

Design and Fabrication of Automatic Potato Peeling Machine

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Abstract

Peeling of potato is an inevitable need [8]. The potato peeling process faces a large range of problems like that of your time consuming and becomes inefficient during weekly breakdown maintenances. It's vital for the food processing industry still as in domestic point of view. Mechanization of processing operations will play an important role in removing the negative attributes of the standard processing techniques and promote timely large scale production with desired quality. This paper shows the chronological Development of mechanical peeling and also highlights a new concept of potato peeler, which might be the essential requirement under breakdown maintenance. The aim of our paper is to style and fabricate the prototype of the peeling machine. It's geared toward providing a base for the commercial production of a peeling machine, using locally available raw materials at a comparatively low cost. The machine constitutes a drum, abrasive based peeling [11].

Keywords: *Potato Peeling Machine, Quality, Mechanical peeling, Components*

INTRODUCTION

Peeling of potatoes and fruits is one of the most frequent operations at hotels, canteens and restaurants, even for household purposes[10]. The vegetable is probably the most popular Food and

widely consumed item in the Indian diet. It is grown all over the country, with Uttar Pradesh growing the maximum quantity. India ranks fourth in area and third in global vegetable production. It produces around 8 % of the world's total production.

There are different types of mechanical peelers in Roshan. Metal [1-15] the machine used for peeling operation is an abrasive coated rotating drum with a peeling efficiency 78% and a peeling loss of 6%. While Vishal.S.Karpe et al. [2].designed an automatic fruit peeling machine, where the peeling is accomplished by placing the fruits between rotating fruit holders, thus getting peeled horizontally. P.Embomwomyl et al [3-12] emphasize the concept of design and Development of a semi-automated potato slicing machine, the electrically operated device is designed to cut the whole into slices of the thickness of 2.5mm. Ajibola et al [4] designed a manual potato peeler cum slicer; the material used was stainless steel, and the slicing efficiency was 88%. S.K. Tyagi et al [5] fabricated a potato washing cum peeling machine which consists of a specially designed peeling drum and spraying unit for washing[10].

Based on the mechanism used for peeling, the system uses a knife or blade, abrasive rollers, milling cutters and rotary cutters[12]. Rotary cutters are more flexible among all, even on different, uneven surfaces[13]. Among the current peeling methods, mechanical peeling can attract customer satisfaction because of its

benefits. The mechanical peeling became so popular because they produced fresh peeled products. As the view of customers became more important for food processing industries, more researchers have shown interest in the mechanical peeling process[8]. Many factors were considered in the design of the cutting machine, which includes the physical and mechanical properties of the materials for construction. The blade of the cutting machine is usually expected to be sharp enough to cut easily. Further, the materials needed for the construction of the machine must neither contaminate the potato nor get corroded when in contact with water[7]. Stainless steel materials were therefore used for fabricating components. Other considerations in designing the machine included the cutting resistance of the potatoes, moisture content and thickness of the slice, speed of cut, maximum power requirement, power source and contamination[9].

LITERATURE REVIEW

Roshan M. Hatwar, Kunal T. Rahandale, Mohan G. rivedi, DzConcept, Design and Development of Semi-Automated Potato Slicing Machinedz the look of the semi-automated potato chips machine is predicated on the technical idea of the mixture of rotary and longitudinal motion

produced by motor and leverage mechanism, blade angle and also the rotation of the wheel provides required slices thickness. The machine is straightforward to control and simple to fabricate. This machine allows in its simplicity of design and modest cost with the power to come up with thin uniform slices. The capacity of the machine is 60kg/h and a pair of 0mm thickness of chips.

