Blender blade component analysis engineering essay

The blade component in the blender is function to crushing and mixing the ingredient with a very fast rotating speed. First we need to understand the structure of the blade to enable the blade perform the process like slicing and mincing. We know blade need to be fixed under high rotational speed operation, therefore the blade must have the high modulus of rigidity to prevent any distortion during the operation. It is because the shearing force acts on the blade is very high due to its speed. Since it is rotate in high speed when the food are being dump into the food container, it will cause a impact acts on the blade that will cause the blade to break or crack if the blade do not tough enough.

Besides that, the shaft will keep in contact with the food and always expose to the food chemical, therefore it must be total chemical inert. The rusting process must not be occurred to prevent health hazardous incident. The high wear resistance is also important to the blade, as it will always operate for the interrupted process. The cyclic loading will cause fatigue therefore we need hard blade. Usually wear resistance can be increase by doing a coating on the blade. Sharp edges with good strength is also very important to enable the blade perform the mincing or grinding process efficiently. The blade is versatile enough to cut almost all the food material that can be blend if needed, strength again is needed.

Here is the summary f the blender blade properties that we use as guideline in blade material selection.

Hardness

High strength

Stainless

High rigidity

High wear resistance

2. 2 MATERIAL SELECTION

2. 2. 1 BLENDER BLADE MATERIAL SELECTION

In the selection material we must consider many aspects to ensure the product that we have made successful in overall aspect. There some criteria that must be consider such as :

Physical & Mechanical Considerations

Thermal Considerations

Chemical Considerations

Bearing and Wear Considerations

Cost

Type of uses and etc

To start the material selection of the component, we have to use the various comparison charts to compare diverse of material that available. In this time around, we use the specific stiffness to specific strength, strength to cost, strength to toughness, and young modulus to density. These are primary chart that we use to ensure our selection.

In the specific stiffness to specific strength chart, we can get the result of the material that has medium specific strength and high specific stiffness. This is an important criterion of stiffness in our product.

In the strength to cost chart, we need to compromise the cost and the strength that we can maintain competitive price with the strength for safety.

In the young modulus to density chart, we need to have the mid range of density to prevent overweight of product with the high young modulus. High young modulus means that the stress that the, material can withstand before it's deform.

In between strength and toughness, we need to have both for the blades do not fail prematurely especially face the impact motion of the food encountered by blades.

Figure 3 : STRENGTH AND TOUGHNESS COMPARISON CHART

Figure 4 : SPECIFIC STIFFNESS AND SPECIFIC STRENGTH COMPARISON CHART

Figure 5 : YOUNG MODULUS AND DENSITY COMPARISON

Figure 6 : STRENGHT AND COST COMPARISON CHART

From the comparison we have made above, the suitable material that we can choose is mainly metal material either alloyed or not. But we need to consider rusting process that will that place for ferrous metal. Then we can choose either alloyed metal or ferrous alloyed metal like stainless steel.

In the result we get, we also found the material to applicable to our blade component production like ceramics. The reason we do not take it as comparison because of its brittleness. We cannot have the brittle will cause it crack when it is over it's limit then will cause the safety problem.

Based on the characteristic we found in the component, We have decide to compare two material in making blade of blender:

Alloy steel

Stainless steel

Alloy Steel Properties

[5] Alloy steel is the steel that contain some alloying elements like molybdenum, manganese, nickel, chromium, vanadium, silicon and boron. Compare with carbon steel, the properties of Alloy steels have greater strength, hardness, hot hardness, wear resistance, hardenability, and Toughness. However, to obtain the require properties, they are needed to be heat treated.

Stainless Steel Properties

[6] Stainless steel differs from carbon steel by content of chromium in steel. The main different property of the stainless steel is its corrosion resistance. Carbon steel rusts when exposed to air and moisture. This iron oxide film is active and accelerates corrosion by forming more iron oxide. Stainless steels have sufficient amount of chromium present so that a passive film of chromium oxide to prevents further corrosion

Blade material Comparison Chart

STAINLESS STEEL

PARAMETER

ALLOY STEEL

620 MPa.

Ultimate tensile strength

570 MPa.

240-290 MPa.

Yield strength

440-500 MPa.

20-24 %

Elongation

15-18 %

- High ultimate tensile

strength.

