VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI, KARNATAKA - 590018

Project Report on

"STUDY ON CONVERTING ARECA HUSK INTO BIOMASS FUEL"

Submitted in partial fulfillment of the requirements for the award of the degree

BACHELOR OF ENGINEERING
in
MECHANICAL ENGINEERING

By

A B VIVEK NAYAK viveknayak1540@gmail.com

AKASH akashskadarsh@gmail.com

KARTHIK karthikmendon088@gmail.com

MANJUSH NAYAK nayakmanjush2001@gmail.com

Under the guidance of

Dr. VIJAY V S

vijayv@sjec.ac.in

Assistant Professor
Department of Mechanical Engineering
St Joseph Engineering College, Mangaluru

ST JOSEPH ENGINEERING COLLEGE
MANGALURU 575028
2022-2023

INTRODUCTION

1.1 Biomass fuel

Biomass refers to organic matter derived from living or recently living organisms, such as plants and animals, as well as their by-products and waste. It is a renewable and sustainable source of energy that can be used to produce electricity, heat, and transportation fuels.

Biomass can be converted into energy through various processes, including combustion, gasification, and pyrolysis. In combustion, the biomass is burned to generate heat, which can be used directly or converted into electricity. In gasification, the biomass is converted into a gas that can be used to generate electricity or produce fuels such as ethanol. In pyrolysis, the biomass is heated in the absence of oxygen to produce a liquid or gas that can be used as fuel.

Biomass is considered carbon-neutral because the carbon released during combustion is offset by the carbon absorbed by the plants during their growth. Additionally, biomass can be sourced from agricultural, forestry, and waste streams, reducing the reliance on non-renewable sources of energy.

1.2 Briquettes

Biomass briquettes are a type of renewable energy source that are produced from biomass materials such as sawdust, rice husk, peanut shell, and other agricultural waste. These materials are compressed under high pressure without using any binder or adhesive to form small, dense, and cylindrical briquettes. The process of making biomass briquettes is known as briquetting.

Biomass briquettes are a sustainable alternative to traditional fossil fuels such as coal, oil, and gas. They have several advantages, including lower greenhouse gas emissions, reduced ash content, and higher energy density. Biomass briquettes can be used for heating and cooking purposes, as well as in industrial boilers and power plants.

Biomass briquettes are also cost-effective and can be produced locally, providing employment opportunities for rural communities. They also help in reducing the amount of waste generated from agricultural and forestry activities.

Fig1.1 Types of briquettes

1.3 Areca husk

Areca husk, also known as betel nut husk, is a by-product of the betel nut industry. Betel nut is a popular stimulant consumed by millions of people in Southeast Asia, India, and other parts of the world. The betel nut is wrapped in a leaf along with other ingredients like lime and spices and then chewed. Areca husk is the outer covering of the betel nut, which is removed before the nut is consumed. In recent years, there has been increasing interest in the potential uses of areca husk. Research has shown that it contains various bioactive compounds such as alkaloids, flavonoids, and tannins, which have potential applications in medicine and industry. One of the most promising uses of areca husk is as a source of bioactive compounds for the pharmaceutical industry. Studies have shown that some of the alkaloids found in areca husk have anti-cancer, anti-inflammatory, and anti-microbial properties. These compounds could be used to develop new drugs to treat a range of diseases. In addition to its potential medicinal uses, areca husk also has applications in industry. The tannins found in areca husk have been shown to have properties that make them useful in the production of adhesives, dyes, and leather. Areca husk could also be used as a biofuel, as it contains a high level of cellulose, which can be converted into energy.

Fig. 1.2 Areca Husk

Areca nut is a popular cash crop in many parts of the world, especially in South and Southeast Asia. The outer fibrous covering of the areca nut, known as the husk, is often discarded as waste. However, the husk can be used as a source of biofuel. Areca husk has a high calorific value and can be burned to generate heat or electricity. It can also be converted into bio char, which is a type of charcoal that can be used as a soil amendment to improve soil fertility and reduce greenhouse gas emissions. In recent years, there has been growing interest in using agricultural waste products, including areca husk, as a source of renewable energy. This can help to reduce the dependence on fossil fuels and promote sustainable development.

However, it is important to note that the use of areca husk as a biofuel should be done in a sustainable manner, taking into account factors such as environmental impact, social and economic benefits, and the needs of local communities.

1.3.1 Areca nut Husk Fiber

Areca nut husk fiber is a natural fiber that is obtained from the husk of the areca nut. Areca nut is a fruit that is commonly found in South and Southeast Asia. The husk of the areca nut is usually discarded as waste after the nut is harvested. However, the husk contains a fibrous material that can be processed into a useful fiber.

Areca nut husk fiber is a versatile material that can be used in a variety of applications. It has high tensile strength and is resistant to abrasion, making it suitable for use in textiles and ropes. The fiber is also biodegradable and eco-friendly, making it a sustainable alternative to synthetic fibers.

