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Hardness Analysis of Bearing on Heat Treatment Process

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ABSTRACT

Bearing is a mechanical element that resembles a loaded shaft, so that rotation or back and forth motion can be smooth, safe and long lasting. Bearings should be sturdy and durable to allow the shaft and other machine elements to work properly. If the bearing is not working properly then the performance of the whole system will decline or not work properly. For this reason, materials from high-carbon steel bearings should be durable and durable. To obtain the desired properties of the metal, the Heat Treatment process, especially the outer and inner ring, is used. Hardness testing of the outer and inner ring of the bearing is performed after the Heat Treatment process. Testing the violence using the Digital Rockwell Hardness Tester, the value of the violence can be read directly on the scale of the tool. The Heat Treatment process of the outer and inner ring of the bearing can produce the mechanical properties that the manufacturer wants, namely Rockwell hardness 62-64 HRC. If the result of the hardness test is in accordance with the factory standard, then the outer and inner ring meet the manufacturer's quality requirements.

INTRODUCTION

Nowadays in the free trade, every company should be able to provide the products they produce in accordance with current consumer demand, both in terms of product, product quality and market price tailored to the product. Thus the company will be able to compete with other companies with similar production (in this case bearing) and it will not be possible to win the competition. For this, the company must be fully aware of the importance of good production system planning, from raw materials to the final output produced so that the results are well received by the public. In its use the bearing is used as a bearing. The bearings used are Ball Bearing types [1-7].

Bearing is a mechanical element that focuses on the load shaft, so that rotation or back and forth movement can be smooth, safe and long lasting. Bearings should be sturdy and durable to allow the shaft and other machine elements to work properly. If the bearing does not work properly then the performance of the whole system will decline or not work properly [8-14].

In this study the purpose is to analyze the hardness of the bearings produced on the heat treatment process using a hardness Rockwell tester.

Based on chemical composition, metal and alloy can be divided into two parts [15]:
1. Iron metals (Ferrous)
2. Nonferrous metals

Iron metals are metals and alloys that contain iron (Fe) as its main element. Whereas non-iron metals are materials that contain little or no iron content. Included in metal and alloy are:
1. Cast Iron
2. Carbon steel
3. Alloy Steel

In the application of the technique it is necessary to choose the type of metal and alloy with suitable properties for operation so that the wearer can provide optimum performance. These attributes include: strength and durability at low temperatures, high or high temperature, fatigue, corrosion and oxidation, wear or other properties.

Steel

Steel is an alloy, consisting of iron, carbon and other elements. Steel can be formed by casting or casting. Carbon is one of the most important elements as it can increase the hardness and strength of steel. Steel is the most widely used metal in engineering, in the form of plates, sheets, pipes, sticks, profiles and so on. According to its composite elements, steel classification follows SAE (Society of automotive

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Engineers) and AISI (American Iron and Steel Institute) [16].

Equilibrium Chart of Fe-Fe_3C

Iron or Fe metal is a major component of various commercial steel alloys. Besides Fe, in steel there are other elements such as carbon (C), manganese (Mn), silicon (Si), phosphorus (P), sulfur (S), chrome (Cr), nickel (Ni), molybdenum (Mo) and others -more. These elements are added with the aim of improving physical or mechanical properties, but may also be subjected to processes as unwanted impurities. Fe-Fe_3C equilibrium phase diagram is one of the most important equilibrium.

From these images carbon steel can be grouped into:
1. "Pure" iron, with very low carbon content
2. Steel, with 2% carbon content
3. Cast iron or cast iron, with 2-4.5% carbon content.

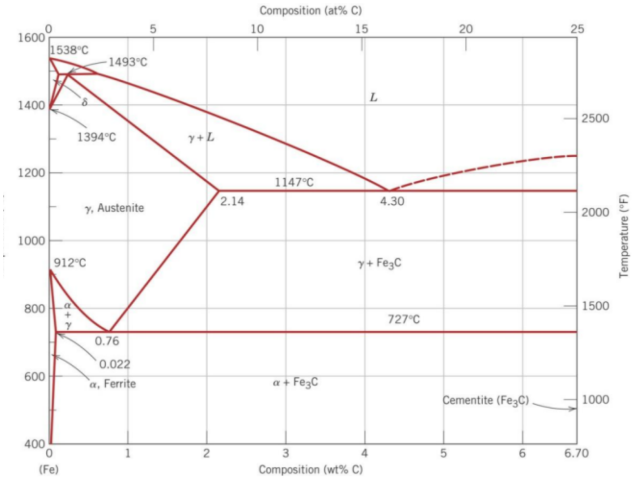

Fig. 1. Equilibrium diagram phase of Fe-Fe_3C [5]

