Analysis of Engineering Metrology & Material Behavior
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Abstract:
With the recent renovations in heat treatment technology analysis of Hardening & Tempering Pre ferrate Micro structure & avoid. The affecting factors are such as Jigging method, Temperature selection & Type of Furnace in ferrous carbon steels, it has unfulfillment of mechanical properties, Life time less. Control the Pre ferrate Structure by use below the factors 1.Advance Shield Quench Furnace use .2.Temperature Selection Based on carbon content. 3. Proper Jigging Method to avoid product life time. This Advance heat treatment Furnace are fully avoid the Oxygen layer formation and Retain austenite For all type of ferrous steels & alloy steel. In heat treatment technology are fully concentrate the material strength without change the body shape it can be change the internal structure and grain Size. This major modification of carbon steel is to improve ductility, to improve toughness, strength, hardness and tensile strength and to relive internal stress developed in the material. Here basically the experiment of harness and ultimate tensile strength is done to get idea about heat treated carbon steel, which has extensive uses in all industrial and scientific fields.

Keywords: Hardening, Micro structure, Jigging method, Quench Furnace, Retain austenite.

1. INTRODUCTION
As we know there is a little bit of steel in everybody life. Steel has many practical applications in every aspects of life. Steel with favorable properties are the best among the goods. The steel is being divided as low carbon steel, high carbon steel, medium carbon steel, high carbon steel on the basis of carbon content. Carbon steel ha carbon content of 0.30% to 0.60%. Medium carbon steel is the most common form of steel as it’s provides material properties that are acceptable for many applications. It is neither externally brittle nor ductile due to its lower carbon content. It has lower tensile strength and malleable. Steel with Medium carbon steel has properties similar to iron. As the carbon content increases, the metal becomes harder and stronger but less ductile and more difficult to weld. The process heat treatment is carried out first by heating the metal and then cooling it in water, oil and brine water. The purpose of heat treatment is to soften the metal, to change the grain size, to modify the structure of the material and relive the stress set up in the material. The various heat treatment process are annealing, normalizing, hardening, austempering, mar tempering, tempering and surface hardening. Case hardening is the process of hardening the surface of metal, often Medium carbon steel by infusing elements into the metal surface forming a hard, wear resistant hard surface. Carbon steel (plain carbon steel) is completely surrounded by granules of charcoal which is activated by barium carbonate. The carburizing process does not harden the steel it only increases the carbon content to some pre determined depth below the surface to a sufficient level to allow subsequent quench hardening.

The most important heat treatments and their purposes are:
Stress relieving - a low-temperature treatment, to reduce or relieve Internal stresses remaining after casting Annealing - to improve ductility and toughness, to reduce hardness and to remove carbides Normalizing - to improve strength with some ductility Hardening and tempering - to increase hardness or to give improved Strength and higher proof stress ratio. Austempering - to yield bainitic structures of high strength, with significant ductility and good wear resistance. Surface hardening - by induction, flame, or laser to produce a local wear resistant hard surface. Carbon steel (plain carbon steel) is steel which contain main alloying element is carbon. Here we find maximum up to 1.5% carbon and other alloying elements like copper, manganese, silicon. Most of the steel produced now-a-days is plain carbon steel. It is divided into the following types depending upon the carbon content.

1. Dead or mild steel (up to 0.15% carbon)
2. Low carbon steel (0.15%-0.45% carbon)
3. Medium carbon steel(0.45%-0.8% carbon)
4. High carbon steel (0.8%-1.5% carbon)

Steel with low carbon content has properties similar to iron. As the carbon content increases the metal becomes harder and stronger but less ductile and more difficult to weld. Higher carbon content lowers the melting point and its temperature resistance carbon content cannot alter yield strength of material.

1.1 MEDIUM CARBON STEELS
Medium carbon steel has carbon content of 0.30% to 0.60% of carbon steel is the most common type of steel as its price is...
relatively low while its provides material properties that are acceptable for many applications. It is neither externally brittle nor ductile due to its medium carbon content. It has lower tensile strength and malleable.

