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Miniature Cotton Opener Machine

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Abstract: *The cloth opening machine deals with the processing of waste cotton cloth into regenerated or recycled cotton for low-grade products such as insulation, mop heads, rags, and stuffing. This machine is used to produce recycled cotton with good quality at minimal investment but the quality of the regenerated cotton will never be equal to the quality of the original cotton. It will produce an effective and efficient amount of regenerated or recycled cotton for the given input volume of feed of the waste materials. It consists of the main cylinder, doffer, taken-in or licker-in roller, stripper roller and feed roller. In this machine, the opening time of the waste cotton cloth is reduced to increase the recycling rate of the waste cotton cloths. A saw-toothed wire is wound over the rollers, which produces the eminent opening effect. Miniature level cotton opener machine is not available in the market, so this work focuses on the design and fabrication of miniature cotton opener machines the fabricated cotton opener machine is found working satisfactorily.*

Keywords: *Cotton or fibre, Opener, doffer, licker-in, stripping device, recycled cotton.*

I. INTRODUCTION

The availability of the waste materials is abundant in the global, at the same time requirement of the cotton also increased to balance the shortage recycled cotton can be used for the required purposes. The principle of the miniature cotton opener machine is to produce regenerated or recycled cotton from the waste cotton cloths; it can be obtained by the carding process. It is the process also called a mechanical process that disentangles cleans and intermixes fibre to produce a continuous web or sliver suitable for subsequent processing. The recycled or regenerated cotton is used for the development of nonwovens, tapes, and hybrid yarn structures is an emerging trend. The opener machine is designed to produce decided opening effect for which the setting clearance or distance in between the openers and the shape & size of the toothed wire over the cylinder was optimized and enhanced. The recycled or regenerated cotton is used for the developments of nonwovens, tapes and hybrid yarn structures are an emerging trend. The quality factors that are important for determining the market value of the recycled cotton or natural cotton are its grade and staple length. The grade is calculated with several quality parameters such as fibre length, strength, fineness (micronaire), non-lint content, moisture content, etc. In this machine, there are different roller each one performs one operation. First, the feed roller is used to feed the sheet of waste materials to the action of a fast revolving Licker-in roller. Finally, the control rollers are used for the collection of the web or sliver, it also provides safety for the worker. The licker-in, main cylinder, and doffer, which are the major rollers involve in the opening of the waste cotton cloths. Based on the production rate and type of waste materials, the roller's speed can be decided and also the specification of the saw-toothed wire. The single-phase AC motor is used for rotation of the rollers, with the belt drives and chain drives. In this machine, the worm gearbox also employed for the speed reduction of the roller, to get the desired speed or RPM of the different roller involved in the rolling action. A comb is placed over the main cylinder surface for the fine opening of the cotton and to enhance the quality of the recycled cotton. Miniature opener machines have opportunities in the testing of the cotton materials and also for dyeing of the cotton cloths. This machine will contribute to the women's empowerments, it has less investment cost through which the women can make money by selling the recycled cotton for the largest mills and industries.

II. LITERATURE SURVEY

The journals are collected from the Journal of Textile Science & Engineering and Elsevier (science direct) related to miniature cloth roving and opener machines. In this study, totally 20 papers are collected for miniature opener machines. The opening effect of the opener machine is achieved by the saw-toothed wire cylinder, in which the effect of the opening was the major problem, it can be recovered by using proper saw-toothed wire and setting distance or clearance between the different cylinders. For the testing of composition of cotton cloths, we go the larger opener machine, it requires a high amount of input feed for the machine and power consumption is more. To overcome the problem, the miniature opener machine provides the solution. Muhammad Furqan Khurshid, et al., [1] stated that preparing of waste carbon fibre on opener machine for the advancements of nonwovens tapes and cross breed yarn structures was a developing pattern. This key examination assists with understanding the conduct of carbon fibre on carding process and to change the ideal carbon fibre properties, for example, fibre direction, fibre length and fibre grating in nonwoven, tape

and mixture yarn structures which improved the exhibition of reused At that point, the impact of these parameters on card bit quality was surveyed regarding fibre direction, fibre length, and bit attachment power.

