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Design &Analysis of Cotton Picking Machine in View of Cotton Fibre Strength

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Abstract:-This research work will give a new technology in the field of cotton boll picking mechanism and to develop machine which is low weight ergonomically which could be used to pick cotton bolls. In India entire cotton is handpick by labor, internationally available machine for cotton boll picking is costlier and its shows that due to spindle type cotton picking machine, percentage of short fibre content increases result in poor quality of cotton fibre strength. Suction type cotton boll picking machine will give new technology in the field of agriculture, which is helpful for Indian farmer, it is not costly and easy to handle. Farmer can easily use suction type cotton-picking machine.

Keywords:-cotton fibre/cotton harvesting/cotton fibre properties/cotton fibre testing/suction type cotton picking machine/design/conclusion.

Introduction:- Cotton picking machine already exist in market. But due to mechanical cotton harvesting it loses the quality of fiber strength .In earlier days cotton picking is done by hand that was giving a good quality of cotton with good fiber strength but it require more time. In general cotton harvesting required -5KPa breaking off force to lift a cotton locks from burr. To overcome to this problem analyze the design of cotton picking machine and made the modification to improve the quality of product.

Spindle - type cotton picking machine, is one of the cotton picking machine which remove the cotton from open bolls .The spindles, which rotate on their axes at a high speed, are attached to a drum that also turns, causing the spindles to enter the plant. The cotton fibre is wrapped around the moistened spindles and then taken off by a special device called the doffer, from which the cotton is delivered to a large basket carried above the machine. During wrapping of cotton fibre around the spindles bars, fibre was stretched will result in increase short fibre content and trash and hence loses fibre quality and strength.

COTTON CHARACTERISTICS:-

Cotton:-cotton is defined as "A soft white fibrous substance which surrounds the seed of the cotton plant and is made into textile fibre and thread for sewing" in other word it can be defined as "A crop plant with white hairs"

STRENGTH OF COTTON DEPENDS ON PHYSICAL PROPERTY OF COTTON:-

Fibre length is described as "the average length of the longer one-half of the fibers (upper half mean length)" This measure is taken by scanning a "beard " of parallel fibers through a sensing region

Length uniformity:-Length uniformity or uniformity ratio is determined as " a ratio between the mean length and the upper half mean length of the fibres and is expressed as a percentage

Micronaire: –is the property of cotton which determine cotton fibre fineness and maturity

Fineness:- is important property will decide the spinable count of cotton

Maturity:- is a characteristics of cotton which is related to the extent of development of cell wall

Strength:-fibre strength is expressed in terms of tenacity defined as the load or force required to break a fibre of unit linear density

Short fibre content:-will effect on efficiency and product quality

METHOD OF DETERMINING SHORT FIBRE CONTENT:

Short fibre content can be determine by comb-sorter method and HVI-900 machine

Comb-sorter method: Comb sorter is a instrument consist of a bed of upright and parallel comb which control the fibre and enable the sample to be fractionated into length group

Prepare a sample of 300g of cotton. Prepare a sliver is placed on the comb With the help of tweezers withdrew fibres in small groups in the order of decreasing length Fibres are laid side by side on the velvet pad.

ANALYSIS OF COMB-SORTER DIAGRAM:

