

An Undergraduate Technical Research Submitted to the
College of Engineering, Architecture and Technology
Palawan State University
Puerto Princesa City

As Partial Fulfillment of the Requirements
For the Degree of
Bachelor of Science in Mechanical Engineering

**DESIGN AND FABRICATION OF KAPOK (CEIBA
PENTANDRA) FIBER EXTRACTING MACHINE**

by

ALIJUN FERNANDEZ DELLIRO
ALLAN ANTHONY VILLON ABUTATIL
CHRISTIAN KYTH SERVANO INOCENCIO
HERNAN DALE PADUGA PARANGUE

March, 2019

ABSTRACT

Kapok (Ceiba Pentandra) fiber is known as a an organic fibre. It has been used as a stuffing in pillows and mattresses.

In the province of Palawan making pillows from Kapok fiber is still a practice especially those from far flung areas where most people rely in nature and in traditional system. The process in separating the seeds from the fiber is done by means of using the hand and a Mosquito net. Scratching the Kapok fiber with seeds in the Mosquito net will eventually separate both of it, but this process takes up too much time and effort.

The proposed extractor machine can solve the problem by speeding up the process of extracting Kapok fiber. Furthermore, this could pave the way for an industry of pillow production using the kapok fibre.

The designed equipment works using 6 hp engine which provides the primary motion required to run the machine. The motion and torque are transmitted to the main shaft via pulleys, v-belt and bearing. It also consist of Flat bar crusher welded in 4in diameter cylinder tube attached in shaft and in walls, thrower on the other side which drives the Product fiber to the outlet and the by product goes down to the exit and a blower in order to extract the fiber needed.

The extracting machine is more efficient if the desired power is meet; too much power applied will give a higher stress concentration in some parts of the machine especially in shafts, which could result to its malfunction and destruction.

APPROVAL SHEET

This is to certify that we have supervised the preparation of and read the research paper prepared by **HERNAN DALE P. PARANGUE, CHRISTIAN KYTH INOCENCIO, ALIJUN F.DELLIRO** and **ALLAN ANTHONY V. ABUTATIL** entitled **DESIGN AND FABRICATION OF KAPOK (*CEIBA PENTANDRA*) FIBER EXTRACTING MACHINE** and that the said paper has been submitted for final examination by the Oral Examination Committee.

Engr. Edwin A. Lusoc
ADVISER

As members of the Oral Examination Committee, we certify that we have examined this paper and hereby recommend that it be accepted as partial fulfilment of the undergraduate requirement for the Degree **Bachelor of Science in Mechanical Engineering**.

Engr. Pinky S. Dela Cruz
Panel Member 1

Engr. Beberth J. Samillan
Panel Member 2

Engr. Roy C. Dayupay
Panel Member 3

This research paper is hereby approved and accepted by the College of Engineering, Architecture & Technology as partial fulfilment of the undergraduate requirement for the Degree **Bachelor of Science in Mechanical Engineering**.

Engr. Elucila M. Sespeña, PhD
Dean, College of Engineering, Architecture & Technology

ACKNOWLEDGEMENT

We would like to express our deepest appreciation and gratitude to the following individuals who helped made this study possible.

To Prof. Edwin A. Lusoc, our ME Project Study II-Adviser, for his patient guidance, enthusiastic encouragement and constructive criticism and for helping us in the fabrication and offering some resources to support our project;

To Engr. Roy C. Dayupay, Engr. Pinky S. Dela Cruz, and Engr. Beberth J. Samillan ; for their advice, support and assistance and for sharing their expertise and knowledge;

To our dear friends and classmates for giving their moral support and encouragement;

To our dearest parents for their support and encouragement throughout our study; and

Above all, the authors' praise and thanks go to our Almighty God for His guidance and overflowing blessings undeservingly bestowed upon them.

The Researchers

FIGURES

Figures	Page
3.2.1 Research paradigm	20
3.3.1 Proposed Analysis of the Study	21
3.4.1 Design layout	22
3.4.2 External layout	23
3.4.3 Internal layout	23
3.4.4 Machine Crusher layout	24
3.5.1 Blower Internal Layout	24
3.5.2 Blower External layout	24
4.6 Methods for the Fabrication of the Kapok fiber Extractor machine	33

LIST OF TABLES

Table	Page
4.1 Materials and Specification	25
4.5 Bill of Quantities and other Expenses	31
5.1.2 Production rate of the machine	34

TABLE OF CONTENTS

Title Page	i
Abstract	ii
Approval Sheet	iii
Acknowledgement	iv
List of Figures	v
List of Tables	vi
Table of Contents	vii

Chapter 1	INTRODUCTION	Page
1.1	Background of the Study	11
1.2	Statement of the Problem	11
1.3	Objective of the Study	11
1.4	Significance of the Study	11
1.5	Scope and Delimitation	12
1.6	Assumption of the Study	12

Chapter 2	REVIEW OF RELATED LITERATURE	13
2.1	Review of Related Literature	13
2.1.1	Physical and Chemical Properties of Kapok (<i>Ceiba pentandra</i>) and Balsa (<i>Ochroma pyramidale</i>) Fibers.	13
2.1.2	Chemical Composition of Kapok (<i>Ceibapentandra</i>) Seed and Physicochemical Properties of its Oil.	14
2.1.3	Design, Construction, Evaluation of fiber Extracting Machine.	15
2.1.4	Design and fabrication of Corn De-seeding Machine.	15
2.1.5	Development of Guna Seed Extractor.	16
2.1.6	Design and Testing of a Fish bone separator Machine.	17
2.1.7	Rice Milling.	18
2.1.8	Development of Low cost Rice Milling Machine.	18
2.1.9	Design and Fabrication of Multi crop Thresher to enhance the seed Germination rate.	19

Chapter 3 CONCEPTUAL/ THEORETICAL FRAMEWORK

3.1	Conceptualization	20
3.2	Research paradigm	20
3.3	Proposed Analysis of the Study	21
3.4	Design of the machine	22
3.5	Design of the machine Blower	24

Chapter 4 MATERIALS AND METHODOLOGY

4.1	Materials and usage	25
4.2	Materials and Usage	26
4.3	Tools Used	27
4.4	Computation	28
4.5	Bill of Quantities and other Expenses	29
4.6	Methods of fabrication of the Machine	31

Chapter 5 RESULTS AND DISCUSSION

5.1	Testing	32
5.1.1	Result	32

Chapter 6 CONCLUSION AND RECOMMENDATIONS

6.1	Conclusion	34
-----	------------	----

6.2	Recommendation	34
-----	----------------	----

REFERENCES	37
-------------------	----

GLOSSARY OF TECHNICAL TERMS	39
------------------------------------	----

APPENDICES

Appendix A	Kapok Fiber Extracting Machine	41
------------	--------------------------------	----

Appndeix B	User manual	42
------------	-------------	----

Chapter 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Kapok (*Ceiba pentandra*), also known as *Java cotton*, *Java kapok*, *silk-cotton* or *Samauma*, it is a type of tree that grows in tropical places like the Philippines. The main product of this plants is its dried fruit containing a silk fiber which is cotton-like, but not compact, popularly used as stuffing in pillows and mattresses.

Nowadays, in some areas of the Philippines which has kapok trees, especially in province of Palawan, many people are still using the traditional way of extracting the seed from fiber. They separate the seed and fiber by using their hands.

Designing a machine that could extract the Kapok fiber from its seed and shell is one the solution to help farmers to have faster production, reduce the time of work and to improve the product rate compared to the traditional way of extracting the fiber from seed.

The study aims to find out whether the designed Kapok fiber extracting Machine would be effective and efficient. This study specifically sought to provide an answer to the questions such as: what is the appropriate design of the belt-driven motor extractor machine and how to fabricate the belt-driven motor separator machine.

The main objective of the study is to design and fabricate Kapok Fiber Extracting machine. This study also aims to identify the production rate of fiber and the overall production.

