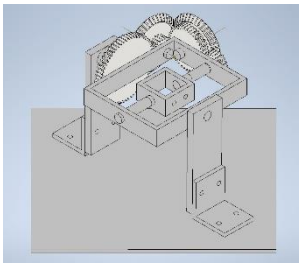
TA202A PROJECT REPORT

(Wax Ball Making Machine)



Group No. 51 (Thursday)

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Remarks: _____

Project Overview

The objective of Wax Ball making Machine is to develop a process for quick production of balls made up of low melting point materials. This project consists of 9 parts, for one of which wood was bought as raw material and the part actually manufactured by us. The cost of the project is calculated to be Rs. 5678 . The project could have been made better by cutting the shape for cavity using CNC machines which would have made it more accurate hemisphere, and holes could have been made in the gears in order to reduce weight.

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Torque and other calculations

Speed calculations according to gear teeth ratio:

No of teeth in Fixed Spur gear = 60

No of teeth in Large Spur gear = 40

No of teeth in Bevel gear 1= 40

No of teeth in Bevel gear 2= 40

No of teeth in Small Spur gear = 20

Therefore, angular velocity increases by a factor of

$$\frac{60}{40} \cdot \frac{40}{40} \cdot \frac{40}{40} \cdot \frac{40}{20} = 3$$

Hence angular velocity of the small spur gear is 3 times the angular velocity of motor.

Torque calculations:

Density of mild steel: 7850 kg/m^3

Density of teak wood: 685 kg/m^3

Required acceleration torque is given by: $\tau = \frac{J \times N}{9.55 \times t}$, where:

J is moment of inertia

N is speed in rpm

t is acceleration time

First calculating Moment of Inertia:

- Due to frames(inner and outer):

  For a frame with length l, breadth b, height h and thickness t, moment about required axis is given by

$$J = \frac{\rho h[lb^3 - (l - 2t)(b - 2h)^3]}{12}$$

  Hence, we put values as $l = 0.135, b = 0.17, h = 0.025, t = 0.006$ for outer frame and get $J = 0.0029$

  For inner frame, as $l = 0.09, b = 0.09, h = 0.025, t = 0.006$ for outer frame and get $J = 0.000467$

All are in SI Units (kgm^2)

- Due to gears and counterweight:

Modelling gears as cylinders,

$$J = \frac{\rho \pi d^4 t}{32}$$

We calculated J for each gear by putting values as already mentioned above and in drawings.

SpurFixed :0.0005056

SpurLarge:0.00009987

SpurSmall:0.00000624

BevelGear:0.00033175

All are in SI Units (kgm^2)

- Due to wooden block:

$$J = \rho abc \frac{a^2 + b^2}{12}$$

Putting $a = b = c = 0.067m$, we get $J = 0.0001541 kgm^2$

Effective J for torque calculation,

$$J_{eff} = (J_{block} + J_{innerframe} + J_{spursmall})(\frac{D_{SpurFixed}D_{SpurLarge}}{D_{SpurSmall}^2})^2 + (J_{spurlarge} + 2J_{BevelGear} + J_{spursmall})\left(\frac{D_{spurfixed}}{D_{spursmall}}\right)^2 + J_{static},$$ where

$$J_{static} = J_{frames} + J_{block} + J_{gears} + J_{counterweight}$$

Putting values, $J_{eff} = 0.06499$. For acceleration time 0.15sec and rotation speed 30RPM,

$$T = \frac{J \times 30}{9.55 \times 0.15} = 1.3610Nm$$

With a factor of safety 2, $T = 2.722\ Nm$.

Hence we take a motor of 3Nm torque.