Grace Kakonke et al., [2] described that the nonwoven textures are for the most part utilized in current dispensable clean items where their main role was to offer superb retentiveness just as solace to customers. Uncoated textures showed lower ingestion limits than covered textures, whose assimilation limit changed relying upon the covering polymer utilized. The issue is that nonwoven textures can't be made totally from chicken quill filaments because of their poor length. The manufacture of novel NACs was accomplished by covering the novel needle-punched nonwoven textures with superabsorbent polymers. It could well control cotton yarn quality by anticipating yarn quality, etc.

Zhenlong Hu et al., [3] stated that it was a key record of cotton yarn quality. The cotton yarn quality forecast technique is proposed with Recurrent Neural Network (RNN). It tried RNN, MLR, SVR, and ANN with 200 arrangements of information. Exploratory outcomes show that the Recurrent Neural Network (RNN) is the best precision among these four calculations. Since the preparation of the cotton yarn generation had time arrangement, the paper proposed another profound neural system; it was a fake Recurrent Neural Network (RNN).

Kuei- Feng Chen et al., [4] described that a material washing gadget contains: a clothes washer and a fibre opener. The clothes washer incorporates numerous Tran strategic organized on water and different orientation fixed in the water. The fibre opener incorporates different Trans strategic orchestrated on the water, numerous heading fixed in the water, and in any event, two work wheels organized in the water. The fibre opener was mounted behind the clothes washer, and the material was conveyed between the clothes washer and the fibre opener by method for the various transmission rollers and the different orientation of the clothes washer and the fibre opener and the least two work wheels.

MaschinenfabrikRieter, [5] stated that a bundle opener for the remove - from fibre tufts from fibre bunches incorporates a take-off pinnacle, which is masterminded on a level drive or a pivoting outline, and a take-off arm. The take-off pinnacle makes it feasible for the take-off unit to be moved over the outside of the fibre bunches. To this end, the take-off pinnacle is masterminded on an even drive or a pivoting outline. To this end, a take-off unit is moved over the fibre bundles. The take-off arm was hung on the take-off pinnacle in a guide to be vertically flexible.

Gerhard Gschliesser, [6] discussed the procedure for adjusting the stacking power of a breaker component of a bunch opener on a parcel bunch incorporates setting a power sensor used to quantify the stacking power at no heap; bringing down the breaker component onto the bundle bunch until arriving at a stacking power that is at any rate twice as high as an upper stacking power at which the breaker component gets a lift direction during typical breaking activity; diminished the heap on the breaker component; setting the stacking power at a negative worth which incorporates signal twisting impacts, and bringing down the breaker component until the stacking power estimated by the heap sensor comes to at any rate the degree of the upper stacking power. To do as such, the breaker component is moved over the fibre bundles.

TruetzschlerGmb et al., [7] stated that a saw tooth wire in which every tooth has a tooth tip and a tooth front having a first portion stretching out from the tooth tip towards a tooth side remote from an orientation edge and towards the tooth back and converging into a curved second section that converges into a third fragment reaching out towards the tooth side and converging into an inward fourth fragment. That converges into a tooth back of the following tooth. The length of a digression from a defining moment of the second fragment to the tooth side was more noteworthy than or equivalent to a large portion of the dividing between the tooth tip and the tooth side.

Keith. Johnson et al., [8] describe that a plate, for example, however not constrained to a seed opener circle was furnished alongside a seed opener get together for a grower, that includes a hard face covering along the inclined surface district. Such a gathering can include a help carriage, and a couple of collaborating first and second measure wheels mounted to a help carriage for revolution. Ideally, the first and second opener plates are found forwardly and underneath the first and second check wheels. The hard face covering is ideally a laser cladding that structures a metallurgical bond with the basic steel base material.

