Design and Development of Maize Thresher for Rural Dwellers by Human Pedal Power

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Abstract: In this paper, we are going to see the development of any existing technology. In different ages human always tried to develop new methods, new technology for the upgradation of living style. In developing world, maize threshing is done by various PTO operated machines, but in rural areas the farmers who lack in financial condition cannot afford this machine .So they use various hectic process which leads to monotonous work. To overcome this problem, a pedal power with flywheel concept is used for design and development. The estimated cost is very less as compared to other hand operated machines and power operated machines .i.e. (15100/-Rs). At last the testing has been taken to ascertain production capacity of machine and its viability

Keywords: Design, fabrication, Maize thresher.

I. INTRODUCTION

In Asia, maize production is over 200 billion kilograms a year and it is expected that the total maize production in developing countries will eventually overtake production in industrialized countries. Maize is one of the most important staple crops in the world. In India, maize is inferior grain which is used both as food and fodder. Its grains provide food and are used for obtaining starch and glucose. Its stalk is fed to cattle. There have been large variations in the production of maize in India since independence. For threshing various types of threshers are available in market. This thresher uses the energy of electricity. But in rural and remote areas the scarcity of electricity generally found in day to day life. However on the other side the running cost and the initial cost of existing thresher are so high that poor person who has the less then the acreage farms cannot afford it. In this new concept electricity is not needed and instead of two people only one person can do the work and acquire good quantity of production without any difficulty .the production cost is also less for this machine. The new machine is based on human powered flywheel motor concept is used. A market survey from different regions for art of maize threshing as revealed some facts that point towards further development in the present machine. Survey of Sangli district town kavthe-ekand after survey we found that two types of electricity operated maize threshing was available. These machines have good production rate but production rate but production rate depends upon availability of electricity. Due to the frequent load shading the production rate have been decreased. Survey of walwa taluka nearby Sangli district: due to unavailability of maize threshing machines people from this area travels to the near city which is 10 to 20 kms away for obtaining the maize grains. A proposed solution over the present state of art is being explained through this article. A solution is the evolution of the unique machine, which would run with the help of human power. A proposed machine can be developed by using following procedure. Firstly the threshing strength of different cobs will be estimated by performing test on apparatus, which is made especially for this work. The estimated threshing force will be used for finding the threshing force. The weight of the process unit the kinematic entities of different links the reaction force offered due to threshing force will be use for the estimation of load torque, in fact this load torque becomes useful for the estimation of demand power. This demand power will be useful in to ascertain the dimension of various components associated with the machine by obtaining design dimensions of components' fabrication will be done at last trials will be taken to ascertain viability and production capacity.

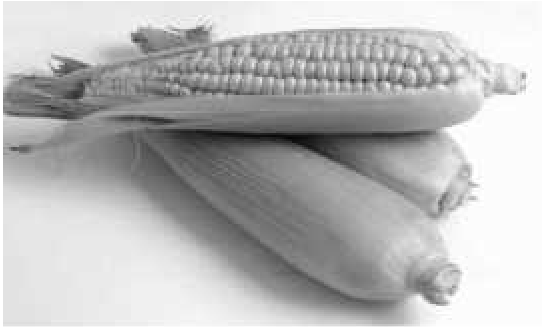


Fig 1: corn/maize

II. ESTIMATION OF DEMAND POWER AND DESIGN OF PARTS

A. ***Estimation of demand power****:* - A systematic and proper procedure is need for good design. For design of any machine, firstly a demand power for the proposed machine is being estimated. This demand power is then became an epic center for the estimation of dimensions of components used in present machine. This is in a systematic manner presented in forthcoming articles. Through the literature survey, the beater discs whose surfaces are designed with alternating rasp bars and grooves, and which are attached to the secondary shaft extending to the threshing chamber, rotate with the shaft, giving rise to centripetal force required to thresh the maize cob is given by[1].

$F = m\ {}^2 r$, where: *F* = centripetal force; *m* = mass of discs; *w* = angular velocity; *r* = max disc radius. The angular velocity (w) is given by w = $\frac{2\pi}{6}$=27.89 rad/sec.Therefore threshing force is given by $F = m\ {}^2 r$=105.01 N. Hence, the power needed to drive the shaft at 266.4 rpm is calculated from P = F * V=263.58 watt, Approx 264 watt, Where V = w * r =2.5101 m/s,

Now, to calculate HP = 0.35 HP, Torque developed at shaft is given by, T = F * r = 9.45 N-m.

Thus this torque is applied to threshing shaft. Thus from above calculations, it is somehow confirmed that the demand power for threshing the maize (cob) is equal to 0.3 hp. However, at present the torque due to gear pairs and frictional torque due to bearings are not considered so far. Hence, it is assumed that to overcome these torques and overload conditions it may further demand 0.2 hp. Therefore the total power which is to be supplied to the machine will be approximately 0.5 hp.