In addition to its use in textiles and ropes, areca nut husk fiber is also used in the production of various handicrafts and home decor items. It can be woven into mats, baskets, and other decorative items. The fiber is also used in the production of paper and packaging materials.

Fig1.3 Areca husk fiber

Fig1.4 Areca husk shell and fiber

1.4 Sawdust

Sawdust is a byproduct of wood processing, created when wood is sawn or planed into lumber. It is a fine, powdery material that is produced in large quantities in sawmills and woodworking shops. Sawdust is composed mainly of cellulose, hemicellulose, and lignin, which are the major components of wood.

Sawdust has many uses and applications. It is commonly used as a fuel for heating and cooking, as it is a low-cost and readily available biomass fuel. Sawdust can also be used in the production of particleboard, a composite material that is made by binding together small wood particles with resin. In addition, sawdust can be used as a soil amendment, as it is rich in organic matter and can help to improve soil structure and fertility.

Sawdust is also a valuable raw material for the production of biofuels and other bioproducts. It can be converted into biochar, a type of charcoal that is used as a soil amendment and for carbon sequestration. Sawdust can also be processed into bio-oil, a liquid fuel that can be used as a substitute for diesel or gasoline.

Fig. 1.5 Sawdust

1.5 Binders

Binder is a substance that is used to hold together the solid particles of the fuel. Solid fuels, such as charcoal or briquettes, are made by compressing and shaping a mixture of solid particles, such as wood or coal dust. The binder is added to the mixture to help hold the particles together and provide structural integrity to the fuel.
Binders for solid fuels can be organic or inorganic. Organic binders are typically derived from plant or animal sources, such as starch, lignin, or molasses. Inorganic binders, on the other hand, are usually mineral-based, such as clay or cement.

1.5.1 Refined flour as binder (Maida)

Maida, also known as all-purpose flour, is a fine white flour that is made from wheat. It is commonly used in baking and cooking to make cakes, bread, and other baked goods. In addition to its culinary uses, Maida can also be used as a binder in various applications.

As a binder, Maida is often used in the production of briquettes and pellets made from biomass materials such as sawdust, rice husk, and other agricultural waste. When mixed with these materials, Maida helps to bind the particles together, forming a dense and solid mass that can be burned as fuel.

Maida is also used as a binder in the production of animal feed. It is mixed with other ingredients such as grains, soybean meal, and vitamins and minerals to form a pellet or mash that is fed to livestock.

Overall, maida is a versatile and useful ingredient that can be used as a binder in various applications. Its binding properties make it a valuable additive in the production of briquettes, pellets, and animal feed. However, it should be noted that the use of maida as a binder may not be suitable for all applications, and alternative binders may be needed depending on the specific requirements of the product.

Fig 1.6 Maida

1.6 Objectives of the project:

- To produce areca fibers from waste areca nut husk.
- To convert the areca fibers into biomass in the form of fuel briquettes.
- To mix saw dust with areca husk in different combination and study its fuel properties.

WORKING METHODOLOGY

2.1 Flow chart

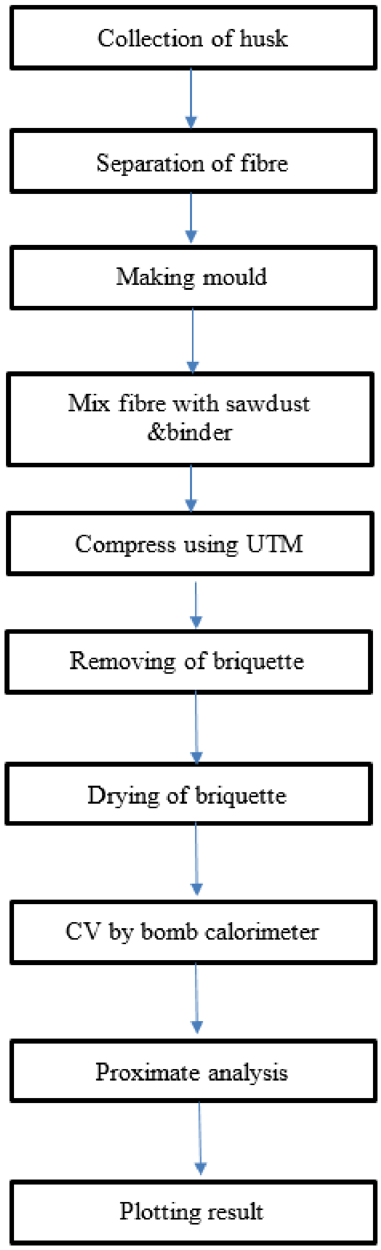

Fig 3.1 Flow Chart

The methods carried for doing the project is shown in the above flowchart and detailed process is explained below.

2.2 Collection of areca husk:

Areca husk is the outer covering of the areca nut, which is a fruit produced by the areca palm tree. Areca husks are often discarded as waste, but they can be collected and used for various purposes.