Ghadge et al., [9] stated that cotton build-up tests drawn from thickly stuffed parcels are required to be very much opened and cleaned before being utilized for fibre quality evaluation utilizing current testing hardware. Cotton build-up tests utilized for testing fibre quality parameters must be spotless and liberated from any non-build up content. Directly, HVI testing research facilities open cotton build-up tests either physically by hand or by utilizing refuse analyzer and opener blender. Henceforth they require tidying and opening up to guarantee the exact estimation of micronaire values.

Hasan et al., [10] discussed that a recovered fibre fabricated from cellulose subordinates was getting ubiquity these days because of its biodegradability and condition convenience relying upon the less land and water utilization comparative with natural and the regular cotton. The turning process streamlining of Tencel was performed and evaluated right now correlation with the regular

cotton process. A more extensive setting with low creation speed is watched for Tencel preparing with predominant yarn quality. Quality parameters of various yarn tallies assessed and thought about.

Curtis Thomas Curles et al., [11] stated that round module opener for use with a round module of cotton arranged inside a wrap, including an edge, an empty transport gathering that was bolstered by the casing and moves the round module of cotton a first way that is corresponding to a longitudinal focus hub of the round module opener, a slitter get together that is verified to the casing and cuts through the wrap along its whole length as the round module of cotton moves in the primary course, and a picker get together including a majority of work ions, the picker get together being rotatable so the majority of work ions first penetrate a first segment of the wrap and are accordingly pulled back from the main part of the opener wrap, in this way isolating the principal segment of the wrap from the round cotton module. Walker Hanlon, [12] described that abuse the effect of the U.S. Common War on the British cotton material industry, which diminished supplies of cotton from the Southern U S, compelling British makers to move to bring down quality Indian cotton. As these new advancements got accessible, I show that the general cost of Indian/U.S. cotton bounced back to its pre-war level, despite the expanded relative stockpile of Indian cotton. Also, as these new advances were presented, the general cost of Indian to U.S. cotton bounced back to (and in certain years over) the normal level saw during the pre-war period, despite a significant increment in the overall inventory of Indian to U.S. cotton.

Abdullah SESSİZ et al., [13] stated the impacts of the cotton picker model and driver's capacity on cotton collect misfortunes and cotton quality was researched. Four cotton pickers have four paddled and one picker has six paddled with a baler. John Deere cotton pickers were utilized in the 2013 cotton gather season. All in all, no distinction was found between cotton build-up quality by hand reap and cotton pickers. Then again, the cotton picker model and driver's capacities were measurably varied on gather misfortunes.

Britta Jacobs et al., [14] describes that gadget on a turning room arrangement machine, for instance, a fibre rush feeder, carding machine, cleaner or something like that, for Supplying and additionally releasing fibre material, a plate-like guide component having a guide Surface co-works with at any rate one transport roll situated inverse, the fibre material being guided towards and along the guide Surface. Xue-zhi et al., [15] stated the impact of various measured of pin carding plate and saw-tooth carding plate individually introduced under the licker-in of carding machine on polyester yarn bushiness was examined. The shagginess of polyester yarns delivered in the state of introducing pin carding plate and saw-tooth carding plate under the licker-in at four unique measures were tried by YG172 yarn bristliness analyser. As indicated by the above conversation, following ends can be gotten: For pin carding plate, the measure of 0.7mm is generally helpful for decreasing the quantity of polyester yarn furriness, while that of 1.0mm is generally horrible for lessening the quantity of polyester yarn bristliness.

Alagirusamy, [16] stated the procedure control perspectives identified with the blow room and carding activities in the staple fibre yarn producing process. Procedure control perspectives identified with these capacities are talked about giving quality and efficiency related issues and the control exercises required at various zones of these two activities. The control of procedure parameters in these activities, which will at last influence the yarn properties, are additionally examined in detail notwithstanding the control extracts required on the crude material determination.

Owais Anwar Golra et al., [17] said to contemplate the working of two unique mixes of stationary pads having distinctive wire focuses per square inch and its effect on squander rate decrease and cotton fibre conduct. The blend of stationary pads utilized in set-A has given the best outcomes in regards to the nature of the yarn, improvement in the quality of yarn and the waste rate decrease in the carding machine or from the carding office.