This study will introduce a machine that could separate the Kapok fiber from seed and would let the farmers have faster production, lessen the time and effort and to improve the product rate

which is better than traditional way.

The resources of Kapok Dried fruit is only limited in the province of Palawan. This study covers the designing, fabricating and testing of the Kapok fiber extracting machine that is manufactured in Rizal Palawan. Hence, it focuses on the analysis of production rate of kapok fiber.

Chapter 2

REVIEW RELATED LITERATURE

Different types of related literature are reviewed in this chapter in order to have a better understanding of this study.

Kapok fiber based on the study of K.M. Anigo, B.M.D. Dauda, A.B. Sallau and I.E.Chindo. Kapok [*Ceibapentandra*(L) Gaertn., Family Bombacaceae], the silk cotton tree, is native to the New world and Africa, found widespread in the tropics and in several plantations in Southeast Asia, and known for its white silky floss. There is a strong ecological, botanical and cytological evidence that the original distribution of this tree may have been in western and central Africa. Kapok is a fast growing tree and becomes productive within four to five years. Yields increase for about 8 years and its economical lifespan is about 60 years. A tree under optimal conditions may yield 330-400 fruits per year, giving 15-18 kg fibre and about 30 kg seeds. Kapok tree produces between 500 and 4,000 fruits at one time, with each fruit containing 200 seeds. Each kapok tree bears 1000 to 2000 pods annually. When these fruit burst open, silky fibers spread the many seeds all over the environs.

Kapok fiber is an agricultural product obtained from the fruits of the kapok tree. Kapok fibers are fluffy, light-weight, and too in elastic to be span. Kapok fiber is much appreciated for its low density and insulating properties that made it suitable for a large number of commercial applications, including pillows, upholstery, mattresses, soft toys, clothes stuffing, thermal and acoustic insulation. Kapok wood is a light, porous and resistant timber useful for plywood, packaging, carvings, and dugout canoes. The seeds are also used as food/feed for humans and livestock. Hassan et al., (2007) reported that the Kapok seed is a very good source of edible oil

and have the potential for use as raw material in paint industries. Kapok seed also has the potential to be used as raw material for biodiesel (Putriet *al.*, 2012). [1]

Kapok Fiber Characteristics based on the study of Renny Purnawati, Fauzi Febrianto, I Nyoman J Wistara, Siti Nikmatin, Wahyu Hidayat, Seung Hwan Lee, Nam Hun Kim. Physical and Chemical Properties of Kapok (*Ceiba pentandra*) and Balsa (*Ochroma pyramidale*) Fiber. Natural fibers derived from lignocellulosic materials are considered to be more environment-friendly than petroleum-based synthetic fibers. Several natural fibers, such as seedpod fibers, have a potential for development, including kapok and balsa fibers. The characteristics of both fibers were evaluated to determine their suitability for specific valuable applications. The purpose of this study was to analyze some important fundamental properties of kapok and balsa fibers, including their dimensions, morphology, chemical components, and wettability. The results showed that the average fiber lengths for kapok and balsa were 1.63 and 1.30 cm, respectively. Kapok and balsa fibers had thin cell walls and large lumens filled with air. The kapok fiber was composed of 38.09% α -cellulose, 14.09% lignin, and 2.34% wax content, whereas the balsa fiber was composed 44.62% α -cellulose, 16.60% lignin, and 2.29% wax content. The characteristics of kapok and balsa fibers were examined by X-ray diffraction, Fourier-transform infrared spectroscopy and differential scanning calorimetry analyses. The contact angle of the distilled water on kapok and balsa fibers was more than 90°, indicating that both fibers are hydrophobic with low wettability properties because of to the presence of wax on the fiber surface. [2]

In addition, according to the research of Nazilla Tarabi Hossein, Mousazadeh Ali Jafari, Jalil Taghizadeh-Tameh about “Design, construction and evaluation of a fiber extracting machine from *Calotropis*(milkweed) stems “, natural fibers have been of great interest recently in many researches and industries. A fiber extracting machine is designed and constructed, based on mechanical method. The machine performance is evaluated in their research as well. The machine consists of three separation units and two feeding units. Each separation unit is comprised of: a frame, a pair of blades, a pair of roller, two yoke and power transmission system. Some physical and mechanical properties of stems and barks are determined as predesigning steps. Analyzing extracting efficiency at three speed levels and two moisture contents shows that the maximum extracting efficiency (with 98%) is at rotational velocity of 40 rpm with the moisture content of 75% w.b. Experimental test shows that ther maximum consumed power was about 958 W while whole stem is located in the machine. The capacity of extraction machine based on dried mass of barks and fibers was 2 kg/h approximately. [3]

Furthermore, according to the study entitled “Design and Fabrication of Corn De-Seeding Machine” by Pavan Kumar K P, Kushal Gowda Y N, Ravikumara M H. The principles of an extracting machine always rotates in the idea of a mechanically operated equipment. The designed equipment works using electric motor which provides the primary motion required to run the machine. The motion and torque are transmitted to the main shaft via pulleys, v-belt and bearing; a rod of 4mm diameter has been welded along its circumference from one end to other end. The main shaft with welded rod on its surface is rotated in a clockwise direction with the help of the motor. The maize collected in the hopper are introduced into the machine through the inlet. The maize comes in contact with the rotating main shaft inside the corn guider barrel. The Maize is subjected to the continuous impact force and rotatory motion due to the welded helical

rod on the surface of the rotating shaft, the Kernels gets separated or deseeded from the cob. A straight rod is welded near the front end of the corn guider which helps in the de-seeding as well as guiding the cob towards the cob outlet. Since the Corn guider or barrel is designed as a tapered section, the maize moves along the length of the barrel in the forward direction until it reaches the cob outlet spout. The cob comes out of the outlet provided for it near the front end of the machine whereas the kernels will come out through the outlet provided for it at the bottom of the machine. [4]

Also, according to the study about “Development of a Guna Seed Extractor” by N.A. Aviara; S.K. Shittu and M.A. Haque. Guna seed extraction presents an onerous task and has been the labour and time consuming operation that militates against the large scale production and processing of this important oil crop. To overcome this problem, a Guna seed extractor that works on the principle of impact from breaker arms and macerators was developed. The seed extractor consists of a hopper equipped with flow rate control device, a seed extraction unit, winnowing unit and power system. Result of tests and analyses showed that the performance indicators (percentage effective seed extraction, cleaning efficiency, cleaning loss, percentage seed loss at concave, material retention and percentage seed retention) were significantly affected by fruit moisture content (storage duration), material feed rate and machine speed at 1 and 5% level. Maximum cleaning efficiency of 94.15% and 91.28% for the *colocynthis* and *lanatus* varieties respectively, was obtained at the material feed rate of 375 kg/h, machine speed of 939 min, and fruit moisture contents of 87.21% and 85.07%. Maximum cleaning loss was less than 30% and percentage seed retention was high at low fruit moisture content, material feed rate and machine speed. Practically no seed damage was recorded. Regression models that could be used to express the relationship existing between the seed extractor performance indices and fruit

moisture content, material feed rate and machine speed were established for each variety of Guna crop. [5]

According to the study about “Design and testing of a fish bone separator machine” by Alejandro Booman, Aníbal Márquez, María Amelia Parin, Aurora Zugarramurdi

