

Design and Fabrication of Solar Powered Coir Spinning Machine

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ABSTRACT - India is one of the top producers and exports of coir in the international market with more than 70% of world production. Indian coir products are in great demand because of their price, quality, attractiveness and eco-friendliness. More than 50% of coir yarns are made in a mechanized spinning method. Still the traditional manual spinning process is continuous in rural areas, giving jobs to the graduated and specifically for women. In the present work, the DC motor is used to run the spinning machine. Solar power is used to run the motor to have continuous and improved spinning. The present solar-powered coir spinning machine improves the production rate, yarn quality, and uniformity by reducing human fatigue and power requirements.

Keywords - Coir, Yarn, Manual spinning Machine, Motorized spinning machine, Solar power, Coir rope

I. INTRODUCTION

Coir is one of the by-products of coconut fiber and is naturally obloquies from/extracted from the outside of the husk. Coir is environmentally friendly as it is biodegradable. Coir and coir fiber products sustain the livelihood of a significant segment of popular in the coastal belt of southern India. The production and processing methods in the coir industry continue to be manual and traditional. The machine used for spinning the coir fiber is manual and traditional. Indian coir products are in great demand in the international market because of their special attributes like fitness, price, and craft-man ship.

It is necessary for the coir to be dry when producing the rope. On rainy days, it is necessary to wait for the coir to dry – there is no apparent covering to keep the coir dry and the ‘runway’ (area where the coir yarn is made) is not waterproof. It has a flat roof made of leaves, but this only provides shade from the sun.

Unnithan Bhaskaran, K [1] studied coir products in India. The studies of coir products have three parts. The first part is a background of the industry; it deals with the location factors and the various processes in the manufacture of coir products and the structure and organization of the industry. Thomas Issac, T.M [2] has done the theoretical study on the evolution of organization of production for the coir yarn spinning industry. He explained the production techniques that prevail in the industry and the production relations in hand spun yarn

organizations are discussed separately. He remarks that the export orientation of the industry and extremely fragmented production structure necessitated a long chain of middle men for the collection and disposal of the yarn.

Thomas Issac T.M. and Nair K.K. [3] have published the book on "modernization and employment" and they explained in detail about the crisis in Kerala's coir industry. This book draws on the features of the industry during the fifties. The traditional process of coir production, the relevance of the coir industry in the economy of Kerala, the pitiable condition of coir workers, and improvement in the conditions of the workers through the leadership of militant trade unionism. It reviews the socio- political, economic and technological factors that affect trends in the coir industry in Kerala. This book expresses the view that the policy of unfettered mechanization is not socially acceptable since coir production is the major source of employment after agriculture in the coastal areas. However, at the same time, it suggests technology choice for reducing the period of retting, mechanization of fiber extraction and the spinning process choices.

The Government of India-coir board [4] conducted a study on the marketing of coir and coir products which indicated the expanding role of co-operatives societies in developing a stable internal market for coir yarn at the same time. A change in policy towards modernization sets in new trends in the industry that would result in its organization on modern lines and making it more productive, efficient and remuneration. The joint effort of

policy is formulators, procedures, workers, experts in coir products. Manikandan Pillai [5] formulated the model coir village scheme and focused on the welfare of coir workers and the scheme on the model coir village program gave major emphasis on extending assistance in improving the basic amenities and living conditions of coir workers received the program and its success was a motivating factor for taking up welfare programs for coir workers in a big way in the succeeding years.

Ajithkumar. P [6] has studied about the economic utilization of coir pith. Management of this waste material for economic advantage is therefore, of crucial importance from the point of view of protection of the environment and the future of this highly labour-oriented industry. Sundaresan. R [7] “globalization, technological change and traditional industries - a study on coir yarn spinning industry in Kerala” made an attempt to compare the traditional and modern technologies in coir industry and evaluated the input of technological change under the globalized regime and he also mentioned that the modernization of coir industry in the global regime had succeeded neither in bringing more benefits to the workers nor a better prospects to the industry. Vijayaraghavan V. S. [8] has done a theoretical study on the promotion of coir industry in India. The coir industry in the state of Kerala was reeling under accurate raw materials like coir fiber and yarn and, to add the mystery, there is a shortage of labour force especially in the spinning sector, which has resulted in the low outflow of coir yarn to the manufacturing sector.

In the present work, a solar-powered coir spinning machine is to be fabricated which will reduce human fatigue and improve the uniform spinning. This will reduce the cost of production and it is also possible to produce the coir with great quality as it replaces the traditional way of spinning manually.

A. Manual Machine

The coir fiber is spun using a traditional wheel which is rotated by a woman or child and another woman/man spins the coir into yarn through rotating spindles by moving to and fro. The construction of the traditional coir spinner setup is very large and also has more weight. Figure 1 shows the traditionally used manually operated coir spinning machine.



