Design of Coconut Rancidity Testing Machine

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Abstract-*In day to day life coconut product has various uses, so it is important to test rancidity of coconut before processing the coconut. The rancid coconuts are not useful for food industries as coconut processing line stops. hence it is become very important to detect its rancidity. But this should be done before breaking the coconut shell for extraction of the coconut meat and water to avoid contamination in food processing line. The conventional method of rancidity testing are not reliable and economical. The proposed method involves creation of vibrational waves in the coconut and the frequency measurement is done by using vibrometer.*

Keywords:-coconut rancidity, coconut testing, impact test.

I. INTRODUCTION

The coconut is used in daily edible items of the regular food. The different industries used destructive methods to check rancidity of the coconut but this method is not suitable because it stop the production chain. Different methods such as slosh test ultrasonic testing and conventional methods are used for checking coconut rancidity. The proposed system used to give small impact force on coconut shell and frequency of vibrational waves is obtained with the help of vibrometer. The frequency depends on strength of coconut shell, coconut meat, quantity of coconut water and its viscosity. There are different frequency range for mature, rancid, non-rancid coconuts.

It is a non-destructive method which helps to reduce checking time, wastage of the material. Old methods such as ultrasonic testing are uneconomical. The system is suitable for quick checking and small industry.

II. LITERATURE

1] S. Chaudhari& V. Shinde carried out research on "Coconut rancidity testing using slosh testing mechanism" The proposed method involves creation of vibration response of the coconut shell to be tested by striking a brass tong onto the shell at various intensities and study of peak acceleration, displacement and frequency of the holding pad to detect rancidity of the coconut.

The research has been carried out in this field are destructive methods involving comparison in laminar viscosity of coconut water flowing through pipes after survey in State centre of the Coconut Development Board, it is found that there are no non-destructive techniques developed for use in this field. Slosh testing is based on the principle of frequency response range comparison between a rancid coconut and a normal coconut. This frequency range is used to determine experimental validation.

2] M. Hejnova carried out research on Service life of assessment of cam mechanism. This paper deals with wear mechanisms at cam mechanisms in its first part, then describes factors affecting the life and the last part deals with a methodology of durability testing.

3] L.NagyT.Szabo&E.Jakab carried out research on functional analysis and mechatronic design of cam controlled mechanism. Objective of the project was to design and construct of a new state of the art pinion-engaging mechanism for starter motors. a cam follower mechanism which contains the following parts: dc servo motor, rotational to translational transducer and the drive pinion.

4] S.Jianping,T.Zhaoping carried out research on the parametric design and motion analysis about line translating tip follower cam mechanism based on model datum graph. It uses a powerful design software pro/e, complicated disc cam mechanism was full Parametrically designed and their motion was simulated and analyzed and can generate automatically cam profile according to the parameter imported by the consumer.

III. PROBLEM STATEMENT

In any coconut processing industry, a destructive technique is used and a coconut is first broken, water is extracted and coir is used for various purposes. Hence, it becomes very important firstly to analyze the rancidity of the coconut for acceptance. But this should be done before breaking the coconut for water extraction so that immature or rancid coconuts are not being processed further

IV.OBJECTIVE

Designing and checking safety of important parts of coconut rancidity test machine.

A. Different methods to check the rancidity

i.) Naked eye inspection

It is most primary testing of coconut for its rancidity. Depending on the visual observations as colour it is decided that the coconut is rancid or not.

ii.) Ultrasonic testing

It is one of the non-destructive method. The ultrasonic waves are used as transmitted waves through the coconut. Depending on the output frequency it is decided whether the coconut is rancid or not.

iii.) Slosh test

Depending on the sound of coconut water after sloshing the coconut is considered rancid or mature.

V. PROPOSED SYSTEM

This system is used to detect rancid coconut without breaking it. This detection is based on the frequency response of vibrational waves at the output vibrometer.

System components

The proposed system consist of following components:

1) Motor
2) Spur gear pair
3) Shaft
4) Cam follower mechanism
5) Spring
6) Platform stand
7) Clamping jaws
8) Vibrometer

VI. WORKING

Firstly all the coir of the coconut is removed .the spherical coconut should be open for testing. Then coconut is clamped in jaws. Using cam follower mechanism impact is occurred on coconut shell removed from the coconut stock before it goes shell. At the instant when impact occurs the vibrational waves transmit through the coconut. There is different frequency for rancid and non rancid coconut. The rancid coconut is removed from the stock before it goes for operation. Thus the product wastage is avoided.

