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**MATRIC NUMBER: 15/ENG06/035**

**DEPARTMENT: MECHANICAL ENGINEERING**

**COURSE CODE: MEE 510 (PRODUCT DESIGN)**

**PROJECT TOPIC: Design and fabrication of a pelletizer for agro based products**

Material selection, functions and reason for selection.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/N** | **Components**  | **Function** | **Materials** | **Reasons for Selection** |
|  | Headstock  | It houses the spindle (on a lathe, the spindle holds a chunk which holds and rotates the work piece) | Mild Steel | Durability High Strength |
|  | Tool Rest  | It supports one end of the work when machining between centers | Angle bar mild steel  | Durability High Strength |
|  | Tailstock  | It provides a support the free end of work during operation. | Cast Iron | High Strength Better wear resistance Easy Machinability |
|  | Shaft  | It transfers torque and motion from the pulley to turn the headstock | Cast Iron  | High strength better wear resistance easy Machinability |
|  | Flange Bearing  | Put the bearing into position | Cast Iron | Firm support better wear resistance  |
|  | Pulley  | It transmits the torque from the electric motor to the Shaft | Cast Iron  | Low cost  |
|  | Stand  | It allows the body to rest on firmly and absorbed vibration | Angle bar mild steel | Durability high strength  |
|  | Bearing  | To allow free movement of the live center | Cast Iron | Low cost  |
|  | V-Belt  | To transmit the torque from the electric motor to the pulley | V-belt 25mm IS-2494-1974 Leather  | Suitability for the working condition in service  |
|  | Metal Sheet  | It is used to protect the headstock | 1mm mild steel | High strength  |
|  | Electric motor  | To generate a torque for theSystem | 2hp |  |

Design specification

|  |  |  |  |
| --- | --- | --- | --- |
| Part no | Component parts | Quantity | Dimension |
|  | v-belt | 2 | 800mm diameter |
|  | pully | 1 | 700mm |
|  | Angular iron | 4 | 6mm thickness |
|  | shaft | 2 | 30mm |
|  | Electric motor | 1 | 2hp |
|  | Mild steel plate | 2 | 6mm thickness |
|  | Pillow bearing | 2 | 25mm diameter |

1. Belt Design

The belts is used to transmit power from one shaft to another by means of pulleys which rotate at the same speed or at different speeds. The amount of power transmitted by a belt depends upon the following factors:

1. The velocity of the belt.
2. The tension under which the belt is placed on the pulleys.
3. The arc of contact between the belt and the smaller pulley.
4. The conditions under which the belt is used.

A belt can also be defined as a loop of flexible material used to link two or more rotating shafts mechanically. Belts are frequently necessary to reduce the higher rotational speeds of the electric motor to lower values required by mechanical equipment. A *V*-belt is selected for this design.