Design of Machine Components: Chain design, Flywheel design, Spur gear design, Shaft design, Antifriction design.

1. CHAIN DESIGN:

Design Power: $P_d = P_R * K_L$………………………………….K_L = 1.4 (for heavy shock, 10 hrs day).

Pitch circle diameter: $D_P = \frac{p}{s} \frac{h}{(\frac{1}{T})}$, pitch line velocity: $V_p = \frac{\pi D_p N_p}{6 * 1}$,

Power capacity / strand: $P = P^2 * \{\left(\frac{V_p}{1}\right) - (\frac{V}{5})^{1.4}) * (26 - 25 \cos\left(\frac{1}{1}\right) * K_L$

Length of chain in pitches: $L_p = \{\left(\frac{T_g+T_p}{2}\right) + \left(\frac{2C}{P}\right) + \left(\frac{P(T_g-T_p)^2}{4\ C}\right)\}$.

Recommended wear load, $F_w = 0.35 * P^2$ = 56.451 N

Maximum permissible bored: $d < (\frac{T_{p-5}}{4}) * P$< 34.92= 34.92. Hence the design is safe.

2. Flywheel design:

Calculate the mass of flywheel= ρ*w*h*π*D, Moment of inertia= mK^2 : K =D/2

Calculate the kinetic energy, K.E. =$\frac{1}{2} * I * \omega^2$.

Power= kinetic energy/ time=0.5 hp, Let the rim cross section be Am^2, m= ρ*w*h*D

We know b =2h, A = 2h *h, h= 0.029m^2=29mm, b=2h = 2*29= 58mm

Now find out stresses in flywheel, Assume$V_s < 1600m/m$.$V_s = \frac{\pi D_u N}{6}$ = 6.69m/sec

Calculate stresses: Centrifugal stresses: $\sigma_1 = \rho * V_{s^2}$ = 0.0482 N-mm^2

Stresses due to bending of rim $\sigma_2 = \rho * V_{s^2} * \pi^2 * \frac{D_u}{t^2 * h}$, hence, design is safe.

3. Spur gear design:

Design power (Pd): Pd = $P_R * K_L$ .... k = 1.80 = 0.50*180=1hp=746watt

Tooth load, $F_t = \frac{P_d}{V_p}$ $V_p = \frac{\pi D_p N_p}{6 \ *1}$= 0.278m m/s, Calculate actual value $F_t = \frac{7}{C.2 \ *3}$ = 894 N

PCD of pinion $D_p = m * T_P$= 3 * 85 = 255 mm $D_g = m * T_g$= 3* 87 = 261 mm

$V_p = 0.278 * m$ = 0.278 * 3 = 0.9 m/s, Dynamic load, F_d

$F_d = F_t + [\frac{2 \ V_p * C_e * b + F_t}{2 \ V_p + \sqrt{C_e * b + F_t}}]$ C = 5900 (20^C full depth)

$F_d = 2102.738\ N$ $F_d > F_b$…………….Hence design is safe.

4. DESIGN OF SHAFT

Design torque, T_d

$T_d = \frac{6 \ *P*1 \ \ *K_L}{2\Pi N}$………………………….$K_L$ = 2, Td$= \frac{6 \ *.3 \ \ *2}{2\pi * 2 \ \ .4}$,Td = 24.60 N-mm

Resultant bending moment for the point B, C, and D are as follows:

Resultant BM at B= $\sqrt{(M_B{}^2) + (M_B{}^2)}$ =53.38 N, BM at C =$\sqrt{M_C{}^2) + (M_C{}^2)}$ = 97.94 N

Resultant BM at D =$\sqrt{(M_D{}^2) + (M_D{}^2)}$ = 68.40 N

Equivalent twisting moment,

$T_e = \sqrt{(K_m * M)^2 + (K_t * T)^2}$ = 66.90 * 10^3 N- mm

Now calculating the shaft diameter

$T_e = \frac{\pi}{1} * \tau * d^3$: 66.90 * 10^3 = $\frac{\pi}{1}$ * 42 * d^3 .:d^3 = $\frac{6 \ .9 \ *1 \ ^3}{8.2}$,d= 20.09 mm

Selecting standard diameter, d = 25 mm

5. DESIGN OF ANTIFRICTION BEARING

There are two antifriction bearings B1 and B2 used in the experimental setup. The maximum reaction developed at bearing B2 i.e. R_P = 667.33 N is considered for designing the bearing.

1. Equivalent load coming on bearing,Fe, N

Fe = (XF_r+ YF_a) $K_sK_oK_pK_r$,F_r= 667.33 N

F_a= 0, Ne = F_a/ F_r,e = 0

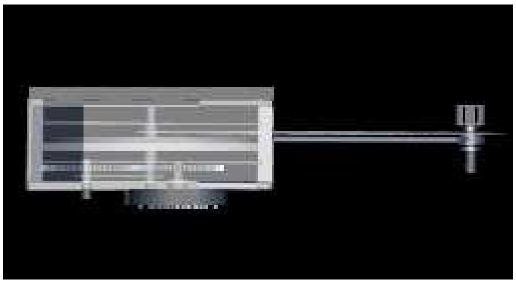
Selecting self aligning ball bearing,X = 1, Y = 2.3

Kp = 1 (no preloaded bearing),Kr = 1(outer race fixed inner raceRotating).

