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REVIEW PAPER ON DESIGN AND MODELING OF MULTIPURPOSE FIBER EXTRACTING MACHINE

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ABSTRACT
The focus of the project is to design and development of a multipurpose fiber extracting machine which can extract different types of fiber based on type of source. The manual extraction of fiber produces also a good quality but it is time consuming process and labor expense is quite high and output is quite low. The existing machines for extracting fiber from different sources are manually operated, low efficiency, time consuming, unsafe process, so it cannot be recommended for mass production. Thus, the aim of the project is to develop a machine suitable for mass production and yields good quality of fiber to increase the productivity.

KEYWORDS:, Fiber, fiber extraction, pseudo stem, leafs, spinning technology, types of fiber extraction machine, etc.

INTRODUCTION
Natural fibers are obtained from natural sources. It has many advantages over artificially manufactured synthetic fibers. These fibers have high specific properties with low density. They are ecofriendly unlike synthetic fibers because they are biodegradable and non-abrasive. The disposal of natural fiber composites is easy, they can be easily combusted or composted at the end of their product lifecycle. As compared to the cost benefits synthetic fibers, natural fibers comparably offer high security if used for automotive applications.

The distinct mechanical properties of natural fibers are comparable to those of traditional reinforcements. Thus, the intrinsic properties of natural fibers can satisfy the requests of the global market especially for those industries concerned in weight reduction. The natural fiber has been an important textile material in human civilization. The fabrics of pineapple leaf fiber are easy to print and dye, sweat-absorbent and breathable, hard and not wrinkling, and it has good antibacterial and deodorization performances. With growing environmental awareness, ecological concerns and legislations, eco fiber have received increasing attention during the recent decades.


Fig. 1 Pineapple fiber & Fig 2 Pineapple leaves


Fig 3 Banana Pseudo Stem & Fig 4 Banana Fiber

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Table 1: Physical Chemical and Tensile Properties of some lignocellulosic fibers used for biocomposites [Adapted from Ref. 3, 8, 10]

Fiber	Dimensions L(mm)/D(µm)	α-Cellulose (%)	Lignin (%)	Young's Modulus (GPa)	Ultimate Tensile Strength (MPa)	Elongation at Break (%)
Sugarcane Bagasse	10-300/10-34	32-44	19-24	17.9[a]-27.1	222	1.1
Banana	300-900 /12-30	60-65	5-10	27-32	700-800	2.5-3.7
Jute	120/25-30	59-71	11.8-12.9	10-30	400-800	1.5-1.8
Ramie	900-1200 / 20-80	80-85	0.5	44	500-870	1.2
Curaua Wet	35/7-10	70.7-73.6	7.5-11.1	30-80[b] 10.5	1250-3000[b] 439-495 (MOR)[c]	4.5-6[b] 1.3
Curaua Dry				27.1 34-96[d]	117 (MOR)[c] 495 87-310[d]	1.3-3.2 4.4.9[d]
Sisal	900/8-50	60-67	8-12	17-22	530-630	3.64-5.12
Coir	20-150/10-50	43.77	45	6	220	23.9-51.4
Luffa-cylindrica	25-60 (Diameter)	62	11.2	-	-	-

a – Calculated; b - Diameter: 30-60m; Test length- 20mm and Strain rate-5mm/min; c- MOR: Modulus of Rupture; d – Diameter range 26-64 µm

Fig 5 Properties of Fiber (Physical and Mechanical)

EXTRACTION METHOD

MANUAL METHOD

Fiber can be obtained from waste stalk, leaf and roots of plant therefore they are known as plant fibers. Generally abundant of fiber is obtained from surface near to the outer sheath of stem and leaves of the plant. It can be peeled-off easily in ribbons of strips of 5-10 cm wide and 2-5 mm thick along the entire length of the sheath. The undressing process is known as Tuxying and the ribbons are called as Tuxies**.**

The fiber extracting processes are:

- Bacnis Process: It is the common stripping process in which trunks are pulled apart and sheath is undressed. The fiber is obtained by removing pulpy and pulling away the ribbons (tuxy)

.

- Loenit Process: In this process ribbon are obtained by the use of knife or any sharp pointed tool. Ribbons are obtained from one sheath at a time. 20-25 kg of fiber is dried, cleaned and bundled.

CHEMICAL EXTRACTION

For Chemical extraction, alkali treatment is used. The alkali NAOH reduces roughness of fiber and good quality of fiber is obtained. In addition, sulfuric acid, hydrogen peroxide, protease, pectinase and sodium citrate were used.