Table 3.8: Bill of Engineering Measurement and Evaluation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **1** | **Materials** | **Parts** | **Quantity** | **Rate** | **Processing** | **Amount** |
| 2 | Angle Iron 3"x3" 6mm thick | Frame | 2 | 9000 |  | 18000 |
| 3 | Angle Iron 2"x2" 6mm thick | Frame | 1 | 6500 |  | 6500 |
| 4 | Mild steel plate 6mmX500mm x500mm | Frame | 1 | 30000 |  | 30000 |
| 5 | Mild steel diameter 30 x400mm | Spindle Shaft | 1 | 3000 | 15000 | 18000 |
| 6 | Mild steel diameter 25x300mm | Tail stock Shaft | 1 | 2000 | 6500 | 8500 |
| 7 | Mild steel diameter 25x350mm | Electric motor base hinge | 1 | 2500 | 3000 | 5500 |
| 8 | Mild steel hollow diameter 60x250x5mm | Tail stock barrel | 1 | 5500 | 7500 | 13000 |
| 9 | Hand wheel diameter 120mm | Tail stock handle | 1 | 1500 | 1000 | 2500 |
| 10 | Pillow bearing diameter 25mm | Bearing | 2 | 4000 |  | 8000 |
| 11 | Mild steel diameter120x200mm | big step pulley | 1 | 15000 | 9500 | 24500 |
| 12 | Mild steel diameter 70x150mm | small step pulley | 1 | 3000 | 5500 | 8500 |
| 13 | Sheet metal 1mmx600x200mm | Frame | 1 | 18000 |  | 18000 |
| 14 | Mild steel bar 60x200mm | Revolving center | 1 | 3500 | 2500 | 6000 |
| 15 | Mild steel bar 50x100mm | Dead center | 1 | 2000 | 2000 | 4000 |
| 16 | Mild steel bar 25x400mm | lock, hand for tail stock | 1 | 3000 | 1500 | 4500 |
| 17 | Mild steel bar 50x400mm | Lock base for tail stock | 1 | 4000 | 2500 | 6000 |
| 18 | Mild steel plate10x100x300mm | Crest base slider | 1 | 12000 | 2500 | 14500 |
| 19 | Electric motor 2hp | Power | 1 | 50000 |  | 50000 |
| 20 | V belt | Transmission | 1 | 1500 |  | 1500 |
| 21 | M10 bolts and nut, flat washer and spring | Fastner | 1 dozen each | 1300 |  | 1300 |
| 22 | M8 bolts and nut, flat washer and spring | Fastner | 1 dozen each | 1000 |  | 1000 |
| 23 | M12 bolts and nut, flat washer and spring | Fastner | 1 dozen each | 1500 |  | 1500 |
| 24 | M24x50 bolts and nut, flat washer and spring | Fastner | 1 dozen each | 3000 |  | 3000 |
| 25 | electrode |   | 1pack | 5000 |  | 5000 |
| 26 | cutting disc |   | 4 pieces | 500 |  | 2000 |
| 27 | grinding disc |   | 3pieces | 1000 |  | 3000 |
| 28 | hack saw blade |   | 3pieces | 1000 |  | 3000 |
| 29 | paint red oxide | Paint | 1litre | 1500 |  | 1500 |
| 30 | paint blue | Paint | 1litre | 1500 |  | 1500 |
| 31 | tinner | Paint | 1litre | 1500 |  | 1500 |
| 32 | paint brush |   | 2 pieces | 500 |  | 1000 |
| 33 | Transport |   |  |  |  | 30000 |
|   | **TOTAL** |   |  |  |  | 302800 |

 **DESIGN CALCULATIONS**

With reference to some standard values recorded by (Khurmi & Gupta, 2005), the following assumptions were made.

1. Allowable tensile stress in belt, a = 2.8MPa = 2.8*N/mm2*
2. Coefficient of friction between belt and pulley (u)=0.25
3. Maximum permissible stress in the shaft, Tmax = 42N/mm2
4. Required speed of belt, V=6.7m/s = 400m/min
5. **Length of Belt Required**

 The length of the belt is given by;

$$L=\frac{π (D+d)}{2}+\frac{2y\left(D-d\right)}{4y}2+2y$$

 Where:

 L = the length of belt

 D = diameter of motor pulley

 d = diameter of the spindle pulley

 Y = distance between the two pulleys

$$L=\frac{π (D+d)}{2}+\frac{2y\left(D-d\right)}{4y}2+2y$$

$$L=\frac{π (120+80)}{2}+(\frac{\left(120-80\right)}{4×580})2+2×580$$

$L$ =1474.2mm

Hence standard grade A V-belt designated A 62, 1636 is selected.

1. **Power Transmitted Per Belt**

According to (Banga, et al, 2004), the power transmitted per belt is given as the product of the belt velocity and the effective pull applied at the rim of the pulley. It is expressed mathematically as:

$$P=\left(T\_{1}-T\_{2}\right)V$$

Where:

P = power transmitted

T1 = tension in the belt tight side

T2 = tension in the belt slack side

V = velocity of belt

For a wood working lathe the belt drive operates at a speed range of 1 to 10m/s (Khurmi and Gupta, 2008), with a spindle speed ranging from 1200 to 36000rpm.