Xin Guo et al., [18] stated that the impact of web cleaner on the front plate suction type of carding machine on the nature of card fragment was contemplated. The outcomes show that, when the suction volume was between 120~240m³/h, the scope of short fibre content in card fragment was 12.03~14.0% in the single side suction and was 15.6~16.8% in the twofold sides suction; In this way, it very well may be seen that under a similar suction volume, the front web cleaner with single side suction was increasingly gainful to improving the nature of card bit, so it was better for the front web cleaner to utilize single side suction structure.

Hans Rosemann et al., [19] stated that saw-tooth wire for creating saw-tooth all-steel garments for a roller or a carding component of a turning room machine, having a prolong base locale (foot) and an abutting toothed area (edge) in which teeth are framed by cutting, the teeth including a tooth front, a tooth back and two side flanks, between the tooth back and the tooth front of two progressively organized teeth there is a neck.

Hubert Hergeth et al., [20] stated that In particular, air direction accomplished by planning the fibre opener in Such way that the fumes air from the diaper machine which has passed on the filaments to the diaper machine is guided back to the fibre opener and serves to expel the strands from the opener roller. This is accomplished by structuring the fibre opener in Such way that the fumes air from the diaper machine which has passed on the strands to the diaper machine is guided back to the fibre opener and serves to expel the filaments from the opener roller.

III. OBJECTIVE

The objective of the work is to produce an effective and efficient amount of recycled cotton from the waste cotton cloths with good quality and to increase the production rate of recycled cotton.

- A. To open the tuft of cottons or fibres
- B. To make the fibre or cotton parallel & straight.
- C. To remove remaining trash particles.
- D. To remove short fibres.
- E. To remove naps.
- F. To produce a rove like fibre or cotton called sliver, which is uniform in per unit length.