Fig 6 Plot PH against no of days

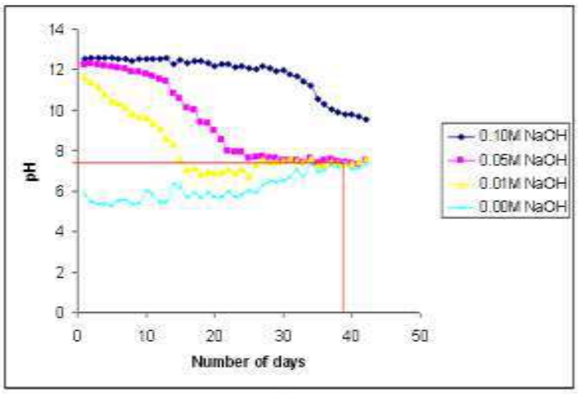

Figure 1: Plot of pH against number of days

Fiber-OH + NaOH -------Fiber-O-Na++ H2O

Thus main disadvantage of chemical extraction is time period taken in the whole process. It can be seen from above graph to produce good quality fiber; chemical extraction takes 35-40 days. The process is costly. There is lot of wastage in the process.

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MECHANICAL EXTRACTION

It is simple machine consisting of single roller which rolls on fixed support. The roller is provided with horizontal stainless steel blades with blunt edges. Generally, 27 blades are used. 1hp motor is used to provide input power to machine. The machine reduces labor work and increases fiber production by 20-25 times as compared to manual process. In this process, cut stems of banana plants of 100-200 cm in length are crushed between two drum rollers. Due to crushing the pulpy part is removed and fiber is obtained.

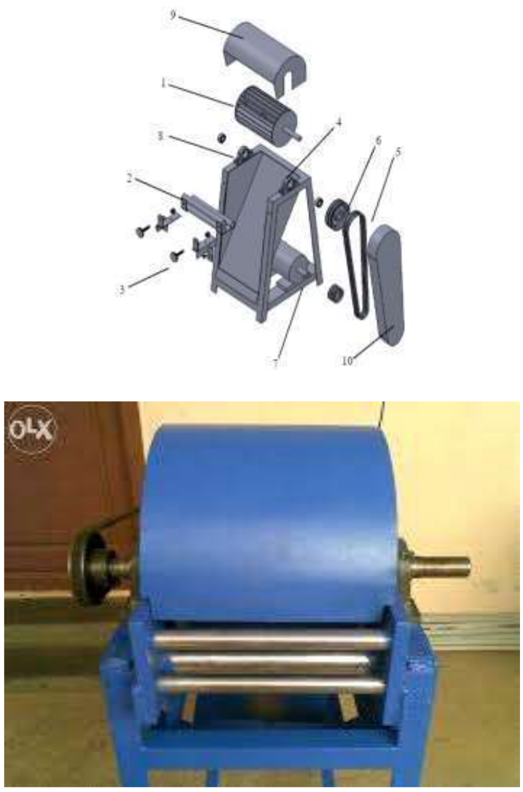

Fig 7 Exploded view of existing machine

PROBLEM IDENTIFICATION

- Certain care is needed to avoid damage.
- Impurities in the rolled fibers such as Pigments, broken fibers, knots.
- The manual extraction of banana fibers was time consuming, and caused damage to the fiber.
- This type of technique cannot be recommended for mass production.
- Fibers produced are not of uniform size.
- In addition, there is a safety issue. It is reported that many accidents have happened in past
- Time consuming process.

PROBLEM SORTING

While designing the machine, the most important factor affecting the quality of fiber are clearance between two roller ,speed of roller, and feeding position. Change in these factors causes change in quality of fiber. Superior quality of fiber is one which contains no pulpy matter or pigments or knots. They are uniform in size and are straight.

For our design, clearance of 1mm, crushing roller speed of 775 rpm and feed position of 180 degree are suitable. Instead of single crushing roller, we are providing dual crushing roller and one scratching roller for complete removal of pulpy material and knots. The average force required for extraction of fiber is 177N for banana and 180N for pineapple.

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By providing hopper and conveyor, we can automate the process. This will give rise to increase in production and reduction in time required. Due to hopper, there will be complete utilization of machine and it will reduce human work.

CONCEPTUAL DESIGN

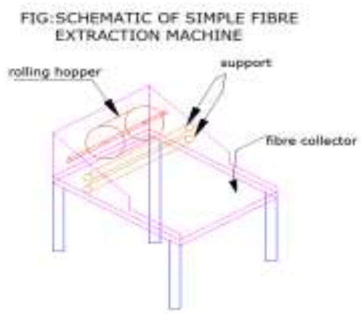

Fig 8 Line Diagram of model

- It will reduce time required
- It will reduce workers effort
- Rate of production is very high
- This method is suitable for mass production
- Quality of fiber is improved

SELECTION AND DESIGNING

Roller – Roller is the most important element in this machine. It applies necessary squeezing force on pseudo stem and leaves separating the pulpy material and pigments, leaving only the fiber. Type of the roller used mainly affect the quality of fiber.