Vivekanand, DzDesign and Fabrication of Twisted Potato Crisps Makerdz The design of the twisted potato crisps maker relies on the technical idea of the mix of rotary and longitudinal motion produced by the handle, blade and also the pitch of stud provides required slices thickness. The slicing efficiency obtained was 95.8-96.1%, with average losses of 4.1%. The capacity of the machine was 9.6kh/h, and the thickness of crisps meets the necessity of a small scale processing unit. Mr. Kartika S.B., Mr. Arahamth, DzDesign and Development of a Potato Slicerdz The devices have an easy construction and might be used for slicing within the range of (1.2mm). The slicer is safer and more productive. These devices are simple as there's no need for a power source, and there's no complex mechanism. The potato slicer may be used for slicing the potato-

like potato, carrot, onion, etc Khan Chand, R.K. Pandey, N.C.Shahi, U.C. Lohani, DzPedal Operated Integrated Potato Peeler and Slicerdz A pedal-operated integrated potato peeler and slicer was designed and developed. The scale of the unit was 960*990*1.110mm, and therefore the weight of the unit was 80kg. It may be operated by one person. Its capacity and efficiency was 65kg/hr and 88.5%, respectively. The integrated unit saved 88% and 54% energy consumption compared to manual peeling-slicing and the hand-operated peeler-slicer team.

Tony Thomas A., Muthukrishnan A., Sre Nandha Guhan K.S. DzDesign and Development of Automated Potato Cutting Machinedz Thus, this work provides another to the present automatic potato cutter, in terms of automating the potato entry into the cutting apparatus, eliminating power fluctuation and lesser initial investment time consumption is a smaller amount in comparison to manual cutting. This work provides the specified output, and also the style of the cuts is completed by use of the various cutting grid.

METHODOLOGY

1. Study of cutting and peeling mechanisms.
2. We developed a design for cutting and peeling.
3. Material selection for frames, drum, disc plate, gear, pulley, shaft.
4. Design of belt, gear, shaft
5. Selection of motor.
6. Drawing 2D Catia
7. Fabrication and testing of the machine.



Fig.1 Abrasive drum

COMPONENTS AND OUTLINE

Abrasive drum Figure.1 shows the abrasive drum. This cylinder is surfaced by tricky alumina abrasive, 1.4 millimeters thick that's glued to a cotton web packing- which is successively glued to the cylinder. This part plays a many roles in peeling the potato[12].

Specification of DC motor:

Speed $N = 60 \text{ rpm}$

Voltage $V = 12 \text{ Volt}$

Current $I = 7.5 \text{ A}$

Power $P = V \times I = 12 \times 7.5 = 90 \text{ W}$

Torque $T = (P \times 60) / (2 \times 3.14 \times N)$

$= (90 \times 60) / (2 \times 3.14 \times 60) = 15 \text{ Nm}$

Speed $N = 1440 \text{ rpm}$

Power $P = 1.5 \text{ horse power} = 1119 \text{ W}$

Torque $T = (P \times 60) / (2 \times 3.14 \times N)$

$= (1119 \times 60) / (2 \times 3.14 \times 1440) = 7.5 \text{ Nm}$

MATERIAL SELECTION

Table 1: Material Properties

Material	Weight of 1m*1m*0.02m sheet (Kg)	Brinell hardness (BHN)	Resistance to break (Joules)	Corrosion rate (mm/year)
Mild Steel	7.7	130	190	0.36
Stainless Steel	7.5	123	178	0.38

From Table.1, we can know the properties of mild steel and stainless steel. Mild steel was the material selected for the fabrication of the frame, disc plate, drum and shaft. Cutting blades are of the material stainless steel.