IV. CONSTRUCTION

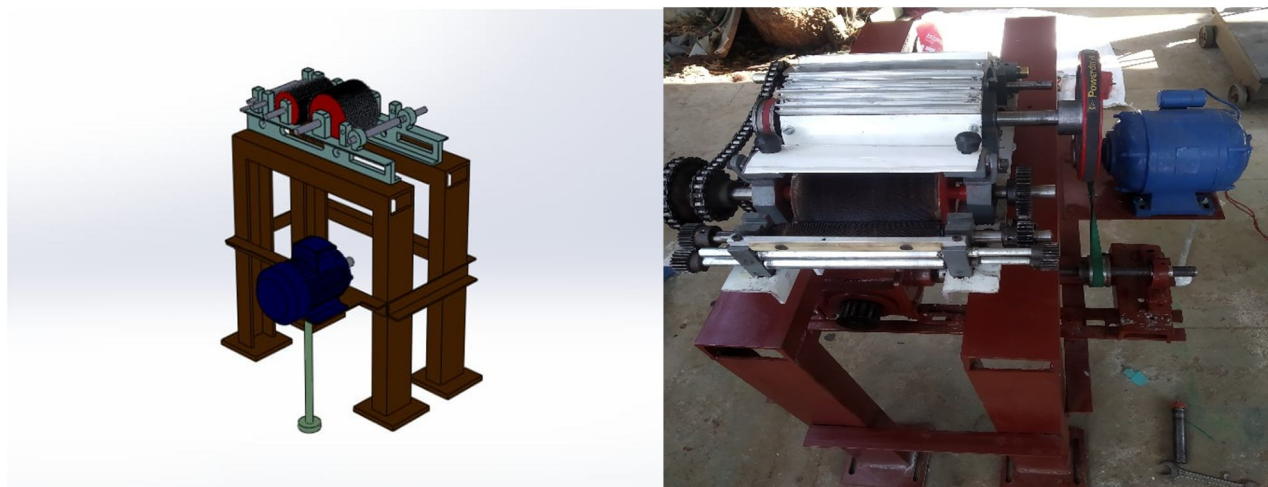


Fig. 1 Modelling Design & Actual Work

An opener machine for waste cotton materials has a feed plate & feed roller arrangement, licker-in or take-in cylinder, main cylinder, doffing cylinder and stripping cylinder with control rollers. The cylinders or rollers are mounted with a rigid frame by using mounting with bearings. The main cylinder has a v-belt drive from the motor. The gearbox was driven by the motor with the flat belt drive (cross belt). The doffer and feed roller are driven by roller chain drives. The frame is bolted with the base table for replacements. The casing is provided for each cylinder, to collect the cotton without any loses during the operating condition. Opener machines conventionally include two frame sides supporting a licker-in roller, main cylinder, feed roller, doffer and stripper with relative operating arrangements such as pulleys, belts, etc. and axillary equipment. Both the frame side members are fixed in the proper position over the table, with bolt & nut.

Parameters	Normal Setting 1	Setting 2
Feed plate to feed roll	0.15 mm	0.15 mm
Feed roll to licker in	0.75 mm	0.75 mm
Licker in to mote knife	0.35 mm	0.35 mm
Licker in to under casing	1.00 mm	1.00 mm
Licker in to combing segment	0.55 mm	0.55 mm
Cylinder to licker in	0.2 mm	0.2 mm
Cylinder to top back plate	0.55 mm	0.55 mm
Cylinder to bottom back plate	1.00 mm	1.00 mm
Cylinder to flats	0.35/0.25/0.25 mm	0.25/0.2/0.2 mm
Cylinder to under casing	1.00 mm	1.00 mm
Cylinder to front plate (top)	1.00 mm	1.00 mm
Cylinder to doffer	0.15 mm	0.125 mm

TABLE. 1 SETTING CLEARANCE

V. COMPONENT DETAILS

A. Feed Roller

It feeds the sheet of cotton to the action of revolving Licker-in roller. It has the feed arrangement consists of a feed roller and feed plate. The waste materials can be compressed into a sheet form for the quick and easy opening in the licker-in. The feed roller has 25mm diameter & 385mm length and weight is 1.3kg. The speed at which the feed roller is rotates around 15rpm. It is made up of mild steel, it has some notches over the surface for the quick pickup of waste material pieces from the feed plate and coating zinc to avoid corrosion.

B. Licker-in Roller

It is also called a taken-in roller. A roller on the opener machine, particularly the roller that opens the waste cotton materials as it is fed into the opener and transfers the cotton to the main cylinder. The main function of the licker-in roller is to open the waste cotton cloth pieces into very small kinds of stuff. The roller which receives cotton from the feed roller is called the licker-in roller. The setting between the feed roller and licker-in is 0.45 to 0.7mm. The licker-in roller has 40mm diameter & 340mm length and weight is around 1.5kg. The roller rotates at a speed of 960rpm and the cylinder is made of MS materials, over the cylinder surface, a saw-toothed wire is wound radially. The card wire type saw-toothed wire is used in this type of licker-in roller.

1) Licker-in Wire Specification

- a) Type of Wire: L5505 x 4.5TPI
- b) Height of Wire: 5.50mm.
- c) Face Angle or F. Angle of Wire: 5°.
- d) Pitch of the Wire: 6.60mm.
- e) Rib of the Wire: 1.40mm.
- f) Points per square inch (PPSI) of Wire: 440.

C. Main Cylinder

The main cylinder is placed in between the licker-in and doffer roller. The small opened stuff from the licker-in passes over the surface of the main cylinder, mote knives, grid bars & carding segments eliminate a great part of impurities. The main cylinder rotates at 540rpm and the diameter of the roller with wire is around 175mm & 400mm length. The weight of the roller is around 9.5kg. Its function is to clean the opened cotton and also assist for the fine opening of the waste materials. The setting between the licker-in roller and the main cylinder is around 0.2mm. The main cylinder and its wire made up of mild steel.

1) Main Cylinder wire Specification

- a) Type of Wire: CU2040 x 1550.
- b) Height Of Wire: 2.00mm.
- c) Face Angle or F. Angle of Wire: 40°.
- d) Pitch of the Wire: 1.50mm.
- e) Rib of the Wire: 0.50mm.
- f) Points per Square Inch (PPSI) of Wire: 860.

