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CAUSE EFFECT DIAGRAM OF HEAT TREATMENT PROCESS

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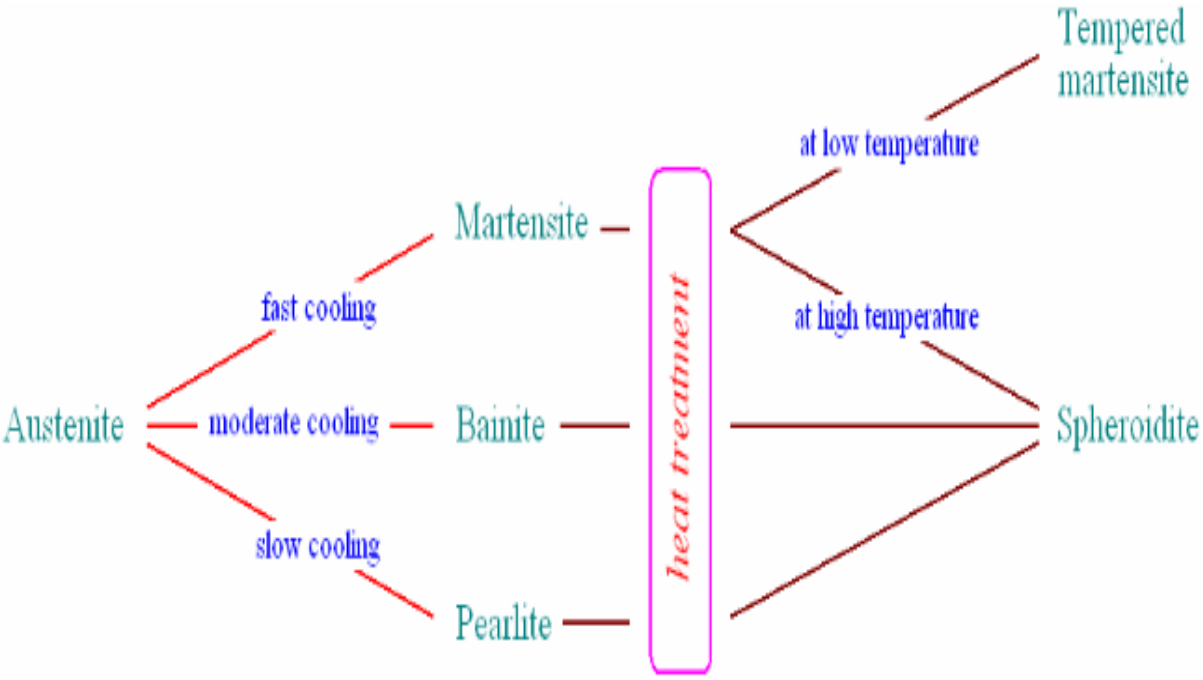
1. **ABSTRACT:** *Heat treatment is an operation or combination of operations involving heating at a specific rate, soaking at a temperature for a period of time and cooling at some specified rate. The aim is to obtain a desired microstructure to achieve certain predetermined properties (physical, mechanical, magnetic or electrical) .*

The major objectives of heat treatment are

- To increase strength, harness and wear resistance **(bulk hardening, surface hardening)**
- To increase ductility and softness **(tempering, recrystallization annealing)**
- To increase toughness **(tempering, recrystallization annealing)**
- To obtain fine grain size **(recrystallization annealing, full annealing, normalizing)**
- To remove internal stresses induced by differential deformation by cold working, nonuniform cooling from high temperature during casting and welding **(stress relief annealing)**
- To improve machineability **(full annealing and normalizing)**
- To improve cutting properties of tool steels **(hardening and tempering)**
- to improve surface properties **(surface hardening, corrosion resistance-stabilizing treatment and high temperature resistance-precipitation hardening, surface treatment)**
- to improve electrical properties **(recrystallization, tempering, age hardening)**
- to improve magnetic properties **(hardening, phase transformation)**



2.Fundamentals of heat treatment:

Fe-C equilibrium diagram. Isothermal and continuous cooling transformation diagrams for plain carbon and alloy steels. Microstructure and mechanical properties of Pearlite, bainiteand martensite,austenitic grain size, hardenability, its measurement and control.

