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DESIGN AND DEVELOPMENT OF SUGARCANE JUICER MACHINE

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ABSTRACT-The main objective in this paper is to design and manufacture a machine that is able extract sugarcane juice automatically with maximum juice extraction efficiency. The machine must facilitate such that the human involvement while extracting juice is reduced and effective isolations to prevent injury to the operator.. After that, detailed experimentation is carried out to understand various factors affecting the juice extraction process and the extraction efficiency. The basic design & dimensional requirements enlisted by this five conceptual designs generated among them isone of the conceptual designs chosen for the best design based on feasibility ranking. Design is to be implemented into reality through manufacturing assembly with good aesthetic. Then performance of machine is checked and compared with the other machines also confirmed that all objectives are satisfied. The human involvement in system operation is reduced when the system is actually working. The sugarcane juice extractor can be replaced by conventional cane juicers in juice bars cafes, restaurants, hotels etc.

Keywords: Shaft, Roller, Bearings, Gears, Pinion, etc.

I. INTRODUCTION

The juice extraction is done by different types of machines available in the market where some are having inbuilt workstations, some are placed on the workstations. The work station as the place for the vendor to work and extract the juice. During smashing the canes, the vendor has taken too much effort to make its no of bends and push inside the rollers. Sometimes we had observed that motors can't supply that much torque we need so it gets stuck in between and increases the more chances of failure. The 1kg of sugarcane can give approximately 300ml of juice so the squeezer should apply more and more pressure on the canes to get maximum quantity of juice. So instead of making no of bends and wasting our energy is a somewhat piffle. So, we can reduce vendor's effort by simple type adding one more roller which will help to extract maximum juice.[4]

II. PROBLEM STATEMENT

1. The major cane processing stages are converting the sugar-cane to its essential derivatives. Various methods are included for boiling the cane to extract the juice, use of the wooden presses and applications of more sophisticated mills are driven mechanically or by bullocks.
2. The high power requirements during processing of sugar-cane constitutes the major constrain in the development of small scale sugar processing plants.
3. The development of the small scale sugar-cane juice extractor was therefore to meet the needs of the small scale farmers who cannot afford high capacity and complex cane crushers. [2]

III. LITERATURE REVIEW

Santosh Y. Salunkhe(2015), Three roller sugar mill is the most vital part of sugar industry. Sugar roller mill is used to separate the sucrose-containing juice from the cane i.e. extraction of juice consists of three rollers namely Top, Feed and Discharge. The extraction of juice in the mill is achieved by squeezing the prepared cane between two rollers. FEA method is a numerical technique used to carry out the stress analysis. In this method the solid model of the component is subdivided into smaller

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elements constraints and loads are applied to the model. The 3D Geometrical model is created by using modelling software Pro-E. The static structural analysis ofthe roller shaft is being carried out using analysis software ANSYS Workbench. The results for maximum shear stress on the Top, Feed, and Discharge roller are calculated analytically and compared with the results from the software. Static structural analysis of all the three rollers is done using a forged steel materials for analysing the results.[6]

IV. DESIGN ANALYSIS

A. Analytical method

The various terms relating to the sugarcane mill rollers used as per the following: -

a. Shaft- A round forged steel bar on which the cast iron shell is fitted.

b. Roller journal – The polished surface of both the ends of shell- seat on which the bearings are fitted. It looks like a knurling surface.

c. Pintle end- The shaft ends having a key-way for the sprocket- fitting is known as Pintle end.

d. Square end- The shafts end on which pinion and coupling are fitted.

e. Shell – It is a hollow cast-iron round which is shrunk - fitted on the shaft.

f. The roller shaft is an important item of the sugar mill equipment and being subjected to heavy loading and it must be made to high standard of quality.[7]

Where,

Shaft Material- 45C8 (C - 0.35-0.45 %, Mn - 0.60 to 0.90%)

Density- 7850 Kg/m^3.

E - Modulus of Elasticity = 210 Gpa.

Poisson's ratio = 0.31

Syt - yield strength in tension - 380 Mpa

Sut - ultimate tensile strength - 710Mpa

Se - Endurance limit = 23 Kg/mm2

Kf - Stress concentration factor =1.