D. Doffer

Doffer is a revolving cylinder or a vibrating bar with teeth or saw-tooth wire, in an opener machine, which doffs off from the cylinders. The function of the doffer is to take off the cotton that lies more or less evenly distributed between the cylinder wires to condense them so that they constitute a coherent web or sliver. The doffer wire strips the cotton from the main cylinder. The rate of transfer is called the transfer ratio. The transfer needs to be optimized to reduce the recirculation on the cylinder to a minimum. The speed at which the doffer rotates is around 11rpm. The setting between the main cylinder and doffer is around 0.125 to 0.15mm. The doffer diameter is 120mm & 400mm length and weight is around 5.8kg

1) Doffer wire Specification

- a) Type of Wire: DC4030 x 1880.
- b) Height of Wire: 4.00mm.
- c) Face angle or F. Angle of Wire: 30°.
- d) Pitch of the Wire: 1.80mm.
- e) Rib of the Wire: 0.80mm.

f) *Points per Square Inch (PPSI) of Wire:* 315.

E. *Stripper Roller*

Stripping is mandatory in carding process, during this process fibre and impurities become embedded in the wires of the cylinder & doffer which may reduce their effectiveness of carding and increases the nep count in card sliver and finally affect the quality of the yarn. So stripping the dust, fibres & impurities from the card clothing is essential to regain their efficiency. The stripper roller rotates around 32rpm. The diameter of the stripper roller is 40mm and its length is 360mm. The weight is around 2kg and it made of mild steel.

1) *Stripper Wire Specification*

- a) Type of wire: S40 (-28) x 3418.
- b) Height of wire: 4.00mm.
- c) Face angle or F. Angle of wire: -28° .
- d) Pitch of the wire: 3.40mm.
- e) Rib of the wire: 1.80mm.
- f) Points per square inch (PPSI) of wire: 105.

F. *Control Roller*

In the opener machine, for the safety purpose, these control rollers are provided. When the opened cotton from the stripper than it transferred into the control rollers for discharge. There are two control rollers one is top control roller and the other one is a bottom roller, in between the rollers the recycled cotton or web formed. Its function was creating a web or sliver formation of cotton was easy handling, and also provide safety for workers while running the machine. Both the rollers rotate at the same speed is upto 36.5rpm. The diameter of the rollers is 22mm and its length is 375mm.

G. *Motor*

An electric motor is a machine which converts electrical energy into mechanical energy. It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule. The horsepower used for electrical machines is defined as exactly 746 W. The 1HP electric motor is used to operate the entire system, in which the torque is produced up to 5000Nmm. Single-phase motor is used in this machine to encourage the cottage industries and energy conservation. The motor shaft diameter is 20mm.

H. *Worm Gear Box*

The worm gears used to transmit power between two non-intersecting, non-parallel shafts. The angle between the non-intersecting shafts is usually, but not necessarily, a right angle. The worm gear drive consists of a worm and a worm wheel. If the tooth of a helical gear makes complete revolutions on the pitch cylinder, the resulting gear is known a worm. The mating gear is called worm gear or worm wheel. The worm in worm and worm gear drive is the same as the screw in screw and nut pair. The speed ratio of the gearbox is 80:1. The purpose of the gearbox is to reduce the speed as much as possible, so the worm gearbox is also called speed reducer.

I. *Heel and Toe Arrangement*

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J. *Belt and Chain Drive Arrangements*

Belt drives are used for power transmission, between the motor and main cylinder (V- Belt) and also for the motor to the gearbox (Flat Belt). In this machine, both open and cross belt drives (main cylinder to doffer) are employed. Roller chain drives are used to transmit power between the rollers and from the gearbox to rollers.

K. Base Table

The base table is made of U-channel (4 x 2) and it is a mild steel material. The height is 787.5mm (31”), 940mm (37”) length and 381mm (15”) width. It is used to support the entire miniature machine setup. It consists of two legs, the weight of single-leg is around 12 to 15 kg.