The developed machine was based in the principle of deboning fish by forcing the flesh through small holes combining compression and shear action over the product, so the fish bones are forced to lay flat over a perforated surface. This allows for the extrusion of meat through the holes, so not only the bones, but also scales and skin are kept on the outer side of the drum. A perforated drum was set up along with means for providing cyclic pressing and shearing action on process product against it. A semi-manual prototype, at 60% scale of the full intended capacity, having a motor-driven perforated drum, was built to demonstrate the feasibility of the development. Species from the Atlantic Ocean and carps from inland waters were processed in short batches. Using the data obtained from prototype operation, a full-scale machine was built. The developed FBSM uses a drum with a diameter of about 1/5 of the usual in belted machines. This fish meat-bone separation machine is, basically, a perforated rotating drum (1), a set of oscillating matching curvature beams (2) that press the fish against the drum. The auxiliary elements are an intake hopper (3) and a pair of scrappers (4 and 5) that clear the drum orifices from outside. A spiraled scrapper (6) aids in the removal of the boneless flesh being accumulated inside the drum. An oscillating pre-press (7), reduces the fish thickness in such a way that it can be introduced between the drum and the matching beams (2) for the final pressing. A camshaft (8) moves the matching beams. An eccentric mechanism (9) is used to set the gap between the drum and the matching beams. All movements are provided by the gear chain (10). A

mechanical seal (11) hold scales and raw material in place. Skins, scales and bones exit through the hopper (12), and deboned fish flesh exits through a hopper (13). [6]

Also, according to the study entitled “Rice Milling” by Poonam Dhankhar, milling refers to the removal or separation of husk (de-husking) and bran to obtain the edible portion for consumption. The process has to be accomplished with care to prevent excessive breakage of the kernel and improve recovery of paddy or rice. The extent of recovery during milling depends on many factors like variety of paddy, degree of milling required, the quality of equipment used, the operators, etc. Milling is the process wherein the rice grain is transformed into a form suitable for human consumption, therefore, it has to be done with utmost care to prevent breakage of the kernel and improve the recovery. Rice is milled further to create a more visually appealing white rice. After harvesting and drying, the paddy is subjected to the primary milling operation which includes de-husking as well as the removal of bran layers (polishing) before it is consumed. [7]

According to the study entitled “Development of a low cost Rice Milling machine” by Olufemi Bamidele Busari, Olayide Rasaq Adetunji, Peter Olaitan Aiyedun and Sunday Benga Aderibigbe, in the design and fabrication of a certain equipment, it is very important to carefully select the material and method. This is to ensure that the final product meets its specification and work as intended. In the selection of suitable material that will satisfy a design and product requirement, it is necessary to look at many aspects so that the components and assembly are fabricated within the resources available. Cleaning and separation should be accomplished in the minimum possible space. The grain should move in a direction different from the motion of chaff to separate the grain from chaff the knowledge of aerodynamic properties of rice such as drag

coefficient and terminal velocity are necessary in the design since air will be used as a carrier for separating the rice from the unwanted materials. [8]

Lastly, according to the study entitled “Design and Fabrication of Multi-crop Thresher to enhance the seed germination rate” by Abhay.A.Mulgun, a thresher was developed for threshing seeds which has a similarity to extracting machine. The major components of the machine include threshing, blower and cleaning units. The operation can be done by rotational motion of a cylinder fitted with beater pegs above a stationary grid which results in the removal of the seeds. After beating out, the grains fall through a conveyor grid into the cleaning unit which consists of sieves that undergo reciprocating motion. Whilst the grains are moving over these sieves, a constant blast of air is being sucked through them which blow out materials that are lighter than the grain through blower exit. The machine was designed to be powered by a ½ hp electric motor. It was tested to thresh, separate and clean the seeds. Thus, the optimum operating parameters of the machine were 13% moisture content (wet basis) of seeds and 1500 rpm threshing drum speed. The successful development of this machine is expected to reduce drudgery associated with the traditional method of threshing millet. [9]

Chapter 3

CONCEPTUAL/ THEORETICAL FRAMEWORK

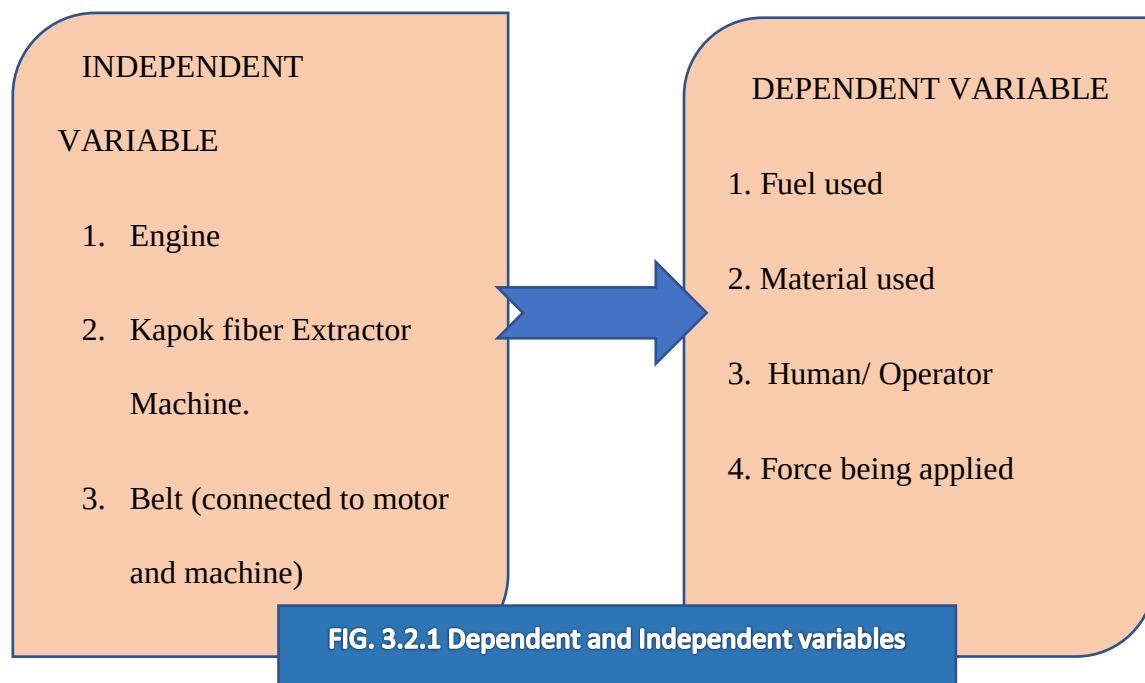
3.1 CONCEPTUALIZATION

This study conceptualized that the fabrication of Kapok Extractor is a useful tool to help the farmers produce more Kapok fiber which could lead to industry of Kapok Pillow production.

3.2 Research Paradigm

The figure below shows the dependent and independent variables.

The Dependent variables are the variables that are determined in the experiment and the effect which varied depending on the data used in independent variable, are the variables examined to obtain the desired result.