B. Design analysis of Roller

Let the force failure be - 110 N

Force = 110×2 = 220 N

Let the mass of sugarcane be =130 or 150 kg

F=mω2r

220 =0.13×(2π×1400÷60)2×r

r = 0.669 m

Día=0.133m =133 mm = 150mm

C. Design analysis of shaft

Shaft Material- 45C8 (C - 0.35-0.45 %, Mn - 0.60 to 0.90%)

Where,

Input data:-

L1=550mm

L2=400 mm

L3=400 mm

D- Roller Dia. OD. = 150 mm

HP- Mill power for drive = 1 HP.

N- rpm of roller shaft = 10 rpm

Shaft dia. = 40mm

Net Bending movement is,

$= RB \times 275 - \frac{W \times (75)2}{2}$

$= 75w - \frac{(75)^2 W}{2}$

$= 75 \times 75 \times 103 \times 275 - \frac{(75)^2}{2} \times 75 \times 103$

= 133593750 N-mm

$I = \frac{\pi}{64}$ X d4 ...(3.2)

E = 210 GPa for steel

$$= \frac{210 \times 10 \frac{133593750^3}{\frac{\pi}{64} \times d^4}}{\frac{d}{2}}$$

d^3= 64798.798   d = 40.16 mm

D. Design Analysis of Gear

Gear Calculation,…{All data from PSG design data}

Torque on input shaft

$P = T \times \frac{2\pi N}{60}$.... (3.3)

$1HP = 746 = T \times \frac{2\pi \times 10}{60}$

$746 = T \times \frac{2\pi \times 1}{6}$

T = 712.377 N-m

Let as consider a Gear Ratio = 3:1

∴ If driver turn at 10 rpm, the driven gear run at 10 x 3 = 30rpm

$\frac{N_1}{N_2} = \frac{T_2}{T_1}$ to set gear teeth the relation is

$\frac{T_2}{T_1} = \frac{1}{3}$ T1 = 3T2

Let as consider teeth on pinion be 15

thus, gear teeth be 3 x 15 = 45

Gear Geometry – For 20-degree pressure angle

N = 25… (pinion)

Rp (pitch circle) = m x $\frac{N}{2}$ = 3.5 x $\frac{25}{2}$ = 43.75mm

Rb (base circle radius)= 0.94 x Rp =41.125mm

Ra (Addendum) = Rp + m = 47.25mm

Rd (Dedendum) = Rp – 1.25 x m = 39.375mm

Rp = 45 x $\frac{3.5}{2}$ = 78.75 N..(gear 45 teeth)

