International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 09 | Sep 2023 www.irjet.net p-ISSN: 2395-0072

# Development of Machine for Opening and Cleaning of Cotton Fibre in Laboratories.

**Rupesh K Amarghade[1], Dr. Minhaj Ahemad Rehman[2], Amisha H Malviya[3]**

*Department of Mechanical Engineering, St. Vincent Pallotti College of Engineering, Nagpur, India*

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**Abstract –** *A machine has been designed and developed for cleaning and opening up of cotton lint samples drawn from densely packed bales for fibre quality assessment in fibre testing laboratories.*

***Key Words***: Cotton, Fibre, Fineness, Lint, Micronaire, Opener, Testing

## 1. INTRODUCTION

Cotton Fibre Quality Testing laboratories use fibre test samples drawn from densely packed bales, which need to be restored to their original natural state of fluffiness before quality testing to get accurate results. Presently, fibres samples are opened manually by employing human labour, which is not only slow but also causes human drudgery and is too costly.

### 1.1 Limitations and Design flaws of existing Lint Opener

Overall size of machine is very large (920x760x800 mm), Each subassembly, Link-in cylinder, feeder cylinder and suction assembly is driven by separate electric motor[1]. Hence, three electric motors are used which lead to more power consumption. Machine is not portable and cannot be carried to different sites. Chain drive power transmission mechanism for feeder roller is complicated and not rigid. Frequent problem of roller-chain run-out occurs. Suction piping system cannot be cleaned without disassembling. Overall selected specifications of machine components are overdesigned.

### 1.2 Main objectives of present project work

On the basis of feedback received from existing users of this lint opener machine and overall limitations it is decided to redesign the complete machine and all mechanisms with following main objectives.

To reduce overall size and weight of lint opener machine so as to make it portable.

To reduce number of electric motors so as to reduce power consumption.

To implement modified rigid and compact power transmission system for feeder roller.

To implement compact and without piping suction system.

To suggest optimum design specifications of machine components keeping intact all other parameters related to quality of open lint.

## 2. SCOPE OF WORK (METHODOLOGY):

To study existing lint opening machine. To study mechanism of power transmission of existing machine. Identify areas of design modifications so as to reduce machine size. To redesign complete machine of smaller size which will be portable. To design and select standard components for power transmission. To design machine frame and blower suction duct. To prepare CAD Models of parts and assembly of complete machine. To perform mechanism simulation, Kinematic and Dynamic analysis of machine assembly. To create 2-D detailing and production drawing of all machine components and assembly.

**Table -1:** Influence of Lint Opening on Micronaire Value of Cotton Samples

| Cotton Variety | | H6 | Lra5166 | H6 | H4 | G Cot 16 |
|---|---|---|---|---|---|---|
| Micronaire Value | Opening | 3 | 3.3 | 3.5 | 3.6 | 3.6 |
| | Unopening | 3.4 | 3.7 | 4.2 | 4 | 4.3 |
| Deviation | | 0.4 | 0.4 | 0.7 | 0.4 | 0.7 |
| Deviation % | | 13 | 12 | 20 | 11 | 19 |

Overall size of existing Lint-Opener is: 790x920x780 mm (HxWxD). No. of motors=3 (One each for Feeder, Licker-In Cylinder and Blower). Power transmission units: From 0.5 Hp, 3-Ph 1440 rpm motor to Licker-In Cylinder through V-Belt Drive (center dist. 265 mm). Speed of Licker-in cylinder is 1200 rpm. From geared motor to Feeder roller through series of chain drives, to get feeder roller speed about 8 to 10 rpm. Center distance 450 mm. Separate suction unit driven by 0.5 HP,2800 rpm motor with blower. Other units: Suction piping, lint collection chamber for (20 gm Lint), filters, M.S. Frame.

**Identified areas of design modifications (Methodology)**: Power transmission system to Licker-In Cylinder. Instead of simple V-Belt, timer belt and pulley can be used and center

distance can be reduced which will decrease overall size. Power transmission system for feeder roller: Existing chain drive to be replaced with other rigid drive –compact drive which will lead to size reduction. Power can be transmitted from Licker-In cylinder which can eliminate one motor. Suction System: Existing suction piping system if taking too much space. It can be replaced with duct type system with compact design. Existing Suction blower/motor assembly is oversized and bully design. This can be made compact.

