Introduction

1.1 General description

Coconut oil is an edible oil extracted from the kernel or meat of matured coconuts harvested from the coconut palm (*Cocos nucifera*). [1] Throughout the tropical world, it has provided the primary source of fat in the diets of millions of people for generations. It has various applications in food, medicine, and industry. Coconut oil is very heat-stable, which makes it suited to methods of cooking at high temperatures like frying. Because of its stability, it is slow to oxidize and, thus, resistant to rancidity, lasting up to two years owing to the high saturated fat content.[2]

Coconut oil is commonly used in cooking, especially for frying and is a common flavor in many South Asian countries. In recent years, virgin coconut oil has increasingly become popular in natural food circles and with vegans. Coconut oil has been tested for use as a feedstock for biodiesel to be used as a diesel engine fuel. In this manner, it can be applied to power generators and transport using diesel engines. Coconut oil is sold in cylindrical containers rather than bottles due to its inability to be poured. [3]

Coconut oil can be extracted through "dry" or "wet" processing. Dry processing requires the meat to be extracted from the shell and dried using fire, sunlight, or kilns to create copra. The copra is pressed or dissolved with solvents, producing the coconut oil and a high-protein, high-fiber mash. The mash is of poor quality for human consumption and is instead fed to ruminants; there is no process to extract protein from the mash. The preparation and storage of copra often occurs in unhygienic conditions, yielding poor quality oil that requires refining. [4] A portion of the oil extracted from copra is lost to spoilage, to insects or rodents, and to the process of extraction. The all-wet process uses raw coconut rather than dried copra, and the protein in the coconut creates an emulsion of oil and water. The more problematic step is breaking up the emulsion to recover the oil. This used to be done by prolonged boiling, but this produces discolored oil and is not economical. [5]

1.2 Background of the study

At present coconut oil is very popular in various uses. But in the world some renowned group of company produce this oil for some limited purpose. There also some local oil extraction industry in our area, but there production process and the quality of oil is not very good. The environment of these coconut oil industries is not good. If the coconut meat dries by the help of heating appliance, it may be reducing it nutrition value. In southern part of Bangladesh huge amount of coconut is produced and is used to make different types of cakes. [6] Those people use this coconut to make different types of cake and take the coconut water for their refreshment. But huge amount of coconut meats are thrown out as waste. For this reason an initiative was taken to invent an economical coconut oil extracting machine which can be operated very easily.

1.3 Objective

The main objectives of this project are to design, manufacture, oil extraction of the machine and cost analysis of the product. Additionally expected to use laboratory facilities to analyze the nutrition value and to make bio-fuel by using produced oil.

1.4 Outline of the thesis

Chapter one- Introduction of coconut oil, its extraction process, application of the oil.

Chapter two- Literature review of the coconut oil and its extraction process.

Chapter three- Clarifies the design procedure and construction of the extraction process.

Chapter four- Application of the coconut oil.

Chapter five- Advantages and disadvantages of the coconut oil.

Chapter six- Advantages and limitations of the extracting machine.

Chapter seven- User manual.

Chapter eight- Conclusion and recommendation for further work.

Literature Review

2.1 History

For about 4000 years of the documented historical use of the fruits of the coconut palm as a food and a pharmaceutical, the news has all been good. It was seen as a sustainable resource from which the harvested materials influenced every aspect of the lives of tropical communities, but most importantly its fruit, the coconut flesh, water, milk and oil. [7]

The use of coconut oil around the world in tropical regions is prolific: South and Central America, Africa and Asia. Early European explorers, including Captain Cook, wrote affectionately about the beauty of communities across the Pacific using coconut oil as an integral part of their daily lives. In England, after the war, coconut oil was sold as "margarine" and in the USA as "coconut butter".

All this changed in 1954 even though it has been known for nearly a century that coconut oil is more nutritious than other oils. Over many decades, coconut oil received bad publicity due to its saturated fat content but what the proponents of "saturated fat is bad for you" did not do was to differentiate between the three different types of saturated fat. All the saturated fats were simply generalized under one category, ignoring the fact that some saturated fat is in fact necessary for human health. [8]

Modern research has shown that not all saturated fats are alike and coconut oil is unique in its structural make-up due to its medium chain fatty acids - the closest to those found in human breast milk that nature provides. They are the reason why coconut oil is used extensively in baby formula and also in sports drinks and energy bars, where it is usually described as MCT (medium chain try glycosides). [9] This disguises the fact that some form of coconut oil has been used. The medium chain fatty acids in coconut oil are more easily digested than fats found in other oils. This is because they are processed directly in the liver and immediately converted into energy. There is therefore less strain on the liver, pancreas and digestive system and, being easily digested, they also tend to improve the absorption of other nutrients.

2.2 Production Rate of Coconut

Ramu is famous for the large coconut garden in Bangladesh, which is located at the 3-4 Km far away from Ramu Sub-district. It is also the largest Coconut Seed Garden in Bangladesh. When the garden was made, only 34 coconut trees were in the garden. But now it put up with about one million Coconut tree. The coconut garden of Ramu made upon two hundred acres land. It is an asset of Bangladesh Government and maintained by Food Crops Wing of Department of Agricultural Extension under Agriculture Ministry. [10]

S. No.	Country	Production (1000 MT)
1	Philippines	1,690.00
2	Indonesia	968.00
3	India	447.00
4	Viet Nam	153.00
5	Mexico	143.00
6	Papua New Guinea	63.00
7	Thailand	46.00
8	Sri Lanka	38.00
9	Malaysia	32.00
10	Cote C'ivoire	28.00
11	Bangladesh	01.00

Table 2.1: Production of coconut

2.3 Application of Coconut Oil

The application of coconut oil is enormous. There is numerous use of coconut oil in different sections.

2.4 Health Benefits

Coconut oil is vastly used for health benefits. It include hair care, skin care, stress relief, maintaining cholesterol levels, weight loss, increased immunity, proper digestion and metabolism, relief from kidney problems, heart diseases, high blood pressure, diabetes, HIV and cancer, dental care, and bone strength. These benefits of oil can be attributed to the presence of lauric acid, capric acid and caprylic acid, and its properties such as antimicrobial, antioxidant, antifungal, antibacterial and soothing properties. [11]

In the last decade coconut oil was considered harmful for the human body due to its high saturated fat content. This consideration was proved wrong when the composition of coconut oil was researched thoroughly. Before moving on to the benefits of coconut oil in detail, it is important to understand its composition.

