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FIBER SEPERATION FROM WOOD PULP USING SLIDER CRANK MECHANISM

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Abstract: The Fiber separating machine is used to separate the fibers from their raw material (wood pulp). The machine is based on slider crank mechanism in this an iron disk is mounted to the electrical motor. A slider with a rough tooth is present in its bottom. By using the connecting rod, the disk and slider are connected together. The connecting rod converts the rotary motion into the linear motion. By using the forward and backward motion the fibers are de - fiberized from the raw material (wood pulp). This machine is used for small scale industries where bulk machines are not required. The main application of this wood pulp fiber is the making of napkins.

Key words: raw material, slider crank mechanism, de – fiberized, wood pulp, napkins.

1. INTRODUCTION

Non-Woven is a sheet, web (or) fabric like materials made from stable fiber (short) that have not been converted into yarns (thread) which are bonded together by means of mechanical, chemical, heat (or) solvent method. It is also called as “shaped fabrics” (or) “yarn – free fabrics” and it is used in textile manufacturing industry, medical and automobile and many other industries. Where, it is cost-effective and bio-degradable. There are different types of non – woven process namely, air laid & wet laid process, spun bonding, melt blowing and finally needle binding process. Where, the fibers are produced by the use of sharp teeth fruit peeler following the slider crank mechanism. In this process an electrical motor which runs on AC power is mounted on the rigid base and a solid circular disc is fixed to the motor and sharp teeth peelers made up of stainless steel are arranged in parallel together to form a comb like structure are connected to the circular disc by the help of connecting rod through nuts and bolts. In which the fiber is produced from the wood pulp by the action of peeler connected to the motor. The produced fiber has the following properties like, Absorbency, Bacterial barrier, Filtering, Flame-retardancy, Liquid-repellency and softness etc. and it can be used for many applications like, Air bags, Car roofs and seat covers, Insulation for roofs and tiles, Thermal and acoustic

insulation, Pots for bio-degradable plants, Materials for capillary irrigation, Coffee and tea bags, Protections for shock absorbers, Odour control, HEVA/HEPA/ULPA filters, Filters for liquids: oil, beer, milk, refrigerant liquids, fruit juices etc.

A. SPECIFICATIONS OF MOTOR

PARAMETER	VALUES
RATED VOLTAGE	230V
FREQUENCY	50Hz
RATED CURRENT	1.5 Amps
RATED POWER	150W
RATED SPEED	1300Rpm
TYPE	CSR
DUTY	S2 60 Min
INSULATION	F ¹ class
EFFICIENCY	50% Nominal
CAPACITOR	8MFD

Table 1.1 Motor Specifications

2. EXPERIMENTAL

2.1 FORMULA USED

1. Bending moment, $M/I = \sigma_b/Y$

Where, $\sigma_b = M \times Y/I$ (N/m²)

2. Area Moment Of Inertia (I) = $b \times d^3/12$ (RECTANGLE) (m⁴)

3. Center Distance (Y) = Thickness/2 (m)

σ_b = bending moment, N/m²

M = moment, N/m

b = breadth, m

d = depth, m

Y = center distance, m

2.2 DESIGN CALCULATION

□ For Connecting Rod (Rectangular Bar)

Bending Moment,

$$M/I = \sigma_b/Y$$

$$\sigma_b = M \times Y/I$$

Area Moment Of Inertia (I) = $B \times d^3/12$ (Rectangle)

$$I = (30) \times (6^3)/12$$

$$I = 540 \text{ mm}^4 = 0.54 \text{ m}^4$$

$$\text{Breadth (B)} = 30 \text{ mm} = 0.03 \text{ m}$$

$$\text{Depth (D)} = 6 \text{ mm} = 0.006 \text{ m}$$

$$\text{Center Distance (Y)} = \text{Thickness}/2$$

$$Y = 6/2$$

$$Y = 3 \text{ mm} = 0.003 \text{ m}$$

To Find Moment (M),

Let Us Consider,

The Connecting Rod As Uniformly – Distributed Load (UDL), Due To Both Ends Is Fixed.