But weight per meter length of belt

W =1.06N/M

Mass per length, m =$\frac{1.06}{9.81}$

 = 0.11kg/m

**3. Centrifugal tension:**

$$T\_{C}=MV^{2}$$

 Where:

 $T\_{C}$= the centrifugal tension

 M = mass per length

 V = required speed of belt

 therefore; $T\_{C}=MV^{2}$

 = 0.11 X 82

 = 7.04N

1. **Maximum tension in the belt:**

Allowable tensile stress in belt, a = 2.81MPa= 2.8*N/mm2*

$$T=a×A$$

= 2.8 x 83.25

= 233.1N

Hence, in the belt tight side:

$$T\_{1}=T-T\_{C}$$

=233.1-7.04

= 226.06N

According to (Erik *et al.,* 2000), the lap angle (Ѳ) is given as

$$θ=2cos^{-1}(\frac{D-d}{2y})$$

Where:

D = diameter of driven pulley

D = diameter of driving pulley

Y = distance between centers of pulleys

$θ$ = are of control (lap angle)

$θ$ $ =2cos^{-1}(\frac{120-80}{2×580})$

= 176.04o

1. **Shaft Speed and Motor Speed**
2. Shaft speed (N1): According Khurmi & Gupta, 2005 the shaft speed is calculated by the formula:

 $N\_{1}=\frac{1000×V}{π×D}$

= $ N\_{1}=\frac{1000×400}{π×120}$

= 1060 rpm.

1. Motor speed (N2): According Khurmi & Gupta, 2005 the speed of the motor is gotten from the formula:

$N\_{2}=\frac{1000×V}{π×d}$=

$$N\_{1}=\frac{1000×400}{π×80}$$

= 1591 rpm.

1. **Power required**

Power(req) = Power transmitted by belt x machine service factor

 $P\_{(req)}=P×K$

= 1.4 x 1.3

= 1.82kw

= 1820w

= 2.0 Horse power

Torque = $ \frac{Power }{Angutar }$

 = $ \frac{p }{w }$

=P $÷ \frac{2πN }{60 }$

=$ \frac{60P }{2πN }$

= $ \frac{60 X 1820 }{2 x π x 1591}$

= $ \frac{109200 }{9997.844 }$

 = 10.92NM

The implies that the motor have a capacity of 2hp and can rotate at 1591rpm given a torque of 10.92NM

Where service factor for a machine tool is 2.0

1. **Torque transmitted by the shaft:**

 $T=\left(T\_{1}-T\_{2}\right)R$

 = $T=\left(226.06-16.6\right)65$

 = 13614.9 N-mm

Vertical weight on the pulley:

 $W=\left(T\_{1}+T\_{2}\right)$

 = $T=\left(226.06+16.6\right)$

 = 242.66N

 Bending moment:

$M=W×X$

 = 242.66 x 150

 = 36399Nmm

 Substituting T equation 3.13 and M 3.15 in equation

d = ($ \frac{16 }{πomax }$ (M2 +T2)1/3

d = ($ \frac{16 }{π42 }$ (363992 + 13614,92) 1/3

 = 4469.89mm

**Discussion of Results**

The model of the machine was tasted and simulation was carried out in dynamic simulation environment of the Autodesk Inventor Software. The shafts are made of steel with the required properties. Other components were appropriately computed and calculated and they all indicate design compliance.

Wood lathe machine was fabricated based on engineering approach with the aid of software computer aided design and values, the performance and efficiency of the machine is a benchmarked against the commercially available wood lathe machines. The wood lathe machine was tested to determine the extent to which the design specification and the overall performance goals of the machine were achieved. This was done at the College of Engineering central workshop. The test of the result confirmed the performance of the machine. The electric motor rotated the headstock spindle with the aid of the V- belt ad pulley with the speed range of 1591 rpm and the headstock spindle rotated the wood mounted between the headstock and the tailstock centers of 480mm to create the desired shape.