- **Composition of coconut oil:**

Coconut oil consists of more than ninety percent of saturated fats with traces of few unsaturated fatty acids, such as monounsaturated fatty acids and polyunsaturated fatty acids. Virgin coconut oil is no different from this.

- ✓ Saturated fatty acids: Most of them are medium chain triglycerides, which are supposed to assimilate well. Lauric acid is the chief contributor, with more than forty percent of the share, followed by capric acid, caprylic acid, myristic acid and palmitic.
- ✓ Polyunsaturated fatty acids: Linoleic acid.
- ✓ Monounsaturated fatty acids: Oleic acid.
- ✓ Poly-phenols: Coconut contains gallic acid, which is phenolic acid. These poly-phenols are supposed to be responsible for the fragrance and the taste of coconut oil and Virgin Coconut Oil is rich in these poly-phenols.
- ✓ Certain derivatives of fatty acid like betaines, ethanolamide, ethoxylates, fatty esters, fatty polysorbates, monoglycerides and polyol esters.

- ✓ Fatty chlorides, fatty alcohol sulphate and fatty alcohol ether sulphate, all of which are derivatives of fatty alcohols.
- ✓ Vitamin-E and Vitamin K and minerals such as Iron.

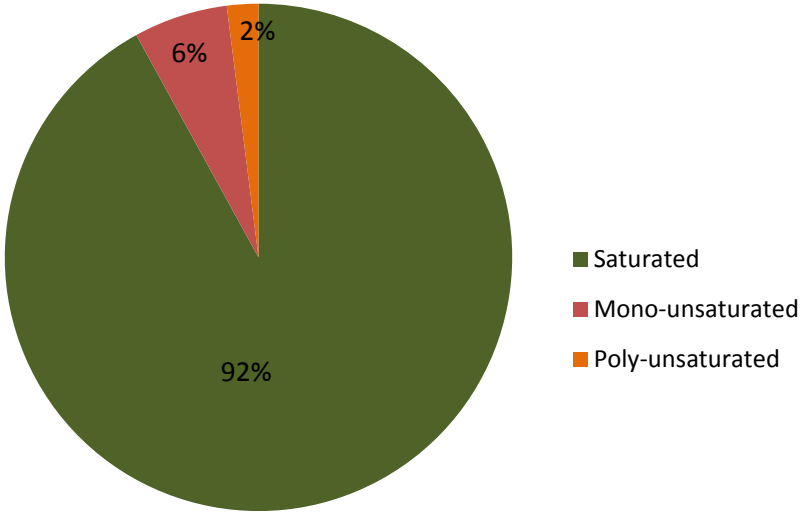


Chart 2.1: Fatty acid composition of coconut oil

The human body converts lauric acid into monolaurin which is claimed to help in dealing with viruses and bacteria causing diseases such as herpes, influenza, cytomegalovirus, and even HIV. It helps in fighting harmful bacteria such as listeria monocytogenes and helicobacter pylori, and harmful protozoa such as Guardia labia. Followings are the detailed discussion of health benefits of coconut oil. [12]

2.4.1 Hair Care

Coconut oil is one of the best natural nutrition for hair. It helps in healthy growth of hair providing them a shiny complexion. It is effective in reducing the protein loss for damaged and undamaged hair. Regular head massage with coconut oil ensures that scalp is free of dandruff, even if the scalp is dry. It is therefore used as hair care oil and used in manufacturing various conditioners, and dandruff relief creams.

2.4.2 Skin Care

Coconut oil is excellent massage oil for the skin as well. It acts as an effective moisturizer on all types of skins including dry skin. The benefit of coconut oil on the skin is comparable to that of mineral oil. Further, unlike mineral oil, there is no chance of having any adverse side effects on the skin with the application of coconut oil. Coconut oil therefore is a safe solution for preventing dryness and flaking of skin. It also delays wrinkles, and sagging of skin which normally become prominent with age. Coconut oil also helps in treating various skin problems including psoriasis, dermatitis, eczema and other skin infections. Therefore coconut oil forms the basic ingredient of various body care products such as soaps, lotions, creams, etc., used for skin care. Coconut oil also helps in preventing premature aging and degenerative diseases due to its antioxidant properties.

2.4.3 Heart Disease

There is a misconception spread among many people that coconut oil is not good for the heart. This is because it contains a large quantity of saturated fats. However, coconut oil is beneficial for the heart. It contains about 50% lauric acid, which helps in preventing various heart problems including high cholesterol levels and high blood pressure. The saturated fats present in coconut oil are not harmful as it happens in case of other vegetables oils. It does not lead to increase in LDL (Low-Density Lipoprotein) levels. It also reduces the incidence of injury in arteries and therefore helps in preventing atherosclerosis.

2.4.4 Weight Loss

Coconut oil is very useful in reducing weight. It contains short and medium-chain fatty acids that help in taking off excessive weight. It is also easy to digest and it helps in healthy functioning of the thyroid and enzymes systems. Further, it increases the body metabolism by removing stress on pancreases, thereby burning out more energy and helping obese and overweight people reduce their weight. Hence, people living in tropical coastal areas, who eat coconut oil daily as their primary cooking oil, are normally not fat, or overweight.

2.4.5 Digestion

Internal use of coconut oil occurs primarily as cooking oil. Coconut oil helps in improving the digestive system and thus prevents various stomach and digestion related problems including irritable bowel syndrome. The saturated fats present in coconut oil have anti-microbial properties and help in dealing with various bacteria, fungi, parasites, etc., that cause indigestion. Coconut oil also helps in absorption of other nutrients such as vitamins, minerals and amino acids.

2.4.6 Immunity

Coconut oil is also good for the immune system. It strengthens the immune system as it contains anti-microbial lipids, lauric acid, capric acid and caprylic acid which have anti-fungal, anti-bacterial and anti-viral properties. The human body converts lauric acid into monolaurin which is claimed to help in dealing with viruses and bacteria causing diseases such as herpes, influenza, cytomegalovirus, and even HIV. It helps in fighting harmful bacteria such as listeria monocytogenes and helicobacter pylori, and harmful protozoa such as Guardia labia.