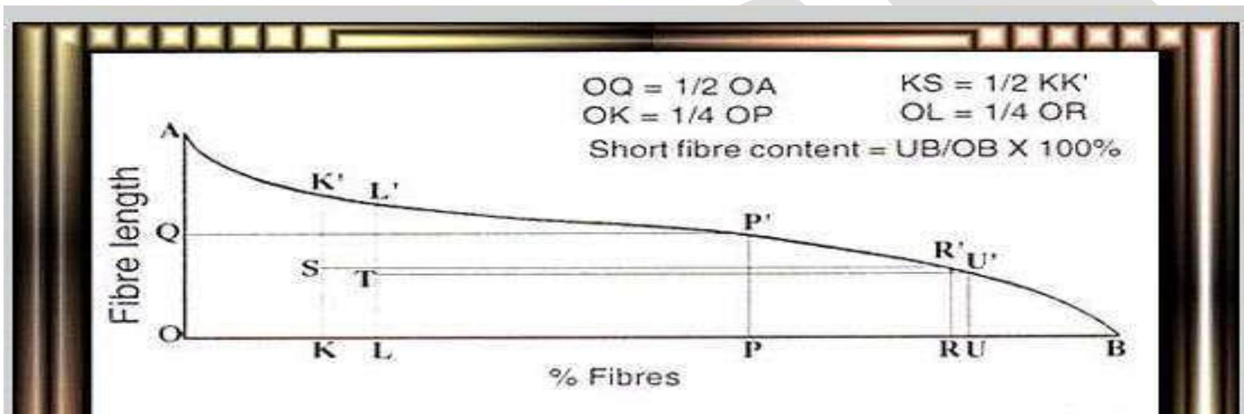


Fig. 1.6 Short fibre content by the Baer Sorter method

Procedure to determine short fibre content

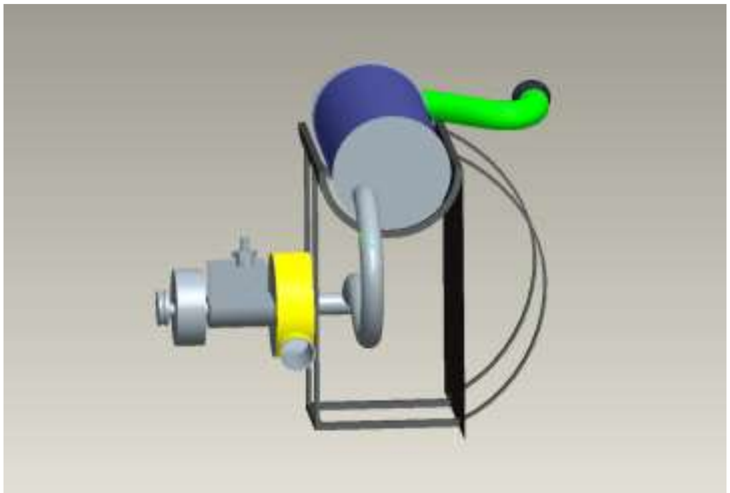
Q is the mid point of OA. From Q draw QP' parallel to OB to cut the curve at P'. Drop the perpendicular P'P on OB. Mark OK equal to 1/4OP and erect perpendicular KK' towards curve. S is the mid point of K'K. From S draw SR' parallel to OB to cut the curve at R'. Draw the perpendicular RR' .Mark off OL equal to 1/4OR .Erect the perpendicular LL' this is the effective length

Percentage of short fibre content can be calculated by Short fibre content = (UB/OB) x 100

SUCTION TYPE COTTON PICKING MACHINE:-

The main motive is to design suction type cotton-picking machine to overcome the problem of manual picking which will reduce cost and time. Therefore, there is an urgent need to develop such a system, which helps to Indian framer .This machine is suck cotton from fully mature cotton ball with less percentage of short fibre content.

CAD MODEL OF SUCTION TYPE COTTON PICKING MACHINE:-



CONSTRUCTION AND WORKING:-

Pulley connected to the shaft of engine will drives the rotor and by its rotation magnetic field generates current in primary and secondary circuit induces magnetic flux in armature change in magnetic flux by breaker point produce 170 volts in primary circuits and induces 10000 volts in secondary circuit firing spark plug .Spark plug ignites air-fuel mixture inside cylinder by high voltage in gap between centre and electrodes, moves the piston inside cylinder will rotates the cam shaft. This cam shaft rotates the impeller at high speed developed a required air suction pressure which can easily suck cotton from plant.

DESIGN CALCULATION OF SUCTION TYPE COTTON PICKING MACHINE:-

A normal cotton boll can be plucked by pneumatic force of 3.5N, with discharge of 0.025 m^3/s at a velocity of 12.73m/s. for to produce this force we consider a stander 11.34 Kw power of IC- Engine with 5000 rpm. Which is connecting with impeller to produce required Force to collect cotton from cotton boll.

Design of Shaft.

Engine power= 11.34 Kw.

Speed = 5000 rpm

Calculate the Torque

Power $P = \frac{2\pi NT}{60} \times K_L$

Where $K_L - Load\ Factor$ =1.15

$$1.34 \times 10^3 = \frac{2 \times 3.14 \times 5000 \times T}{60} \times 1.15$$

T = 19.606 N-m

Assume material SAE 1030 and FOS is 3.