$$\text{Total Length (L)} = 400 \text{ mm} = 0.4 \text{ m}$$

Figure. 1: UDL load

$$\text{Density (P)} = \text{Mass}/\text{Volume}$$

$$\text{Mass (M)} = P \times A \times L$$

$$\text{Area (A)} = L \times B$$

$$A = 0.03 \times 0.4 = 0.012 \text{ m}^2$$

Density of the Mild Steel (P) = 7850 Kg/m^3

Mass (M) = $7850 \times 0.012 \times 0.4$

Mass (M) = 37.68 Kg/m^3

To Convert UDL to Point Load,

Weight of the UDL (W) = $37.68 \times (9.81 \times 10^3)$

$W = 3.69 \times 10^5 \text{ KN/m}$

Point Load = $(W \times L) \times (L/2)$

$\Rightarrow ((3.69 \times 10^5) \times (0.4)) \times (0.4/2)$

Point Load (W) = $29520 \text{ KN} = 29.52 \times 10^3 \text{ KN}$.

Thus Moment (M) = $W \times \text{Length}$

$M = 29520 \times 0.4$

$\Rightarrow 11,808 \text{ KN/M}$

Moment (M) = $11,808 \times 10^3 \text{ N/m}$

Thus Bending Moment,

$$\sigma_b = (11,808 \times 10^3) \times (0.003)/0.54$$

$$\sigma_b = 65,600 \text{ N/m}^2 = 65.6 \times 10^3 \text{ N/m}^2$$

Where,

The Allowable Bending Stress (σ_b),

$$(\sigma_b) = 220 \text{ Mpa}$$

$$1 \text{ Pascal} = 1 \text{ N/m}^2$$

$$\text{Mega Newton} = 10^6$$

$$(\sigma_b) = 220 \times 10^6 \text{ N/m}^2$$

Hence,

$$65.6 \times 10^3 \text{ N/m}^2 < 220 \times 10^6 \text{ N/m}^2$$

The Bending Stress Is Less Than The Allowable Bending Stress.

Thus, the Design for Connecting Rod (Rectangular Bar) Is Safe.

2.3 SPECIFICATIONS OF THE SLIDER CRANK MECHANISM

Specifications of the Slider Crank Mechanism

- Length of the Connecting Rod (l) = 600mm
- Radius of the Crank (r) = 150mm.

Based on l/r Ratio up to = 3 To 5.

Where,

$$l/r = 400/100 = "4"$$

Hence, It Satisfies the l/r Ratio.

2.4 SCHEMATIC DIAGRAM

Figure. 2: schematic diagram

2.5 SOLIDWORKS DESIGN MODEL

Figure. 3: solidworks design model

2.6 FABRICATION SETUP

Figure. 4: fiber separation machine

2.7 FIBER SEPARATOR TOOL

Figure. 5: fiber separating tool (made up of stainless steel)

3. WORKING MECHANISM

3.1 SLIDER – CRANK MECHANISM

☐ **First – Inversion**

Figure. 6: first - inversion

- ☐ Link – 1 is Fixed
- ☐ Link – 2 Rotates
- ☐ Link – 3 Oscillates
- ☐ Link – 4 Reciprocates
- ☐ It is used to convert the reciprocating motion into rotary motion.
- ☐ Example: - Steam Engine.

3.2 WORKING-PRINCIPLE

- It is based on the **SLIDER-CRANK MECHANISM (FIRST- INVERSION)**.
- It is used to convert the reciprocating motion into rotary motion.
- Example: - Steam Engine.
- The working of the fiber separation machine is used to separate fiber from the wood pulp (slider-crank) by using the metal curry comb we can separate the fiber from the wood-pulp.
- Where the comb is made by cutting the sharp-edges of the peeler, and by using tig-welding we can weld the sharp-edges on the stainless steel plate.
- In which the comb is operated by the use of connecting rod.
- By the use of circular disc connected to the motor which runs at a specific speed, where the small fibers are passed through the base way and it is collected in the fiber collecting bin.

4. RESULTS AND DISCUSSION

In this, the fibers are produced from the wood pulp by using slider crank mechanism and the photographic images of the final product are produced here,

Figure. 7: left side shows the wood pulp (raw - material) image and the right side shows the image of the final output of the wood pulp (raw - material) in small fiber form.