2.4.7 Healing & Infection

When applied on infections, it forms a chemical layer which protects the infected body part from external dust, air, fungi, bacteria and virus. Coconut oil is most effective on bruises as it speeds up the healing process by repairing damaged tissues.

Coconut oil is very effective against a variety of infections due to its antifungal, antiviral, and antibacterial properties. According to the Coconut Research Center, coconut oil kills viruses that cause influenza, measles, hepatitis, herpes, SARS, etc. It also kills bacteria that cause ulcers, throat infections, urinary tract infections, pneumonia, and gonorrhea, etc. Coconut oil is also effective on fungi and yeast that cause candidiasis, ringworm, athlete's foot, thrush, diaper rash, etc. [13]

2.4.8 Others

Coconut oil is strongly recommended for other benefits which are given below. Usage of coconut oil mildly helps for the following:

- Liver: The presence of medium chain triglycerides and fatty acids helps in preventing liver diseases as the substances are easily converted into energy when they reach the liver, thus reducing work load on the liver and also preventing accumulation of fat.
- Kidney: Coconut oil helps in preventing kidney and gall bladder diseases. It also helps in dissolving kidney stones.
- Pancreatitis: Coconut oil is also believed to be useful in treating pancreatitis.
- Stress Relief: Coconut oil is very soothing and hence it helps in removing stress. Applying coconut oil to the head followed with a gentle massage helps in removing mental fatigue.
- Diabetes: Coconut oil helps in controlling blood sugar, and improves the secretion of insulin. It also helps in effective utilization of blood glucose, thereby preventing and treating diabetes.
- Bones: Coconut oil improves the ability of our body to absorb important minerals. These include calcium and magnesium which are necessary for development of bones. Thus coconut oil is very useful to women who are prone to osteoporosis after middle age.
- Dental Care: Calcium is an important element present in teeth. Since coconut oil facilitates absorption of calcium by the body, it helps in getting strong teeth. Coconut oil also stops tooth decay.
- HIV and Cancer: It is believed that coconut oil plays an instrumental role in reducing viral susceptibility of HIV and cancer patients. Preliminary research has shown indications of the effect of coconut oil on reducing the viral load of HIV patients.

2.5 Lubricant

Coconut oil has been tested for use as an engine lubricant; the producer claims the oil reduces fuel consumption, smoke emissions and allows the engine to run at a cooler temperature. As an engine lubricant, coconut oil performs better than mineral based engine oil in terms of lubricity, smoke point, flash point and resistance to oxidation. It also dissolves carbon deposits left in the engine by mineral based engine oils. The dissolved carbon burns easily during the combustion process. It is not the fuel that leaves the majority of carbon deposits, but mineral based lubricants. It is found that engines treated with coconut oil as an oil additive produce no more or less smoke than without coconut oil. Engine maintenance costs are reduced when compared to the use of mineral based engine lubricants. Coconut oil is also cheaper, lasting more than a year of use in a vehicle driven daily.

2.6 Coconut Oil as Fuel in Simple Diesel Engines

Coconut oil can be used directly as fuel in simple diesel engines of the pre combustion type. This is the kind normally used in irrigation pumps and grinding mills. When the oil is made from copra it becomes too expensive, but if you are in the right area, you can make the oil directly from the coconut.

The coconut meat is scraped out from the fresh nut and dried in a solar drier to about 10% humidity. While still warm it is pressed in a manual ram press of the kind used for sunflower or sesame. The leftover can be used as animal feed.

When filtered through a car oil filter or a sand filter it can be used as fuel 1 liter of oil comparing to 1 liter of diesel. This is only possible in hot tropical countries.

2.7 Coconut Oil as Biofuel

The research for the use of coconut oil for the production of alternative renewable and environmental friendly biodiesel fuel as an alternative to conventional diesel fuel has been done successfully. Test quantities of coconut oil biodiesel were produced through trans esterification reaction using 100g coconut oil, 20.0% ethanol (wt. % coconut oil), 0.8%potassium hydroxide catalyst at 65°C reaction temperature and 120 min reaction time.

Method of producing bio-fuel

The following figure gives an overview of the options to use coconut oil in Compression (Diesel) engines. Coconut oil can be blended with diesel, straight in an adapted engine or turned into biodiesel. Because of higher specific density and slightly lower energy content, specific fuel consumption using coconut oil is generally higher.

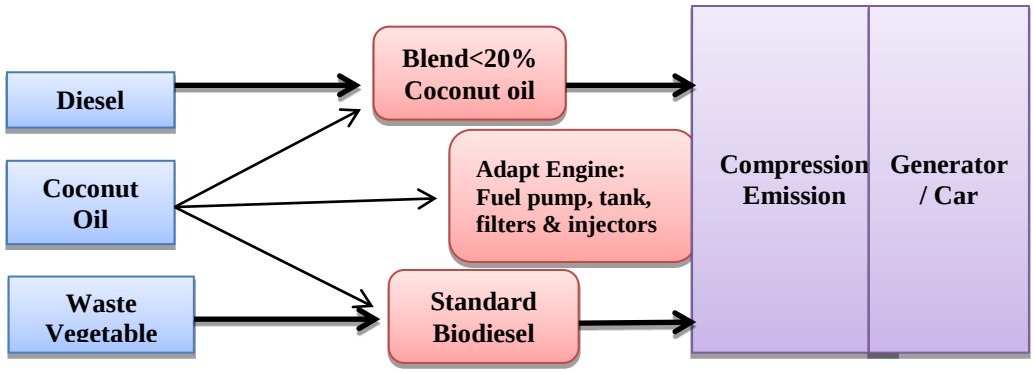


Chart 2.2: Overview of bio-fuel choices for compression (diesel) engine

Coconut oil is triglycerides, inherently containing glycerin. The biodiesel process (trans esterification) turns the oils into esters, separating out the glycerin from the main product (biodiesel). The glycerin sinks to the bottom and the biodiesel floats on top and can be decanted off. The process is called trans-esterification, which substitutes alcohol for the glycerin in a chemical reaction, using a catalyst. Trans-esterification chemistry for ethyl ester (biodiesel) production is

$$\begin{array}{lcl} CH_2COOR_1 & & CH_3CH_2COOR_1 \quad CH_2OH \\ CHCOOR_2 + 3CH_3CH_2OH & \xrightarrow{KOH} & CH_3CH_2COOR_2 + CHOH \\ CH_2COOR_3 & & CH_3CH_2COOR_3 \quad CH_2OH \end{array}$$