The solid phases that can be found in the diagram are:

a. Ferrite (α)

The maximum solubility of carbon was achieved at 0.02%. While at only 0.005%.

b. Austenite (γ)

Solid solubility in austenite reached a maximum value of 2.08% at and decreased to 0.8% at 1148 °C.

c. delta (δ)

Solid carbon solubility reached a maximum value of 0.09% at 1145 °C.

d. Cement (Fe_3C)

Cement is a metallic compound with a composition of Fe = 93.3% and carbon 6.6%. The nature of this phase is harsh but fragile.

AISI steel of 52100

AISI steel of 52100 (SUJ 2) is a high quality chromium and carbon steel. This type of steel is commonly used as bearing steel. This type of steel has a hardness characteristic of 62-66 HRC. The alloy elements are actually added to improve the properties of the steel itself. The alloy elements here can be elements that have been added to the steel or from the impurities that were carried during the construction process. However, both have the effect of increasing or decreasing the properties of steel [9].

Heat Treatment “Heat Treatment” is a combination of heat and cold treatment of solid materials for a certain period of time, resulting in the desired mechanical properties. The commercial benefits of heat treatment need not be doubted, heat treatment is not a stand-alone process but rather a unit of the whole production process. The heat treatment of the AISI 52100 steel is achieved of 885 °C, and cooling is done slowly in the air.

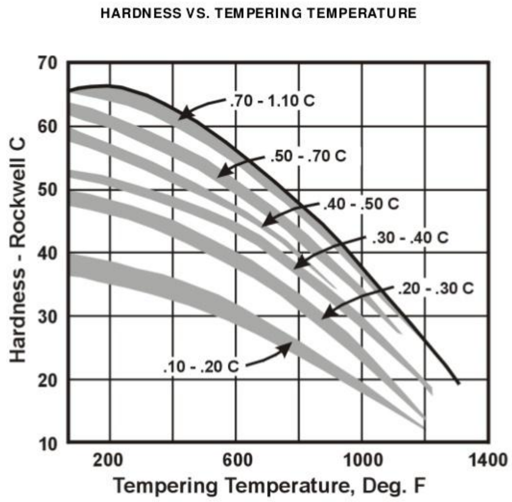

Fig. 2. Hardness between tempering temperature [7]

Annealing process

Anil process is the process of heating the material to a certain temperature for a certain period of time followed by slow cooling until the temperature is relatively low across the transformation area. Cooling is done in the kitchen or in media with good heat insulation [10].

Hardening Process

The heating to reach the austenitic temperature during the hardening process is quite rapid, but it is worth noting that an overestimation of the

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temperature can greatly increase the likelihood of distortion of cracked material, which is why frequent heating is often performed. The length of heating is determined by the time it takes for the temperature to be even, and the carbides are all soluble. This should be noted in terms of energy savings. In addition, prolonged heating increases the risk of cracking on the surface [11].

Process of Temper

The steel obtained from the results of the above process is very hard, brittle and has a high residual stress, so in order to be used well it requires additional treatment namely compression process. The extraction process is a heat treatment process with heating to temperature. It thus enhances the durability and durability as well as enhances the hardening properties of steel. But on the other hand there is a reduction in its strength and hardness [13-17].

Test of hardness

There are several reasons why material testing is so important, including [18-19]:

1. Check for material grade (as per specification)
2. Make sure the material provides the desired properties
3. Final check
4. Check for use (detects material loss and damage occurred)

Hardening testing is a test performed to determine the material's resistance to deformation or permanent identification on the material surface

Rockwell hardness test

This test uses diamond cones as a tool for measuring the hardness of a metal. Rockwell method is a test of hardness with direct reading [20-21]. This method is widely used for practical considerations. The most commonly used Rockwell method is Rockwell:

1. A, use diamond indentor with a load of 60 kg.
2. B, using 1/16 inch diameter steel ball indentor with 100 kg load.
3. C, use diamond indentor with a load of 150 kg.

This cone will tear the metal surface, inward h from the surface. Depth of h determines the hardness of the test metal.

