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Design & Modeling of New Mini Carding Machine for small scale industry

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Abstract
Carding is the most important and the slowest process in the cotton processing unit. It contributes a lot to yarn quality. Many small and large production machines are available in market. The techno economic analysis [1][2]of Khadi making compelled to perform reengineering of carding process. Various machines have been studied and analyzed. The small production machine with the capacity of 60 kg sliver per 8 hrs has been planned. Various parameters have been studied. The dimensions of various components have been finalized. The cad model has been prepared.

I. Introduction

Carding is the most important process in spinning. It is closely attached with the yarn quality [3]. It involves the arranging of fibers in parallel fashion, necessary for all staple fibers to produce fine yarns. Before converting the raw cotton into yarn the impurities must be removed from it. The fibers of raw cotton disentangled and straightened by using this process. It involves opening the flocks into individual fibers and clean by removing the impurities. It forms the silver by removing neps and short fibers. In this process the lap is passed through sequential cylinder covered with different wire grades and brushes having different diameter. A belt having flat plats (wire brushes) slowly moves concentrically above the main cylinder. As the cylinder rotates the cotton is pulled by the cylinder through the small gap between the wire brushes. As the flats and cylinder rotate in different directions the teasing action occurs which removes the remaining trash, disentangles the fibers and arranges it in relative parallel manner in the form of thin web. This web is further advance towards the doffer, stiffing rollers and converts into sliver after passing from calendar rollers**.**

Components of carding machine and their operation.

Various components are working simultaneously in single unit to convert raw cotton into finish round bar Sliver. They are

1) Feed region:- It consist of lap stands fluted, wooden lap rollers, a polished feed plate, a pair of selvedge guide plate, steel fluted rollers and weighting system. The entire unit is mounted on the main frame with slide arrangement for proper alignment. The lap rollers unwound and advance lap sheet towards licker-in roller with the help of feed plate and fluted feed roller. Another method is to feed the cotton as flocks in the hopper. In the planned machine flock feeding will be preferred. Cotton after ginning would be directly fed to the card. The operation of pressing of cotton would be eliminated [13]
2) Licker-In region: It consists of hallow cylinder with surface of series square bottomed spirally cut grove 2 to 4 per cm running around it from one end the other. The main aim of this roller is to hold good fiber and permit short fibers, light trash and dirt to fall away.[4]
3) Cylinder region:- It is most important part of carding machine. All parts are built around and directly or indirectly adjusted to it. It's having 130 to 150 wire points per square cm and inclined in the direction of rotation of cylinder. The main objective of cylinder is to open the cotton completely even to the separation of one fiber from all the others. It also collects and removes the short fiber, reduces naps.
4) Casing or Screen under the Cylinder:- It is the metal plate which can closing the cylinder, licker-in and doffer for creating draft and also left the dirt, dust and short fibers by fall out.
5) Flat Plates:- The flat plate is long cast iron bar with strengthening rib. The aim of flat plate is to eliminate short fiber and impurities
6) Doffer region:- The doffer is a cast iron cylinder of the same width as of main cylinder comparatively small in diameter. The doffer provides the combing action to the fiber.

7) Stiffing rollers:- Stiffing rollers is having same size as doffer. The coarse wire is wound on the surface of the stiffing roller.
8) Calendar roller:- The calendar roller is made from steel and having grove on it. The two roller are mesh and rotating in opposite direction to convert the lap into round rope like sliver.

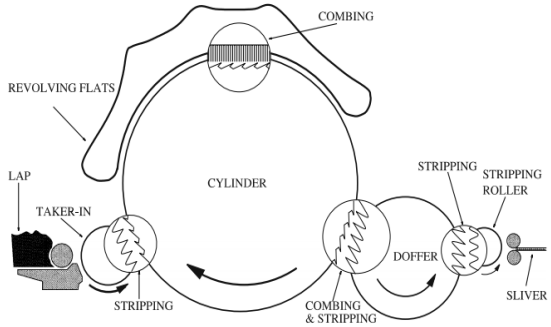


Figure 1.A diagram of carding machine.

II. Need of reengineering

Various small and New carding machines are available. Few attempts have been made to use such a small card to use as production card with some modifications [3]. Few small machines have been designed only to fulfill the requirement of research and test laboratories [6][7]. Commercial carding machines produced by the manufacturers like Trutzschler, Reiter, Platt, are commonly used in modern spinning mills.