Oil (Triglycerides) — Alcohol (Ethanol) — Biodiesel — Glycerin

In the Laboratory scale production of coconut oil biodiesel, the following materials were used; 1 liter of coconut oil, 200 ml of ethanol 99+% pure, potassium hydroxide (KOH), blender, scales accurate to 0.1 grams, measuring beakers for ethanol and oil, translucent plastic container with bung and screw-on cap, funnels, bottle for settling and washing, duct tape and thermometer. The major feedstock source used in this work is coconut oil. [14]

By the stoichiometric equation of the process, 1 mole of coconut oil is required to react with 3 moles of ethanol to produce 3 moles of the biodiesel and 1 mole of glycerol. 100g coconut oil was used for the Trans esterification process. Reaction temperature for the process must be below the boiling point of alcohol (ethanol, 78°C) used; therefore, a reaction temperature of 65°C was selected. Different researchers have reported different reaction times for Trans esterification process as well as the entire biodiesel production process. The reported reaction time ranges from less than 30 minutes to more than 120 minutes. Reaction time of 120 minutes was therefore selected. [15]

The mixture was poured from the blender into a bottle for settling and the lid was screwed on tightly. The reaction mixture was allowed to stand overnight to allow phase separation occurred by gravity settling. The Coconut biodiesel at the top was later carefully decanted leaving the glycerol at the base.

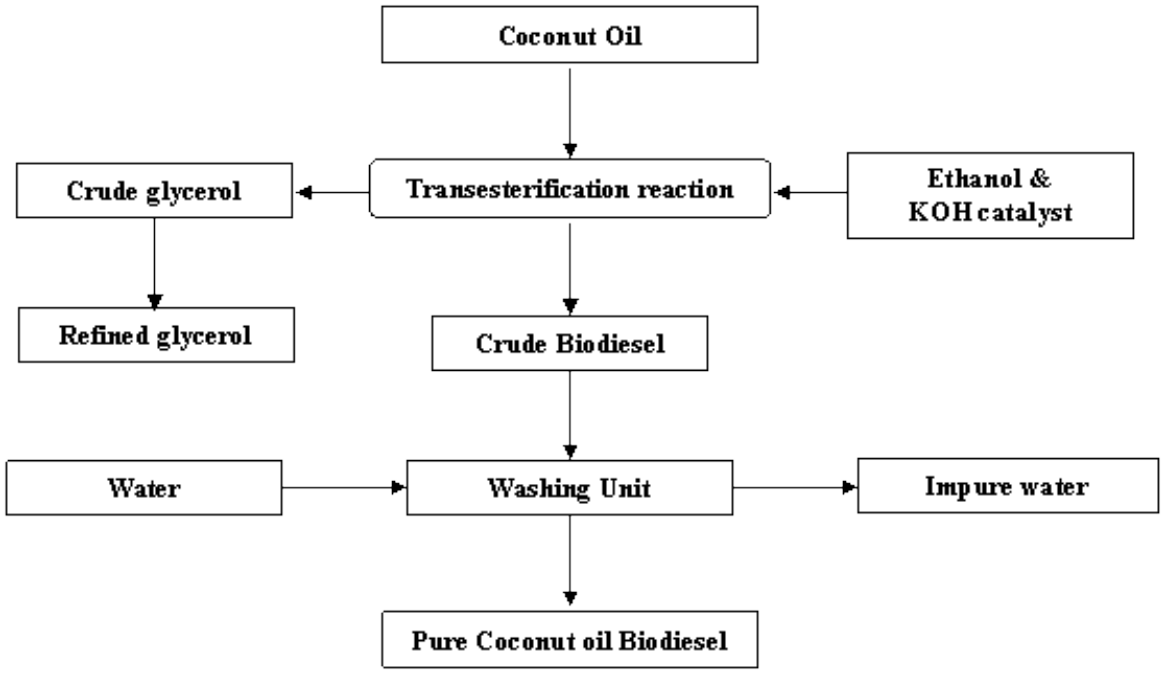


Chart 2.3: Process flow chart of biodiesel production from coconut oil

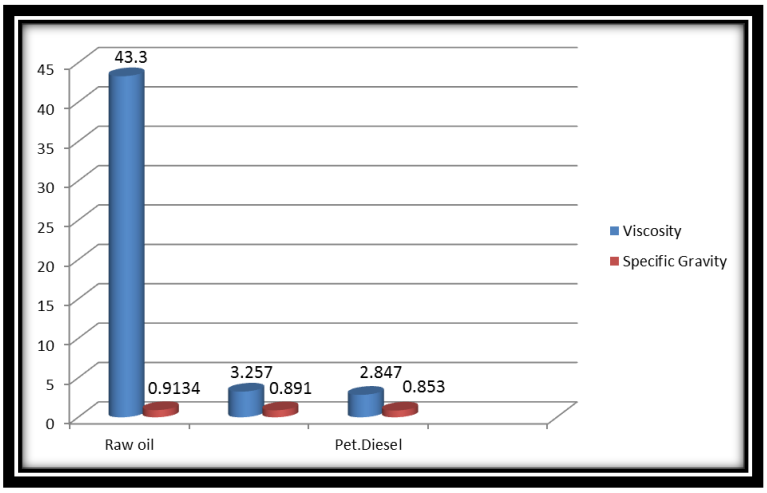


Chart 2.4: Physical characteristics of coconut oil and other fuel

2.8 Comparison of Coconut oil with Diesel Fuel

Characteristics	Diesel fuel	Coconut oil
Viscosity ($40Cmm^2s^{-1}$)	2	24-38
Cetane No	40-60	24-28
Cloud point ^0C	-9	25
Calories MJ	38	35
Flash point ^0C	60-70	177
Ash %	0.02%	0.05-0.15%

