

**METHODOLOGY TO EVALUATE OPTIMIZATION OF PROCESS  
PARAMETER OF GAS CARBURIZING CHAMBER**Prof. Anup Junankar<sup>1</sup>, Prof. Shrikant Kholgade<sup>2</sup>, Shubham Shende<sup>3</sup>, Akash Dhande<sup>4</sup><sup>1</sup>Mechanical Engineering, JD college of engineering & Management, Nagpur<sup>2</sup>Mechanical Engineering, JD college of engineering & Management, Nagpur<sup>3</sup>Mechanical Engineering, JD college of engineering & Management, Nagpur<sup>4</sup>Mechanical Engineering, JD college of engineering & Management, Nagpur

**Abstract:** Heat treatment is a controlled method for heating and cooling to achieve certain mechanical properties, such as hardness, strength, flexibility, and the reduction of residual stresses. However, we are focusing on hardness. In heat treatment process temperature is controlled over heating cycle. The result obtained makes it possible for the heat treatment of both ferrous and non-ferrous metals and their alloy in order to alter their microstructures and enhance their properties. Heat treatment may be defined as heating and cooling operations applied to metal and alloys in solid state so as to obtain the desired property. Heat treatment by using gas carburizing chamber is the deposition of carbon on a work material by controlled heating and cooling of a material to achieve certain mechanical properties. The following operating parameters are furnace temperature, soaking time and quenching time were taken from optimization of Taguchi technique and design of experiment, by using gas carburizing chamber certain properties like hardness can be increased.

**Keyword:** Gas carburizing chamber, Taguchi method, performance parameter, orthogonal array, heat treatment, mechanical properties.

**1. INTRODUCTION**

Heat treatment is defined as heating and cooling operations applied to metals and alloys in solid state so as to obtain the desired properties. Heat treatment is often associated with increasing the hardness of material to improve machinability. Heat treatment by using gas carburizing chamber is the deposition of carbon on work material by controlled heating and cooling of material to achieve certain value of hardness. The case hardening heat treatment process performed on gas carburizing chamber which is easy to operate and less costly furnace. Heat treatment is easy to achieve on steel that's why we have selected mild steel, EN-19 and EN-24. These materials have low percentage of carbon so hardening process is easily achievable. Carburizing and case hardening are "thermo chemical" treatment, usually conducted at temperature in the range 800-950<sup>0</sup> C. In this experiment we are using carburizing liquid for deposition of carbon on the surface of material to increase the hardness. The deposition of carbon is introduced in controlled level. Quenching oil is used for cooling the material.

Hardness is the metallurgical metalworking process used to increase hardness of material. The hardening treatment for most steel consists of heating the steel to a set temperature and then rapidly cooling by plunging deep in to oil, water. Most steels require rapid cooling (quenching) for hardening but a few can be used air cooled with the same result. Hardening increases the hardness and strength of the steel, but makes it less ductile. Generally harder the steel the more brittle it becomes. To remove some brittleness one should temper the steel after hardening.

**2. METHODOLOGY**

We have to know what are the effects of heat produced by the welding and cutting as on metal. The process of heat treating is the method by which metal is heated and cooled in a series of specific operations that never allow the metal to reach the molten state. The purpose of heat treating is that we can make a metal harder, stronger and more resistant to impact. Also heat treating can make a metal softer and more ductile. There are several different types of heat treatment processes. To increase the hardness of materials we are choosing the hardening process.

Following steps are followed during experiment:-

**Step 1) Selection of materials:-** The selected three materials are EN-19, EN-24, & MS-PLATE. Because, of low carbon content (Range from 0.38% to 0.43% carbon) and usually referred as nickel-chromium-molybdenum high tensile steel.

**Step 2) Decide of performance parameter:-** The selected performance parameters are:

- I) **Furnace Temperature:-** A furnace is a device used for high temperature heating and the selected furnace temperature range is between 800<sup>o</sup>c to 950<sup>o</sup>c.
- II) **Soaking Time:-** Once a metal part has been heated to the required time.

**III) Quenching Time:-** Quench time is a measure of how long a steel casting spends at high temperature during quenching.

**Step 3) Testing of material (before experiment)& process parameter selection:-** The materials were to know the carbon percentage and the resultant carbon percentage in it were; In EN-19 **0.401% C**, In EN-24 **0.361% C** & In MS-PLATE **0.219% C**.

**GAS CARBURIZING-OPERATING CONDITION**

SR. NO	PARAMETER	NOTATION	LEVEL 1	LEVEL 2	LEVEL 3
1.	FURNACE TEMPERATURE	A	850 <sup>0</sup> C	875 <sup>0</sup> C	900 <sup>0</sup> C
2.	SOAKING TIME	B	20 MIN	30 MIN	40 MIN
3.	QUENCHING TIME	C	3 MIN	6 MIN	9 MIN

**Step 4) Design of experiment:-** Taguchi method are statistical method or sometimes it also known as robust design method develop by genichi taguchi to improve of quality manufacturing goods and more recently also applied to engineering, biotechnology, marketing and advertising. The taguchi method is based on orthogonal arrays to minimize the number of experiments and to effectively improve product quality Some of its many advantages include. Orthogonal L9 Array in Taguchi Method

SR.NO	L1	L2	L3
1.	1	1	1
2.	1	2	2
3.	1	3	3
4.	2	1	1
5.	2	2	2
6.	2	3	3
7.	3	1	1
8.	3	2	2
9.	3	3	3

**Step 5) Performance of experiment:-** For performing experiments on gas carburizing chamber to increase the required property I.e hardness of the material. The hardness of material the better material is steel, because steel have low carbon content and hardness, and it can be easily increased by increasing carbon percentage of steel. Generally the temperature for gas carburizing is 800 to 950<sup>0</sup> c.

To select and appropriate Orthogonal array for experiments, the total degrees of freedom need to be computed. The degrees of freedom are defined as the number of comparison between process parameter that need to be determine which level is better. For example, three level process parameter are to be considered, there are three level and three factors.

**Step 6) Applying Taguchi technique:-** The taguchi method provides laying out the experimental condition using specially design tables called orthogonal array ( OA) .Taguchi method is a problem solving tool which can improve the performance of the product process and system in a short development cycle with reduced cost.

Some of its many advantages include:-

- 1) Designs orthogonal arrays (OA) to balance process parameter and minimize test runs.
- 2) Employ single to noise (S\N) ratio to analyze experiment data and conclude more information. Taguchi recommends using the S\N ratio for determining quality characteristics implemented in engineering design problems.

### 3. CONCLUSION

Since the purpose of this study is to optimize value of hardness within optimal levels of process parameter, the higher the better quality characteristics is selected. Each parameter has three levels. The current study considered hardness as optimization criteria and also analyzed the influence of each heat treatment parameter on the quality of the research object.

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