VI. WORKING PRINCIPLE

A process in the manufacture of recycled cotton whereby the waste cotton cloth is opened, aligned, cleaned and formed into a continuous untwisted strands called carding process. Carding process is defined as the reduction of an entangled mass of cotton to the filmy web by opening them between two closely spaced relatively moving surfaces clothed with sharp wire points.

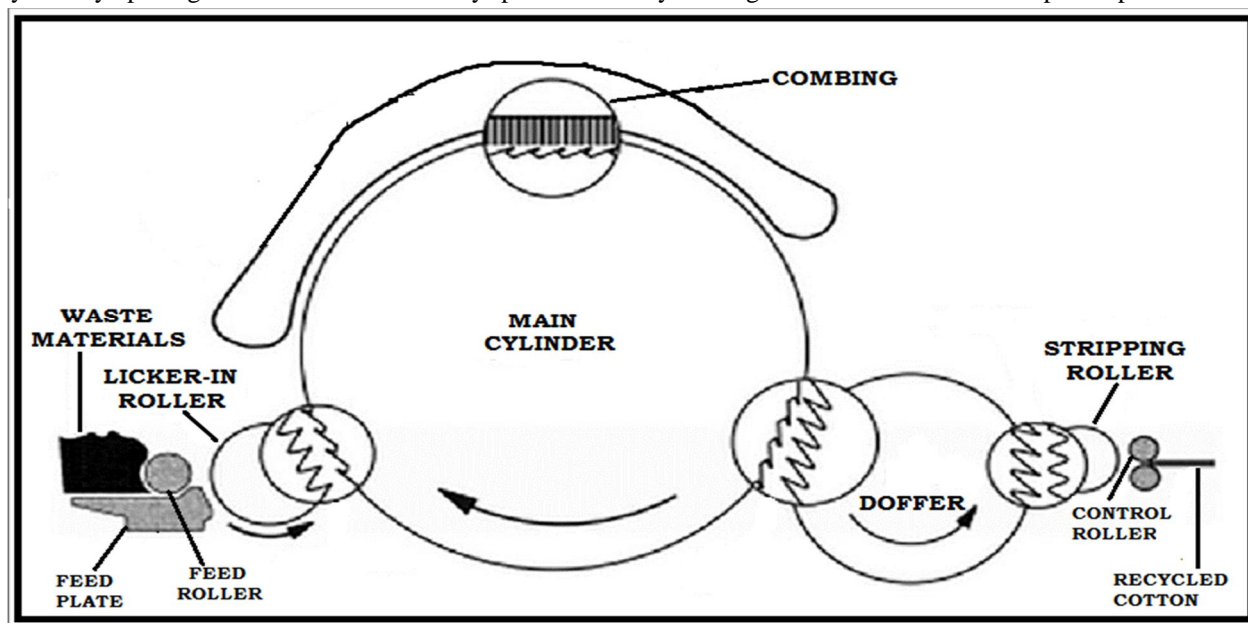


FIG. 2 WORKING OF ROLLERS

A. Four Actions in Opener Machine

- 1) Combing action
- 2) Carding action
- 3) Stripping action
- 4) Doffing action

Supplying the waste raw materials into the feed plate & feed roller arrangement, the feed roller compresses the raw material into sheet form, then it flows into the licker-in or take-in roller. The licker-in starts the opening process, in which the material is pulled into it. Take-in roller opens the waste cloths into very tiny flocks. Due to the centrifugal force of the rotating licker-in, the partial opening process occurs, then it transfers to the main cylinder. When the material passes to the main cylinder, mote knives, grid bars, and opener segments remove the major part of impurities. The carding operation between the main cylinder & flats is the important operation in the opener machine

. The opened cotton from a cylinder is passed into doffer. The function of the doffer is to collect the recycled or opened cotton from cylinder surface within the minimum rotation of the cylinder. It combines the cotton into the web. Because of its considerably lower speed relative to the cylinder. Stripping roller grasp the web from doffer and then transmit to the control roller or calendar roller. Over the stripper, the cleaning roller is placed and it cleans stripes cotton, naps & foreign matters from other rollers. The control roller produces a continuous web form of recycled cotton for other purposes. Carding is the process of arranging the fibre in parallel fusion.