Table 2.2: Characteristics comparison of Diesel fuel and Coconut oil

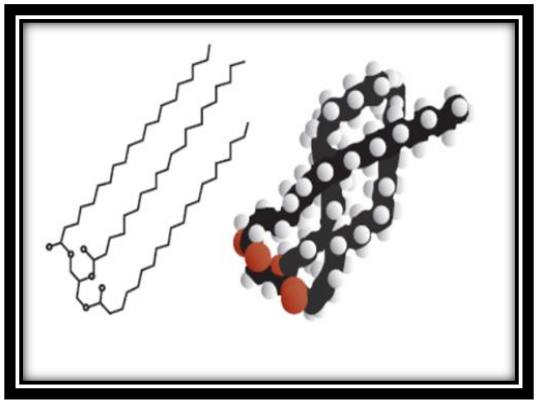


Figure 2.1: Coconut oil molecule

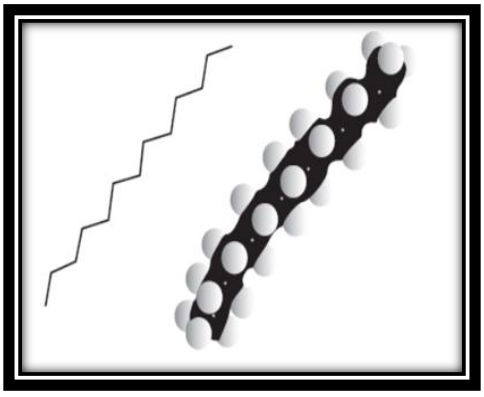


Figure 2.2: Diesel oil molecule [16]

- Coconut oil makes an excellent diesel substitute with some criteria
    - ✓ It solidifies at approximately 25°C.
    - ✓ It runs best on stationary plant with constant fixed load of around 75% capacity.
    - ✓ It runs best with indirect injection systems.
    - ✓ It operates better at approximately 70°C as the viscosity is lower.
    - ✓ Clean the injector every 150 hours for the first year to determine the level of carbonizing and set up a suitable future regime.
    - ✓ A duel tank system works well starting and running the first 15min on petroleum diesel then switching over to coconut oil and end the day's work in the reverse manner shutting down for the last 15mins on petroleum diesel.
    - ✓ Preheat the CNO fuel using a heat exchanger running off the cooling system.
    - ✓ It is not successful with Lucas/CAV rotary injector pumps and the more modern engines but older style engines coming out of China and India are much more suited as is gravity feed fuel tanks.
- Coconut oil has less emissions and toxic fumes than petroleum diesel fuel.
- Coconut oil runs smoother and reduces engine knock. [17]
- Coconut oil is available to the producer in remote areas to run machinery and generate electricity when the roads are cut off in the wet or prices are too high.
- Coconut Oil is a sustainable resource.

2.9 Advantages of Coconut Oil

There are many advantages of coconut oil. They are:

2.9.1 Advantages on Skin

- Prevents premature aging
- Dry skin, psoriasis, and dermatitis
- Amazing deep moisturizing properties due to similarity of molecular structure to the skins own bio-support network.
- Rapidly hydrate, condition and shield your skin to prevent moisture loss.
- High in anti-aging and healing vitamins A, C and E - in the forms easily utilized by the skin.
- Contains natural anti-oxidants to help skin repair and protect it from free radicals and other environmental aging factors.
- Highly effective in helping to prevent liver spots and other blemishes caused by overexposure to sunlight, and the inevitable aging process.
- Contains fatty acids that help prevent fungal and bacterial infection in and on the skin, also decongesting pores.
- Is soothing and healing when applied to skin irritations.
- With sustained use over time, actually improves the skins support network and healing processes slowing skin aging. [18]
- Is great for massage and daily moisturizing, readily washes out of linens.

2.9.2 Advantage on Hair

- It increases hair growth
- It is perfect for dry hair, which is more inclinable to hair damage.
- Coconut oil keeps hair free from different infections, due to its anti-microbial and anti-bacterial functions.

2.9.3 Advantage on Body

- Stress relief.
- Proven with sustained use to really help keep connective tissues strong and supple.
- Helps prevent heart disease based on the unique blend of fatty acids.
- Helps regulate cholesterol.
- Enhances proper thyroid function.
- Enhances and maintains a healthy immune system.
- Helps in preventing kidney and gall bladder diseases, helps in dissolving kidney stones.
- Helps in controlling blood sugar and improves the secretion of insulin.
- Helps prevent and treat diabetes.
- Helps in absorption of calcium.
- Helps prevent tooth decay.

2.9.4 Advantages as Medicine

- Kills viruses that cause influenza, herpes, measles, hepatitis C, SARS, AIDS, and other illnesses.
- Kills bacteria that cause ulcers, throat infections, urinary tract infections, gum disease and cavities, pneumonia, and gonorrhea, and other diseases.
- Kills fungi and yeasts that cause ringworm, athlete's foot, thrush, diaper rash, and other infections.
- Improves digestion and absorption of other nutrients including vitamins, minerals, and amino acids.
- Improves calcium and magnesium absorption and supports the development of strong bones and teeth.
- Supports tissue healing and repair.
- Supports and aids immune system function.
- Functions as a protective antioxidant.
- Does not deplete the body's antioxidant reserves like other oils do.

2.9.5 Advantages as Fuel

- Can be used to produce bio-fuel.
- It decreases of emissions of poisonous gases and particulate matter as compared to diesel.
- The use of coconut oil can be considered CO_2 neutral.
- It is also safe to handle and transport because it is less toxic than and has a high flash point of about 300 F (148 C) compared to petroleum diesel fuel, which has a flash point of 125 F (52 C).

2.9.6 Advantage as Lubricant

- Coconut oil can be used as a lubricant which can be used in lathe machine, sewing machine, other textile machineries etc.

2.10 Disadvantages of Coconut Oil

Coconut oil has so many advantages, though it has some disadvantages too. Its disadvantages are discussed below:

- **Does not effect on the common cold**:

In coconut oil there are medium chain fatty acids (MCFAs) which can kill many types of viruses including the influenza virus that causes the flu. But they are helpless against the virus (rhinovirus) that triggers the common cold. In fact, no medications or herbal remedies are capable of fighting rhinovirus, except your body immune system. MCFAs effectively deal with the infection by producing specific antibodies, which disarm the virus-infected cells. Any infection could leave the immune system vulnerable to invasion by more bacteria, germs and viruses. That is where MCFAs come into play. MCFAs help by killing those harmful microorganisms and ease the burden off the immune system so that it can focus on fighting the cold virus effectively. So it's still important to eat coconut oil when someone is down with common cold.

- **Excessive consumption may harm:**

Excessive consumption of coconut oil may cause diarrhea like symptoms if the body is not used to sudden change.

