International Journal of Engineering Research and General ScienceVolume 2, Issue 5, August – September 2014
ISSN 2091-2730

Design, fabrication and Performance Evaluation of Polisher Machine of Mini Dal Mill

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Abstract— This paper describes the detail information of design procedure of polisher machine. Pictorial views of fabricated machine is given. The processed dal sample is tested for reflectivity. Schematic of test apparatus is given. Apparatus consist of LDR , which detects incoming light in the form of resistance. Three Dal samples are tested. Surface of Polished Dal samples found more reflective than unpolished Dal sample.

Keywords— design, polishing, pigeonpea, mini dal mill, fabrication, experimentation, test setup.

1.0 INTRODUCTION

The cotyledon of dry seeds excluding seed coat is called dal. In India and many Asian countries, Pigeonpea is mainly consumed as dhal acceptable appearance, texture, palatability, digestibility, and overall nutritional quality. The polishing is one of the important value addition steps in Dal processing. The polishing is done to improve the appearance of the Dal, which helps in fetching premium price to the processor. Whole pulses such as pea, black gram, green gram, and splits(dal) are polished for value adding. Some consumers prefer unpolished dal, whereas others need dal with attractive colour(polished dal). Accordingly, dal is polished in different ways such as nylon polish, oil-water polish, colour polish and so on. Polishing is a process of removal of outer layer from a surface. The cylindrical roller mounted with hard rubber, leather or emery cone polisher and roller mounted with brushes are used for the purpose. The powder particles are removed by rubbing action. Speed and sizes of these types of polisher are similar to those of the cylindrical dehusking roller. Another type of machinery provided for this purpose is a set of screw conveyors arranged in battery for repeated rubbings. The flights and shaft are covered with nylon rope or velvet cloth. The speed of each screw conveyor varies. The repeated rubbing adds to the luster of the dal, which makes it more attractive. These polishers are commonly known as nylon polisher or velet polisher, depending on material used and are available in a set of 2, 3, 4 or 5 screw conveyors. The splitting and polishing is done to increase the shelf life of pigeon pea. The Dal mills are used for splitting of pulse into two cotyledons followed by polishing. Seed treatment to reduce storage losses is becoming increasingly important.

2.0 DESIGN OF POLISHER MACHINE

This chapter gives the design calculation of major components of the machine, e.g. design calculation of shaft, belt and pulley drive.

2.1 DESIGN CONSIDERATION

Objective is to clean the surface of dal i.e. polish dal grains.

The value of force required to break dal grain is called as bio yield force. The machine is designed considering the bio-yield force of dal grains. From literature it is found that this force is different for length, breadth and thickness. Among three minimum is at length i.e. 81.06N.

F = 78.74 N

This much force is imparted on grains against the lower half inner periphery.

Hence,

1hp motor is selected.

2.2 Drive selection

Motor speed, N1 = 1440 rpm

Velocity, Vr = 8

Hence V-belt drive is selected for power transmission.

2.3 Design of V-belt drive

D1 = 58.8mm

Hence,1440 / 180 = D2 / 58.

D2 = 406mm
Checking,
Vp = π D1 N1 / 60
= **3.83 m/sec**
The peripheral velocity(Vp) for de-hulling i.e. splitting is recommended 10 m/s.
1] Power per belt = $(F_w - F_c)\,x\,\dfrac{(e^{\mu\theta/\sin(\alpha/2)} - 1)\,x\,V_p}{e^{\mu\theta/\sin(\alpha/2)}}$ = **2.378 kW**
2] Number of belts , N = Pd / power peer belt = 0.345, N = 1
3] Length of belt , L = $\pi/2(D2+D1) + 2C + (D2 - D1)^2 / 4C$ = **1988 mm**
Standard length of belt selected ,L = 77 inch
2.4 Design of bigger pulley
1) Width of pulley w = (n-1) e + 2f
For section-A, W = (n-1) e + 2 f = **21mm**
2) Pitch diameter ,Dp
For v-groove details , α = 38 degree, Recommended Dp = 200mm
3) Type of construction
According to diameter of pulley , D2 = 406mm
Arm construction type selected
No. Of arms = 1,No. Of sets = 1
4) Rim thickness
T = 0.375 √D + 3 **= 11mm**
2.5 DESIGN OF MAIN SHAFT
1) DESIGN TORQUE
T_d= 60xPxK_l/(2xπxN)------ [K_l=1.75 for electrical motor and line shaft]
T_d= 69.259 N-m
2) Forces on belt drive
$T_d = (T_1 - T_2)D_2/2$
(T_1-T_2) = 341.177 N-m -------------------------------(1)
$T_1/T_2 = e^{\mu\theta}$
Where ,Coefficient of friction, μ= 0.3
Angle of lap on smaller pulley, θ= 2.364
$T_1/T_2 = e^{0.3x\,2.364}$
T_1 = 2.032 T_2--------------------------------(2)
From equation (1) and (2)
2.032 $T_2 - T_2$ = 341.177
T_1 = 671.77 N , T_2 = 330.6 N
2.6 FORCE CALCULATION ON MAIN SHAFT