Design of belt

$$2.3 \log (T_1/T_2) = \mu \theta \sin \alpha$$

θ – Angle of wrap of an open belt

μ - coefficient of friction

T1 – Tension in the tight side of the belt

T2 – Tension in the slack side of the belt

$$2\alpha = 40^\circ$$

Angle of wrap, $\theta = 180 - 2\alpha$

$$\theta = 180 - 2 \times 20 = 140^\circ$$

$$= 140 \times \pi / 180$$

$$= 2.44 \text{ rad}$$

Belt speed, $v = \pi \times D \times N / 60$

$$v = \pi \times 25.4 \times 10^{-3} \times 1440 / 60$$

$$= 1.915 \text{ m/s}$$

Power, $p = (T_1 - T_2) v$

$$T_1 - T_2 = p / v$$

$$T_1 - T_2 = 11191.915 / 584.34 = 19.15 \text{ N}$$

$$T_1 - T_2 = 584.34 \text{ N} \dots\dots\dots (1)$$

$$\mu = 0.3$$

$$T_1 / T_2 = e^{0.3 \times 2.44 \sin 20}$$

$$T_1 / T_2 = 8.5$$

$$T_1 = 8.5 \times T_2 \dots\dots\dots (2)$$

$$(8.5 \times T_2) - T_2 = 584.34$$

$$7.5 T_2 = 584.34$$

$$T_2 = 584.34 / 7.5 = 77.9 \text{ N}$$

$T_1 = 8.5 \times 77.9 = 662.3 \text{ N}$, where T_1 and T_2 are tensions on the belt.

Design of shaft for DC motor

$$1 \text{ Kg} = 1000 \text{ g} = 9.81 \text{ N}$$

$$1 \text{ g} = 9.81 \times 10^{-3} \text{ N}$$

$$\text{Weight of cam} = 1000 \text{ g} = 9.81 \text{ N}$$

$$\text{Weight of gear} = 1600 \text{ g} = 15.7 \text{ N}$$

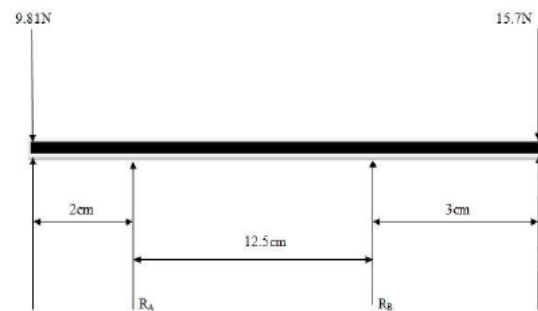


Figure 2: Free body diagram

From Figure.2, $R_A + R_B = (9.81 + 15.7) = 25.51 \text{ N}$

$$(-9.81 \times 14.59) + (R_A \times 12.5) + (15.7 \times 3) = 0$$

$$-143.12 + 12.5 R_A + 47.1 = 0$$

Therefore, $R_A = 7.61 \text{ N}$ and $R_B = 17.89 \text{ N}$

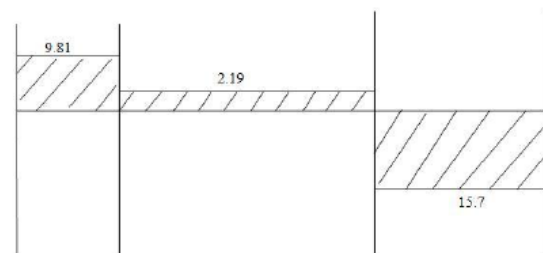


Figure 3: Shear force diagram

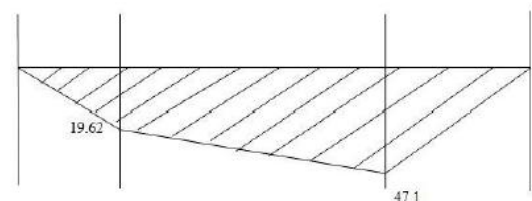


Figure 4: Bending moment diagram

From Figure.4, Maximum bending moment $(M) = (15.7 \times 3)$

$$M = 47.1 \text{ Ncm} = 47.1 \times 10^{-2} \text{ Nm}$$

$$P = (2\pi \times N \times T) / 60$$

$$90 = (2 \times 3.14 \times 60 \times T) / 60$$

ie, $T = 15 \text{ Nm}$.

$$T_{\text{equivalent}} = (M_2^2 + T_2^2)^{1/2} = (0.472^2 + 152)^{1/2}$$

$$= 15 \text{ Nm}$$

We selected material mild steel, which has a shear stress of 200 MPa.

$$t = 16 T / \pi d^3$$

$$200 \times 10^6 = (16 \times 15) / (3.14 \times d^3)$$

Solving we get,

$$d = 7.25 \times 10^{-3} \text{ m}$$

$$= 7.62 \text{ mm}$$

Standardizing the diameter with reference to data handbook by K. Mahadevan, design of shaft – page no: 57 – Table

$$d = 8 \text{ mm}.$$

In a similar way shaft for AC motor was designed and the diameter obtained was 15 millimeters.