- **Flavor:**

Most people love its aromatic flavor. However, some people may not like it. People who do not like it can mix the oil with other food containing strong flavor or use RBD (1) coconut oil where it possesses very light or no smell of coconut oil.

- **Turn snowy easily:**

The region where the temperature usually stays below 24^0Cthe coconut oil turns snowy easily below that temperature.

- **Cooking temperature above its smoke point:**

Coconut oil does have its smoke point at 177^0C. If this oil is heated beyond this level, the oil's saturated fatty acid structure will break down, and quickly and easily react with free radicals in the air to form new structure, which will most likely hold trans-fat. Trans-fat kills healthy cells of the body and can trigger cancerous and other degenerative diseases.

- **Cause Acne Breakout:**

Numerous people have used coconut oil to successfully clear their acne-prone face and help them close up the pores to make the skin smoother and flawless. But few people do get an even worse acne breakout condition with coconut oil. This is because the anti-toxin properties in coconut oil are so powerful that they purge out layers of toxin deep from underneath the skin, so it may appear that it is getting worse from using coconut oil, which in fact is a healing crisis. [19]

Methodology

3.1 Design of Coconut Oil Extraction Machine

When designing a coconut oil extraction machine, a few crucial considerations should be kept in mind, particularly method of oil extraction, environmental condition, type of pressure applied, material of the cylinder used, type of hydraulic jack used, amount of pressure to be applied, material of the basement and the stand etc. It was also considered that if the use of the machine will be continuous or seasonal.

3.1.1 Design of Machine

With a view to produce coconut oil from coconut meat by utilizing hydraulic pressure, the design was planned. A scrapper will be used to collect coconut meat after breaking the coconut shell. The meat will be dried by sunlight to keep the nutrition value and quality of the oil intact. The dry coconut meat will be kept in a porous cylindrical container. A piston will be used to press the coconut meat and oil will come out from the coconut meat. A hydraulic jack will provide sufficient pressure over the piston.

3.1.2 Design Requirements

To design the coconut oil extraction machine, the following criteria were considered:

- Compact and light weight so one person can easily move that machine from one place to another.
- Enough strong to withstand the given pressure.
- Easy to assembling and disassembling
- Simple construction and components.
- Maintenance and operation should be easy and simple.
- Capital cost should be low.
- Quite enough to operate in home.
- Life time of that machine will be more.
- Safe.

3.2 Design Stages

3.2.1 Initial Step

In the initial step, two vertical mild steel U-cannels were fixed on the basement. One horizontal bar was fixed to hold the cylinder. The hydraulic jack was placed between the horizontal bars to apply the pressure on the cylinder. But the horizontal bar holding the cylinder was not strong enough to hold the hydraulic jack pressure over the piston and it was bended. So design was modified.

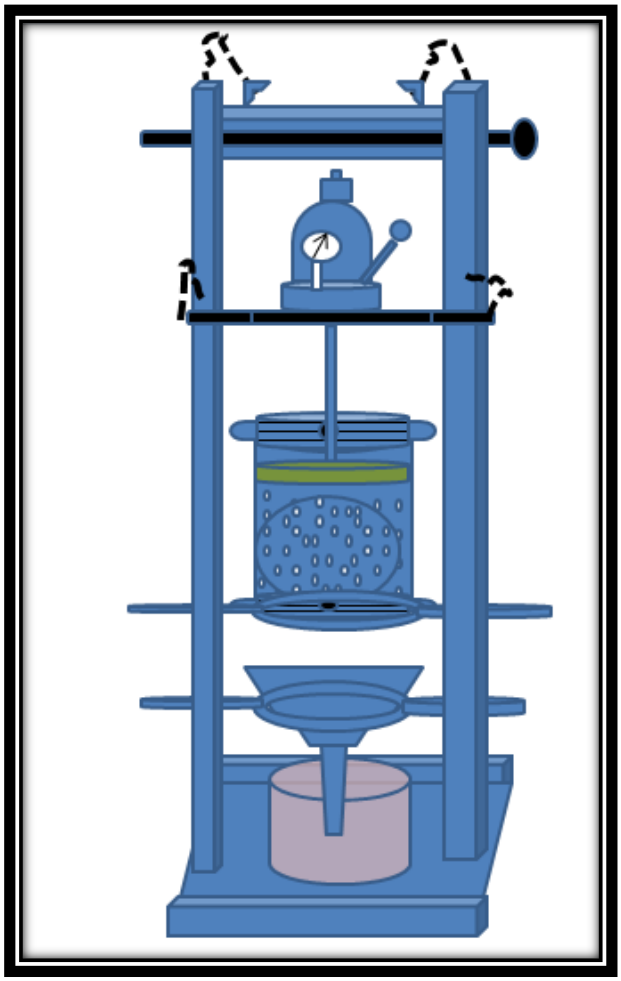


Figure 3.1: First design of the setup

3.2.2 Final Step

In final step, design was fully modified and all components are totally examined by computer simulation. Solid works 2011 version software was used to design the machine. To hold two ton hydraulic jack pressure, different materials were used such as- stainless steel, mild steel, Cast iron angle bars, steel stand, square bar for basement, steel sheet to strengthen the basement, U-channels etc. In final setup all dimensions are given in centimeter.