3.3. PROPOSED ANALYSIS OF THE STUDY

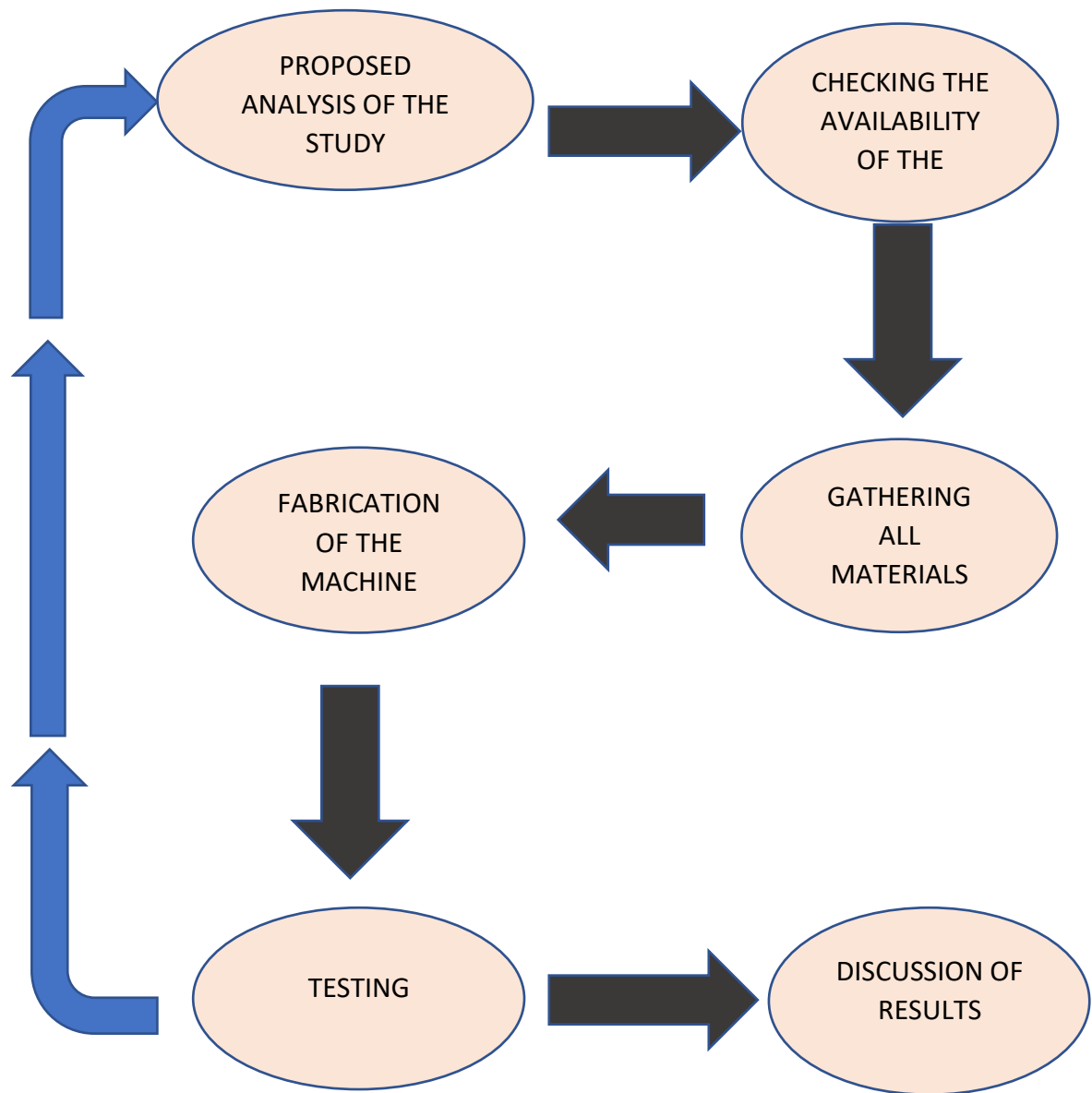


FIG. 3.3.1 Flow Analysis of the study

3.4 Design of the Kapok fiber Extracting Machine