**DESIGN OF POWER TRANSMISSION SYSTEM FOR LICKER-IN CYLINDER (METHODOLOGY):**

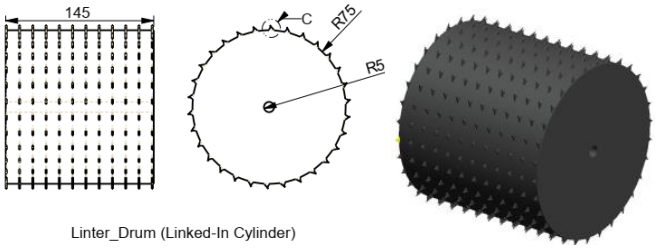



**Chart -1**: **Licker-in cylinder**

**A. PHYSICAL PROPERTIES FORM CAD MODEL Material:**

Steel
VOLUME = 2.5551331e+06 MM^3
SURFACE AREA = 1.1852522e+05 MM^2
DENSITY = 7.8270820e-09 TONNE / MM^3
MASS = 1.9999236e-02 TONNE.

**B. TOUQUE REQUIRED TO OVERCOME SELF INERTIA:**

Mass =20 Kg (Apporx), Radius of Gyration = 75 mm=0.75 meter ∴ Mass M.I = I = M.k2 = 11.25 Kg.m2, ∴ Initial torque considering angular accelation (α) as 0.1 m/sec2.
T= I x α = 1.125 N.m, Considering, friction between lint and Licker-In cylinder and other losses..
Design torque, Td = 1.5 xT = 1.68 N.m.

**C. MOTOR AND BELT SELECTION:**

Torque developed by 1 HP,1440 RPM E-Motor
P =2πNT/60 = 5 N.m ( Approx) >> 1.68 N.m (required 0
Hence, 1 H.P. single Phase, 1440 RPM, electric motor is selected.

Now, Problem Statement: to select suitable Timer ( Cogged V-Belt and pulley to transmit max. 1 Hp (0.75 Kw) power with velocity ratio of 1440:1200 rpm.
Solution: From catalogue of Goodyear Company Cogged Belts, Belt section BX with following specifications is selected.

**D. MOTOR AND BELT SELECTION:**

| Goodyear_Cogged Belt (BX Series) | |
|---|---|
| Belt Type: | Classic |
| Cord Material: | Polyester |
| Effective Length (mm): | 2609 |
| Item Weight (lbs): | 0.9 |
| Outside Circumference (mm): | 2624 |
| Rib Angle: | 38° |
| Thickness (mm): | 11 |
| Top Width (mm): | 17 |

Belt (BX Series)

Worm Gear

To transmit power at minimum center distance with such a high velocity ratio (1:120) only suitable drive is Worm-Worm Gear, also this is rigid. Now. Licker-In Cylinder and feeder roller shaft axis are parallel.. Hence we need to use two worm gear drives..( One of Licker-In Cylinder and other on feeder roller.

**E. Worm Gear_Licker-In Cylinder:**
Torque = 5 N.m , Power = 750 Watt, VR = 10:1,
Input RPM =1200.

**F. Worm Gear_Licker-In Cylinder:**
Torque = 5 N.m , Power = 750 Watt, VR = 12:1,
Input RPM =120

SW-3 & SW-4 MINIATURE RIGHT ANGLE WORM GEARBOX SPEED REDUCERS.

| | |
|---|---|
| SW3-10 | 70451:Miniature Worm Gear Speed Reducer, 10:1 Ratio, 1/4" Input Shaft, 3/16" Output Shafts0.1873 |
| SW3-20 | 70452:Miniature Worm Gear Speed Reducer, 20:1 Ratio, 1/4" Input Shaft, 3/16" Output Shafts 20:1 0.1873 |

**Mechanical Features** :Machined aluminum housing
Bearings - oil impregnated bronze
Weight - 0.25 lb.

**Technical Features** -Torque - 2.5 N.m maximum input torque for all ratios Ratios - 5:1, 10:1, 20:1, Speed to 3000 rpm , Size - 1.5” x 1.5” x 1.08” , Max. backlash – 2°