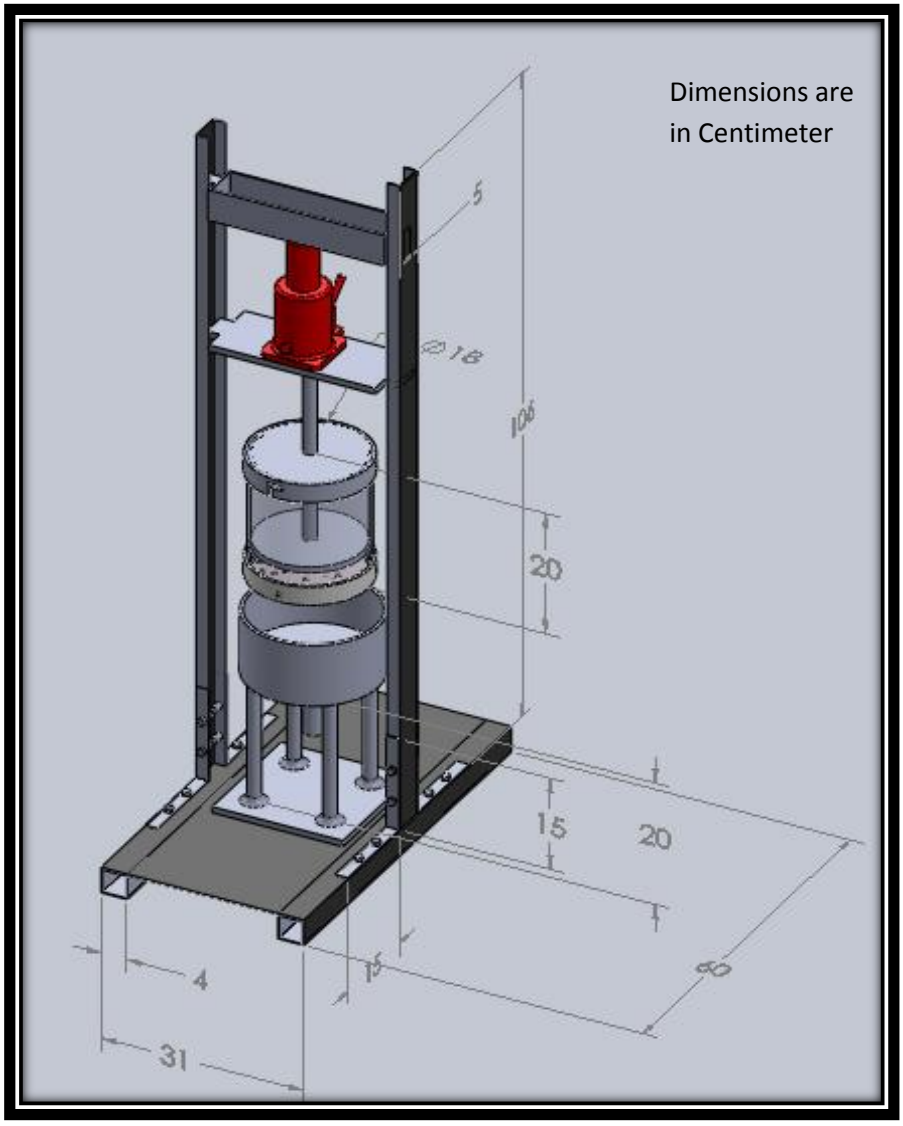


Figure 3.2: Final setup

3.3 Components of Machine

- Hydraulic jack
- Mild steel bar
- Angle bar
- Piston
- Cylinder
- Steel sheet basement
- Stand
- Nut and bolt
- Scrapper

3.3.1 Hydraulic jack

To obtain greater compressive force, a device is used called hydraulic jack. By the help of a lever, jack pressure is transmitted to the piston to move downwards inside the cylinder.

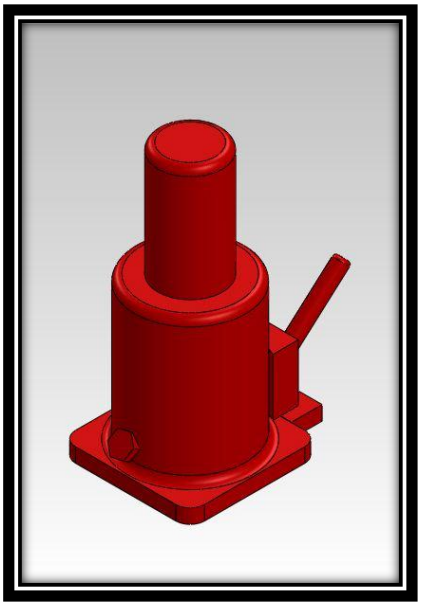


Figure 3.3: Hydraulic jack

3.3.2 Mild Steel Bar

Two vertical mild steel bars are the mainframe of the machine. Mild steel refers to low carbon steel; typically the AISI grades 1005 through 1025, which are usually used for structural applications. The bar was made strong enough to hold the cylinder and withstands high pressure of the hydraulic press.

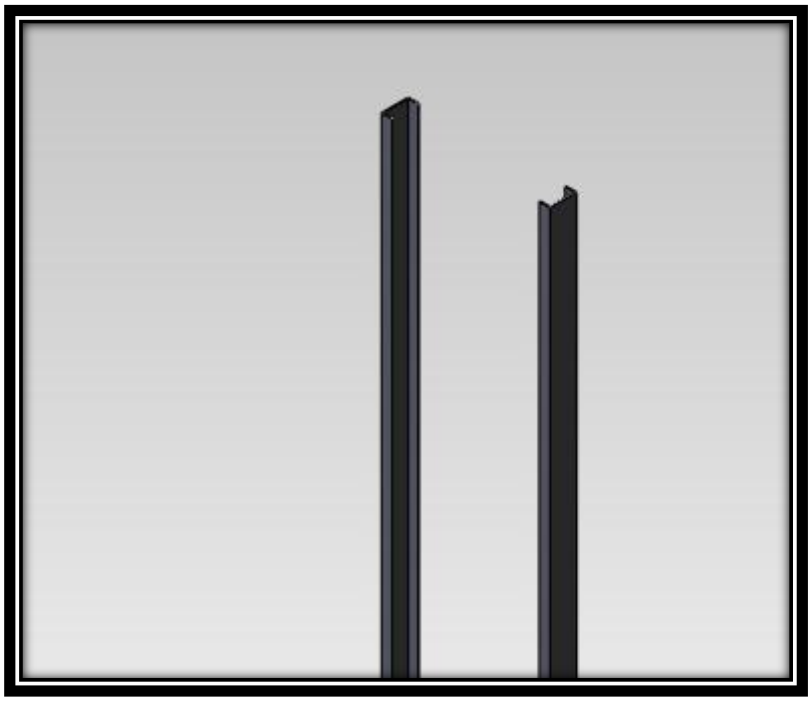


Figure 3.4: Mild steel bar

3.3.3 Angle Bar

Gray cast iron angle bar is used to hold the U-channels. Grey cast iron is characterized by its graphitic microstructure. It is the most commonly used cast iron. Most cast irons have a chemical composition of 2.5 to 4.0% carbon, 1 to 3% silicon, and the remainder is iron. Grey cast iron has less tensile strength and shock resistance than steel.

The angle bar is drilled to attach nut and bolt to the mild steel bar and basement. There are 4 drill holes in each angle bar. Total 4 angle bars are used in the machine as well as 16 nuts and bolts are attached.