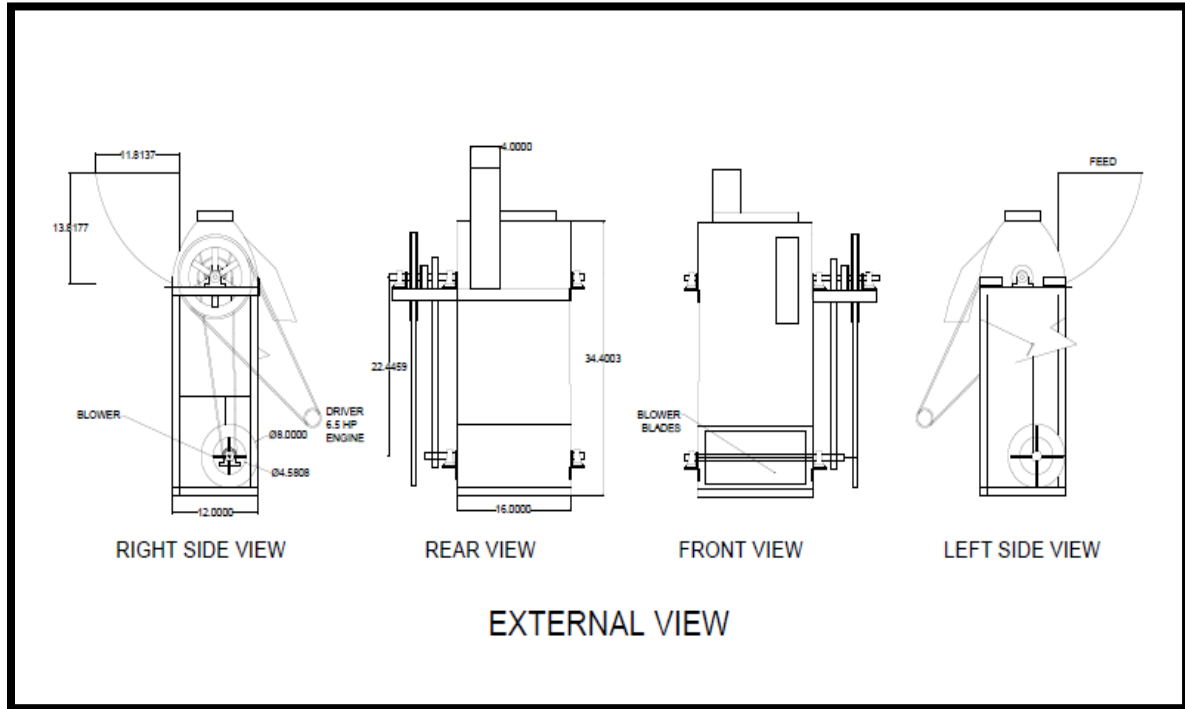
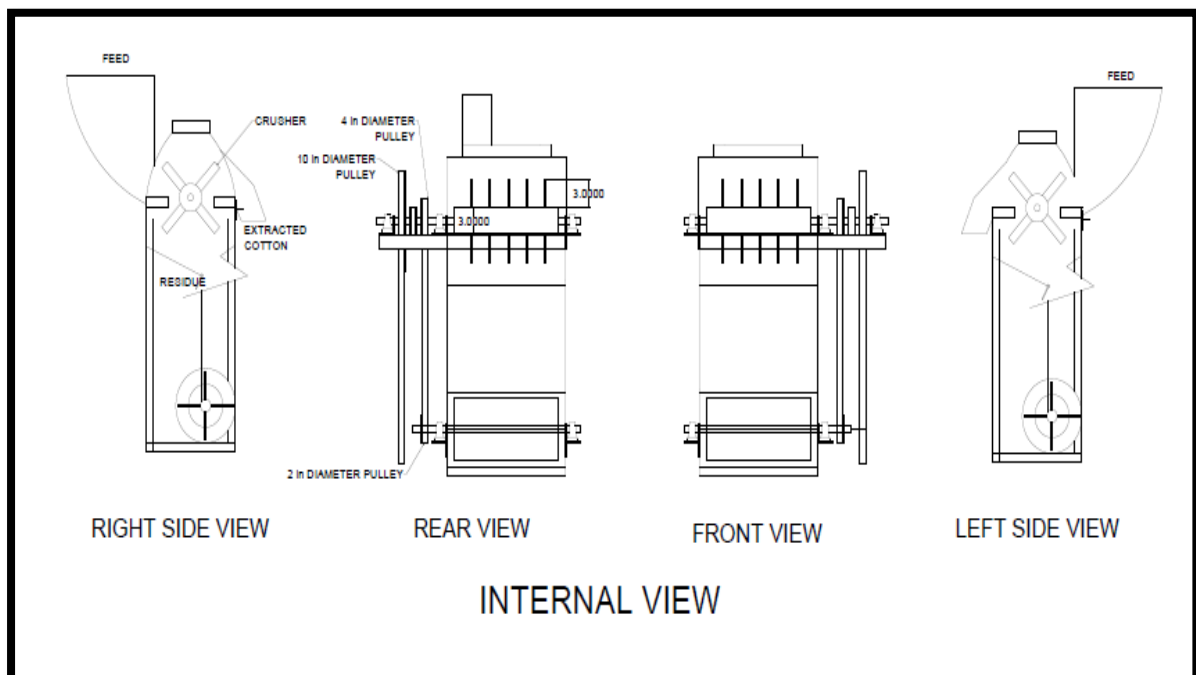
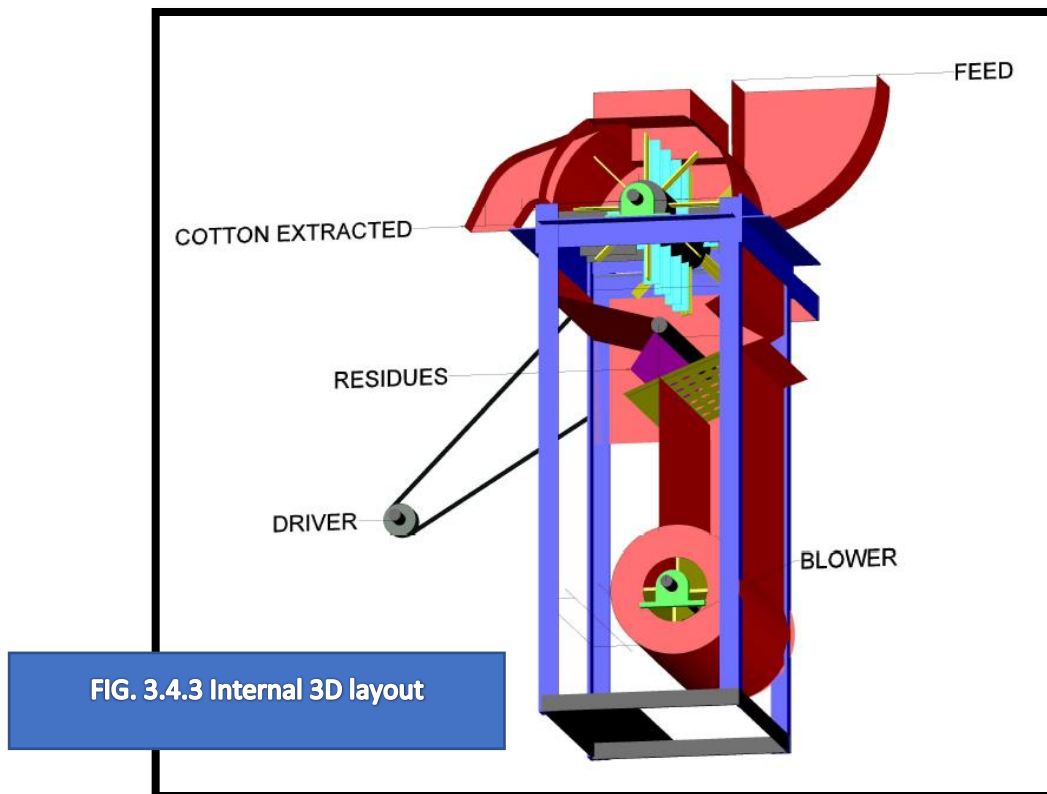
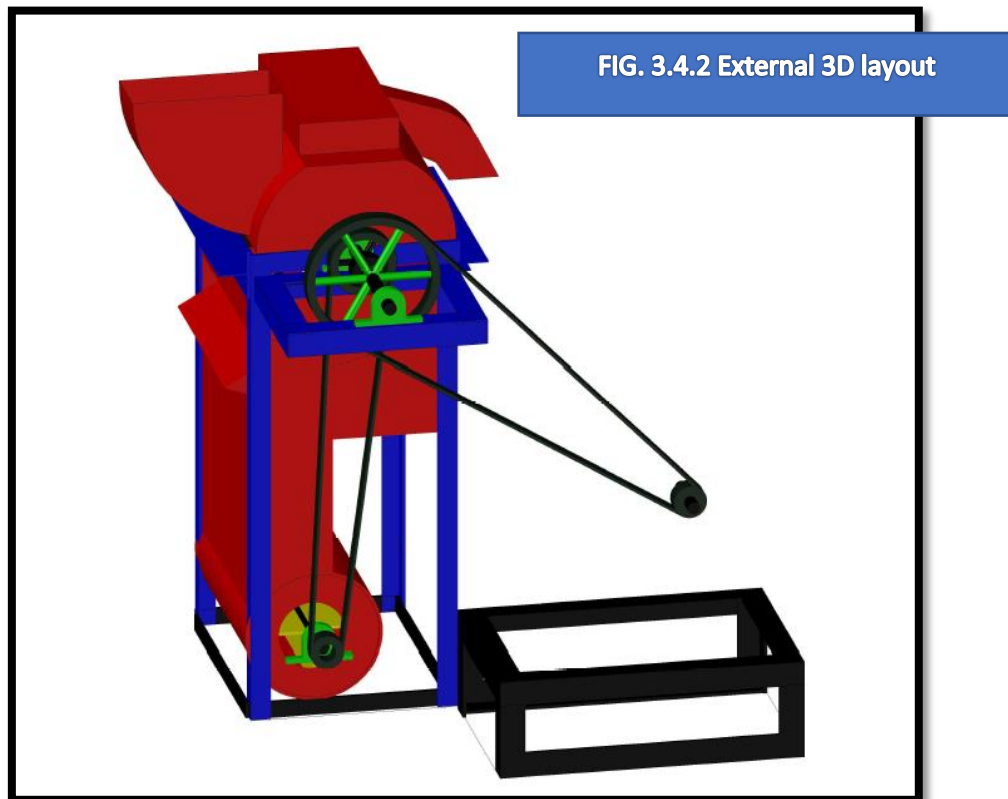
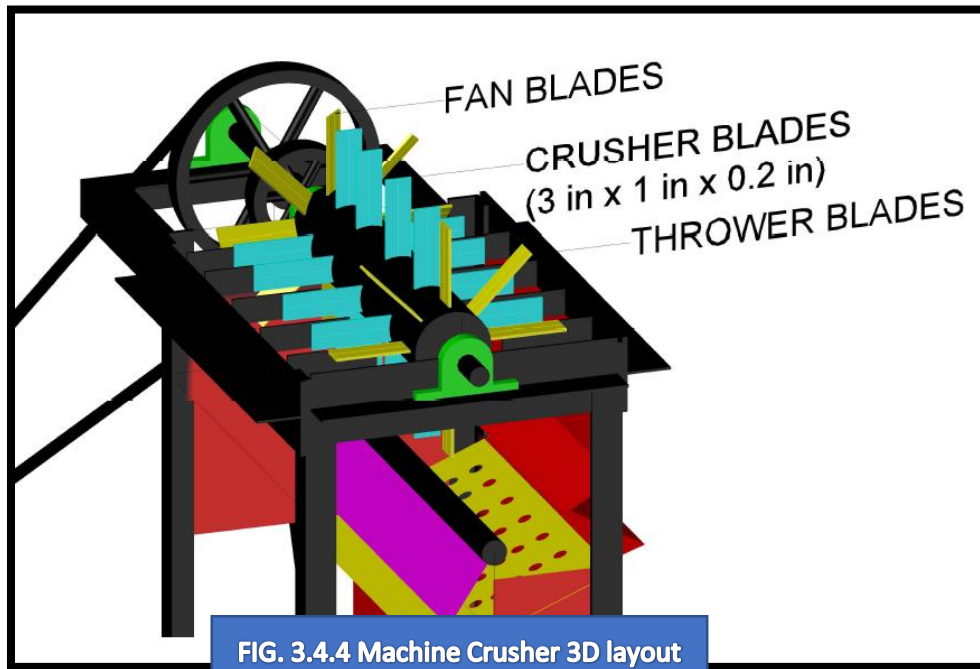