When compared extraction fiber unit, the crushing line saw roller could separate a good texture of banana leaf sheath. While a scratching roller which is of square tooth could remove the pulpy impurities with damaging the fiber. So in our model we are going to use dual saw rollers and one square tooth roller or rasp bar roller.

Fig 9(a) Rasp bar roller

Fig 9(b) Crushing saw roller

Fig 10 (a) Good Quality of fiber

Fig 10(b) Bad Quality of fiber

The force required for banana is 177 Kgf and for pineapple is 180 Kgf
So considering average force required for extraction be 177
Factor of safety =1.5
Fc=mrω2= 177*15
N = 775 rpm; ω= 73.3rad/s; m=density*volume=1767.15d2
Diameter = 100 mm
Thus solid roller of 82 mm is required, but hollow roller is recommended. So keeping torque constant & inner diameter 80% of outer diameter we get
Ds3 = (Do4- Di4)/Do
Outer diameter = 105mm
Inner diameter = 30 mm
T = F*R = 177*.0525 = 9.29 Nm

Fig 11 Dual Rollers

Two plane rollers of stainless steel 105mm in diameter connected by a gear will be used.

Power Required
P= (2πNT)/60
= 754. 15 watt
= 1 Hp

Belt Drive

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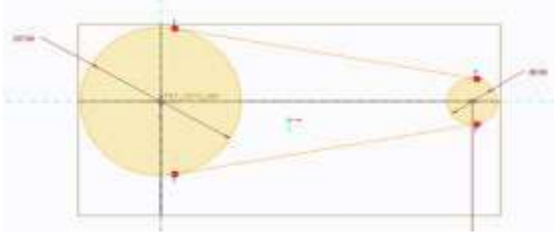

Fig 12 Belt Drive

N1= 925 RPM (MOTOR RPM)
N2 = 260 RPM (SCRATCHING ROLLER)
If we consider pulley of motor to be D1= 120 mm
N1D1=N2D2   D2= 420mm
Peripheral Velocity
$\mathrm{Vp} = \frac{\pi \mathrm{DN}}{60} = \frac{\pi \times 120 \times 819}{60} = 5.15\mathrm{m/s}$
Centre Distance

$$\mathrm{C} = 2(\mathrm{dL} + \mathrm{dS})$$
$$\mathrm{C} = 2(420 + 120) = 1080\mathrm{mm}$$

Determination of angle of wrap

$$\beta = \sin^{-1}\left(\frac{\mathrm{dL} - \mathrm{dS}}{2\mathrm{C}}\right) = 7.98^{\circ}$$
$$\alpha\mathrm{L} = 180 + 2\beta = 3.4 \text{ rad}$$
$$\alpha\mathrm{S} = 180 - 2\beta = 2.86 \text{ rad}$$

Density of leather = 1000 kg/m3

$$\mathrm{Pd} = \mathrm{bt}(\sigma - \rho \mathrm{v}^2)\left[1 - \frac{1}{e^{\mu\alpha}}\right]\mathrm{v}$$
$$825 = \mathrm{bt}\left(2 - 1000 \times \frac{5.15^2}{1000000}\right)\left[1 - \frac{1}{2.72}\right]5.15$$
$$\mathrm{bt} = 128.36 \text{ mm2}$$

Standard belt thickness t=4mm
b= 35mm

Height of machine from ground-
For the ease and comfort of operator, the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level. Enough clearance should be provided from ground for cleaning purpose.

SCOPE
Natural Fiber is finding much interest as a substitute for glass or carbon reinforced polymer composites recently. Multipurpose fiber extracting machine which can be used for extraction of fiber from different sources like Banana pseudo stem, pineapple leaves, jute and bamboo as per their size and shape. Machine will reduce the investment as a single machine is used for various types. As the machine is very simple to use, it can be operated by any skilled or unskilled person.

RESEARCH METHODOLOGY
In current study, we create the CAD model of multipurpose fiber extracting machine, after that analysis of design will be performed. Then the modifications and analysis of modified design will be performed then results will be discussed and design will be finalized.

CONCLUSIONS
The multi-purpose fiber extracting machine will be designed with higher efficiency. This will reduce the investment as a single machine is used for various types. The problem of impurities and quality of fiber will be solved. It can be operated by any skilled or unskilled labor and also reduce manual operation. Thus, it is suitable for mass production.

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