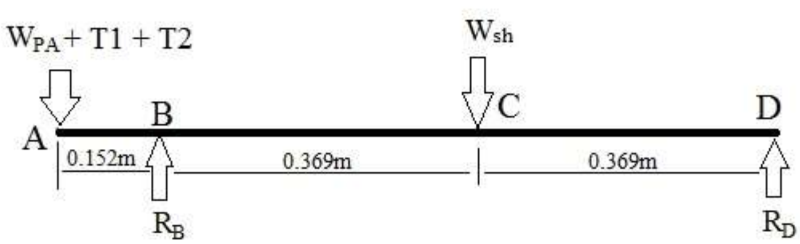

Fig 2.1 Vertical shear force diagram
Weight of pulley , W_{pa} = 5.5kg = **54N**
Weight of main shaft with rotor , W_{sh} = 15kg = **147.15N**
At static equilibrium, Σ F = 0
$R_{vb} + R_{vd}$ = 1203.62-----------------------------(1)
Taking moment at point B,
Hence, ΣMb = 0
R_{vd} = 144.1N
Substituting above value in equation (1)

Hence , $\mathbf{R_{vb} = 1.59N}$

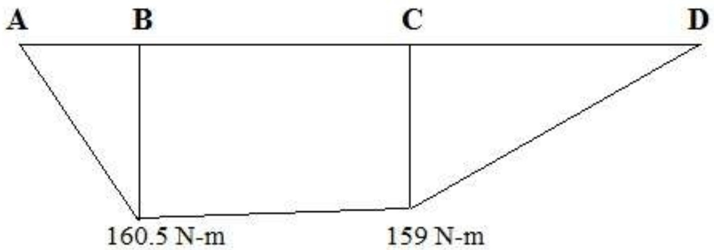

Fig 2.2 vertical bending moment

$M_a = 0$, $M_b =$ **- 160.58 N-m ,** $M_c =$ **-159.45 N-m,** $M_d = 0$

Selecting maximum moment on shaft

M = 160.58N-m

Selecting shaft material SAE 1030

S_{yt} = 296Mpa, S_{yt} = 296/2 = 148 Mpa, T_{max}=0.3 x S_{yt} = **44.4 Mpa**

S_{ut} = 527Mpa, S_{ut} = 527/2 = 263.5Mpa, T_{max}= 0.18 xS_{ut} = **47.43Mpa**

Selecting T_{max} = 44.4Mpa

For rotating shaft Selecting gradually applied load , $K_b = 1.5$, $K_t = 1$

For diameter of shaft

$$T_{max} = \frac{16 \times 10 \times \sqrt[3]{(Kb\times M)^2 + (Kt\times Td)^2}}{\pi \times D_{sh}^3}$$

Hence, D_{sh} = 30.63mm

Selecting standard diameter of shaft , $\mathbf{D_{sh}}$ **=32mm**

Hub diameter, D_h = 1.5 D_{sh} + 25 = **73mm**

Hub length , L_h = 1.5 xD_{sh} = **42mm**

3.0 Fabrication

3.1 Mechanical Components

1) Roller with shaft

Fig.no 3.1Top View of Roller with Pulley

2) Upper Half Casing With Hopper

Fig.no.3.2 Upper Half Casing With Hopper

3) Lower Half Casing With Frame

4) Polisher Machine

Fig.no.3.3 Lower Half with Velvet Bed

Fig.no.3.4 Assembled Machine

4.0 EXPERIMENTATION

4.1 MATERIALS AND METHODS

Two samples are selected for testing. The first sample selected for testing is output product of a mini dal mill. This sample is dehusked and split tur dal. It contains split unhusked grains, split husked grains, broken grains husk and dust. It is processed through oil mixing, sun drying and dehusking.