- Excellent corrosion and

oxidation resistance.

- High wear resistance

- High fatigue resistance

Advantages

- High strength-to-weight ratio.

- High stress resistance

- Good corrosion resistance

- High wear resistance

- Expensive.

- Cannot be hardened by heat

treatment.

- Hard to form compared to

cast iron

Disadvantages

- Poor in machinebility.

Difficult to done by

machining.

- More brittle than stainless

steel

- Hi strength compare to

stainless steel but less

ultimate tensile strength.

Selected Blade Material – stainless steel

In making blade, we have decided to use stainless steel because of some reason. The most important is because we need the material that have excellent in corrosion and oxidation resistance. This is because we deal in making food processor. So that the quality of food is main idea to ensure the user is safe to use is. Other than that, stainless steel has high wear resistant. This property is good to have in making the blade because it always sharp in cutting the food. The impact toughness is also the part that we tend to choose 304 steel since we have rotate in high speed to cut or slice the food. Stainless steel also has a lot of classification that we can choose for the production of the blade. Therefore we have to choose a specific class to ensure the cost estimation. After we did the research, we decide to choose stainless steel class 304 to be our material for the production.

Stainless Steel – Grade 304

Fe;<0. 08% C; 17. 5-20% Cr; 8-11% Ni; <2% Mn; <1% Si; <0. 045% P; <0. 03% S

[7] These are some of its characteristics:

– Forming and welding properties

– Corrosion/ oxidation resistance

– Deep drawing quality

– Excellent toughness

– Low temperature properties responding well to hardening by cold working

– Ease of cleaning, ease of fabrication, beauty of appearance.

Table 1. Physical properties of 304 grade stainless steel in the annealed condition

Grade

Density (kg/m3)

Elastic Modulus (GPa)

Mean Coefficient of Thermal Expansion (mm/m/°C)

Thermal Conductivity (W/m. K)

Specific Heat

0-100°C (J/kg. K)

0-100°C

0-315°C

0-538°C

at 100°C

at 500°C

304/L/H

8000

193

17. 2

17. 8

18. 4

16. 2

21. 5

500

2. 3 PRODUCT SPECIFICATION AND TECHNICAL DRAWING

2. 3. 1 BLENDER SPECIFICATION

D = 12cm

Feature:

Portable

Rechargeable

light weight

Jar Capacity :

up to 1. 5 liters

H = 30cm

B = 16cm

L = 18cm

2. 3. 2 EXPLODED VIEW OF BLENDER

Figure 2 : Blender Exploded View

Part

Part name

1

Cap

2

Lid

3

Jar

4

Jar / blade seal

5

Blade set

6

Jar coupling

7

On-off button

8

Button spring

9

Upper housing

10

Motor &bushing

11

Motor mount screw

12

Switch, on-off

13

Switch, interlock

14

Screw

15

Mini phone jack

16

Diode

17

Zener diode

18

Battery cell

19

Base cover

20

Screw, handle

21

Foot

22

Charger

2. 3. 3 BLENDER BLADE SPECIFICATION

3. 0 STAGES OF THE PROCESS

3. 1 ALTERNATIVE PROCESS FOR EACH COMPONENT

3. 1. 1 BLENDER BLADE ALTERNATIVE PROCESS

The suitable process of blade production are casting, stamping and forging, we can still produce the blade even with different material. But every process must has it’s limitations and own advantages.

The process selected is shown at table below:

Figure 7 : Blade Manufacturing Alternative Processes

Since we have chosen the material, then we have look at the process to produce the product. There are diverse of process of available outside, we need to choose appropriately to suite the material properties and the functionality of the component. There are several guidelines that we need to obey. The selection of a suitable process is based on the following factors:

Types of materials and its properties

Expected quality and properties of the components

Size, shape, thickness and complexity in producing the components

Tolerances and surface finish

Incoming processes involves

Design and tooling cost

Volume of production

Economy

Now the chart above has shown 3 primary processes that we will discuss further to choose the best production process. Now we discuss the casting process. The process is a popular manufacturing process that can have many advantages. The reasons why we choose the investment casting process among various process of casting are because any material can cast through this method. The investment casting process is economical even for quite low quantity normally minimum quantity is 1000. Furthermore, the complex shape can be produced which meet the blade design. Heat treatment of the casting product is not needed. Excellent surface finish and accuracy also can be produced through this method. Again it suites the component requirement that dimensional and surface finish. But the process has the disadvantages. We have the expensive die tool and material cost , long lead time to have the final product, labor cost is high. After we have seen the process we have the clearer picture of the process.