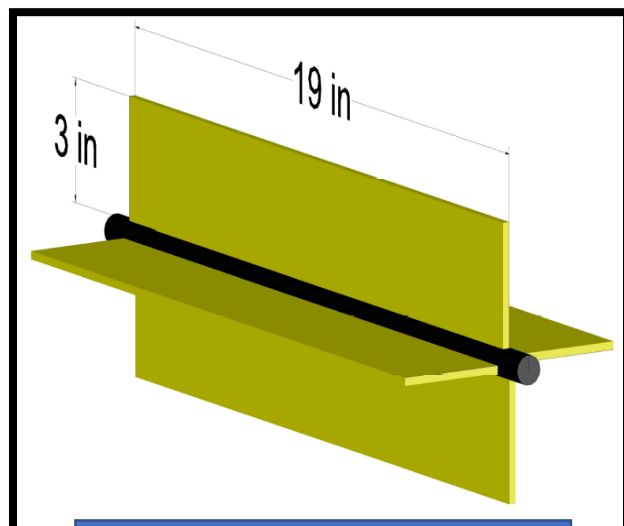
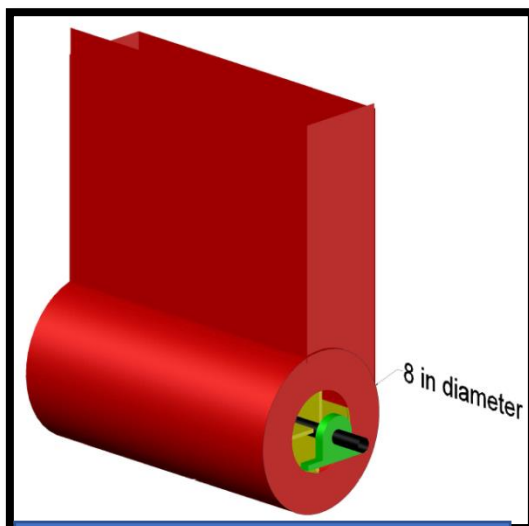
FIG. 3.4.1 Design layout (Unit in Inches)







3.5 Design of the Kapok fiber Extracting Machine Blower



CHAPTER 4

MATERIALS AND METHODS

4.1 Materials specifications

Material	Quantity	Dimensions/Specifications
Plain sheets	1	Gauge 16
Angle bar	1	1 in x 3mm
Angle bar	1	1 ½ x 3mm
Flat bars	1	3/8 x 1
CRS Shafting	1	8ft. / ¾ Ø
Belts	3	
Pulley	3	2 in Ø
Pulley	1	4 in Ø
Pulley	2	10 in Ø
Pillow block	8	¾
Bolts and Nuts	16	
Bolts and Nuts		

This table shows the different specification of materials used in the Fabrication of Kapok fiber Extracting Machine

4.2 MATERIALS AND USAGE

The materials listed below are suitable for the fabrication of Kapok fiber Extractor Machine with the consideration of its physical properties.

- 1. Plain sheets** - Used for the construction of the two layers fully cover housing;
- 2. Bearings** – Served as the roller for the shaft;
- 3. Bolts and Nuts** – Used for tightening many different parts such as pillow block and other different parts;
- 4. Shaft** – Used for transmitting motion and power;
- 5. Belts** – Used as a source of motion from motor shaft, to transfer power efficiently and to track relative motion;
- 6. Pillow Block** - Used to hold the Shaft;
- 7. Motor** - Used as the motion and power source to run the machine;
- 8. Flat Bars**– Used as the teeth in the internal cylinder connected in shafts and in housing wall which performs as the crusher;
- 9. Angle Bar** – used as the frame and housing structure of the entire machine; and
- 10. 6.5 hp Gasoline Engine** – served as the motion and power source to run the machine.

4.3 TOOLS USED

The following are the tools used in the fabrication of the kapok extracting machine:

- | | | |
|----------------------|-----------------------------|---------------------|
| 1. Scissor/Cutter | 9. Grinding Machine | 17. Open End Wrench |
| 2. Hacksaw | 10. File | 18. Steel tape |
| 3. Welding Machine | 11. Sander Machine | |
| 4. Welding Rod | 12 Bevel Edge Socket Chisel | |
| 5. Screw Drive | 13. Drill bits | |
| 6. Adjustable Wrench | 14. Electric drill Machine | |
| 7. Hammer | 15. L - Square | |
| 8. Sand Paper | 16. Metal Chisel | |

4.4 DESIGN COMPUTATION

Solving for the diameter of crusher pulley 1 at a speed of 600 rpm (we assumed the speed of the crusher to be 600rpm).

Given:

$$N_d = 3000 \text{ rpm}$$

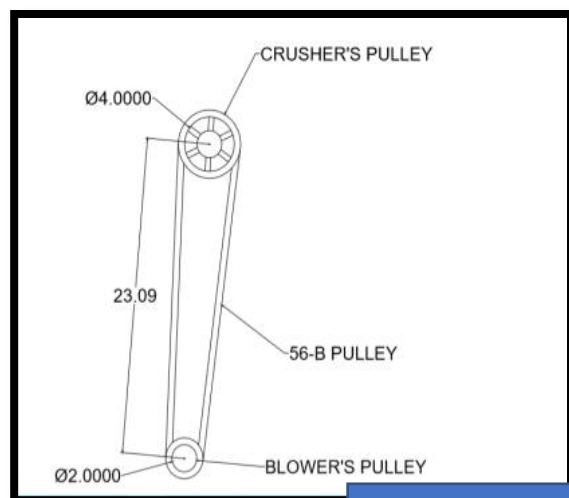
$$D_d = 2 \text{ in}$$

$$N_1 = 600 \text{ rpm}$$

$$D_1 = ?$$

Where:

N_d = speed of the Driver(gasoline engine)



Free body Diagram

D_d = diameter of the driver's pulley.

N_1 = speed of the crusher

D_1 = diameter of the crusher's pulley.

Solution:

$$N_d D_d = N_1 D_1$$

$$3000 \text{ rpm (2 in)} = 600 \text{ rpm ()}$$

$$D_1 = 10 \text{ in}$$

Solving for the diameter of crusher pulley 2 (we assumed the size of the blower's pulley to be 2 in (smallest) and blower speed of 1000 rpm.

$$N_2 = 600 \text{ rpm}$$

$$D_2 = ?$$

$$N_b = 1000 \text{ rpm}$$

$$D_b = 2 \text{ in}$$

$$600 \text{ rpm (} D_2 \text{)} = 1000 \text{ rpm (2 in)}$$

$$D_2 = 3.33333 \text{ in}$$

Available size of pulley = 4 in

Therefore the new speed of the blower will be:

$$600 \text{ rpm (4 in)} = N_b (2 \text{ in})$$

$$N_b = 1200 \text{ rpm}$$

DESIGN SUMMARY OF THE SIZES AND SPEED OF PULLEYS:

BLOWER'S PULLEY :

Diameter : 2 in

Speed : 1200 rpm

DRIVER'S PULLEY:

Diameter : 2 in

Speed : 3000 rpm

CRUSHER'S PULLEY:

Diameter : 4 in

Speed : 600 rpm

CENTER DISTANCE AND BELT LENGTH BETWEEN CRUSHER AND BLOWER:

Proposed center distance : 23 in

$$\begin{aligned}\text{BELT LENGTH} &= 2C + 1.57 (D_2 + D_1) + \frac{(D_2 + D_1)^2}{4C} \\ &= 2(23 \text{ in}) + 1.57 (4 + 2) \frac{(4+2)^2}{4(23)} \\ &= 55.8 \text{ in}\end{aligned}$$

Available size of belt = **56 in**

REQUIRED CENTER DISTANCE FOR 56 in BELT LENGTH

$$B = 4L - 6.28 (D_2 + D_1)$$

$$B = 4(56) - 6.28 (4 + 2)$$

$$B = 186.42 \text{ in}$$

$$\begin{aligned}\text{ACTUAL CENTER DISTANCE} &= \frac{B + \sqrt{B^2 - 32(D_2 + D_1)^2}}{16} \\ &= \frac{186.42 + \sqrt{186.42^2 - 32(4 + 2)^2}}{16} \\ &= \mathbf{23.09 \text{ in}}\end{aligned}$$

CENTER DISTANCE AND BELT LENGTH BETWEEN CRUSHER AND BLOWER:

Proposed center distance : 23 in

$$\begin{aligned}\text{BELT LENGTH} &= 2C + 1.57 (D_2 + D_1) + \frac{(D_2 + D_1)^2}{4C} \\ &= 2(23 \text{ in}) + 1.57 (10 + 2) \frac{(4+2)^2}{4(23)} \\ &= 66.4 \text{ in}\end{aligned}$$