Areca husks are typically discarded after the areca nut is removed, so you may need to collect them from sources such as markets, farms, or processing plants. You can gather the husks by hand or with a rake or broom.

Areca was collected from the areca plantation. Areca was dried for 21 days under the sunlight. Once you have collected the husks, you will need to clean them to remove any dirt, debris, or remaining areca nut fragments. You can rinse them with water and then spread them out to dry in the sun or a well-ventilated area.

Fig. 3.2 Areca husk Collection

2.3 Separation of fiber from the husk

After 21 days, the areca husk was separated from the areca nut by manual method. The husk contained shell and fiber which was bounded together. Now the husk was soaked in water for about 10 days. Then the shell was separated from the fiber. Then the fiber is dried under sunlight. Fiber is then put into mixer and made into small pieces.

Fig 3.3 Separated Fibers

2.4 Making of mold for briquette preparation:

Mold is made of mild steel using the lathe machine. Mold for briquette is a tool or a device used to shape solid fuel into a specific form or size. The mold is an essential component of the briquette making process, as it determines the size and shape of the briquette.

The mold for briquette can be made of various materials, including metal, plastic, or wood, and it can be designed to produce briquettes of different shapes and sizes. Common shapes for briquettes include cylinders, rectangles, and squares.

To use a mold for briquette, the raw material is first mixed with a binder, such as clay or starch, and then fed into the mold. The mold is then pressed or compacted to compress the raw material into the desired shape and size. After the briquette is formed, it is usually left to dry and harden before being used as a fuel source. Dimension of mold is 50mm inner diameter and length is 100mm.

Fig3.4. Mold for making briquette

2.5 Universal testing machine:

A universal testing machine (UTM) is a mechanical testing apparatus that is used to test the tensile, compressive, and flexural strength of materials. It is a versatile piece of equipment that is commonly used in quality control, research and development, and academic settings.

The UTM consists of a load frame, a crosshead, a motor, a control system, and various fixtures and accessories that can be used to hold and manipulate the test specimen. The load frame houses the test specimen and applies the force required to test its strength. The crosshead is attached to the load cell, which measures the force applied to the specimen.

The UTM can be used to perform a variety of tests, including tension, compression, bending, and shear tests. It can be used to test a wide range of materials, including metals, plastics, rubber, composites, and textiles.

Fig 3.5 Universal testing machine

3.6 Preparation of briquette of different proportions:

The briquettes are made using different proportions of areca husk fiber and saw dust. These are bound using the Maida as binder.

Different proportions are as follows**:**

3.6.1 Preparation of 100% areca husk briquette:

In this briquette, 50 gram of areca husk fiber is taken in a mixing container. To the husk fiber, 10 gram of Maida is added. To the above mixture, water is added and mixed evenly. Then the mixture is put into a mold. The mold is kept under the universal testing machine for compression. The compression is made till the pressure is 16.4 KN. The briquette is then removed from the mold. Dimension of briquette is 50mm diameter and 50 mm in length.

Fig 3.6. 100% areca husk briquette

3.6.2 Preparation of 75% areca husk and 25% saw dust briquette:

In this briquette, 37.5 gram of areca husk fiber is taken in a mixing container. 12.5 grams of saw dust is added to the husk fiber. Then 10 grams of maida is added. To the above mixture, water is added and mixed evenly. Then the mixture is put into a mould. The mould is kept under the universal testing machine for compression. The compression is made till the pressure is 16.4 KN. The briquette is then removed from the mould**.** Dimension of briquette is 50mm diameter and 50 mm in length.

Fig 3.7. 75% areca husk and 25% saw dust briquette

3.6.3 Preparation of 50% areca husk and 50% saw dust briquette:

In this briquette, 25 gram of areca husk fiber is taken in a mixing container. 25 grams of saw dust is added to the husk fiber. Then 10 grams of Maida is added. To the above mixture, water is added and mixed evenly. Then the mixture is put into a mold. The mold is kept under the universal testing machine for compression. The compression is made till the pressure is 16.4 KN. The briquette is then removed from the mold. Dimension of briquette is 50mm dia and 50 mm in length.

Fig 3.8. 50% areca husk and 50% saw dust briquette

3.6.4 Preparation of 25% areca husk and 75% saw dust briquette:

In this briquette, 12.5 gram of areca husk fiber is taken in a mixing container. 37.5 grams of saw dust is added to the husk fiber. Then 10 grams of Maida is added. To the above mixture, water is added and mixed evenly. Then the mixture is put into a mold. The mold is kept under the universal testing machine for compression. The compression is made till the pressure is 16.4 KN. The briquette is then removed from the mold. Dimension of briquette is 50mm diameter and 50 mm in length.