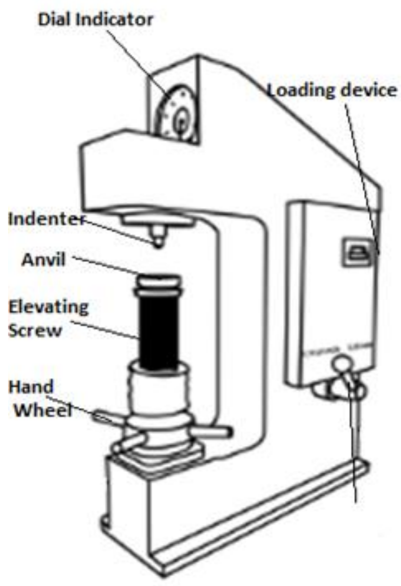

Fig. 3. The process of hardness testing by the Rockwell method [11]

Table 1. Summary of several types of hardness testing [10]

Test	Applied load	Indenter
Brinell	1-250 Kg	Ball(ϕ3,ϕ5,ϕ10 mm)
Rockwell	1-300Kg	Ball, Pyramid
Vickers	1-250Kg	Pyramid
Micro Vickers	0.1-1Kg	Pyramid
Knoop	0.1-1Kg	Elongated pyramid
Shore	Falling ball from 20CM	Ball (ϕ10 mm)

Rolling Bearing

Rolling bearings have the advantage of very small rolling friction. Rolling elements such as balls or rollers, mounted between the outer ring and the inner ring. By turning one of these rings, the ball or roller will make a rolling motion so that the one between them will be much smaller. For balls or rollers, high accuracy in shapes and sizes is a must. Because the area of the box between the ball and rollers with the ring is very small, the magnitude of the load per unit area or the pressure becomes very high. Thus the material used must have high durability and hardness [15].

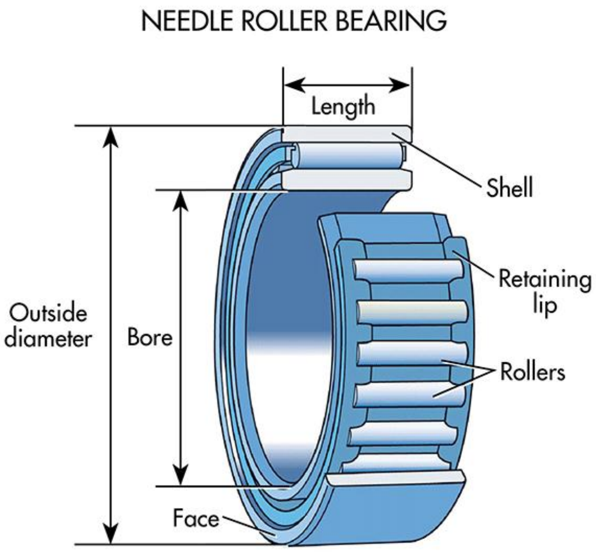

Fig. 4. Component of roll bearing [11]

Lubrication of the Rolling Bearing

Lubrication of the rolling bearing is intended to reduce friction and wear between the rolling elements and the cage, bringing out the heat that occurs, preventing corrosion and avoiding dust ingress. There are two kinds of lubrication methods, namely grease lubrication and oil lubrication [20-21].

Grease lubrication is preferred because the insulation is simpler, and all good quality greases can provide long life. Giving fat is also quite effective, namely periodically. Oil lubrication is a useful way for high speed or high temperature. The most popular of which is the dip lubrication. In this way, with the horizontal axis, oil must be filled to the center of the lowest rolling element. To prevent leakage of lubricants and the entry of foreign matter, there are various insulation devices. These tools can be used alone or in combination. Oil seal is a unit consisting of synthetic rubber with a certain cross section. Oil seals can be sealed more closely, and can be used on rotating shafts or moving back and forth. This ring is very advantageous where the bearing velocity is high enough, the pressure inside is quite large, and the environment is dusty. Mechanical seals are suitable for insulating liquids with relatively low lubrication ability, and can be used for high speeds [22-23].

Heat treatment process

Heat treatment is a combination of heat treatment and cooling of alloy material for a certain time, such that the desired mechanical properties are obtained [19].