4.1 COST ESTIMATION

The cost for manufacturing the fiber separating machine is produced in the tabular column format where, the cost for manufacturing the machine is reduced and displayed here,

COMPONENTS	QUANTITY	AMOUNT (RS.)
SS PLATE	1	50
MS SQUARE PIPE	1	525
MS DISC & SOLID BAR	1	150
SS PEELER	7	70
MOTOR	1	400
BUSHES, NUTS AND BOLTS	AS PER REQUIRED	100
ARC WELDNG, CUTTING	AS PER REQUIRED	300
200ML PAINTS AND BRUSH	AS PER REQUIRED	145

OTHER EXPENDITURES	AS PER REQUIRED	100
(IT INCLUDES BUS		
TRAVEL, AUTO FAIR,		
PETROL CHARGES, TEA		
AND SNACKS)		
TOTOAL COST		Rs. 1,840

Table 4.1 Cost estimation

5. CONCLUSION

This Project is based on the fiber extraction machines, in big industries the extraction process is done by bulk machines but to encourage small scale industries this machine is designed in a simple way which is electrically operated and semi-automatic. The raw wood pulp is feed into the machine and fiber is the output. This fiber is not like cotton it is so different from the cotton. This types of fibers are 90% used in the napkin industry, which is a small-scale industry in many parts of the India. Mr. Arunachalam Muruganantham who is well known as the PAD MAN in our country. He created a mini machine for pad making, which creates job for women in rural India. The extracted fiber from our machine is compressed in Muruganantham's machine and finally the pad, as a finished product is created. Based on all the possibilities this device is made for small scale industries.

5.1 FUTURE SCOPE

The automotive industry is expected to grow by over 20% with the use of non-woven fabrics. Furthermore, India's growing economy will certainly support the growth of non-clothing fabrics such as nonwovens. In which automotive industry is one of the major sectors where nonwovens used. In automobile industry 25 kilograms of nonwovens used in thirty to forty components. Advanced Material Laboratory at Texas Tech University have been trying to find low micronaire cottons that are 33mm and above in length which can be 100% recyclable materials for automobile industry. Cottons that are 3.4 or less in micronaire are heavy which brings huge loss to the cotton industry.

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Meiarul R designed and carried out the experiments, analyzed the data, discussed the results and wrote the paper.

7. REFERENCES

- [1] Optimization of transmission angle for slider – crank mechanism with joint clearances, structural and multidisciplinary optimization, February 2009 by Selçuk Erkaya and Ibrahim Uzmay, 14 March 2008, Publisher - Research Gate, structural and multidisciplinary optimization 37(5):493-508, DOI:[10.1007/s00158-008-0243-6](https://doi.org/10.1007/s00158-008-0243-6),
https://www.researchgate.net/publication/225368369_Optimization_of_transmission_angle_for_slider-crank_mechanism_with_joint_clearances
- [2] Experimental investigation of joint clearance effects on the dynamics of a slider – crank mechanism, multibody system dynamics, June 2010 by Selçuk Erkaya and Ibrahim Uzmay, 14 February 2010, Publisher – Research Gate, Multibody System Dynamics 24(1):81-102, DOI:[10.1007/s11044-010-9192-0](https://doi.org/10.1007/s11044-010-9192-0),
https://www.researchgate.net/publication/225394408_Experimental_investigation_of_joint_clearance_effects_on_the_dynamics_of_a_slider-crank_mechanism
- [3] APPARATUS FOR FORMING AIRLAID WEBS, by Charles E. Dunning, Neenah; Stanley R. Kellenberger, Appleton, both of Wis, US3825381A, United States Patent Dunning et al, Filed: Aug. 1, 1973 Appl. No.: 384,705, DOI: <https://patents.google.com/patent/US3825381A/en>
- [4] SYSTEM FOR PRODUCING AN AIR LAID WEB, by Henning Laursen, John Mosgaard, Otto V. Nielson, Clark L. Poland, EP0168957A1, United States Patent Laursen et al, Filed: Jun. 12, 1984 Appl. NO.: 619,946, DOI: <https://patents.google.com/patent/EP0168957A1>