Fig 3.9 25% areca husk and 75% saw dust briquette

3.7 Testing of briquettes

3.7.1 Calculation of calorific value using bomb calorimeter

A bomb calorimeter is a device used to measure the heat of combustion or calorific value of a substance. It is also known as an oxygen bomb calorimeter, since it involves burning a sample of the substance in a closed vessel or bomb filled with pure oxygen at high pressure. The heat produced by the combustion reaction is then measured using the calorimeter.

Fig 3.10 Bomb Calorimeter

Steps involved in Calorific value test using bomb calorimeter:

1. Sample Preparation: A small sample of the substance whose calorific value is to be determined is taken and it is weighed accurately (1 g).
2. Assembling the Bomb Calorimeter: The bomb calorimeter is assembled by filling the bomb with oxygen at high pressure and filling it with 1580 ml of water and placing the sample inside the bomb. The bomb is then sealed tightly to ensure that no heat escapes during the reaction.
3. Ignition of Sample: The sample is ignited using a spark generated by a wire or filament. This causes the substance to burn rapidly, releasing heat energy.
4. Measurement of Temperature: The heat energy released by the substance causes the temperature of the water in the calorimeter to rise. The change in temperature of the water is measured accurately using a thermometer.
5. Calculation of Calorific Value: The calorific value of the substance is then calculated using the formula.

Fig 3.11. Bomb

3.7.2 Proximate analysis using muffle furnace.

A muffle furnace is a type of furnace used in laboratories and industrial settings for high-temperature applications such as annealing, ashing, calcining, and sintering. It is named for the refractory material or muffle, which separates the material being heated from the fuel or heating element.

The muffle is typically made of a high-temperature material such as ceramic or metal, which can withstand temperatures up to 1800°C or more. The heating element, which may be electric or gas-fired, is located outside the muffle and heats the air or gas inside the furnace chamber. This hot air or gas then flows into the muffle and heats the sample inside it.

Fig 3.12 Muffle Furnace

RESULTS & DISCUSSION

3.1 Tabulation of result

Table 5.1 Tabulation of result

Sl. No.	Areca husk % in briquette	Calorific value in J/g	Moisture Content in %	Ash Content in %	Volatile Matter in %	Fixed Carbon in %
1.	100%	34215	4	8	85	3
2.	75%	33946	5	5	87	3
3.	50%	32957	6	4	88	2
4.	25%	24317	7	2	90	1

3.2 Performance curve of Calorific value

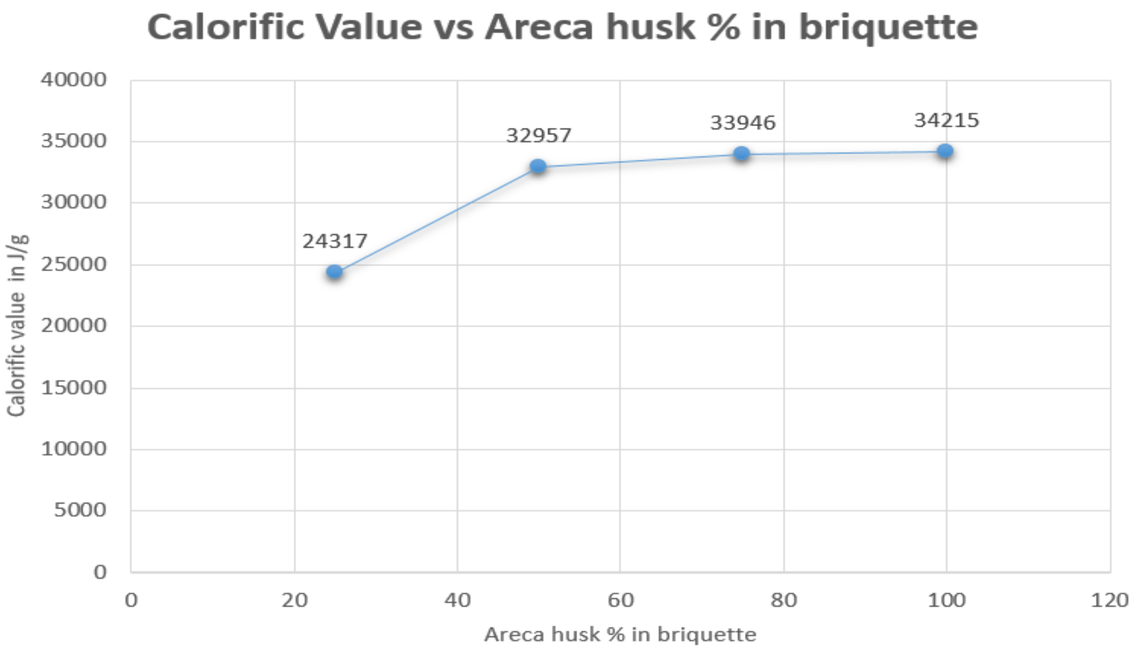

Fig 5.1 Calorific value vs areca husk % in briquette

In the above graph, areca husk percentage is taken in the x –axis and calorific value is taken in the y-axis. Each calorific value is plotted against the percentage of areca husk in briquette.