Figure 1 Manual Operated Coir Spinner Machine

The ‘wheel turner’ reported shoulder pain, and the ‘yarn makers’ reported sore hands. If their hands become too painful they put tape on the sore area. They have tried wearing gloves in the past, but the spinning process requires delicate touch to control the yarn quality, and also the gloves wear out due to the abrasiveness of the coir. It is for this reason that mainly older women carry out the work.

B. Motorized Coir Spinning Machine

This traditional wheel of manual spinning machine has been improved by providing a motor. The wheel is rotated by a motor through belt drive with variable speed arrangements. They run from 1-5pm, in accordance with the power availability. There is no generator or power backup option. Qualitatively speaking, the yarn is better quality (tighter and finer) than the hand-spun yarn. It increases the production rate. Figure 2 shows the motorized wheel arrangement for coir spinning purpose. The traditional motorized coir-spinning machine consumes more power. The motorized coir has a belt drive for producing coir rope and the motor consumes an AC power source. The bi-monthly electricity bill for one machine is Rs.1200 and above.





Figure 2 Motorized Coir Spinning Machine

C. Drawbacks of the Manual and Motorized Coir Spinning Machines

1. The traditional manual spinning machine requires an extra person to operate the wheel, and uniformity in spinning strength is not possible, resulting in a low production rate.
2. Motorized spinning machines consume more power, and to vary the speed, change the belt from one pulley to another pulley manually.
3. During the power cut, there will not be production.
4. The power consumption rate is high, and the slip of the belt drive is also high.
5. The Motor rotates at higher rpm (1450 rpm).

To improve the existing coir spinner machine and to avoid all these difficulties, in the present work, a solar-powered coil spinning machine is designed and fabricated that replaces the ac motor with a dc motor and uses solar power, which is one of the renewable energy sources, to have continuous production without any difficulty with variation speed obtained by using remote control. The use of a remote control is only for on/off purposes and to reduce motor power consumption during idle time. It improves the production of coir yarn and meets the increased demand.

II. SELECTION OF COMPONENTS DESIGN OF SPINNING MACHINE

The following components are selected for the solar-powered coir spinning machine:


- **Spur Gear:** The shaft of the spur gear is coupled with the shaft of the electric motor. The pitch diameter of the gear is 12 cm, and the number of teeth is 45.
- **Hooks:** The hooks are required for spinning the coir. The hooks are welded with spinner gears, and these spinner gears mesh with the main spur gear

and have 7 teeth. There are four hooks placed in the four directions by meshing the main spur gear. The pitch diameter of the spinner gear is 5 cm.

- **DC Motor:** A 12V DC motor is selected to run the main shaft of the coir spinner gear, and the motor is connected through the spinner shaft. The spinning motor has two adjustable speeds, and the speed ranges from 23 to 55 rpm based on the number of yarns to be spun. If the DC motor is on, the spinner rotates the hook for 1:6.25 times the driving shaft.
- **Solar Panel:** The motor consumes 14 watts of power to run. So a solar panel is selected to generate 25 W of power output. Figure 3 shows the photographic views of the solar panel and its name plate details.
- **Frame:** The main gear and hooks, battery, and DC motor and switches are fitted in the main frame. The frame acts as a supporting structure.



(a) Solar Panel

Electrical Parameters SOLAR PHOTOVOLTAIC MODULE	
MODEL : VE1225	Power (Watts) : 25 Wp
Open Circuit Voltage (Voc)	: 21.6 V
Maximum Power Voltage (Vmp)	: 17.61 V
Shortcircuit Current (Isc)	: 1.54 A
Maximum Power Current (Imp)	: 1.371 A
Standard test condition	
Irradiance 1000W/m ² modules Temperature 25°C Spectrum A.M 1.5	
 WARNING ELECTRICAL HAZARD. THIS DEVICE PRODUCES ELECTRICITY WHEN EXPOSED TO LIGHT, COVER THE GLASS WHILE MAKING CONNECTIONS	

(b) Name Plate

Figure 3 Photographic view of the Solar Panel and its Name plate details

III. DESIGN CALCULATION

- Spinner Gear = 7 teeth
- Main Gear = 45 teeth

Mean speed of spinner = $45/7 = 6.25$ times the main gear

The one-revolution main gear rotates the spinner gear 6.25 times.

Motor speed = 50 rpm
 Spinner speed = $50 \times 6.25 = 312.5$ rpm
 Power required to run the motor = 14watts
 Solar panel power output = 25 W
 Time to run the motor for charging power in 1 hour
 = $25/14=1.75$ hr

It means that 1 hour of charging the solar energy in the battery is used to run 1.75 hours of a DC motor.

