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STUDY OF THE PRODUCTION PROCESS FOR SUZUKI IDLE STARTER GEAR AT PT. MORITA TJOKRO GEARINDO

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Abstrak: *Gears are toothed cylindrical wheels that are used to transmit motion and power from one rotating shaft to another shaft. Gear quality is a specific precision that includes index diversity, tooth alignment, tooth profile, root radius, and total compound diversity. In designing gears, it is also necessary to consider the various forming materials and their properties such as mechanical design provisions, resistance and strength against face defects. The Idle Starter Gear has a function as a connector when the motor is started. The purpose of this scientific writing is to understand the production process for making Idle Starter Gears and the stages of each process. The process in making Idle Stater Gears is using a lathe machine for the turning process, a shaper for forming teeth on a small diameter, hobbing the process for forming gears on the outer diameter, carburizing the process of inserting carbon into the surface of the material to increase brittleness, tempering the process of regulating mechanical properties The hardened material becomes softer and its toughness increases, as well as the quality control process of checking the final results again as required. After all the processes are complete, it can be sent to the supplier. The result of this process is that we can find out how the gear formation process is from the beginning to the end and also what is used in each process.*

Keywords: Gears, Heat Treatment, Manufacturing

INTRODUCTION

Currently, the development of the automotive industry is very advanced in terms of technology. A motorized vehicle has several systems combined which have the function of making the vehicle's work easier. In Indonesia, the number of motorbikes used is increasing along with the development of the industrial sector. It cannot be denied that the need for motorbike spare parts is also needed, especially spare parts that have a shelf life.

Gears are toothed cylindrical wheels that are used to transmit motion and power from one rotating shaft to another shaft. Gear quality is a specific precision that includes index diversity, tooth alignment, tooth profile, root radius, and total compound diversity. In designing gears, it is also necessary to consider the various forming materials and their properties such as mechanical design provisions, resistance and strength against face defects. [1]

Today's gears have experienced very rapid development, far compared to when they were first discovered, which were only made of wood and inserted with teeth. Gears are made with the aim of reducing slip symptoms which result in reduced transmission of movement and power to a shaft of the system. As technology develops, gears have undergone many changes, both in terms of geometry and materials which have been adapted to the use of the gear.

Gears have various types which are classified into 3 types, namely based on the position of the axis of the axis, based on the speed of the gear, and based on the type of gear. In terms of size, the basic dimensions of gears are the number of teeth and modules.

In this scientific writing, the author wants to discuss a production process for Idle Stater Gears on Suzuki vehicles using lathe, shapper, hobbing, carburizing, tempering and burning methods and using SCM415 material with a chemical composition in the form of carbon (c), silicon (Si), manganese (Mn), phosphorus (P), sulfur (S), chrome (Cr), molybdenum (Mo).

LITERATURE REVIEW

Understanding Gears

Gears are toothed cylindrical wheels that are used to transmit motion and power from one rotating shaft to another shaft. Gear quality is a specific precision that includes index diversity, tooth alignment, tooth profile, root radius, and total compound diversity. In designing gears, it is also necessary to consider the various forming materials and their properties such as mechanical design provisions, resistance and strength against face defects.

These characteristics are taken into consideration in choosing the type of gear design. Choosing a design with consideration of materials is a factor that needs to be considered to produce a design choice that is not only in accordance with quality standards but also in accordance with the product design.[1]

Types of Gears

Gears have various types which are classified into 3 types, namely based on:

A. Based on the Axis Position of the Axis

1. Gears with parallel shafts

Parallel gears are gears that have teeth in a row on two cylindrical rods. The two cylindrical planes are tangent and one rolls on the other with parallel axes. The following are various types of parallel gears, including:[3]

a. Straight Gear: the most basic gear with a tooth path parallel to the shaft. Found in the gear box on the engine.
b. Bevel Gear: has a threaded tooth path on the distance cylinder. It is found in the gears that drive the valves on motorbike engines.
c. Double Bevel Gear: this gear has axial forces that arise on the teeth which have V-shaped grooves, which cancel each other out. Found in the turbine reduction gear in the generator.
d. Internal Gears and Pinions: used in small size transmission equipment with a large reduction ratio, because the pinyon is located inside the gear.
e. Tooth Bars and Pinyons: the basis of the tooth making tool profile. Found in the use of rec gears on lathe machines.