It is observed that with the increase in areca husk percentage in the briquette, the calorific value increases.

By this we can conclude that higher the percentage of areca husk in the briquette, higher is the calorific value.

3.3 Performance curve of moisture content

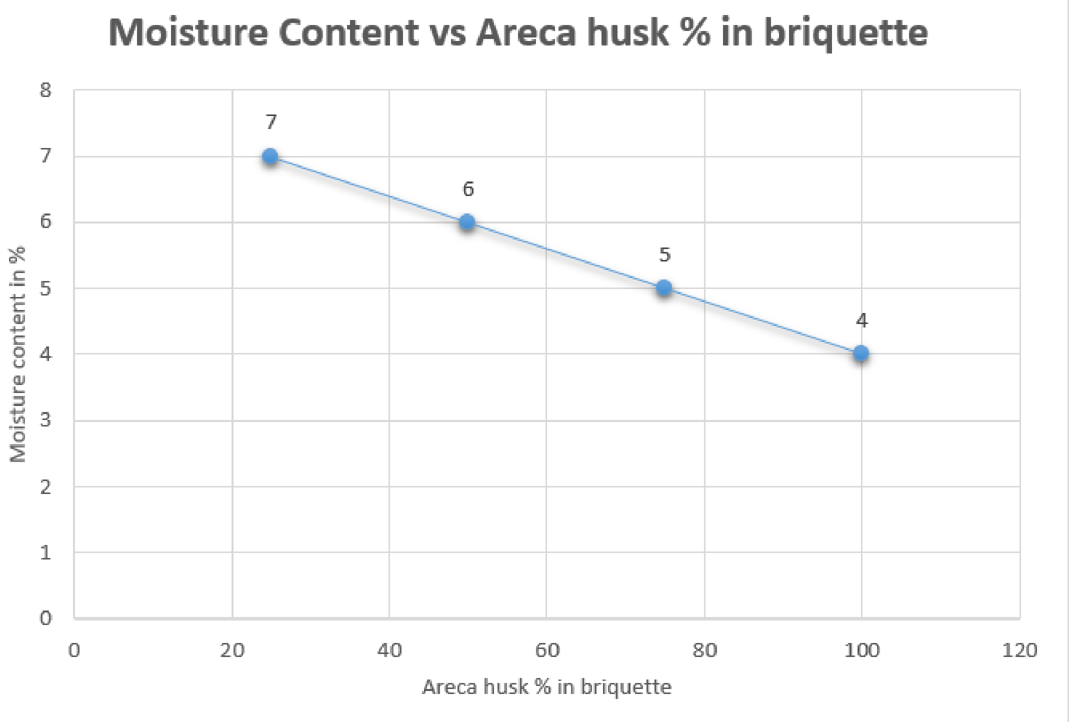

Fig 5.2 Moisture content vs Areca husk % in briquette

In the above graph, areca husk percentage is taken in the x –axis and moisture content is taken in the y-axis. Each moisture content value is plotted against the percentage of areca husk in briquette.

It is observed that with the increase in areca husk percentage in the briquette, the moisture content value decreases.

By this we can conclude that higher the percentage of areca husk in the briquette, lower is the moisture content.