Heat treatment Processes

Annealing, normalizing and hardening of steels, quenching media, tempering. Homogenization. Dimensional and compositional changes during heat treatment. Residual stresses and decarburization

3.Cause Effect Diagram of Heat Treatment Problem

- Change the microstructure in improper heat treatment and using the improper furnace and other parameter of the heat treatment.

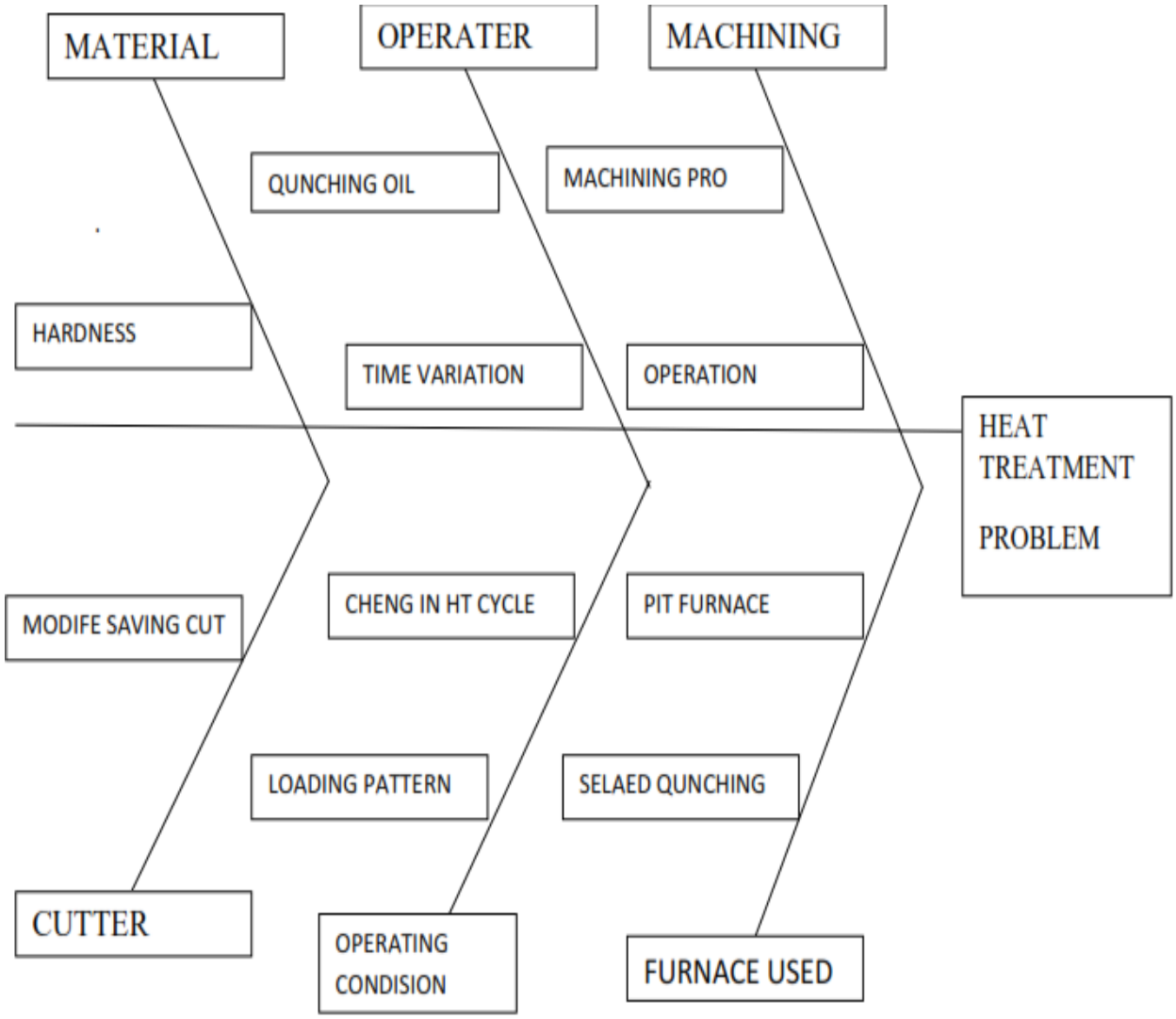


Figure:2 Fish Bone Diagram for Energy Conservation Analysis in heat treatment process