Selection of ball bearing

Shaft diameter = 15 mm

Trail – 1

Assume ball bearing 15BC02 series 6202

$$d = 15 \text{ mm}$$

$$D = 35 \text{ mm}$$

$$B = 11 \text{ mm}$$

(Values obtained from Machine Design data book by Prof. K. Lingaiah, Volume II)

$$L_{10} = 5 \times 365 \times 5 \times 60 \times 160106 = 87.6 \text{ million revolution}$$

$$\text{Static load, } c_0 = 3750 \text{ N}$$

$$\text{Dynamic load, } c = 7800 \text{ N}$$

$$K_s = 1 \text{ for steady state}$$

$$P = F_r \times K_s = 538.64 \times 1 = 538.64 \text{ N}$$

$$L = (CP)^3 = (7800 \times 538.64)^3 = 3036.60 \text{ million revolution}$$

$L > L_{10}$, so the 15BC02 series ball bearing is safe & suitable.

Length of Belt:

$$\text{Length, } L = \pi(r_1 + r_2) + 2 \times x + (r_1 - r_2)^2 / x$$

$$r_1 - \text{radius of driving pulley} = 12.7 \text{ mm}$$

$$r_2 - \text{radius of follower} = 114.3 \text{ mm}$$

$$x - \text{distance between two pulley} = 250 \text{ mm}$$

$$L = \pi(12.7 + 114.3) + 2 \times 250 + (12.7 - 114.3)^2 / 250$$

$$= 940.27 \text{ mm}$$

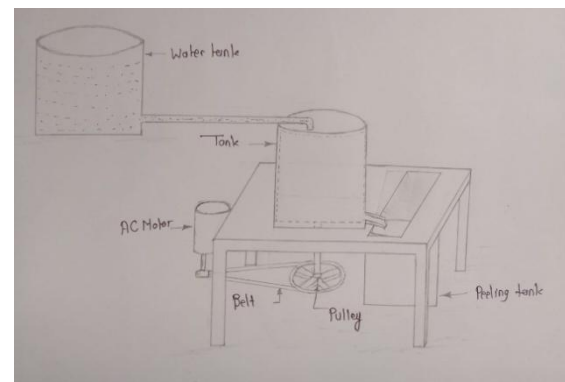


Figure 5: Total assembly

Working

The mechanism of this peeling machine is less complicated [6]. The motor transmits power to the rotating disc through a V-belt and pulley arrangement, during which the motor rotates at a speed of 1440 rpm, which gets reduced to 160 rpm at the driven side [9]. Rotating disc and drum surface being coated with abrasive sheet surface for the peeling action to be

possible [7]. Potato is filled to the drum, and therefore the disc rotates at the underside and force is developed, which make the potato to return involved with the drum surface, which remains stationary, making possible the peeling action. A clearance of 10 mm is provided between the stationary drum and rotating disc for waste removal [11].

CONCLUSION

At the top of the construction, a satisfactory peeling machine was fabricated using the available raw materials and techniques. The performance of the machine is more efficient compared to existing ones. The price of production and maintenance is comparatively cheap. Hence the machines are going to be welcomed by industries given their performance, affordability and ease. The look of the integrated peeling and cutting machine relies on the technical idea of the mixture of all the methods in one, which helps in reduction of manpower and satisfies the requirement for household, industries. The machine is easy to work, safe and straightforward to repair. The technology is affordable and less expensive in comparison to existing peeling machines. It's low overhead. Hence the machine was a successful one.

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