3.4 Performance curve of ash content

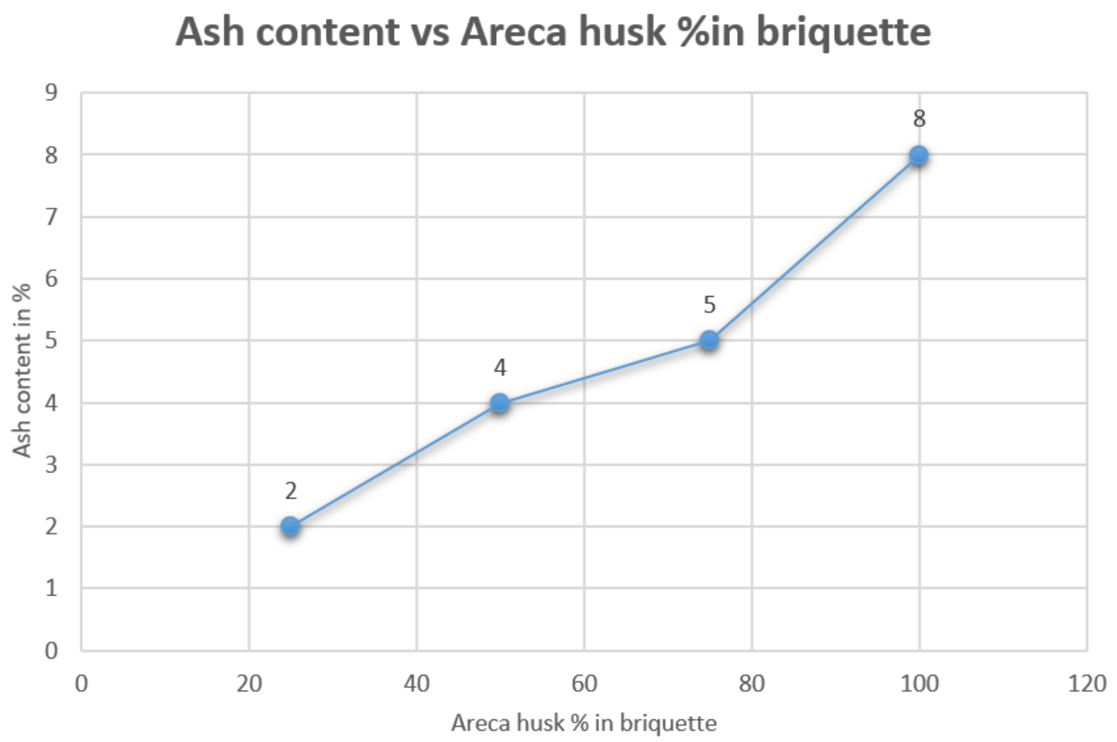

Fig 5.3 Ash content vs Areca husk % in briquette

In the above graph, areca husk percentage is taken in the x –axis and ash content is taken in the y-axis. Each ash content is plotted against the percentage of areca husk in briquette.

It is observed that with the increase in areca husk percentage in the briquette, the ash content increases.

By this we can conclude that higher the percentage of areca husk in the briquette, higher is the ash content.

3.5 Performance curve of volatile matter

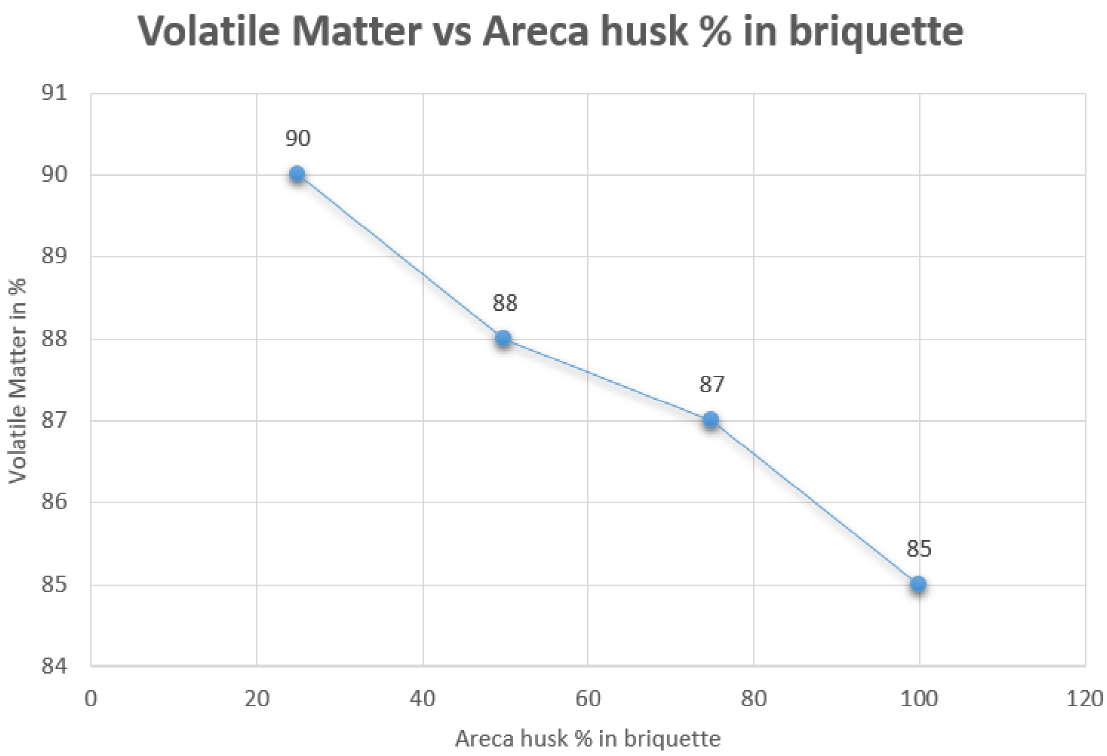

Fig 5.4 Volatile Matter vs Areca husk % in briquette

In the above graph, areca husk percentage is taken in the x –axis and volatile matter is taken in the y-axis. Each volatile matter value is plotted against the percentage of areca husk in briquette.

It is observed that with the increase in areca husk percentage in the briquette, the volatile matter value decreases.

By this we can conclude that higher the percentage of areca husk in the briquette, lower is the volatile matter.