2. Gears with Intersecting Shafts

Intersecting gears are gears whose teeth are located in a row on two conical planes or one cylindrical plane with one circular flat plane. The two planes are tangent to each other and one moves on the other with intersecting axes. There are various types of gears with intersecting shafts, including:

a. Straight Cone Gears
b. Spiral Cone Gears
c. Bevel Cone Gears
d. Surface Gears with Intersecting Shafts

3. Gears with Crossed Shafts

Crossed shaft gears are gears whose teeth are aligned on two cylindrical planes or two conical planes or one cylindrical plane with one thread plane. There are various types of gears with crossed shafts, including:

a. Cross Bevel Gears: bevel gears are softer in operation and the noise level is low with contact between teeth of more than 1. Bevel gears have a band of teeth that form a thread on the pitch cylinder.
b. Cylindrical Worm Gears: have a cylindrical shape and are more commonly used.
c. Double Casing Worm Gear: has a larger contact ratio, used for larger loads.
d. Hypoid Gear: has a spiral-shaped tooth path on a conical plane whose axes cross and the transfer of force to the tooth surface occurs by sliding and rolling.

B. Based on Gear Speed

1. Low Speed, for low gear speed around 0.5 m/sec > V > 10 m/sec.
2. Medium Speed, for medium gear speed around 5 m/sec > V > 20 m/sec.

High Speed, for high gear speeds around 20 m/sec > V > 50 m/sec.

C. Based on Gear Type

1. External Gearing, a gear that has the opposite direction of rotation.
2. Internal Gearing, gears that have the same direction of rotation.
3. Double Helical Gear (Herringbone Gear), a double helical gear has two pairs of V-shaped teeth so it looks like two helical gears joined together. This will form mutually canceling axial thrusts. Has a shape complexity that is more difficult than other gears.
4. Worm Gear, this gear is shaped like a rod-shaped screw that is paired with a regular or spur gear. One of the easiest gears to use to get a high torque ratio but low gear rotation speed. The ratio of the worm gear itself can reach 500:1. However, the disadvantage of using a worm gear is that there is friction in the worm gear which results in low efficiency so the gear must be lubricated.

Heat Treatment

Heat treatment is a heat treatment process used to change the physical and mechanical properties of materials such as metal and steel. The main goal of heat treatment is to increase the strength, hardness, wear resistance, corrosion resistance and microstructure of the material. Following are some common types of heat treatment:

A. Annealing (Normalizing)
1. Annealing is a process where the material is heated to a certain temperature and then slowly cooled to reduce hardness and increase ductility. This process also helps eliminate internal tension in the material.
2. Normalizing is a process similar to annealing, but cooling is carried out in air. This process produces a balance between hardness and ductility.

B. Quenching
1. Hardening is the process of heating a material until it reaches a high temperature and then cooling it quickly (quenched) in a liquid such as oil, water or cold water to increase surface hardness.
2. Tempering is a process after hardening, the material is reheated at a lower temperature to reduce extreme hardness and increase ductility. This process helps reduce the risk of cracking or breaking.

C. Case Hardening
1. Carburizing is the process of mixing carbon into the surface of a material to increase surface hardness.
2. Nitriding is the mixing of nitrogen onto the surface of a material to increase hardness and wear resistance.

D. Tempering

Tempering is the process of heating a material to a certain temperature to reduce the hardness obtained from quenching while maintaining the required ductility.

E. Stress Relieving

Stress Relieving is the process of heating materials to a lower temperature to eliminate internal stresses that may occur during the manufacturing process.

F. Solution Annealing

Solution Annealing is a process used on non-ferrous metals, such as aluminum. This process is used to remove tension and restore desired properties.

RESEARCH METHODS

Manufacturing for SCM415H

In this scientific writing, the author wants to discuss a production process for Idle Stater Gears on Suzuki vehicles using lathe, shapper, hobbing, carburizing, tempering and burning methods and using SCM415 material with a chemical composition in the form of carbon (c), silicon (Si), manganese (Mn), phosphorus (P), sulfur (S), chrome (Cr), molybdenum (Mo).