$\tau = 61\ N/mm^2$

$$T = \frac{\pi}{16} \tau d^3$$

$$19.606 \times 10\text{^}3 = \frac{\pi}{16} \times 61 \times d^3$$

ds= 11.78mm.

Increase the diameter by 50%

ds=17.67mm.

Standardizing Diameter Of Shaft = 20 mm (From Data book page no:- 182)[6]

Design of Impeller.

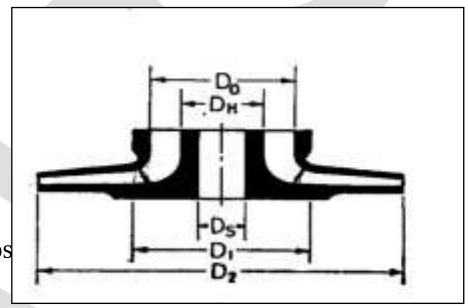
The diameter of the impeller eye, *Do,* is dependent on the shaft diameter, *Ds,* which must initially be approximate. The hub diameter, D_H, is made 5/16 to ½ inch larger than *Ds*. After estimating *Ds* and D_H, *Do* is based on the known flow rate. The inlet vane diameter, D_1, made about the same as *Do* to ensure smooth flow.

The hub diameter, D_H , is made from 5/16 to ½ in. larger than D_s

$$D_{H=}\frac{5}{16}d_s + d_s$$

$$D_H = \frac{5}{16} \times 20 + 20$$

$$D_H = 26.25mm$$



Consider diameter of hub is 28mm. [11] . Fig. 5.1 cros

Selected impeller of discharge is 0.04m^3/s.

Required discharge is 0.25m^3/s, with velocity of 12.73m/s.

$$V_{su} = V_o = 12.73m/s$$

$$Q = \frac{V_{su}\pi {d_{su}}^2}{4}$$

$$0.04 = \frac{12.73 \times 3.14 \times {d_{su}}^2}{4}$$

$${d_{su}}^2 = 50mm$$

Since required diameter of suction pipe is 50mm.

Now,

$$Q = V_0\left[\frac{\pi\, {D_o}^2}{4} - \frac{\pi\, {D_h}^2}{4}\right]$$

$$0.04 = 12.73\left[\frac{3.14 \times {D_o}^2}{4} - \frac{3.14 \times 26.25^2}{4}\right]$$

$D_o = 68.49mm.= D_1$

Since inlet, Diameter of impeller is 70mm (stander Diameter).

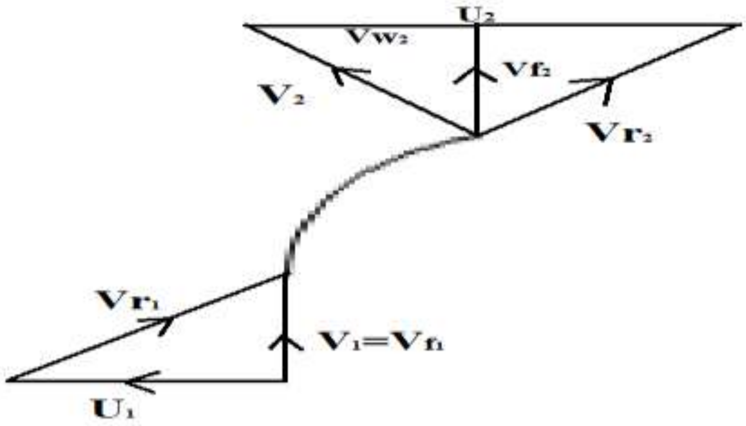


Fig. 5.2 Velocity diagram

$$U_1 = \frac{\pi d_1 N}{60}$$

$$U_1 = \frac{3.14 \times 70 \times 5000}{60 \times 1000}$$

$$U_1 = 18.32\ m/s.$$

Inlet angle is usually 10 º -25 º.