The various models of Mini and New carding machines were designed and manufactured for decentralized spinning [2] units. The production rate of laboratory or experimental carding machine (3 to 5 Kg per 8 Hours) [1] is very low as compared to production machines (500 to 800 Kg per 8 hours). The techno economical analysis on Khadi production in India [2] reveals the need of a machine with the production capacity of 50 to 60 Kg per 8 hours. Analysis of commercial cards and its comparison with small cards made it clear that the reengineering will provide the necessary solution

III. Analysis of commercial carding

The inputs for reengineering have been obtained from the basic parameters of the commercial production cards. Any standard engineering design process is not available for designing the machines for cotton processing. Here few assumptions have been made and geometric parameters like doffer diameter, doffer speed and doffer length have been assumed and the production capacity was obtained [10][14]

Calculation for production capacity of New carding machine

The simple proportionate formulae is use to finalized the parameter of New carding machine

$$\text{Production in } \frac{\text{kg}}{\text{hr}} = \frac{\pi * \text{Doffer dia} * \text{Doffer speed} * \text{time} * 60}{36 * 840 * 2.204 * \text{sliver hank}} * \frac{l}{L}$$

Where l = length of actual carding of scale down model

L = length of actual carding portion of TRUMAC-DK780

$$\text{Production in } \frac{\text{kg}}{\text{hr}} = \frac{3.14 * 6.69 * 180 * 60 * 400}{36 * 840 * 2.204 * 0.120 * 1500}$$

= 7.44 kg/ hr.

The relation with assumed dimensions of doffer, speed and length gives production of 7.44Kg/Hr. (Table II)

Following major changes were observed in the carding technology [3][11][12][13]

1. The stationary flats were converted into revolving flats
2. The surface speed have been increased drastically
3. The wire fineness and card clothing technology have been improved.
4. The location of cylinder have been changed to get more carding action.

While finalizing the dimension for designing experimental model the parameters of high production cards and the small cards have been used.They are-

Cylinder wire (wire angle, height, thickness and population)

Flat topes specification, Lickers-in wire specification, doffer wire specification, feed weight, draft between feed roller and doffer cylinder, flat tops, doffer wire life, Licker-in wire life, cylinder speed, flat speed, Licker-in speed, setting between cylinder and flat tops, setting between Licker-in and feed plate, setting between Licker-in and under casing element (like mote knife, combing segment) setting between cylinder and doffer, Setting between cylinder and cylinder casing.

All above parameter are affecting the performance of carding machine. While designing the New carding all parameters are to be finalized from Production carding machine. The parameters are mention in TABLE I. All these parameters would be used to prepare CFD model.[7][8][9]

IV. Conclusion

For designing the experimental carding machine various geometrical parameters have been obtained. Simple reengineering techniques have been used to prepare the CAD model of the new small carding machine. This CAD model will be useful in

simulation of carding process. CFD analysis would be done with nondeterministic approach. The experimental model will be used for validating CFD model.

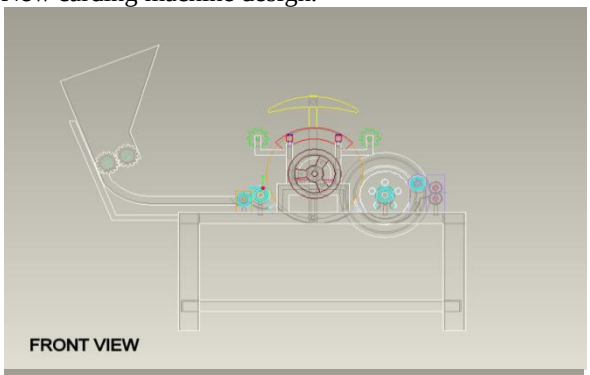
TABLE I
PARAMETERS FOR NEW CARDING MACHINE

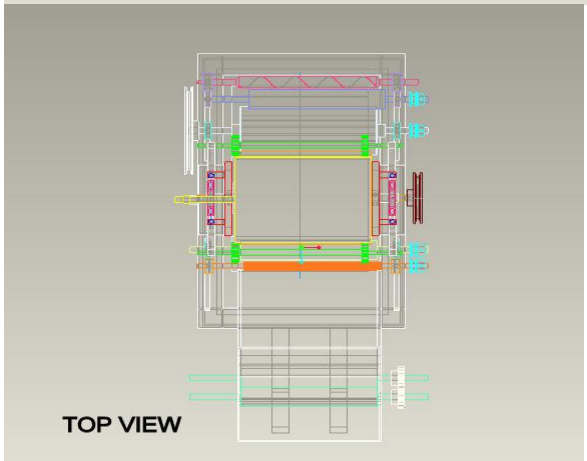
Sr No	Parameters	Value
01	Cylinder Wire a) Wire Angle b) Height of wire c) Population (PPScm)	55 ° 2 mm 130 to 150
02	Doffer roller Wire a) Wire Angle b) Height of wire c) Population(PPSI)	60 ° 5 mm 400
03	Licker-In roller Wire a) Wire Angle b) Height of wire c) Population (row/cm$^{2)}$	85 ° 5 mm 1.5 to 2
04	Draft between Feed roller to Doffer roller	75 to 95
05	Draft between Main Cylinder to Licker-In	2
06	Setting between Cylinder and Doffer	0.125 to 0.15 mm
07	Setting between Cylinder and Flat Tops	0.175 mm
08	Setting between Feed plate and Licker-In	0.45 to 0.7mm
09	Setting between Licker-In and Mote knife	0.35 to 0.5 mm
10	Setting between Licker-In and Combing segment	0.45 to 0.6 mm