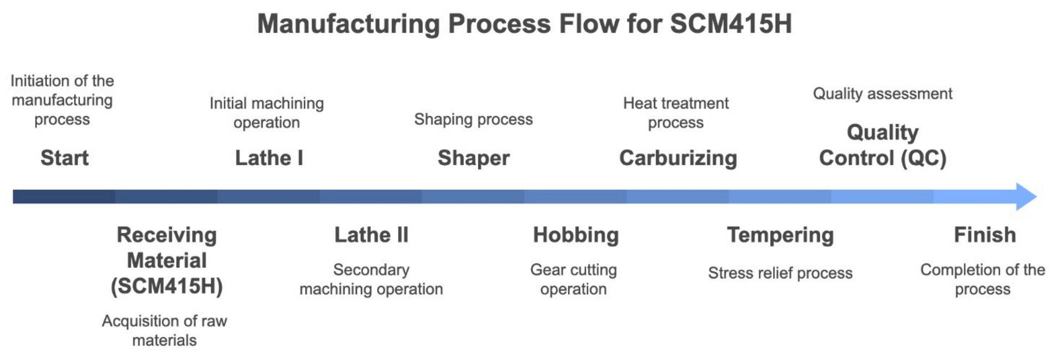

Figure 1. Idle Starter Gear Manufacturing Process

Material SCM415H

The SCM415H material is a steel alloy. Used in structural engineering, such as bolts and nuts, gears, pinions and spindles [5]. With JIS Standards.

Table 1. Chemical Composition of SCM415H Material

Compound	%
C	0.12-0.18
And	0.15-0.35
Mn	0.55-0.95
P	Max 0.03

S	Max 0.03
In	Max 0.25
Cr	0.85-1.25
Mo	0.15-0.03
With	Max 0.03

Tabel 2. Mechanical Composition Material SCM415H/AISI 1518 Steel

(Source: The Piping Mart)

Properties	***Value***	**T**(°C)	***Condition*** **(*Treatment*)**
Density (×1000 kg/m3)	7.7-8.03	25	-
Density (×1000 kg/m3)	7.7-8.03	25	-
Poisson's Ratio	0.27-0.30	25	-
Elastic Modulus (GPa)	190-210	25	-
Tensile Strength (Mpa)	1158	-	-
Yield Strength (Mpa)	1034	25	*Oil Quenched, fine grained, tempered at 425*°C
Elogation (%)	15		
Reduction in Area (%)	53	-	-
Hardness (HB)	335	25	*Oil Quenched, fine grained, tempered at 425*°C

Material Determination Standards

Before carrying out the manufacturing process, the material will be prepared according to the standard sizes that have been determined.

Materials used in the process of making idle starter gears at PT. Morita Tjokro Gearindo is the SCM415H type produced by a supplier in the form of a graduated circle and has a large outer diameter of around 60 mm, a small outer diameter of around 35 mm, a hole diameter of 13 mm, and a material thickness of 182 mm.

Figure 3. Material SCM415H

Making process

In the initial step of making the process carried out is the turning process on the workpiece whose dimensions have been determined on lathe I, the machine used is the CNC LATHE TAKISAWA NEX 105/398. This process is the initial process of making the idle starter gear. This process aims to trim the entire surface area of the workpiece. The following are the steps in lathe I, including:

1. Insert the material into the machine chuck that has been provided in size then turn on the start button on the machine and the machine will carry out turning work on the material.
2. In turning large diameter surfaces from 60 mm to 57.5 mm and for material thickness from 182 mm to 180 mm.

Next, there is the lathe II process which is not much different from the working process of lathe I. In the lathe II process, turning is done on the bottom surface of the material after lathe I. The machine used in lathe II has the same type as lathe I. The following are the steps in the lathe II process , including:

1. Insert the material into the chuck of the machine in a surface position that has not yet been turned, to a predetermined size, then turn on the start button on the machine and the machine will carry out

turning work on the material.

2. This process involves turning small diameters of this material. Where the initial diameter size was 35 mm to 32.4 mm.

The shapper process is the process of forming gears in small circular diameter parts and this process uses a KANZANI CA 100 machine. The following are the process steps for the shaper, including:

1. The first shapper process is to insert the material that has been processed previously into the machine and grip it so that the material does not move easily during the processing process.
2. In this work, the tooth grooves created are sharp teeth. The cutter used has a predetermined position. When machining, the workpiece rotates to adjust the teeth on the material.
3. When the process is complete, there is a liquid or oil to clean the object from cuts in the material and the object is protected from unwanted physical defects in the material.
4. When the work is complete, a checking process is carried out in the form of a size and visual check to ensure that it is as specified, especially on the teeth.