Diameter of ball = 39.7 mm

Volume = $33.51cm^3$

Time taken to solidify = s

PARTS LIST

Part Name	Quantity	Material Required	Manufacture/ Bought	Processes used
Base Plate	1	Mild Steel Plate	Manufactured	Drilling
Angle	2	Mild Steel Angle	Manufactured	Drilling
Stand	2	Mild Steel Flat	Manufactured	Drilling, Cutting with saw
Frame components	1	Mild Steel Flat, Mild Steel Rod dia 12.7mm	Manufactured	Drilling, Cutting with saw, Vertical Milling
Bevel gear	2	Mild Steel Rod dia 90 mm x 12 mm	Manufactured	Turning, Milling
Spur Large	1	Mild Steel Round Rod dia 70 mm x 12 mm	Manufactured	Turning, Milling
Spur Small	2	Mild Steel Round Rod dia 36 mm x 12 mm	Manufactured	Turning, Milling
Spur Fixed	1	Mild Steel Round dia 100 mm x 12 mm dia 28 mm x 35 mm	Manufactured	Turning, Milling
Box	2	Teak Wood, PLA	Manufactured (wood material and springs bought)	Drilling, Cutting with saw

Collars for restricting axial shaft motions will be made as required using 3D Printer.

Bevel Gear Calculations

Without Collar

Outer diameter = 82.828 mm

No. of teeth = 40

Module = 2

Facing angle = 47.025° (For Lathe M/C)

Cutting angle = 42.658° (For Milling M/C)

Depth = 2.157*2 = 4.314 mm

Tap hole = 5.2 mm drill and 0.25 in

Indexing = 40/N = 1

Pitch diameter of gear(o) = 40*2 = 80 mm

Pitch diameter of pinion(d) = 40*2 = 80 mm

Pitch cone angle of gear = $\tan^{-1}(1)$ = 45°

Pitch cone angle of pinion = 90°- 45°= 45°

Pitch cone radius for both gear and pinion = 40√2 mm = 56.5685

Addendum for both gear and pinion = 2

Addendum angle = 2.025°

Dedendum for both = 2.314

Dedendum angle = 2.342°

Addendum + Dedendum = 4.314

Tooth thickness = 1.5708*2 = 3.1416

Cutting angle = 45-2.342 = 42.658

Face angle of gear = 45+2.025 = 47.025

Cutting angle of pinion = 45 - 2.342 = 42.658

Face angle of pinion = 45 + 2.025 = 47.025

Angular addendum of gear = 1.414

Angular addendum of pinion = 1.414

Outside diameter of gear = 80 + 2.828 = 82.828

Outside diameter of pinion = 80 + 2.828 = 82.828

No. of teeth needed to select a cutter for the gear = 40√2 = 56.5685

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No. of teeth needed to select a cutter for the pinion = 40√2 = 56.5685

~ 57

Spur Large Gear Calculations

Without collar

Module (m) = 1.5

Number of teeth (N) = 40

Outer diameter = m(N+2) = 1.5 (22) = 63 mm

Depth of cut = 2.157 m = 3.2355 mm

Rod diameter = 1/2 ”

Indexing = 40 / N = 1

Spur Small Gear Calculations

Without collar

Module(m) = 1.5

Number of teeth(N) = 20

Outer diameter = m(N+2) = 1.5 (22) = 33 mm

Depth of cut = 2.157m = 3.2355 mm

Rod diameter = 1/2 ”

Indexing = 40/N = 2

Spur Fixed Gear Calculations

With collar

Module(m) = 1.5

Number of teeth(N) = 60

Outer diameter = m(N+2) = 1.5 (62) = 93 mm

Depth of cut = 2.157m = 3.2355 mm

Rod diameter = 1/2 ”

Indexing = 40/N = 2/3

Cost Analysis

Mass of project = 13.78 kg

- Hence material cost is around $13.78 \times 100 = 1378$

Hours operated for each operation:

Milling:

- 220 teeth in total makes up 5 hours of milling
- 8 × vertical milling makes up 1 hour of milling

Hence total milling cost is $6 \times 250 = 1500$.

Drilling:

- In total around 5 hours of drilling was done, counted according to number of holes drilled, accounting 5mins for each hole.

Hence total drilling cost is $5 \times 75 = 375$.

Turning:

- Around 12 attempts were made to make pins for fitting gears, making up 2.5 hours of turning
- 6 gears were made in total, adding around 7 hours of turning

Hence total turning cost is $9.5 \times 150 = 1425$.

3D Printing:

- The printer was used for 20 minutes.

Hence 3D printing costs are $\frac{1}{3} \times 100 \approx 34$

Adding all these costs and the electric kit, we get total cost as

$$1378 + 1500 + 375 + 1425 + 1000 + 34 = 5712$$

Total cost is Rs. 5712.