Since

As per the impeller vane blade inlet angle θ is

θ= 13º (vane angle at inlet)

$$\tan\theta = \frac{V_{f1}}{U_1}$$

$$\tan 13 = \frac{V_{f1}}{18.32}$$

$$V_{f1} = 18.80m/s\ .$$

Width of the Impeller

$$b_1 = \frac{Q}{\pi\ \in V_{f1} d_1}$$

Where $\in = 0.85$

$$b_1 = \frac{0.04}{\pi \times 0.07 \times 4.229 \times .85}$$

$b_1 = 50.62\ mm.$

From inlet velocity triangle.

$V_{r1} = 18.80 m/s$

Outlet Diameter of Impeller is 240mm (From impeller)

$$U_2 = \frac{\pi d_2 N}{60}$$

$U_2 = 62.8mm.$

The normal range of discharge angle is 20 º -25 º.

Ø=20º (outlet angle of impeller).

$V_{f1} = V_{f2} =$ 4.229 m/s.

$$\tan\theta = \frac{V_{f2}}{(U_2 - V_{w2})}$$

$V_{w2} =$ 51.18 m/s.

$$\tan\beta = \frac{V_{f2}}{(V_{w2})}$$

$\beta = 4.72$ º.

$$V_{r2} = \sqrt{\left((U_2 - V_{w2})^2 + {V_{f2}}^2\right)}$$

$V_{r2} = 12.36 m/s$.[4]

Pressure Calculation.

Pressure created by impeller at the outlet.

$$P = 249.08 * 1.1 \left(\frac{N * D * 39.37}{1.53 * 10^4}\right)^2$$

$$P = 249.08 * 1.1 \left(\frac{5000 \times 0.24 \times 39.37}{1.53 * 10^4}\right)^2$$

P= 2612.41 Pa.

Now,

$P = \rho g h$

$2612.41 = 1.183 \times 9.81 \times H$

H= 225.10m.

$V = \sqrt{2 \times 9.81 \times H}$

$2612.41 = \sqrt{2 \times 9.81 \times H}$

V=66.45m/s.

Velocity generate at the outlet of impeller is 66.45m/s.

Now,

Pressure difference Δ P = P2 – P1

Δ P = - 98732.59 N/m^2

Pressure Ratio = P2/ P1

= 0.025577.

This pressure difference can easily suck cotton from cotton boll.

Hose pipe design.

Impeller to the tank Pipe diameter.

Q = AV

$0.04 = \frac{\pi}{4} {D_{Pipe}}^2 \times 66.45$

$D_{Pipe} = 29.37 = 30mm.$

Velocity inside the pipe is

Q = AV

$0.04 = \frac{\pi}{4} {D_{Pipe}}^2 \times V$

V=56.617m/s.

Head loss due to friction

$H_l = \frac{4fL\,V^2}{2gD_{pipe}}$

Where,
f- Coefficient of friction
L- Length of pipe
V- Velocity inside the pipe

$Re = \frac{VD_{pipe}}{v}$

ν- Kinematic viscosity of air

$$Re = \frac{56.617 \times .03}{15.98 \times 10^{-6}}$$

$$Re = 1.24579 \times 10^5.$$

Coefficient of friction

$$f = \frac{0.0791}{Re^{1/4}}$$

$$f = 0.004208.$$

$$H_l = \frac{4 \times 0.004208 \times 0.3 \times 56.617^2}{2 \times 9.81 \times 0.03}$$

$$H_l = 0.12$$

Velocity inside the tank.

$$A_1 V_1 = A_2 V_2$$

$$\frac{\pi}{14} 0.03^2 \times 56.617 = \frac{\pi}{4} 0.15^2 V_2$$

V_2 = 2.26m/s.

Now,
Velocity at suction Pipe

$$A_2 V_2 = A_3 V_3$$

$$\frac{\pi}{4} 0.15^2 \times 2.26 = \frac{\pi}{4} 0.05^2 V_3$$

$$V_3 = 20.34\ m/s\ .$$

As required velocity is 12.73m/s and we obtained the velocity at suction is 20.34 m/s so we can easily picked cotton from cotton boll.

conclusion

1) Design of suction type cotton picking machine is simple and easy to handle by farmer.
2) This suction type cotton picking machine reduced cotton harvesting time compare to hand picking and less in cost compare to spindle type cotton picking machine.

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