- To understand how heat treatment is influencing specific material properties
- Compare between two different heat treatment processes

#### Background and Introduction

Heat treatment is controlled process of heating and cooling operations in purpose to reach desired physical and mechanical properties of a metal. Its goal is to improve the structural and physical properties for some particular use or for future work of the metal. There are few heat-treating process, each of these processes bring about different results in metal, all of them involve three basic steps: heating, soaking, and cooling.

**Heating** is the first step in a heat-treating process. Many alloys change structure when they are heated to specific temperatures. The structure of an alloy at room temperature can be either a mechanical mixture, a solid solution, or a combination solid solution and mechanical mixture.

Once a metal part has been heated to the temperature at which desired changes in its structure will take place, it must remain at that temperature until the entire part has been evenly heated throughout. This is known as **soaking**. The more mass the part has, the longer it must be soaked.

After the part has been properly soaked, the third step is to **cool it**. Here again, the structure may change from one chemical composition to another, it may stay the same, or it may revert to its original form. For example, a metal that is a solid solution after heating may stay the same during cooling, change to a mechanical mixture, or change to a combination of the two, depending on the type of metal and the rate of cooling. All of these changes are predictable. For that reason, many metals can be made to conform to specific structures in order to increase their hardness, toughness, ductility, tensile strength, and so forth.

Heating processes can be divided to: Hardening, Tempering, Annealing, Normalizing

**HARDENING:** A ferrous metal is normally hardened by heating the metal to the required temperature and then cooling it rapidly by plunging the hot metal into a quenching medium, such as oil, water, or brine. Most steels must be cooled rapidly to harden them. The hardening process increases the hardness and strength of metal, but also increases its brittleness.

**TEMPERING:** Steel is tempered after being hardened to relieve the internal stresses and reduce its brittleness. Tempering consists of heating the metal to a specified temperature and then permitting the metal to cool. The rate of cooling usually has no effect on the metal structure during tempering. Therefore, the metal is usually permitted to cool in still air. Temperatures used for tempering are normally much lower than the hardening temperatures. The higher the tempering temperature used, the softer the metal becomes.

**ANNEALING:** Metals are annealed to relieve internal stresses, soften them, make them more ductile, and refine their grain structures. Metal is annealed by heating it to a prescribed temperature, holding it at that temperature for the required time, and then cooling it back to room temperature. The rate at which metal is cooled from the annealing temperature varies greatly. Steel must be cooled very slowly to produce maximum softness. This can be done by burying the hot part in sand, ashes, or some other substance that does not conduct heat readily (packing), or by shutting off the furnace and allowing the furnace and part to cool together (furnace cooling).

**NORMALIZING:** Normalizing is achieved by heating the metal to a specified temperature (which is higher than either the hardening or annealing temperatures), soaking the metal until it is uniformly heated, and cooling it in still air.

### Apparatus and Equipment

- bobby pins
- Benson burner, candle, lighter, stow
- twizers, pliers
- cup
- water

### Test Procedure

Prepare the three bobby pins

-water

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### Test Procedure

Prepare the three bobby pins

1. Set up the Benson burner or candle or stow burner or lighter
2. Use the piers or tweezers grab the bobby pin from front and put its end on the open flame
3. Wait till the end of the pin becomes red
4. Then perform following respectively for each bobby pin
5. A) Quickly immerse the pin in cold water to cool it down  
B) Leave the pin to cool down gradually in room temperature  
C) Quickly immerse the pin in cold water and put it again under the heat for short time
6. After is cool down try to open the pin and describe the difference between new pin and heat treated pins

### Data and calculations

Make comparison of the properties as elasticity and hardness after heat treatment process.

Make conclusion which procedure should be perform to get specific properties of the material and which are those proprieties?

Find out which equipment in Petroleum Engineering is undergoing the heat treatment process and which one?

### References

<https://www.youtube.com/watch?v=I9JgwNp7v0E>

[https://www.youtube.com/watch?v=JCF8\\_IVRPJQ](https://www.youtube.com/watch?v=JCF8_IVRPJQ)

<https://www.youtube.com/watch?v=23BxcJOxg4c>

<https://www.youtube.com/watch?v=GnCaCXNTNgw>

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