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Design and Fabrication of Pneumatic Operated Juice Extract Machine

S. D. Bhalekar[1]
Suraj.bhalekar289@gmail.com

Akshay Dalwai[2]
akshaydalwai@gmail.com

Tukaram Dalavi[3]
dalavitushar912@gmail.com

Tushar Dahale[4]
tushardahale75@gmail.com

Abhishek Birajdar[5]
abhishekbirajdar31@gmail.com

Department of Mechanical Engineering,
JSPM Narhe Technical Campus, Pune, India

Abstract— **A juice extractor machine is develop for an extracting a juice from the fruit as well as vegetable. Machine is develop to minimize the human effort and improving the performance of product. The machine is to be operated with an minimum manual interaction and avoid complexity. The process is to be continuous and juice extracted without any toxicity. The convectional machine operated with manually having more uncomfortable for an operator. The juice is collected without any wastage and seeds. The machine is to be constructed with an automation which is helpful to improve efficiency. the electric supply is to be needed for operate the machine.it is possible to run a machine for an high production rate with minimum duration of time which is highly impossible with old juice extractor. The development of the machine is required an electric motor and casting element such as hopper for feeding fruits and supporting the helical screw. The frame of the machine is fabricated with the help of mild steel.**

Index Terms—*construction, extraction, fabrication, performance.*

I. Introduction

The purpose of this research work is based on development and fabrication of fruit juice extractor. This machine having ability to cut the fruits in required proper manner whenever it is to be required. The machine having capability to extract the juice from fruits as well as vegetables with a minimum effort. This process is to be done with the help of lead screw, electric motor and slicing blade.

Extraction is a process by which substance are removed for their original component or raw state. Hence, Extraction of juice (juice extraction) may be defined as the removal of juice from fruits; the juice is separated from the skin or chaff. During the early age, juice extraction was done manually by the means of hand squeezing [1].

As per the increase in demand with time for a juice so far it is an necessary to construct a machine having capability satisfy the customer need in minimum required time with high performance rate [2].

The juice extractor is made up of power unit (electrical motor, belt, pulley and bearing etc.),a hopper through which the fruit will be introduce to the machine compressing chamber, a housing or compressing chamber with a shaft incorporating a set of special arranged presser, a perforated screen (meant to sieve off pult,seeds and skin) a separate juice receiver and an incorporated exit-where the orange waste will be evacuated [3,4].

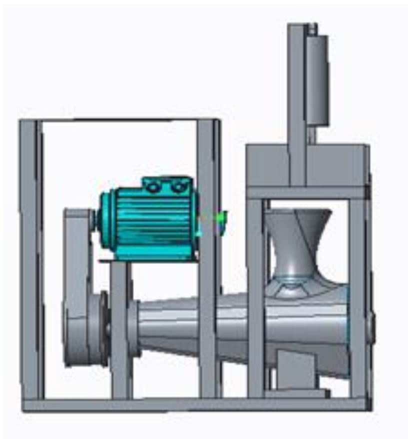


Fig1: Pneumatic operated juice extract machine

A. *Materials Selection*

The following properties were considered in selecting the materials needed for the construction of the extractor [5,6]:

i. Physical properties such as size, shape, density etc.
ii. Mechanical properties which include; strength, toughness, stiffness, fatigue, hardness and wear resistance.
iii. Chemical properties: this includes resistance to oxidation and all forms of corrosion since the machine is to be used in processing food.
iv. Material availability: the materials used were selected based on their availability such that they can be obtained from the market with ease.
v. Cost of materials: materials used can be made available at a cheaper price to peasant farmers.
vi. Cost of maintenance: replaceable parts were not welded to the machine frame in order to allow for easy replacement of parts.
vii. Durability and Hygiene: the machine will come in contact with easily oxidized food (liquid substance). It is therefore necessary to ensure all these parts coming in contact with the juice be made of stainless steel of appropriate strength.

B. *Components*

- Pneumatic Cylinder
- Cutter blade
- Motor
- Lead screw
- Belt Pulley
- Frame
- Juicer casing
- Tray
- Hinges
- Pneumatic connector
- Solenoid valve
- PU pipe
- Feed Hopper

II. Analytical Calculations

A. *Calculation for Belt*

Coefficient of Friction (μ) = 0.4

$$\theta = 3.67 \text{ rad} = 218.28^{o}$$

$$\frac{T1}{T2} = e^{\mu\theta} = 4.34$$

T_1 = Tension on tight side

T_2 = Tension on slack side

T = T1 + T2

T_2 = 533.62 N

T_1 = 2315.89 N

V = Belt Speed

$$V = \frac{\pi \times d \times n}{60 \times 1000} = 3.27 \text{ m/s}$$

Center distance (C) = $\frac{D+d}{2} + d = 205$

Length of Belt (L_b) = $2C + 1.57(D+ d) + \frac{(D-d)^2}{4C}$

$$L_b = 950.48 \text{ mm}$$

Now, belt power (P_d)

$$P_d = \frac{1.36 \times Ks \times P}{K_{\Phi} \times KL} = 0.7383 \text{ kilo watt}$$

Hence, from Manufactures Catalogue Belt B34 is selected Tgweds88f6d6d5wf2d2f5d8esx6e4/v