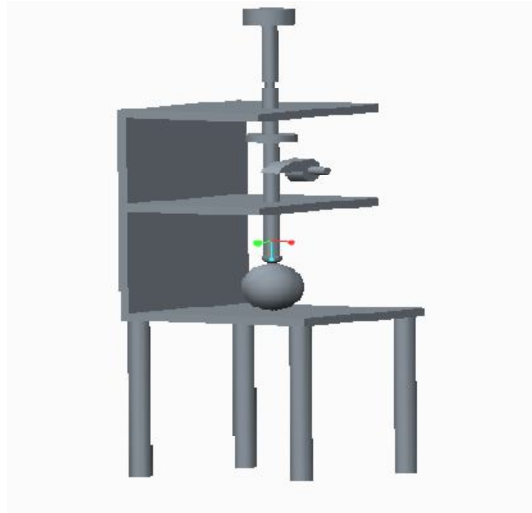

Figure 1: 3D Skeleton of Proposed System

VII. MECHANISM DESIGN CALCULATION

1) Motor specification

- 12V DC Motor
- Working voltage: 12V DC
- No-load speed: 92rpm
- No-load current: 1.30A
- Stall torque: 2-N-m
- Power = 5 watt

2) Spur gears

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YIELD STRENGTH N/mm^2	BHN
55C8	720		265

Table 1: Material Selection for Gear

Gear pressure angle	$\emptyset = 20°$
Minimum no. of teeth on pinion	t=18
Module	m
Face width	B
Lewis form factor	Y
Service factor	C_s=1.25
Load distribution factor	C_a=1.4
Factor of safety	N_f=1.5
Spring index	C=8
Spring deflection	δ
Solid length	L_s
Free length	L_f
Shaft diameter	d

Table 2: Appendix

Since material for both pinion and gear is sametherefore pinion is weaker by default.

Bending stress(σ_b)=S_{ut}/3
=240 N/mm^2

For 20^o full depth,
$Y=0.484 - \frac{2.87}{t}$
=0.3245

$(\sigma_b \times Y)_{pinion} < (\sigma_b \times Y)_{Gear}$

Bending strength(S_b)=m×b× $(\sigma_b \times Y)_{pinion}$
=m×10×m×240×0.3245
=778.93×m^2 **N**

Ratio factor(Q) = $\frac{2T}{T+t}$
=1.7142

Load stress factor for pair (K)=0.156×$[\frac{BHN}{100}]^2$
=1.09551

Wear strength (S_W)=b×Q×d_p×K
=10×m×1.7142×18×m×1.0955
=338.04×m^2 N

Since Wear strength (S_w)<Bending strength(S_b)

Design is based on Wear strength.

Velocity(V)=$\frac{\pi \times d \times n}{60 \times 1000}$ m/s

=$\frac{\pi \times 18 \times m \times 90}{60 \times 1000}$

=0.0848×m

Tangential force(f_t) =$\frac{power}{velocity}$

=$\frac{5}{0.0848 \times m}$

=58.96/m

$F_{t\ max}$ =C_s×C_a×F_t
=1.5×1.4×58.96/m
=123.816/m

Velocity factor (C_v) =$\frac{6}{6+v}$
=$\frac{6}{6+0.0848/m}$

$F_{effective}$=$F_{t\ max}$/C_v

=82.55/m

Module calculation:

Wear strength (S_w)= $F_{effective}$×f.o.s.
338.04×m^2=1.5×82.55/m
m=0.7171 mm
Selecting next module from standard series :
Module = 1 mm
Diameter of pinion =18 mm
Diameter of Gear =108 mm
Bending strength=778.93 N
Wear strength =338.04 N
Velocity =0.0848 m/s
Tangential force =58.96 N
Maximum Tangential force =123.83 N
Error for Grade 7 Gears
$e=11+0.9(m+0.25\sqrt{m}\ )$
$e_p=12.85\mu m$
$e_g=14.23\ \mu m$
total error =12.85+14.23
=27.08 μm
=27.08×10^{-3} mm

Deformation factor(C) for 55c8
C=11500 N/mm^2

Dynamic force F_d=98.273 N
f_{eff} =$F_{tmax} + F_d$
=222.103 N
S_w =f.o.s.*f_{eff}
338.04 =f.o.s * 222.103
f.o.s. =1.52
There spur gear pair is safe