Ks = 2 (moderate shock load),$Fe = (XF_r + YF_a) K_s K_o K_p K_r$ = (1x 667.33 + 0) x 1 x 1 x 1 x 2= 1334.66 N
Life of bearing, L (million revolutions)= L = $(C/Fe)^n$ Kret
Kret = 1 (reliability = 90%), C =$(500)^{(1/3)}$ x Fe,C = 10818.138 N
Dimension d = 25 mm, D = 52 mm, B = 15 mm

III. MODELLING AND FABRICATION OF MAIZE THRESHER BY HUMAN POWER

The fabrication of any machine demands adequate planning and selection of systematic process. Basically, the fabrication is carried out after the design process. Once the required dimension obtained then the only work remains and that is to convert the drawing dimensions into real physical model. The forth coming article focuses on how the design is obtained in previous chapter being converted in real physical model. As per the designed and analytical calculations made in the previous chapter following CAD model is developed by using different commands of Pro E software. This CAD software provides the tools needed to perform modeling of different parts of the proposed machine efficiently and free from tedious and time consuming task. The top view and side view of the model is shown below.



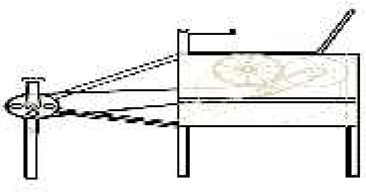


Fig: top view and side view

IV. RESULT AND DISCUSSION

This chapter emphasizes on the discussions about, Testing of maize threshing by human pedal power. &Comparisons between existing and new evolved technology and threshing efficiency. It is the common phrase that any new concept which is being evolved it needs to be verified to check its performance parameters, so that one could compare the newly evolved concept with the existing technology. For the testing purpose the different types of maize cobs have been used. Before threshing, the moisture content is removed and kept up to 15 to 18%.Afterwards the following procedure is adopted. Firstly the known quantities of maize cobs have been taken to process unit to thresh the cobs. Next to this the pedaling is started this pedaling is carried out for one minute. As soon as the shaft is rotates it helps to transmit force to the process unit and helps in threshing of maize cobs. It means available energy stored in the flywheel becomes helpful for this purpose. When the threshing activity takes place, simultaneously the measurement of the speed of the flywheel and the torque required and time is note down with the help of measuring speed logger instruments. Step 2 to 5 is known as one cycle. Once again, rider does pedaling energizes the flywheel note the measurements of speed of the flywheel shaft and process unit shaft and time for threshing. This process unit lasting until the amount of maize cobs are fully threshed with ought breaking of kernels. Steps 1 to 6 are also carried out for the known amount of maize like 500 gms. During testing it is found that the maximum speed gained by the flywheel shaft is 400 rpm. Whilst the time required threshing the maize cobs ranges from 12 to 16 secs.

BOM OF MAIZE THRESHER ENERGIZED BY HPFM MACHINE MAIN ASSEMBLY							
Sr. no.	Name of Components	Dimensions (mm)	Materials & Qty.	Sr. no.	Name of Components	Dimensions (mm)	Materials & Qty.
1	Base Frame	L B H = 800*519*723	1 MS	5	Pinion	PCD=255mm, , no of teeth=85	1 MS
2	Threshing unit	200*170*100	1 MS	6	Bearings	Bore Dia 25 mm	8MS
3	Thresher disc	Dia.= 190 mm,	1 CI	7	Flywheel	Dia = 480 mm, Weight = 20Kg	1 CI
4	Spur Gear	PCD=261 , no of teeth=87	1 CI	8	Chain drive	Length = 122mm	1 CI

V. CONCLUSION

Based on the present works the following are some important conclusions have been done.
A new concept in terms of human powered of flywheel is applied for maize threshing process which finds suitable and viable and reduces human effort compared to hand operated machine as hand operated machine requires two operators whereas new machine requires only one. This machine provides comfort for seating arrangement for different position depending upon ergonomics.
The demand power of the estimated machine estimated as 0.5hp. It is found that the maize threshing strength of cobs depends on the size of the cobs, moisture contain etc After the rider pedals, the speed of flywheel shaft decreases due to gear ratio given due to get the necessary required torque.
The time required for threshing depends upon the quantity of maize which is to be taken. It is seen that for higher quantity the time requirement will be aggrandized. For the present work machine production rate is estimated as 96.65kg/hr. It is also seen that if moisture contained in the maize cobs is more in that condition there will be more breaking of kernel and time required to thresh the cob will be more. The reading are taken for cobs sample for 0.5kg-0.8kg

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