B. *Calculation for Pulley*

Diameter of larger pulley (D) = 260 mm

Diameter of smaller pulley (d) = 50 mm

Velocity ratio (V.R) $= \frac{D}{d} = 5.2$

Speed of smaller pulley (N_1) = 1250 rpm

Speed of larger pulley (N_2) = 240 rpm

Angular speed of smaller pulley = ω_1

M, Angular speed of larger pulley = ω_2

$$\omega_1 = \frac{2 \times \pi \times N_1}{60} = 130.8996 \text{ rad/s}$$

$$\omega_2 = \frac{2 \times \pi \times N_2}{60} = 25.1327 \text{ rad/s}$$

Force generated,

W= weight of component and the raw material

= 10+2 = 12 Kg

$m = \frac{W}{g} = 1.22$ Kg

F = Force generated

m = mass of components and raw material

r = radius of rotation

ω = Speed of rotation

$F = m\, r\, \omega^2 = 100.158$ N

C. Calculation for screw

Transverse pitch $(P_t) = \frac{\pi D}{2} = 9.52$ mm

Axial pitch $(P_a) = \frac{P_t}{\tan\Psi} = 54$ mm

D. Calculation for shaft

S_{yt} =170 Mpa

S_{ut} =480 Mpa

$\tau_s = 0.75\times(0.18\times S_{ut}) = 64.8\ N/mm^2$

$\tau_s = 0.75\times(0.3\times S_{yt}) = 38.25\ N/mm^2$

Shear stress of yield strength is smaller so

$\tau_s = 38.25\ N/mm^2$ is selected.

$\eta = \frac{P_{output}}{P_{input}}$

$P_{output} = 298.4$ w

$P = \frac{2\pi NT}{60}$

T = 11.873 N-mm

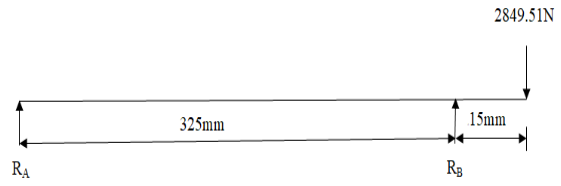
Vertical forces on pulley,

$T_1 = 2315.89$ N

$T_2 = 533.62$ N

$T_1+T_2 = 2849.51$ N

Bending moment on shaft,



$R_A + R_B = 2849.5$

$\Sigma R_A = 0$

$R_B \times 325 = 2849.51\times 340$

$R_B = 2981.03$ N

$R_A = -131.516$ N

$(M_B)_B = 131.51\times 325 = 42742.7$ N-mm

$T_e = \sqrt{(KbM)2 + (KtT)2} = 64114.05$ N-mm

$\tau_{max} = \frac{16\,T_e}{\pi\, d^3}$

d = 20.4376 ≅ 22 mm

D. Design of power required for driving the juice extractor

1) Orange

$P_{orange} = \frac{(D^2 - d^2)\times\rho\times g\times N\times P_a \times F_t \times L}{8000}$

$P_{orange} = 105.527$ watt

But,

$P_{orange} = \frac{2\pi N\ T_{orange}}{60}$

$T_{orange} = 4.198$ Nm = 4198.785 N-mm

$T_{orange} = F_{orange} \times r$

$F_{orange} = 32.298$ N

2) Pineapple:

$P_{pineapple} = \frac{(D^2 - d^2)\times\rho\times g\times N\times P_a \times F_t \times L}{8000}$

$P_{pineapple} = 120.83$ watt

But,

$P_{pineapple} = \frac{2\pi N\ T_{pineapple}}{60}$

$T_{pineapple} = 4.8076$ N-m = 4807.6729N-mm

$T_{pineapple} = F_{pineapple} \times r$

$F_{pineapple} = 36.98$ N

TABLE 1

FORCE REQUIRED FOR DRIVING JUICE EXTRACTOR

Force Genrated By Machine	100.158 N	
Force Required For Fruits	Orange	32.298 N
	Pineapple	36.98 N

E. Working principle

The machine is so constructed that it will remain steady on the ground while in operation. It consists of two feeding hoppers, chopping unit with spikes on shaft, screw (auger) conveyor housed in a cylindrical barrel, waste outlet, juice outlet and main frame. The juice 19 extractor is designed to work on the principle of chopping, crushing and squeezing, and is made up of six units which include: main frame, feed hoppers, chopping unit, juice extraction unit, collecting unit and power transmission unit.

In operation, fruits are introduced in the machine through the first feeding hopper. They are chopped and sliced in the chopping unit by means of the blades (knives) on the shaft and then passed into the cylindrical barrel via the second hopper, where they are crushed on their way into the barrel. The machine 20 convey, crushes, grinds and presses the fruit inside the cylindrical barrel with the aid of the screw conveyor until juice is pressed out of the fruit. The juice extracted is drained through the perforation provided at the bottom of the cylindrical barrel.

III. CONCLUSIONS

1. A multi juice extraction machine was successfully design and fabricated.
2. The performance of this juice extractor is higher than that of conventional juice machine. As well the force and the torque required for extracting the juice from fruits is less compare to old juice extract machine.
3. The cost required for the setup and running cost of the juice extractor is less.
4. Successfully extraction of juice and the process is continuous without required any special arrangement.
5. Based on output of the juice extractor the quality obtained is good. This product can be processed further to establish new product.

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