1.2 ALLOY STEELS
This alloy steels which contains carbon with alloy grades this grades are used heavy duty system applications it has more mechanical properties & chemical properties

2. HEAT TREATMENT PROCESS

2.1 NORMALISING
The process of normalising consist of heating the metal to a temperature of 30 to 50 c above the upper critical temperature for hypo-eutectoid steels and by the same temperature above the lower critical temperature for hyper-eutectoid steel. It is held at this temperature for a considerable time and then quenched in suitable cooling medium. The purpose of normalizing is to refine grain structure, improve machinability and improve tensile strength, to remove strain and to remove dislocation.

2.2 ANNEALING

1 Full annealing:-
Carbon steel is heated to approximately above the upper critical temperature (550-650) for 1 hour. Here all the ferrite transforms into austenite. The steel must then cooled in the realm of 36 per hour. This results in a coarse pearlite structure. Full annealed steel is soft and ductile with no internal stress.

2 Process annealing:-
The steel is heated to a temperature below or close to the lower critical temperature (550-650), held at this temperature for some time and then cooled slowly. The purpose is to relive stress in a cold worked carbon steel with less than 0.3%wt c.

3 Diffusion annealing:-
The process consists of heating the steel to high temperature (1100-1200). It is held at this temperature for 3 hours to 20 hours and then cooled to 800-850 inside the furnace for a period of about 6 to 8 hours. It is further cooled in the air to room temperature. This process is mainly used for ingots and large casting. It is also called isothermal annealing.

2.3 AUSTEMPERING
It is a hardening process, it is also known as isothermal quenching. In this process, the steel is heated above the upper critical temperature at about 875 c where the structure consists entirely of austenite. It is then suddenly cooled by quenching it in a salt bath maintained at a temperature of about 250 c to 525 c.

2.4. MARTEMPERING
This process is also known as steeped quenching or interrupted quenching. It consists of heating steel above the upper critical temperature and quenching it in a salt bath kept at a suitable temperature.

2.5 HARDENING
The process of hardening consist of heating the metal to a temperature of 30-50 c above the upper critical point for hypo-eutectoid steels and by the same temperature above the lower critical temperature for hyper-eutectoid steels. It is held this temperature for some time and then quenched. The purposes of hardening are to increase the hardness of the metal and to make suitable cutting tools.

2.6 TEMPERING
This process consists of reheating the hardened steel to some temperature below the lower critical temperature, followed by any desired rate of cooling. The purpose is to relive internal stress, to reduce brittleness and to make steel tough to resist shock and fatigue.

3. HEAT TREATMENT FURNACE

3.1.1 PIT FURNACE
Pit type furnaces in fuel fired or electric powered configurations that are easy to operate and control. These top loading furnaces have rugged, reinforced shells and high quality insulation. They are engineered to provide long service life, ease of maintenance and optimum thermal efficiency. This is a very specific heat treatment given to high carbon steel requiring extensive machining prior to final hardening & tempering. The main purpose of the treatment is to increase the ductility of the sample. Like stress relief annealing the treatment is done just below A1. Long time heating leads cementite plates to form cementite spheroids. The driving force for this (microstructural) transformation is the reduction in interfacial energy.

3.1.2 SHIELD QUINCH FURNACE
The sealed quench furnaces are a type of heat treatment furnace. ATF’s sealed quench furnaces are of ‘straight through’ type with integral oil and gas quenching features. Suitable for carburising and carbo-nitriding under protective atmospheres, sealed quench furnaces are fully automatic and PLC controlled.

3.1.3 CONVEYOR FURNACE
These highly efficient and economical mesh belt conveyor furnaces are designed for atmosphere and no atmosphere applications at temperatures up to 2100°F (1150°C). Applications include: annealing, bonding, tempering, sintering, and soldering. Belt widths available: 4” to 36”. Belt speeds: 10 to 1 ratios as required.

3.1.4 VACCUM FURNACE
A vacuum furnace is a type of furnace in which the product in the furnace is surrounded by a vacuum during processing. The absence of air or other gases prevents oxidation, heat loss from the product through convection, and removes a source of contamination. This enables the furnace to heat materials (typically metals and ceramics) to temperatures as high as 3,000 °C (5,432 °F) [1] with select materials. Maximum furnace temperatures and vacuum levels depend on melting points and vapor pressures of heated materials.