3)Shaft Design

Material selected for shaft C50
Having ultimate tensile strength =720 Mpa
τ =Sut×0.18
τ =129.6N/mm^2
$m=7850 \times \pi \times \frac{0.108^2}{4} \times 0.01 = 0.719\ Kg$ g
weight =7.05 N
Ft=123.83 N
Spring force= 58.33 N
Rod self weight= 3.89 N
Shaft self weight = 7.05 N
Total force= 193.05N
T=FT *R

129.83×54=7010.82 N-MM

$kt = 1$ ……for suddenly applied & minor shock

$\frac{T}{J} = \frac{\tau}{R}$

$\frac{7010.82}{\frac{\pi}{32}d^4} = \frac{129.6}{\frac{d}{2}}$

$d = 7.23$mm

Diameter of shaft is 8 mm

4) Spring

Material selected for spring C50

Ultimate tensile strength = 720 N/mm^2

G=79.3 GPa ;

S_{ut}=720 N/mm^2

ρ = 7480 Kg/m3 ;

Best spring index (C) : 4 to 12

For industrial and practical purpose most suitable (C) = 8

τ = 0.3× S_{ut}=216 N/mm2

P_{max}= $\frac{strength\ of\ coconut\ shell}{factor\ of\ safety}$ ×area of contact

=58.33 N

Compression in spring = 5 cm

Stiffness (K) =$\frac{P}{\partial}$= 1.1666 N/mm

Wahl factor K_w = $\frac{4C-1}{4C-4}$ = 1.107

d^2=$\frac{Kw(8\times Pmax\times C)}{\pi\times\tau}$,

d = 2.46≈ 2.5 mm

D= c × d = 8 × 2.5 =20 mm

Active coil (N) =$\frac{\partial\times G\times d^3}{8\times Pmax\times D^3}$ =16.59≈ 17

Ls = N× $(2 + d)$ =76.5 mm

Lf = Ls + ∂max+0.15× ∂max =76.5 + 50 +0.15×50=134 mm

P = $\frac{Lf-(2\times d)}{N}$;

pitch(p) =7.58 mm

The strength of coconut shell = 70 N/mm^2

5) compressive forces for impact

Average diameter of Coconut (D_1)=90 mm

Diameter of curved part of tongue (D_2)=20mm

Radius of area of contact between brass tongue and coconut shell is found by: a

a =$\sqrt[3]{\frac{0.75pR_1R_2[1-\mu_1^2]E_1)+[1-\mu_2^2]E_2}{E_1E_2(R_1+R_2)}}$

a =1.181 mm

p_{max}=$\frac{3p}{2\pi a^2}$

p=66 N/mm^2

Maximum Shear Stress

τ_{max}=0.310P_{max}

=20.48 N/mm^2

Ultimate tensile strength for brass =400 N/mm^2

Yield strength =217 N/mm^2

τ_{all}= 0.3× S_{ut}

=120N/mm^2

Ultimate tensile strength for coconut =70N/mm^2

τ_{all} = 0.3× S_{ut}

=21 N/mm^2

$\tau_{coconut}<\tau_{brass}$

$\tau_{max}<\tau_{coconut}$

Design is safe for compressive stresses.

VIII. CONCLUSION

From the survey carried out, we can conclude that all the existing method of coconut rancidity testing are not reliable and are destructive type. The method of coconut rancidity testing based on impact test in non-destructive. Which is simple in construction, operation and maintenance also this is cost effective. The proposed method of coconut rancidity testing is based on impact test which uses frequency response to detect the rancid coconut.

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REFERENCES

[1] S. Chaudhari*, V. Shinde, “Coconut rancidity testing using slosh testing mechanism”, 2015 IJEDR Volume 3 Issue 3 ISSN 2321-9939 (2015)

[2] L.Petru*,G.Mazen*,”PWN control of a DC motor used to drive a conveyor belt” Procedia engineering 100(2015) 299-304

[3] M. Hejnova*, “ Service life assessment of cam mechanisms” Procedia engineering 96 (2014) 157-163.

[4] L.Nagy*,T.Szabo*,E.Jakab*,”Functional analysis and mechatronic design of cam controlled mechanism” Procedia engineering 96 (2014) 302-309.

[5] “The parametric design and motion analysis about line translating tip follower cam mechanism based on model datum graph” ProcediaS.Jianping*,T.Zhaoping engineering 23 (2011) 439-444