3.6 Performance curve of fixed carbon

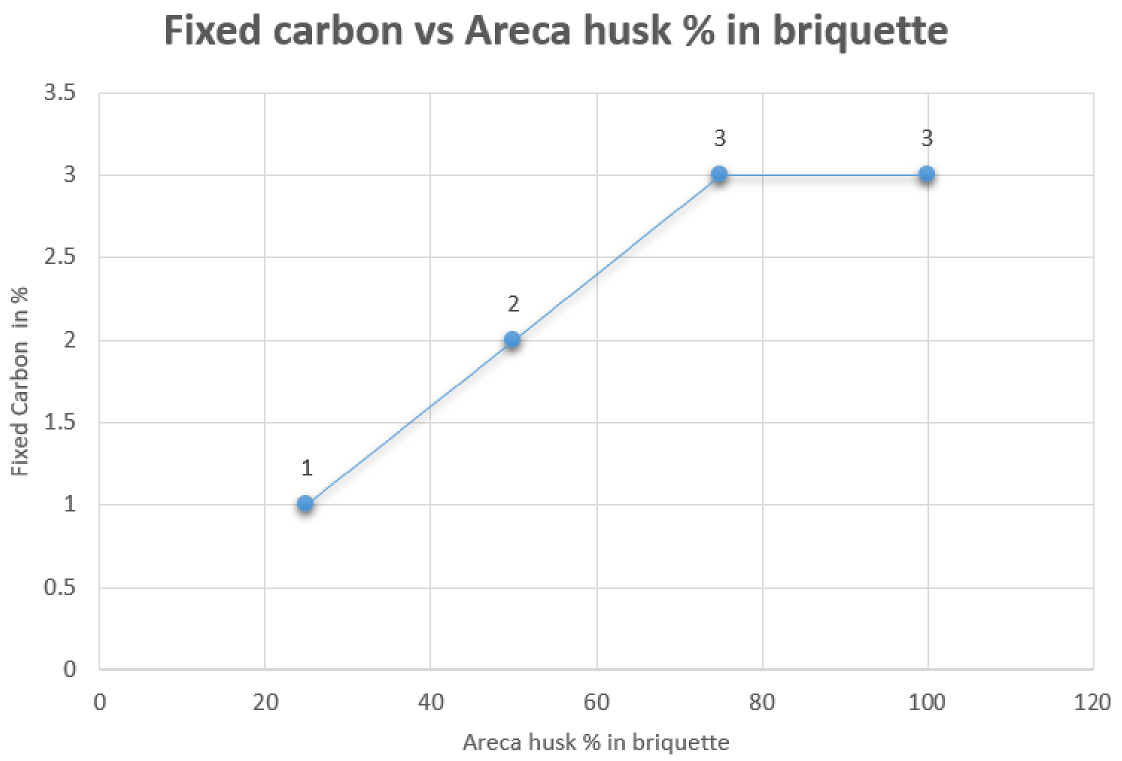

Fig 5.5 Fixed carbon vs Areca husk % in briquette

In the above graph, areca husk percentage is taken in the x –axis and fixed carbon is taken in the y-axis. Each fixed carbon value is plotted against the percentage of areca husk in briquette. It is observed that with the increase in areca husk percentage in the briquette, the fixed carbon increases.

By this we can conclude that higher the percentage of areca husk in the briquette, higher is the fixed carbon.

5.9 Comparison of 100% areca husk with the 100% saw dust briquettes

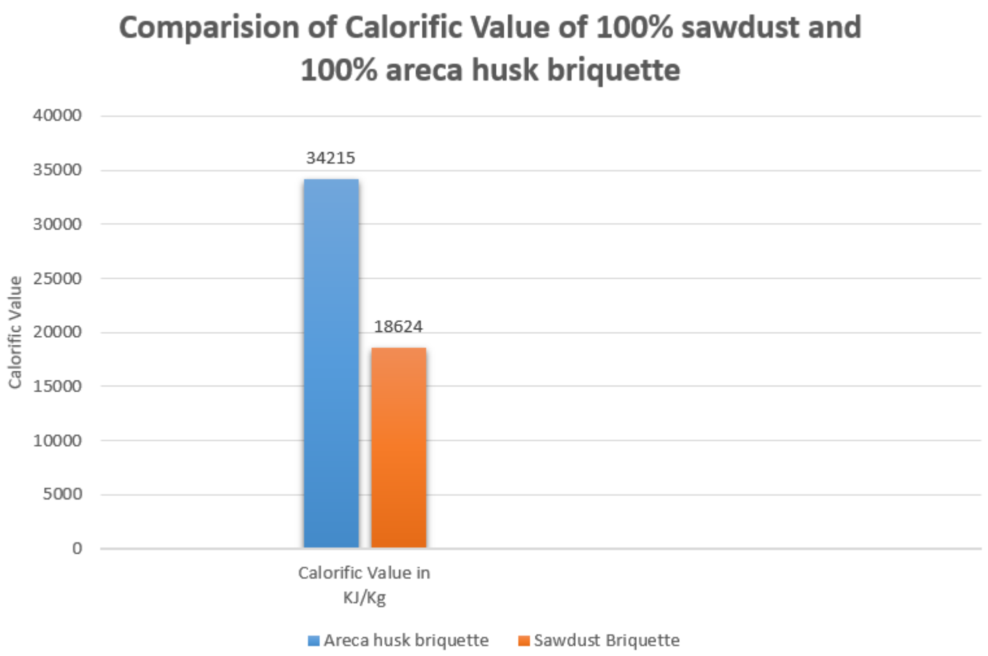

Fig 5.6 Comparison of Calorific value of 100% areca husk and 100% saw dust briquettes