The next process we will discuss the forging process. The blocker type of the forging will be used in this process. This is because this type has the low die cost compared to other forging process. The production rate is high that will meet the company minimum production requirement. Forging will have the die to apply the compressive force on it in order produce the shape we want. In the blocker forging, need to do the machining to get the net shape we want. The part will not be a suitable choice if the parts are thick webs and large fillets. The main cost is come from the die cost which influenced by shape and size of the component. The quantity is also the major concern in cost basis manufacturing.

Then we will reach the stamping discussion. Stamping also the kinds of sheet metal forming using the stamping die and apply the force on the sheet material. [18] The cost effectiveness of the metal stamping process stems from its ability to produce material-intensive parts at production rates much higher than are possible using other traditional methods. With material for stamping approximately equaling usage in another process, the prime area for savings is in cutting production time.

From the above discussions, we can see that stamping will bring us the most economical process. Although we need to bear with the high start-up cost, but through the long term, the turnover is still good. The investment casting is too laborious and long lead time which does not suite our marketing policy; the forging is more suitable for large component.

3. 2 PROCESS SELECTED AND TOTAL PRODUCT STAGES

3. 2. 1 BLENDER BLADE MANUFACTURING PROCESS

3. 2. 1. 1PROCESS SELECTED FOR BLENDER BLADE

After weighing the pros and cons of process, we have chosen the stamping which derived processes from progressive die drawing.

[22] By using stamping process, there are some advantages compare with other process like forging and die casting. First of all, the stamping dies can cost considerably less than the tooling used in other processes. Other than

that, the Quality, accuracy, function, wear life and appearance can all be dramatically improved. By using stamping process, the part of material with tougher and harder properties can also be made. Secondary operations like heat treatment and machining are needed to finish a part. The number of secondary operation is reduced and it can save the cost.

To produce blender blade by stamping process, there are some secondary process to be taken in. after the component is stamped out from the stamping machine, we need to drill a small hole on the component for the assembly purpose. After that, bending process will take in to obtain the functional shape of blender. Then, the component is then to be heat treated to improve its mechanical properties like strength and toughness. Finally, a finishing process will take in to sharpen the blade edge by machining process and improve the wear resistance by addition process like coating of blade with titanium.

3. 2. 1. 2 BLENDER BLADE STEPS FLOW CHART

The stages for blade manufacturing system are shown in the steps flow chart below:

Figure 8 : STAGES OF BLADE MANUFACTURING BY STAMPING

3. 2. 1. 3 BLENDER BLADE PROCESS STAGE AND MACHINE USED

Stamping

The process is start by stamping of a large sheet of metal. We will use blanking process which is a cutting process by using punch and die to produce the blade profile. For blanking process, the product is the part which is sheared out by punch. To carry out the blanking process, the stamping die and stamping machine is needed. The blade product by blanking process is shown at the figure below:

Component

(product)

Strip

(work material)

Scrap (discard)

Figure 9 : blanking of blade

Characteristics Of Stamped Parts

[22] after stamping process, there are BURR-SIDE or CUT RADIUS characteristic on the stamped parts. There is a rough edge or breakaway burr around the side of the pierced holes. At The opposite side, there is a cut radius or “ rollover” effect where the blanking or piercing punch enters the metal surface. Both of these defects can be corrected if they affect the function ablility of the component. Deburring processes can be used to remove the burrs. Deburring process is done by using deburring tool, tumbling, or sanding. Drilling will make the holes straight through the entire part thickness. A shaving station in a progressive die can reduce the need for secondary handling operations. Also, using thicker stock than the final size

called for and double disc grinding, or single side grinding, as required will remove burrs and rollover.

After stamping process, the phenomena of CONCENTRICITY can be found on the product itself. The contour of the inside and outside shows different properties and even thicknesses. the variance can be reduce by extra allowance to the products made.

Besides the concentricity, the flatness/blanking distortions also common phenomena that occur in the stamped product after stamping process. There is the bowing raise in the product due to periphery stress. The size of the bowing varied with the material and type of die used. The solution of the defects can be through the usage of compound die.