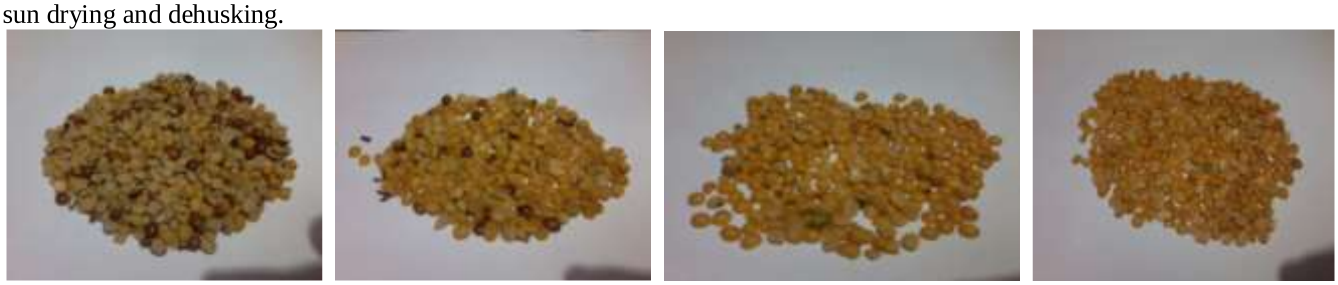

Fig. Prepared Dal Samples

4.2 TESTING

4.2.1 TEST APPARATUS

Photo-conductive cell with a potentiometer is used to compare the shine of surface. Reflections of light from a surface of grains is measured indirectly.

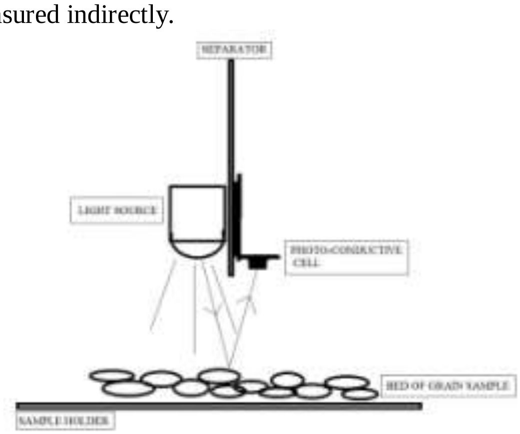

Fig.no.4.1 schematic of test apparatus

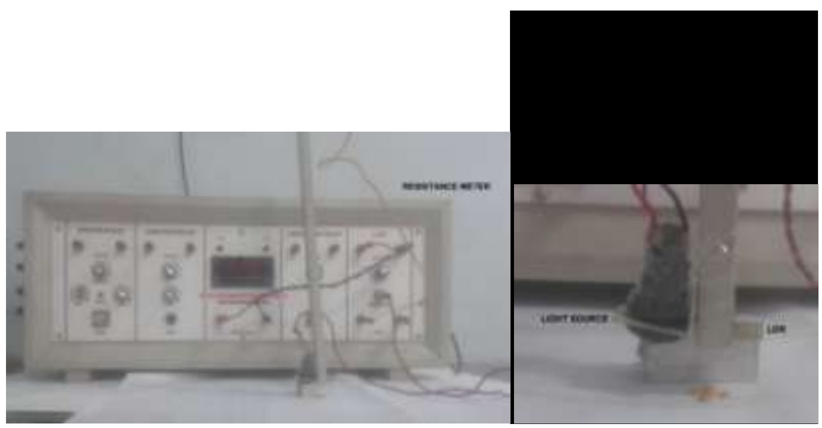

Fig. no.4.2Test Apparatus

Principle of Working:

'When light strikes semi-conductor material, there is decrease in cell resistance'.

4.2.3TESTING RESULT

Three samples are tested for light reflectivity.10 tests are done on each sample and mean values are tabulated.

Results of testing are tabulated as below:

Sr.	Dal Sample	LDR 1	LDR 2

no.		(KΩ) mean value	(KΩ) mean value
1	Unpolished	0.2	0.92
2	Oil polished	0.12	0.74
3	Polished without oil	0.12	0.6

Table.no.4.3 Dal Sample Testing

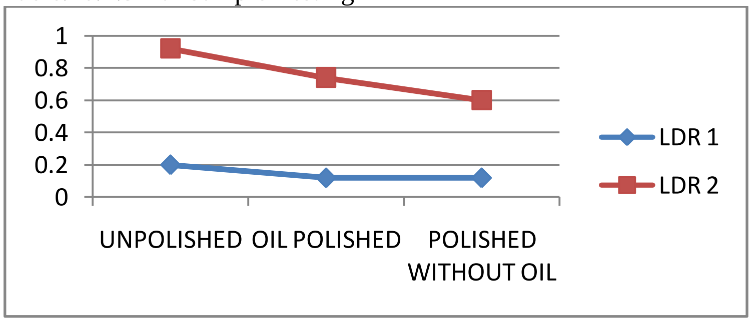

Fig .4.4 Dal sample vs LDR readings

Decrease in resistance indicates increase in intensity of light striking LDR (LIGHT DEPENDENT RESISTOR i.e. Photo-Conductive cell). Above table clearly indicates that grains samples of Tur Dal processed through Polisher Machine have better shine.

5.0 CONCLUSION

Decrease in resistance indicates increase in intensity of light striking LDR (LIGHT DEPENDENT RESISTOR i.e. Photo-Conductive cell). Above table clearly indicates that grains samples of Tur Dal processed through Polisher Machine have better shine. From above study, results shown that there is improvement in the textur of Tur dal.

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