Rb = 0.94 x Rp = 74.025 N

Ra = Rp + m = 78.75 + 3.5 = 82

Rd = Rp – 1.25m = 74.375 N

V. SOFTWARE MODELING

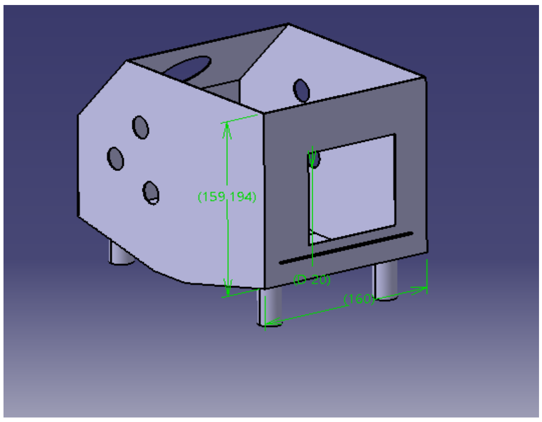

Fig-1: CAD Model for Main Shell

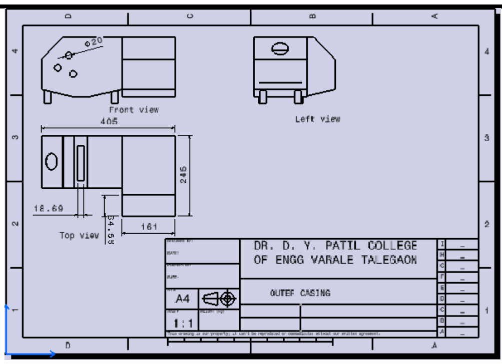

Fig-2: Drafting of Main Shell

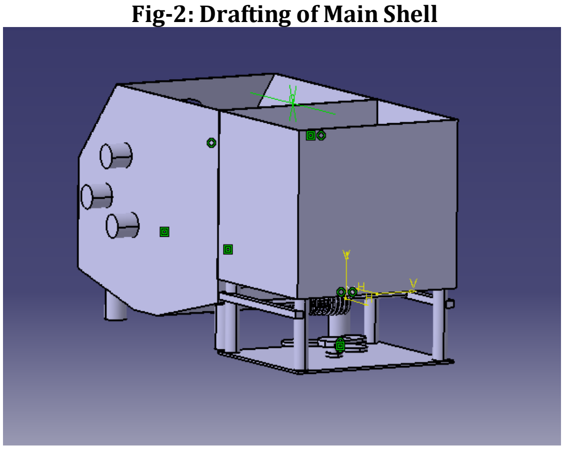

Fig-3: CAD Model for Assembly

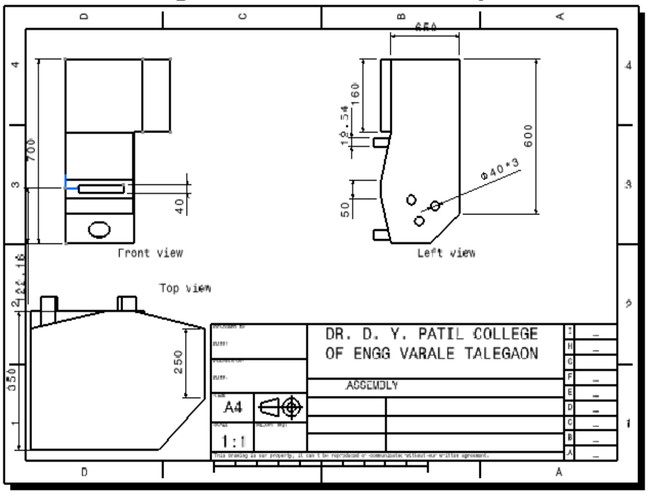

Fig-4: Drafting of Assembly

Table -1: Cast Iron Spur gear

Pressure	Von mice Stress	Deflection	Strain
	Load(N/mm²)	(mm)	
1	3.832	0.002905	$2.21e^{-4}$
2	7.665	0.005811	$4.41e^{-4}$
3	11.497	0.008716	$6.62e^{-4}$
4	15.33	0.011622	$8.82e^{-4}$
5	19.078	0.014488	$1.14e^{-3}$

Table -3: Material of Carbon Shaft and Properties

Mechanical properties	Materials of cardan shaft and their Mechanical properties		
	Steel	Glass/ Epoxy	Carbon /Epoxy
Young's Modulus	210 Gpa	39 Gpa	177 Gpa
Poisson's Ratio XY	0.3	0.3	0.3
YZ		0.3	0.263
ZX		0.3	0.3
Density (kg/m3)	7850	2000	1600 kg/m3
Shear Modulus	80 Gpa	3.8 Gpa	7.8 Gpa
Tensile Ultimate strength	4.6E+08 pa	4.0E+08 pa	4.4E+08 pa

VI. CONCLUSION

The development machine possesses simplicity in the operation and maintenance, as well as being affordable with thelow running and maintenance costs with the reliable efficiency. If it is commercialized, the machine could go a long way in solving the problem of sugar-cane juice extraction domestically, for the local use thereby meeting the sugarcane requirement of the nation.[4]

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VIII. REFERENCES

1].Prakriti N Raj Gangadkar, Comparative performance of locally available sugarcane crushers used in Karnataka, (2016).

[2].Makinde-Ojo, AyoolaMacjay, Improvement Of The Fabrication AndTesting Of A Sugarcane Juice Extractor For The Cottage Industry (2010).

[3].Y R Loh , Resources Conservation and recycling, (2013)

[4].Olaoye, J. O. Development of a sugarcane juice extractor for small scale industry (2011).

[5].A.M. Olaniyan, O.O Babatunde, Development of a small scale sugarcane using screw press (2012).

[6].Santosh Y. Salunkhe, Static Structural Analysis of Conventional Sugar Mill Roller Shaft for Ø40"x 80" Milling Plant (2015).

[7].JitendraS.khot ,Prof.M.B.Mandale,Static Structural Analysis of crushing rollers of three roller sugar mill (2015).

[8].Oriola, K.O., Jekayinfa, S.O., Ola, F.A., Adedoyin, A.S. Akande, F.B.*,Some Mechanical Properties of Sugarcane at Different Sizes and Loadings Relevant to Design and Construction of Sugarcane Juice Extractor (2017).