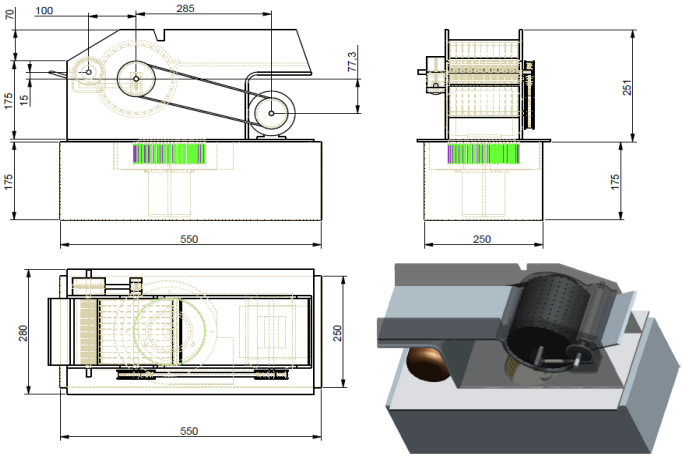
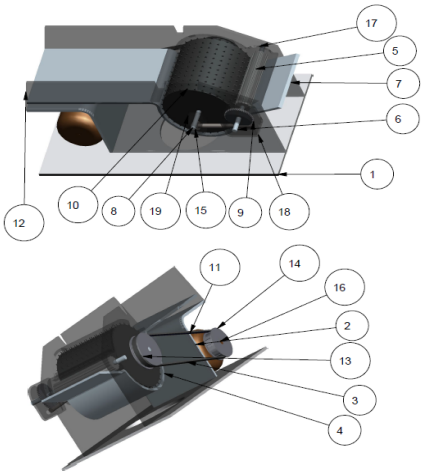



**Fig -1**: Cotton lint opener and isometric views figure




| S.No. | Part Name | Qty. |
|---|---|---|
| 1 | BAASE_PLATE | 1 |
| 2 | BACK_COVER_ | 1 |
| 3 | BELT_ | 1 |
| 4 | BOTTOM_COVER_ | 1 |
| 5 | FEEDER_DRUM | 1 |
| 6 | FEEDER_DRUM_SHAFT | 1 |
| 7 | FEEDER_PLATE_ | 1 |
| 8 | GEAR_WORM_LINTER | 1 |
| 9 | GEAR_WROM_FEEDER | 1 |
| 10 | LINTER_DRUM | 1 |
| 11 | MOTOR | 1 |
| 12 | PLATE_AL-1 | 2 |
| 13 | PULLEY_LINTER | 1 |
| 14 | PULLEY_MOTOR | 1 |
| 15 | SHAFT_LINTER_DRUM | 1 |
| 16 | SHAFT_MOTOR | 1 |
| 17 | TOP_COVER_FR_ | 1 |
| 18 | WORM_GEAR_BOX_FEEDER | |
| 19 | WORM_GEAR_BOX_LINTER | |

**Fig -2**: Modification of Lint Opener isometric views figure.

Cotton lint samples weighing 12-15 g each can be opened manually by hand as shown in the figure 1 where women labourers are employed for the same. This is the simplest method of lint opening in which cotton lint bundles are simply pulled apart by two hands to separate out the entangled fibres and to remove any non-lintimpurities. However, in case of hand opening, the desired optimum extent of lint opening is not achieved and the amount of non-lint content seen is also more as compared to the opening by trash analyser. The presence of non-lint content adversely affects the microanire value of cotton fibres. Besides this opening of samples by hand is very tedious and laborious job that leads to testing of samples without proper opening. The speed of opening of samples is also very slow at only about 35-40 samples per hour.

## 3. CONCLUSIONS

Cotton lint samples used for testing fiber quality parameters must be pure and free of any non-lint material. Cotton lint opening samples are required to obtain accurate micronaire readings. Typically, lint samples obtained for testing are taken from densely packed bales and also contain some non-lint fraction. Thus, they require cleaning and disassembly to ensure accurate measurement of micronaire values. Presently, high volume testing laboratories open cotton lint samples either manually by hand or using a lint analyzer. Although both of these methods have been found to meet the requirement of giving accurate micron readings, these methods still have some shortcomings that need to be addressed when attempting to develop new methods of lint opening.

## ACKNOWLEDGEMENT

The authors gratefully acknowledge the technical assistance from Workshop, SVPCET Nagpur for fabrication of the research prototype of the cotton modification lint opener, as part of the Department of Mechanical Engg. St. Vincent Pallotti college of Engineering & Technology, Nagpur research work . The fabrication of the first prototype involved frequent design changes as per the availability of component parts and the desired performance results.

Testing of the research prototype was carried out at scientific, GTC, Nagpur for which the timely help received from the Dr. Minhaj A. Rehman Associate Professor, Dr. Amit R. Bhende Assistant Professor, Dr. Ghanshyam R. Boob Assistant Professor (SVPCET) Dr SV Ghadge Principal Scientist ICAR GTC, Nagpur, Dr CB Tripathi ICAR Jhansi, and Amisha H Malviya, of the at Nagpur is also duly acknowledged.

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