Force calculations

The torque transmitted by the gear
 = $(60 \times P) / 2\pi N$
 = $(60 \times 14) / 2 \times 3.14 \times 50$
 = 2.675 Nm

The tangential component F_t acts at the pitch circle radius.

Torque = Tangential component force (F_t) \times d/2

Tangential component force F_t
 = $(2 \times \text{Torque})/d$
 = $(2 \times 2.675)/0.47 = 11.4$ N

For radial component Force, F_r

= $F_t \times \tan \phi$
 = $11.38 \times \tan 20 = 4.14$ N

The resultant force F

= $\sqrt{F_t^2 + F_r^2}$
 = $\sqrt{11.38^2 + 4.14^2} = 12$ N

IV. SOLAR POWERED COIR SPINNING MACHINE

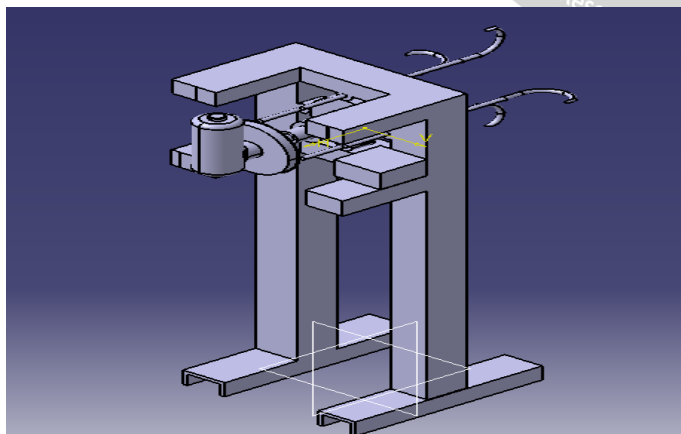


Figure 4 Schematic of coir spinning machine

Figure 4 shows a schematic of the coir spinning machine. CATIA V5 software is used to obtain this assembly view. All the parts are fitted to the frame, excluding the solar panel. The solar panel produces electric energy from direct sunlight due to the photovoltaic

effect. Electrical energy is stored in a rechargeable battery to run a DC pump.

Figure 5 shows the photographic views of the coir spinning machine. A solar panel converts the sunrays falling on it into electrical energy and charged into a rechargeable battery. The motor is connected to the main spur gear shaft and rotates the spinner at a speed ratio of 1:6. It means one rotation of the spur gear rotates the spinner six times. The motor takes power from the battery, and the remote control activates the on/off of the motor through a sensor. The gears are used to vary the two different speeds of the main shaft. The speed variation is controlled manually using a switch. Coir yarn is produced at the gear speed, and using the second gear speed, 4.5 cm to 6 cm diameter ropes are produced effectively. The setup weight is about 35 kg. It is easy to transport and handle in an effective way. Figure 6 shows the remote control and sensor with activator to perform in an effective way of coir rope production. The remote control works up to 100 feet distance.

Output

- Using first gear speed 1st stage coir yarn is produced and also 2 or 3 coir yarns are joining together and produce the coir rope.
- Using second gear speed 4.5-6.0 diameter ropes are produced effectively.

Advantages of solar powered coir spinning Machine

1. Portable to use
2. Handling is simple
3. Low cost of construction
4. Reduce power consumption and avoid electricity bills
5. More efficiency and effective utilization of power
6. A variety of coir ropes up to 4 layers is produced.
7. Reduced manual work compared to traditional methods



(a) Front View



(b) Side View

Figure 5 Photographic views of the Coir Spinning Machine



Figure 6 Remote Control with micro processor

V. DISCUSSION

Thus, the solar powered coir spinning machine successfully works at two different speeds and the coir rope of size 4.5 to 6 cm is produced. The coir spinning machine operates from a 100 feet distance with the help of

remote control and minimizes the power consumption rate compared to a conventional ac motor operated coir spinning machine. The setup is easily shifted from one place to another place for convenience to use. The machine is operated using stored solar energy in the battery. This machine reduces the power consumption, manual work and also reduces the size of the coir spinning machine.

Benefits of the Solar Powered coir spinning machine observed during testing

- 1. Low power consumption:** means it is economical to use solar power
- 2. DC motor option:** again means that solar power can be used
- 3. Remote operation:** Ability to turn wheel on/ off using remote control switches is a good innovation.
- 4. Low noise (compared to traditional or motor operated coir spinning machine):** means coir fiber makers can start work earlier in day (disruption to neighborhood is less), which helps avoid the midday heat and also means the coir quality is softer (reduces chance of hand injuries). Reduction in sound is also beneficial for children studying at home (easier to concentrate)
- 5. Installation process:** Machine is small and easy to install.

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