Available size of belt = **67 in**

REQUIRED CENTER DISTANCE FOR 56 in BELT LENGTH

$$\begin{aligned}B &= 4L - 6.28 (D_2 + D_1) \\ B &= 4(67) - 6.28 (10 + 2) \\ B &= 192.64 \text{ in}\end{aligned}$$

$$\begin{aligned}\text{ACTUAL CENTER DISTANCE} &= \frac{B + \sqrt{B^2 - 32(D_2 + D_1)^2}}{16} \\ &= \frac{192.64 + \sqrt{192.64^2 - 32(10 + 2)^2}}{16} \\ &= \mathbf{23.2249 \text{ in}}\end{aligned}$$

DESIGN SUMMARY OF THE BELTS:

BELT BETWEEN CRUSHER AND BLOWER = **56-B**

BELT BETWEEN CRUSHER AND DRIVER = **67-B**

4.5 BILL OF QUANTITIES AND OTHER EXPENSES

ITEMS				
DESCRIPTION	SIZE	QUANTITIES	UNIT PRICE	AMOUNT
Welding rod		10 pcs.	Php. 12.00	Php. 120.00
CRS Shafting	¾ inch Ø x 8ft. long	1pcs.	Php. 55.00/ft	Php. 440.00
V pulley single	¾ x 2	1 pc.	Php. 70.00	Php. 70.00
V pulley single	¾ x 4	1	Php. 75.00	Php. 75.00
V pulley single	¾ x 10	2	Php. 85.00	Php. 85.00
BH bolt w/ nut	1/2 inch x 2 inch	16 pcs.	Php. 20.75	Php. 332.00
BI bolt w/ nut	5/16 inch x 1.5 inch	16 pcs.	Php. 6.75	Php. 108.00
Bolts and Nuts	5/16 inch x 1 inch	8pcs.	Php. 8.00	Php. 64.00
Bolts and Nuts	3/8 inch x 1.5 inch	4 pcs.	Php. 13.00	Php. 52.00
Bolts and Nuts	1.5 inch x 1.5 inch	2 pcs.	Php. 20.00	Php. 40.00
Angle Bar	3/16 inch x 1 inch	2 pcs.	Php. 435.00	Php. 870.00
Flat Bar	¼ in x 1in	1 pc.	Php. 400.00	400.00
Flat Bar	¼ in x 1in	1 pc.	Php. 255.00	255.00
Plain sheet	1.4 mm thick	1pc.	Php. 1610	Php. 1610
Angle Bar	3/16 inch x 1.5inch	1 pc.	Php. 625.00	Php. 625.00
Pillow Block	¾ Inch	2pcs	Php. 170.00	Php. 340.00
Elastoseal		1 pc.	Php. 60.00	60.00
Labor			Php. 8000.00	Php. 8000
Package delivery		2 times	Php. 800.00	Php. 800.00

Diesel		Php.3000.00	Php. 3000
Fan Belt	3. pcs.	Php. 840.00	Php. 840.00
Oil 40		Php. 260	Php. 260
Gasoline	2 liters	Php. 100.00	Php. 100.00
TOTAL		Php. 18,271.00	

4.6 Methods for the Fabrication of the Kapok Fiber Extracting Machine

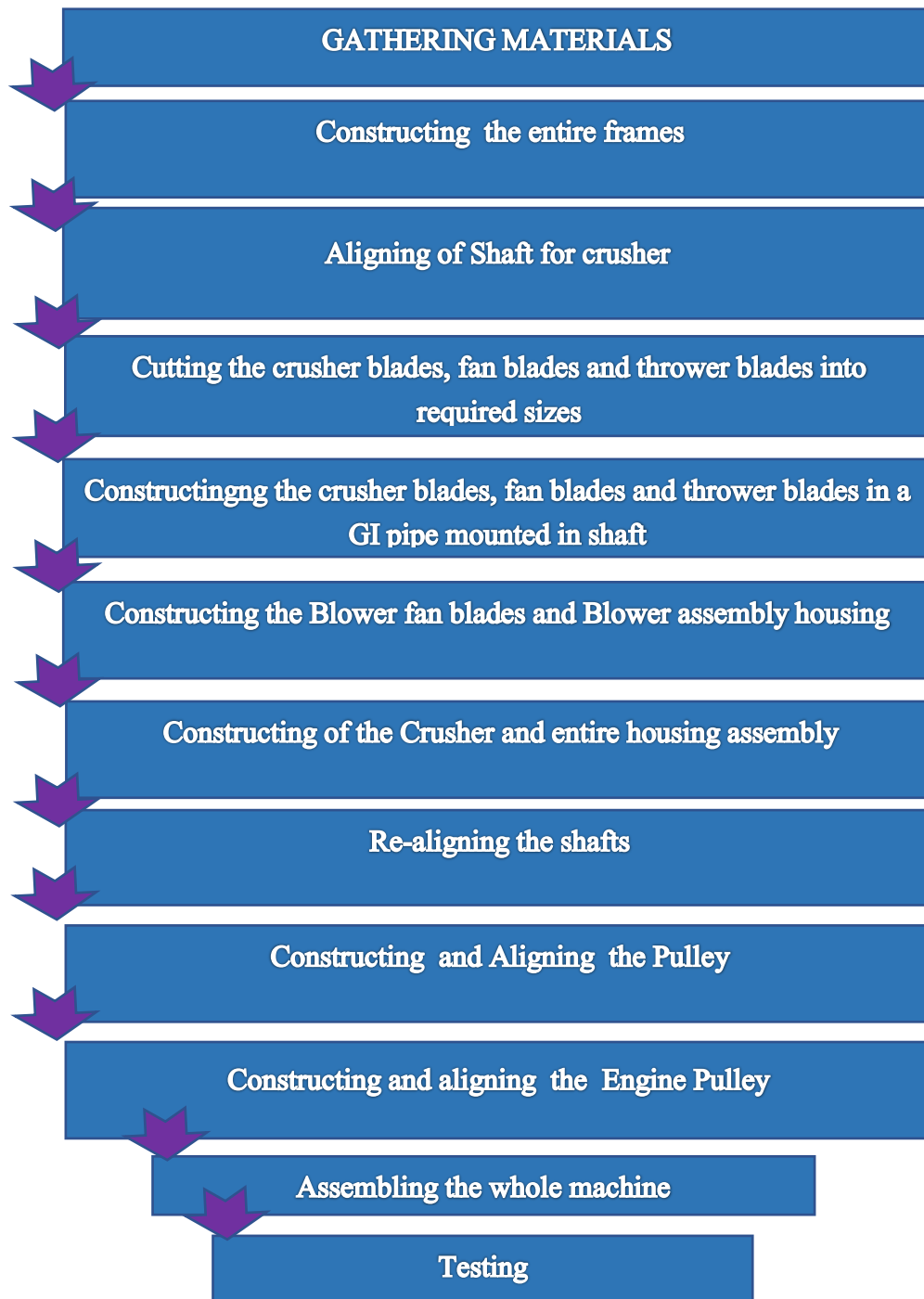


FIG. 4.5.1 Methods of Fabrication

CHAPTER 5

RESULTS AND DISCUSSION

5.1.1 Testing

On the first test the machine was run without any load, and testing the components of the machine for its functionality was done. On the second test the researchers placed ten pcs of unopened Kapok dried fruit which contain its shells; silk fibers and seeds (one by one) every three seconds interval, which served as 100% base load. The Kapok silk fiber was extracted successfully but it was not a 100 percent Silk fiber; it has some seeds but only minimal as the researchers considered five seeds from the 10 pieces base load, and the remaining shells were crushed together with its seeds at the bottom exit of the machine.

Based on the result of the test conducted, the machine worked successfully as expected, but, it was ensured that the machine was in good condition and provided that the Kapok silk fiber to be extracted was completely dry, in order that the machine work efficiently.