3.1.5 JIGGING METHOD
Jig Method is important in heat treatment process as given like this to avoid the retain austenite in core surface area

4. MICRO STRUCTURE

4.1.1 FERRATE
Ferrate is a supercharged iron molecule in which iron is in the plus 6 oxidation state; it is better known as Iron(VI). Ferrate is extremely powerful, can deliver multiple treatments from a single application, does not create disinfection byproducts, is environmentally friendly, and solves difficult treatment
challenges that other oxidants can’t touch. Most importantly, Ferrate is often the least expensive and most effective treatment option.

**4.1.2 PERLITE**

Production, Origin and General Information – Perlite is a glassy volcanic rock with a rhyolitic composition and 2–5 per cent of combined water (Alkan and Doğan, 1998; Doğan and Alkan, 2004). The main known world’s perlite reserves (about 70 per cent) are located along the Aegean coast in Turkey. The commercial product is produced by heating the ground, sieved material to 760–1100°C. The combined water in the perlite is converted to gas at high temperature in the oven and subsequently the volume expands 4–20 times its original volume, resulting in a lightweight high porosity material. Perlite is frequently used in potting soil mixtures and as a standalone growing medium (Grillas et al., 2001; Gül et al., 2005). It is produced in various grades, the most common being 0–2 and 1.5–3.0 mm in diameter. The various grades differ in their physical characteristics.

**5. MICRO STRUCTURE ANALYSIS**

The surface of is affected by the quenching medium and experiences the best possible cooling rate. The interior of the sample is cooled by conduction through the (hot) sample and hence experiences a lower cooling rate. This implies that different parts of the same sample follow different cooling curves on a CCT diagram and give rise to different microstructures. This gives to a varying hardness from centre to circumference. Critical diameter (d_c) is that diameter, which can be through hardened (i.e. we obtain 50% Martensite and 50% pearlite at the centre of the sample). During any cold working operation (say cold rolling), the material becomes harder (due to work hardening), but loses its ductility. This implies that to continue deformation the material needs to be recrystallized (wherein strain free grains replace the ‘cold worked grains’).

5.2 OXIGEN LAYER FORMATION

The pre ferrate structure has more unwanted oxygen layer which include the retain austenite This Advance heat treatment Furnace are fully avoid the Oxygen layer formation and Retain austenite For all type of ferrous steels & alloy steel. In heat treatment technology are fully concentrate the material strength with out change the body shape it can be change the internal structure and grain Size. This major modification of carbon steel is to improve ductility, to improve toughness, strength, hardness and tensile strength and to relive internal stress developed in the material. Here basically the experiment of harness and ultimate tensile strength is done to get idea about heat treated carbon steel, which has extensive uses in all industrial and scientific fields.
5.3 TEMPERATURE HEATING

6. FUTURE WORK

From the various results obtained during the project work it can be concluded that the mechanical properties vary depending upon the various heat treatment processes. Hence depending upon the properties and applications required we should go for a suitable heat treatment processes. When ductility is the only criteria tempering at high temperature for 2 hours gives the best result among all tempering experiments however it is simply the hardness of the low carbon steel that is desired than we should go for low temperature tempering for 1 hour or so. However if strength is also desired along with hardness, this should not be done. It is seen that annealing causes a tremendous increase in % elongation (ductility). It can be clearly seen comparing all the heat treatment processes, optimum Combination of UTS, Yield Strength, % Elongation as well as hardness can be Obtained through austempering only. Heat treating (or heat treatment) is a group of industrial and metalworking processes used to alter the physical, and sometimes chemical, properties of a material. The most common application is metallurgical. Heat treatments are also used in the manufacture of many other materials, such as glass. Heat treatment involves the use of heating or chilling, normally to extreme temperatures, to achieve a desired result such as hardening or softening of a material. Heat treatment techniques include annealing, case hardening, precipitation strengthening, tempering, carburizing, normalizing and quenching. It is noteworthy that while the term heat treatment applies only to processes where the heating and cooling are done for the specific purpose of altering properties intentionally, heating and cooling often occur incidentally during other manufacturing processes such as hot forming or welding.

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