- Improper way to specimen cutting process
- High temperature cutting machinery using
- Not maintain temperature

FIGURE :3 .HIGH TEMPERATURE CUTTING MACHINERY

- During heat treatment process not mention proper temperature

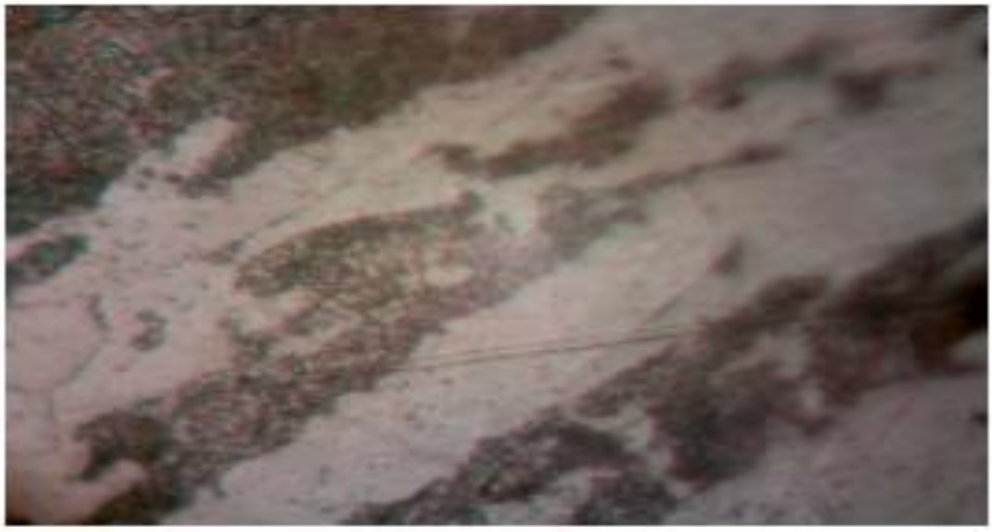


FIGURE:4 CHANGE IN MICRO STRUCTURE

We can reduce the heat treatment problem by using following techniques:

- Proper way to using heat treatment process furnace
- Cutting process in continues using cooling system
- Proper temperature of heat treatment
- Changing in heat treatment process cycle
- Specimen cutting care fully
- Maintain proper temperature in furnace
- Arrangement of all components in proper way
- Checking material specification sheet before parches material
- Cutting process proper way

CONCLUSION

The correlation between the microstructures and mechanical properties of studied along with their fracture surfaces for two different heat treatment processes- Quenching ,Tempering and Austempering.

Author also studied the effect of Copper on the microstructures, mechanical properties and fracture surfaces after heat treating. For **Quenching and Tempering heat treatment cycle, author** observed the following:

- As the tempering temperature increases, ductility of the samples also increased but Compromising with hardness and strength.
- The strength and hardness values were more for the sample with copper while ductility Was found to be more for the sample without copper.
- The fracture surfaces showed a mixed mode of fracture for both the grades of samples.
- But, the percentage of dimple fracture was found to increase with tempering temperature.
- The microstructure in as cast condition shows the Pearlite matrix with graphite nodules in
- both grades of samples, while after quenching and tempering the matrix converted into the
- martensite and tempered martensite. Thus, the strength and elongation was increased in
- tempered samples, but hardness decreases.

For **Austempering heat treatment cycle, author** observed the following:

- As the holding time for austempering increases, the tensile strength initially increases and then decreases. Contrary to it, % elongation first decreases and then increases with time.
- The hardness values normally decreases with austempering time.
- The fracture surfaces showed a mixed mode of fracture for shorter austempering time.
- The percentage of dimple fracture then increased with time. For longer austempering time, percentage of cleavage fracture was found to be more.
- The microstructure was austerity or bainitic ferrite and retained austenite with graphite
- Nodules embedded in it for all periods of time. But, the morphology of bainitic was
- Changed from needles to plate like structure as the austempering time increases. So, the
- Strength and hardness decreases with time and ductility.

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