This is mandatory for all staple cotton. Otherwise, it would be impossible to produce a fine yarn. For higher production rate, higher cylinder speed is required. The cylinder speed determines the production rate, and also the wire front angle (F-angle). The centrifugal force generated by the rollers during high-speed rotation tries to eject the opened cotton from the rollers.

VII. PROBLEM IN THE OPENING PROCESS:

Opening to individual cotton or fibres, elimination of impurities & dust, disentangling of naps, fibre blending, cotton orientation and position and web or sliver formation.

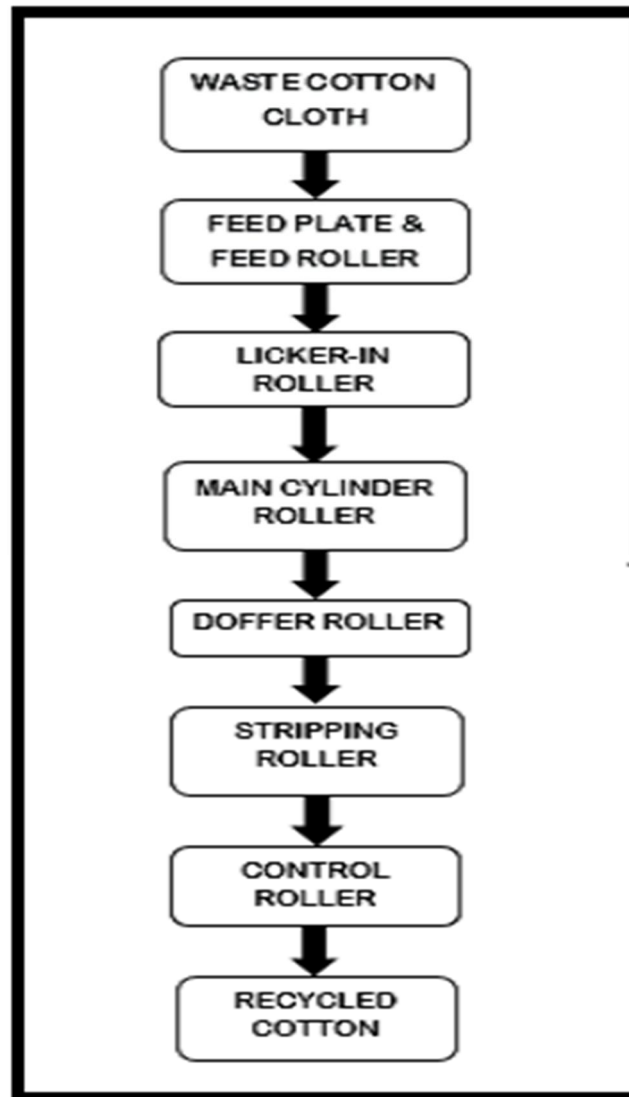


FIG. 3 FLOW PROCESS

VIII. CONCLUSION

This miniature machine gives plenty of experience and difficulties while doing the work, through this work we gained a lot of practical knowledge regarding, designing planning, purchasing, machining, and assembling. This work is a good solution for the cotton industries or mills. The production rate of this machine is 1.5 to 2 kg/hr. and 35 to 40 kg/day. The strength required to the opener for the roving of waste cotton cloth in recycled cotton was calculated with the several parameters and also the opener functions can be designed. The saw-toothed wire of the cotton opener is selected based on the twist of the cylinders and the doffer. The opening effect in the machine is achieved by the proper opener design and the position of the cylinders in which the opening action is taking place in the doffer of the opener setup. The floating of short fibres is restricted by the nip and saw-toothed wires on the front rollers of the machine to reduce the sticking of the regenerated cotton over the opener and main cylinder. The degree of openness is most important in the opener, which was achieved with the help of the setting between the doffer & main cylinder and the main cylinder &licker-in. In textile mills large quantity of cotton is required for dyeing of cloths because of expensive machineries, to overcome the problem this work provides satisfying solution.

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