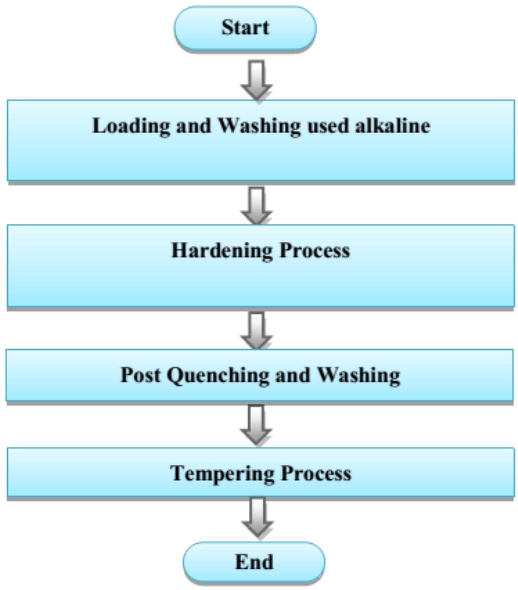

Fig. 5. Heat Treatment process flowchart

EXPERIMENTAL METHOD

The research flowchart is done as in Figure 6 below:

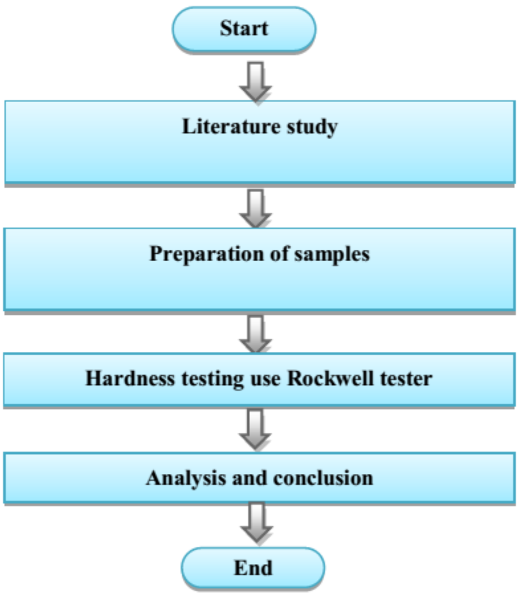

Fig. 6. Flowchart of this research

Based on the Figure 6 the research flow shows the path through which are:

a. Literature studies were conducted in relation to the research topic
b. Preparation of samples about bearing of rolls using heat treatment process
c. Analyze data after processed heat treatment
d. Taking conclusions from the research that has been done.

RESULTS AND DISCUSSION

The results of the hardness values on the outer ring and inner ring type 6301 using a Digital Rockwell Hardness Tester, with a load of 60 kg (have been converted to HRC).

Table 1. Results of hardness testing on the outer ring

Sample	Point				Average
No.	A	B	C	D	(HRC)
1	63.8	63.5	63.5	63.5	63.5
2	63.8	63.6	63.5	63.6	63.6
3	63.3	63.3	63.5	63.3	63.3
4	63.5	63.5	63.5	63.5	63.5
5	63.7	63.5	63.6	63.6	63.6
6	63.6	63.6	63.5	63.5	63.6

The average hardness value of the outer ring is 63.5 HRC.

Table 2. Results of hardness testing on the inner ring

Sample	Point				Average
No.	A	B	C	D	(HRC)
1	63.8	63.5	63.6	63.7	63.6
2	63.6	64.0	63.8	63.8	63.8
3	63.8	63.7	64.0	63.6	63.7
4	63.6	64.6	63.6	63.4	63.5
5	63.8	63.8	64.0	63.8	63.8
6	63.7	63.6	64.0	63.8	63.7

The average value of the hardness of the inner ring is 63.6 HRC.

Hardness analysis

Based on the results of the hardness testing on the outer and inner ring after the Heat Treatment process, the hardness price of:

1. For the outer ring 63.5 HRC
2. For the inner ring 63.6 HRC

Because the factory hardness standard is 62-64 HRC, the outer and inner rings meet the factory quality standards and are ready to be forwarded to the machining process.

CONCLUSION

1. The heat treatment process of the outer and inner rings of the bearings can produce the desired mechanical properties the level of hardness in accordance with the standards desired by the factory, namely the hardness value of Rockwell 62-64 HRC.
2. The Heat Treatment Process of 52100 bearing steel material which is hard and brittle can change the properties of the material to be resilient and resilient.

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