Process *hobbing* is the process of making tooth grooves on the outside. This process uses a KASHIFUJI KP 150/070 machine. The following are the process steps *hobbing*, including:

1. In process *hobbing* The material is installed on the machine with a grip so that during the work there is no other movement and unwanted defects do not occur.
2. In the processing process, the tooth grooves created are straight teeth. Position *cutter* used is in accordance with what has been determined according to the desired material size results.
3. When the process is complete, there is a liquid or oil to clean the object from cuts in the material and the object is protected from unwanted physical defects in the material.
4. When the work is complete, a checking process is carried out in the form of a size and visual check to ensure that it is as specified, especially on the teeth.

Process *carburizing* is the process of inserting carbon into the surface of a material to increase the hardness of the material. The machine used is DOWA FURNANCE TFC 80. The step taken is to insert the workpiece inside *furnance* which has been heated according to the specified temperature, namely around 900°C for approximately 3 hours. This process requires time to determine and pay attention to the internal carbon content *furnance* (usually more than 0.5-1%). After that, process *quenching* with oil *quenching* temperature (90-200)°C. Then the material is washed and continues to the next process.

As well as the last step there is Process *tempering* namely the process of adjusting the mechanical properties of the hardened material to make it softer and its toughness increases. The machine used is DOWA FURNANCE TFC 80. Prediction *tempering* This occurs when the carbon composition changes from martensite to ferrite and pearlite. This condition causes changes in the dimensions or level of tetragonal martensite. The step taken is to insert the workpiece inside *furnance* which has been heated according to the specified temperature, namely around 350°C for approximately 2 hours. After that, process *quenching* with oil *quenching* temperature (90-200)°C. Then the material is washed and continues to the next process.

If there is an error or it does not meet the standards, it will be corrected *quality control*. This process involves checking again after all processes have been carried out. This check uses PT company standards. Morita Tjokro Gearindo by checking dimensions, roughness, size *pitch* and toughness. If there is a deficiency that does not meet the specified conditions, work cannot be done back to the level of surface nourishment unless done *scrap* or the product fails because it is defective and cannot be repaired to the previous stage.

CONCLUSION

Based on the research results of the idle starter gear manufacturing process, it can be concluded that:

1. The material used in the process of making the idle starter gear is SCM415H material which is a steel alloy. Used in structural engineering, such as bolts and nuts, gears, pinions and spindles. The chemical composition of the SCM415H material is in the form of carbon (C), silicon (Si), manganese (Mn), phosphorus (P), sulfur (S), nickel (Ni), chromium (Cr), molybdenum (Mo), and copper. (Cu).Meanwhile, for the Mechanical Composition Material SCM415H, there is a Density of (7.7-8.03)×1000

   kg/m3, Poisson's Ratio of 0.27-0.30, Elastic Modulus of 190-210 GPa, Tensile Strength of 1158 Mpa, Yield Strength of 1034Mpa, Elogation of 15 %, Reduction in Area of 53%, and Hardness of 335 HB.
2. The process of making idle gear starters has several work processes and machines used, with material preparation where the materials used in the process of making idle gear starters at PT. Morita Tjokro Gearindo is the SCM415H type produced by the supplier. Next, the lathe or turning process is the process of trimming the surface of the material according to the dimensions determined by the company. This process uses a CNC LATHE TAKISAWA NEX 105/398 machine. Then the shapper process is the

process of forming gears in the small diameter of the circle. In this work, the tooth grooves created are sharp teeth. The cutter used has a predetermined position. When machining, the workpiece rotates to adjust the teeth on the material. This process uses a KANZANI CA 100 machine. The hobbing process is the process of making tooth grooves on the outside with tooth groove dimensions that have been determined by the company. This process uses a KASHIFUJI KP 150/070 machine. Next there is a heat treatment process in the form of a carburizing process, which is a process of inserting carbon into the surface of the material to increase the hardness of the material. The machine used is DOWA FURNANCE TFC 80 and the tempering process is a process of adjusting the mechanical properties of the hardened material to make it softer and its toughness increases. The machine used is DOWA FURNANCE TFC 80.

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