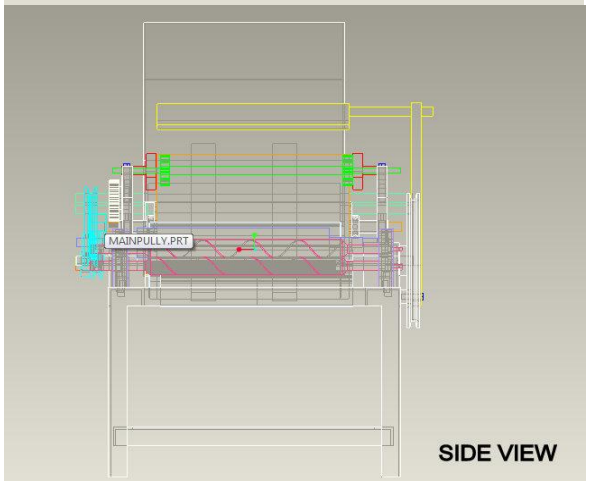
TABLE II
PARAMETERS FOR NEW CARDING MACHINE

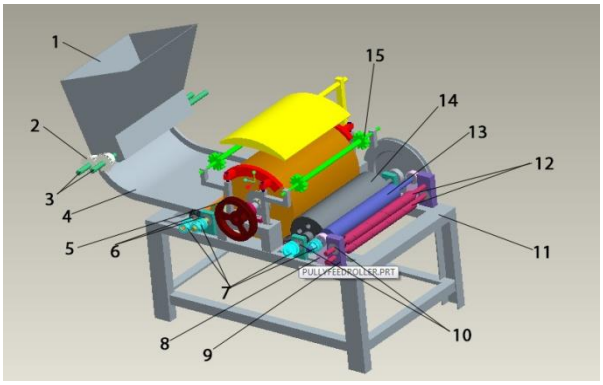
Sr. No.	Parameters	Value
01	Production Rate	7.44 Kg/Hrs
02	Actual draft	100
03	Lap weigh	200 gm/m
04	Doffer dia	170 mm
05	Doffer speed	180 rpm
06	Inclination angle of cylinder wire	$\beta = 55^0$
07	Inclination angle of doffer wire	$\beta = 60^0$
08	Cylinder speed	421 rpm
09	Licker_in speed	1075 rpm
10	Feed roller speed	120 rpm
11	Cylinder dia	320 mm
12	Licker-in dia	60 mm
13	Feed roller dia	40 mm
14	Effective width of all roller	400 mm

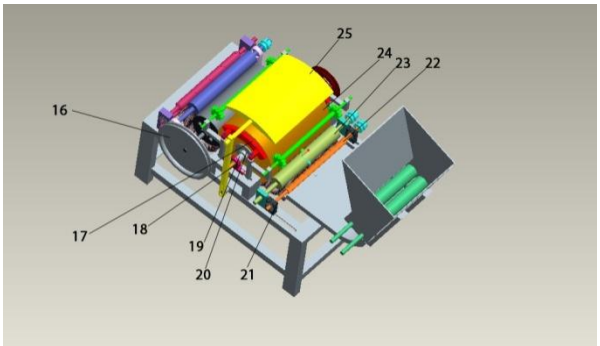
By considering above dimension CAD Model of New carding machine design.











Parts: 1)Hopper, 2) Gear, 3) Straightening Roller, 4)Tray, 5)Cylinder pulley, 6)Pedestal Bearing(Feed Roller & Licker-In), 7)Pulley(Feed Roller, Licker-In & Stiffing roller), 8)Stiffing roller pedestal, 9)Cylinder pedestal, 10)Bearing 6204(Doffer & Calendar roller), 11) Table, 12) Licker-In roller, 13) Stiffing roller, 14) Doffer, 15) Star gear, 16) Doffer pulley, 17) Flat top, 18) Bearing for Cylinder, 19) Sleeve, 20) Cylinder Supporting plate, 21) Feed roller pedestal, 22) Feed roller, 23) Licker-In, 24) Main cylinder 25) Flat plat support

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