Machine used for stamping process – Stamping Machine

In the stamping machine the major operation is where a metal sheet is being punched using a press tool in order to give out into desired shape. Different stamping process require different type of die. Example of blanking die is shown in figure 9

Figure 10 : Stamping Machine

Figure 11 : Stamping Die

Drilling

Once the component is stamped out, the drilling process will take in to drill a hole on the blade for the assembly purpose. A drilling machine is needed to drill the hole. The component after drilling process is shown in the figure below:

Drilling machine

Component

(Product)

Figure : Drilling Of Blade

Machine Used – Drilling Machine

[23] A drilling machine, called a drill press, is used to cut holes into or through metal, wood, or other materials.

Drilling machines use a drilling tool that has cutting edges at its point.

This cutting tool is held in the drill press by a chuck or and is rotated and fed into the work at variable speeds.

Drilling machines may be used to perform other operations like countersinking, boring,

counterboring, spot facing, reaming, and tapping

Figure 13 : drilling machine

Bending

To obtain the better function ability of the blender blade, the shape of the blade should be bending with certain angle as shown in the figure 9. This is a plastic deforming process to change the shape of metal blade. Note has to taken that the bending part of the component is under high stress after the bending process. To overcome it, heat treatment will taking place to hardening and restore the stress. The component after bending process is shown at below:

Figure 14 : Bending Of Blade

Machine used: Bending Machine

[24] Bending is a common manufacturing method to process sheet metal. It is usually done on a Press brake, but also swing-bending-machines are used. With this machine a bending material is being bent by following the predetermined angle as a reference. The bending operation creates a straight line bend while form operation may create a curved bend.

Figure 15 : CNC Bending Machine

Heat treatment

[25] To restore the residual stress that trap in the stamped product, heat treatment is usually carried out. Heat treatment can heat the metal to recrystallization temperature that will realign the grain in the metal. The heat treatment of the metal, the crack can be reduced and it can be hardened as the finer grain can be obtained. The following describe the process heat treatment of the blade.

The blade lay on the ceramic tray then heat up to the specified temperature to harden the part. The oven usually is preheated to faster the process. The heating process last for 2 hours. After process the ceramic tray take out from the oven. The immersion of the product into oil or water to perform quenching. This trap the intricate crystal in the metal structure. This process also results in the metal becoming very brittle. After quenching, the blades are reheated to approximately 260°C. Then the blades are allowed to cool slowly in a process called tempering. This toughens the metal while retaining some of the brittleness needed for fine sharpening. Further heating and cooling cycles may be used to harden other specialized alloys.

Machine Used: Heat Treating Oven

[26] Heat treating oven is use to heat the material up to 760°C – 1370°C

It has the function to control the temperature and pressure of heating.

The box furnace can handle exothermic, endothermic, and enriched atmospheres including air, nitrogen, and argon.

Figure 16 : heat treating oven

Machining

Finally, the blade will undergoes machining process as the finishing process. [25] After the heat-treated blades are cool, they are polished and sharpened. Polishing is performed by machine in our case. A flat belt sander is used to produce a smooth finish to the sides of the blade. This also polishes out any marks from the punch press operation and removes the surface residue from the heat-treat operation. Next the blade is placed into a grinding fixture that passes it through a series of grinding wheels. Each rotating wheel removes the correct amount of metal to form the edge relief, point, rough edge angle, and other features of the working portion of the blade. When the blade is finished with these steps, it will be quite sharp and may appear ready to use. However, the final sharpening steps are required to produce a long-lasting edge.

Honing is the last process to take in. the sharp edge of blade is produced by a fine grinding operation and called honing. The angle of the hone may be between 17 and 30 degrees to the axis of the blade, depending upon the blade application. A smaller angle will produce a sharper edge, but the edge will wear and become dull more quickly. A fine grinding hone, or " stone," is oiled and gently rubbed on the knife edge. This action produces the finest sharpened edge .

Machine Used : Belt Sander

[27] A belt sander is a machine used to sand down wood and other materials for finishing purposes. It consists of an electrical motor that turns a pair of drums on which a seamless loop of sandpaper is mounted.

Figure 17 : Belt Sander

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