The data given below are the testing with its corresponding result.

5.1.2 PRODUCTION RATE OF THE MACHINE

Ratio of kapok fruit:

Mass of 1 kapok (g)	Mass of shell (g)	Mass of seeds (g)	Mass of cotton (g)
29.552	22.868	1.545	4.712
26.71	20.792	1.31	4.623
35.665	25.6	2.14	7.934
31.842	23.7	1.924	6.825
27.92	21.753	1.377	4.82

*NOTE: "The kapok fruit are manually separated from each other."

SHELL : 77.38 %

SEEDS : 5.23 %

COTTON : 15.94%

Average percentage and processing time of the fibre extracted from 1 kapok fruit:

No.of testing	Quantity of kapok fruit	Mass (g)	Processing time (seconds)	Mass of cotton (based on cotton percentage) 15.94% (g)	Cotton extracted (g)	Extracting percentage
1st	1	29.548	12	4.709	3.14	66%
2nd	1	27.6	11.2	4.399	2.61	59%
3rd	1	21.73	10.3	3.464	2.23	64%
4th	1	24.7	10	3.94	2.34	59.4%
5th	1	33.62	13	5.36	3.381	63%

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Based on the tests done, regarding its functionality, the extracting machine is more efficient if the desired power is met; too much power applied will give a higher stress concentration in some parts of the machine especially in shafts, which could result to its malfunction and destruction.

6.2 RECOMMENDATIONS

The researchers would like to recommend the following:

1. A prototype of this machine that could extract larger loads of cotton should be designed;
2. The blower capacity should be increased in order to maximize the production rate of the Kapok fiber;
3. The power capacity of generator/motor should be lessened into the limit of acquired computation;
4. The crusher should be designed into a suitable application for the Kapok fiber; and
5. The speed of production can be increased by minimizing the power required.

BIBLIOGRAPHY

- [1] Renny Purnawati, Fauzi Febrianto, I Nyoman J Wistara, Siti Nikmatin, Wahyu Hidayat, Seung Hwan Lee, Nam Hun Kim, Physical and Chemical Properties of Kapok (*Ceiba pentandra*) and Balsa (*Ochroma pyramidale*) Fibers, Journal of the Korean Wood Science and Technology · August 2018
- [2] K.M. Anigo, B.M.D. Dauda, A.B. Sallau and I.E.Chindo, Chemical Composition of Kapok (*Ceibapentandra*) Seed and Physicochemical Properties of its Oil, Department of Biochemistry, Nigerian Journal of Basic and Applied Science (June, 2013), vol. 21(2), page 105-108
- [3] Nazilla Tarabi Hossein, Mousazadeh Ali Jafari, Jalil Taghizadeh-Tameh, Design, Construction, evaluation of a fiber extracting machine from Calotropis (milkweed) stems, engineering in agriculture, Environment and Food, volume 8, Issue 2, March 2015, Pages 88-94.
- [4] Pavan Kumar K P, Kushal Gowda Y N, Ravikumara M H, “Design and Fabrication of Corn De-Seeding Machine”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Issue 6, June 2018
- [5] N.A. Aviara; S.K. Shittu and M.A. Haque. Guna, “Development of a Guna Seed Extractor”, Department of Agricultural and Environmental Resources Engineering, University of Maiduguri, Maiduguri, Nigeria, Manuscript PM 07 036. Vol. X., May, 2008.

[6] Alejandro Booman, Aníbal Márquez, María Amelia Parin, Aurora Zugarramurdi, “Design and testing of a fish bone separator machine”, *Journal of Food Engineering* 100 (2010) 474–479, INTI Mar del Plata/CIC, Southern Regional Centre, Argentina, Volume 100, Issue 3, October 2010.

[7] Poonam Dhankhar, “Rice Milling”, *M.Tech (Food tech), G.J .U.S & T, Hissar*, Vol. 04, Issue 05 (May. 2014), ||V4|| PP 34-42.

[8] Olufemi Bamidele Busari, Olayide Rasaq Adetunji, Peter Olaitan Aiyedun and Sunday Benga.Aderibigbe, “DEVELOPMENT OF A LOW COST RICE MILLING MACHINE”, *Department of Mechanical Engineering, College of Engineering, Federal University of Agriculture, Abeokuta, P.M.B.2240, Abeokuta, LAUTECH Journal of Engineering and Technology Volume 10, February 2016, Page 85-91.*

[9] Abhay.A.Mulgund, “ DESIGN AND FABRICATION OF MULTICROP THRESHER TO ENHANCE THE SEED GERMINATION RATE”,
U.G Student,IV Semester, Department of Mechanical Engineering, M.S.Ramaiah Institute of Technology. Bengaluru-54, Karnataka, India, Volume: 05, Issue: 05, May-2018, International Research Journal of Engineering and Technology (IRJET)

GLOSSARY OF TECHNICAL TERMS

Auxiliary - An individual or group that assists or functions in a supporting capacity;

Bran - The outer layers of the grain of cereals such as wheat, removed during the process of milling and used as a source of dietary fiber;

Cob - A mixture of clay and straw used as a building material;

Eccentric - A disk or wheel having its axis of revolution displaced from its center so that it is capable of imparting reciprocating motion;

Extrusion - The act or process of pushing or thrusting out;

FBSM – Fish bone separating machine;

Flung- to throw, cast, or hurl with force or violence;

Helical - pertaining to or having the form of a helix; spiral;

Hopper - A usually funnel-shaped container in which materials, such as grain or coal, are stored in readiness for dispensation;

Husk - The outer membranous or green envelope of some fruits or seeds, as that of a walnut or an ear of corn;

Maize - the grain of this plant, used for food, fodder, and as a source of oil;

Millet - a cereal grass, *Setaria italica*, extensively cultivated in the East and in southern Europe for its small seed, or grain, used as food for humans and fowls, but in the U.S. grown chiefly for fodder.

Orifices - An opening, especially to a cavity or passage of the body; a mouth or vent;

Oscillating - To swing back and forth with a steady, uninterrupted rhythm;

Paddy - Rice, especially in the husk, whether gathered or still in the field;

Perforated - Having a hole or holes, especially a row of small holes;

Regression - The process or an instance of regressing, as to a less perfect or less developed state;

Retention - The practice of requiring a student to repeat a class or a year of school because of insufficient educational progress to advance;

Rotary - A part or device that rotates around an axis;

Scrappers - Discarded waste material, especially metal suitable for reprocessing;

Shaft - a rotating or oscillating rod that transmits motion and torque, as a ship's propeller shaft or the drive shaft of an automobile;

Sieves - an instrument with a meshed or perforated bottom, used for separating coarse from fine parts of loose matter, for straining liquid; and

Torque - the measured ability of a rotating element, as of a gear or shaft, to overcome turning resistance;

APPENDIX A

KAPOK FIBER EXTRACTING MACHINE

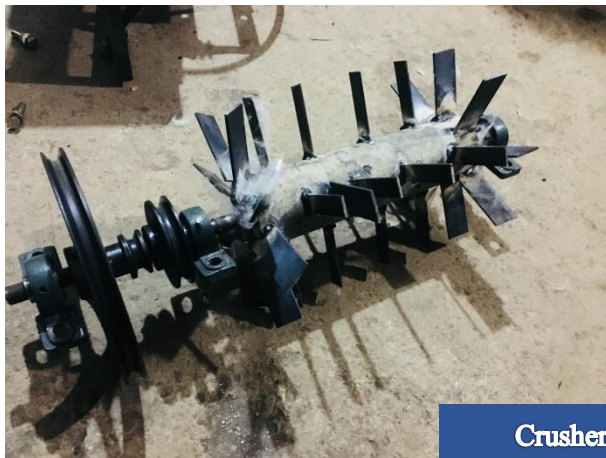


Front side



Rear side

Machine crusher cover



Cylinder crusher and pulley

Crusher



Internal wall Crusher



Machine Blower



Engine Used



Actual set-up of the machine