From the above graphs it is observed that the calorific value of the 100% areca husk is more compared to 100% sawdust briquettes

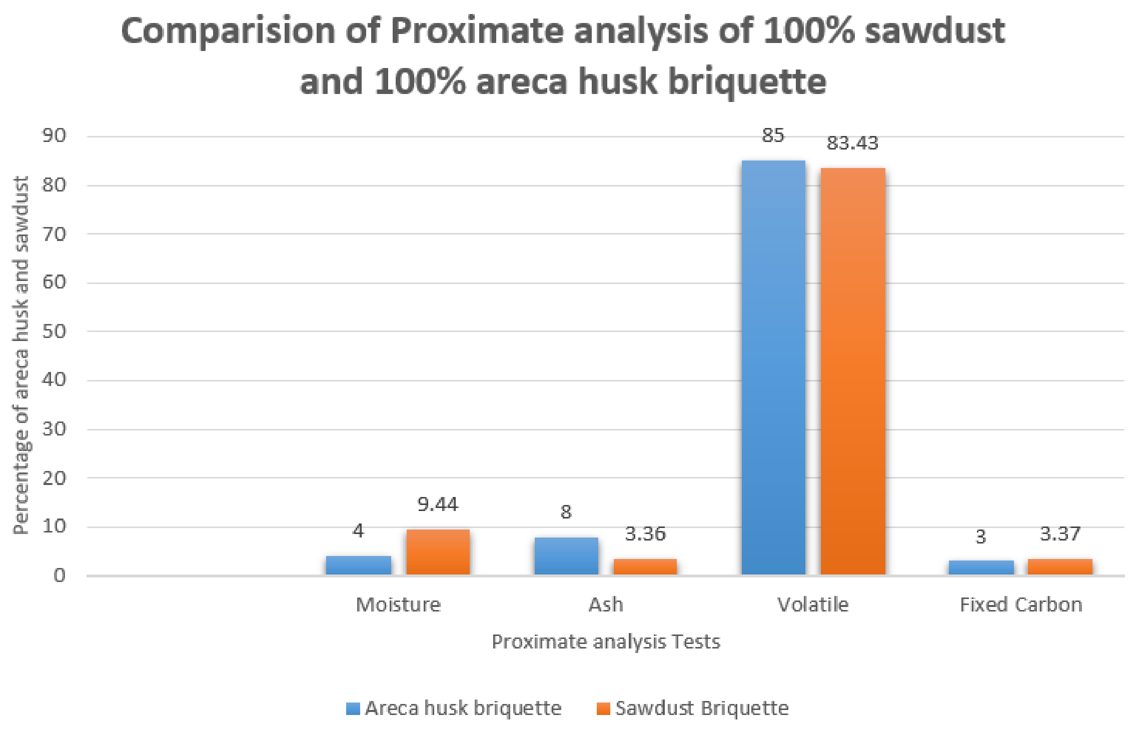

Fig 5.7 Comparison of Proximate analysis of 100% areca husk and 100% saw dust briquettes

In the above graph proximate analysis of 100% areca husk and 100% sawdust briquettes are compared. Here it is observed that the moisture content and fixed carbon content of 100% sawdust briquette is more, Ash content and volatile matter is more for 100% areca husk briquettes.

CONCLUSION AND FUTURE SCOPE

From the project we obtained the calorific value, proximate analysis for the 100%, 75%, 50%, 25% areca husk briquettes. We have observed that calorific value of 100% areca husk briquette which is around 34000 J/g is better than other three combination of briquettes.

According to the values we have obtained from proximate analysis, it is observed that for 100% areca husk briquette ash content was found to be 8%, moisture content was 4%, volatile matter was 85% and fixed carbon was 3%. By analyzing all these values we can conclude that 100% areca husk briquette was better than other three proportions of briquettes.

As the 100% areca husk briquette was the best which we prepared, we have compared it with the 100% sawdust briquette which is currently being used in the process industries (CAMPCO chocolate factory ltd.). It was found that calorific value of sawdust briquette was in the range of 16000-18000 J/g, which was less than the briquette which we have prepared. By this we can conclude that the briquette which we have prepared from 100% areca husk have better advantage over the sawdust briquette.

The present work provides a wider scope for future investigators to explore many other aspects of making the fuel briquette. Some recommendations for future research include:

- Ultimate analysis of the areca husk briquettes to know about the Carbon, Nitrogen, and Sulphur Content in the briquettes.
- Design and Develop the machine for making the areca husk briquette.