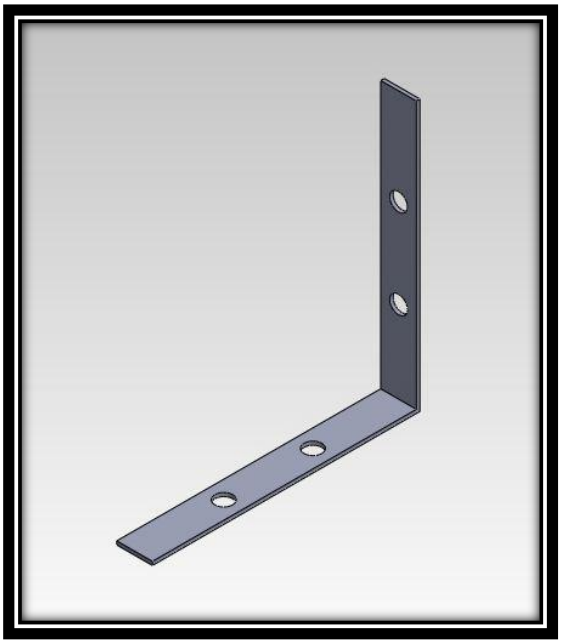


Figure 3.5: Angle bar

3.3.4 Piston

Piston is made by stainless steel. Welded stainless steel is acting to provide pressure to the cylinder.

Specification:

Diameter-16.5 cm

Rod stand-30 cm

Length of upper base-30 cm

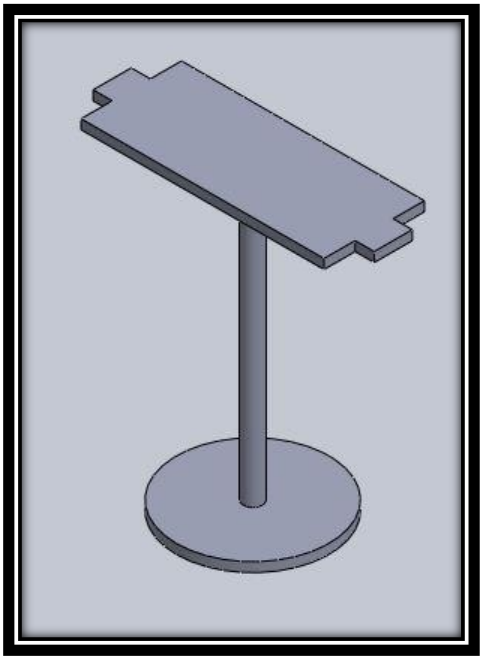


Figure 3.6: piston

3.3.5 Cylinder

A stainless steel cylinder is used to extract the coconut oil. Cylinder base is having lots of tiny holes. Pressure is applied over the piston by hydraulic jack. To hold lower cap a locking machanism is used.

Specification:

Diameter of cylinder- 17 cm

Height of cylinder - 30 cm

Adjustable lower portion

Figure 3.7: Cylinder

3.3.6 Base

Mild steel box bars are used to made stand of the machine. A mild steel sheet is attatched to the base to hold the structure. Two perpendicular U-channel mild steel bars are attatced with the help of four angle bars and sixteen nuts and bolts.

Specification:

Length - 80 cm

Height - 106 cm

Width - 23 cm

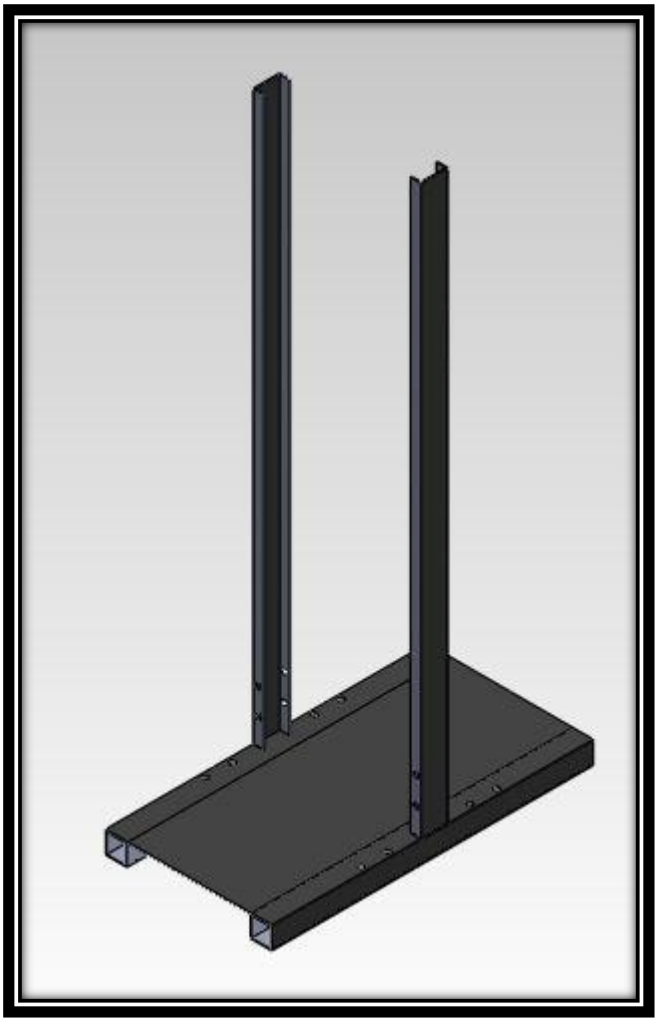


Figure 3.8: Basement

3.3.7 Stand

A stand is used to hold the cylinder assembly. Four cast iron rods are welded together to a metal sheet at the bottom and to the metal ring at the top. These cast iron rods hold the pressure of the piston also.

Specification:

Stand height- 30 cm

Stand base - 20 cm x 20 cm

Figure 3.9: Stand

3.3.8 Nut and Bolt

A nut is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating bolt to fasten a stack of parts together. The two partners are kept together by a combination of their threads' friction, a slight stretch of the bolt, and compression of the parts. The most common shape is hexagonal, for similar reasons as the bolt head - 6 sides give a good granularity of angles for a tool to approach from (good in tight spots), but more (and smaller) corners would be vulnerable to being rounded off. Nut-bolts are used to assemble different components, so that the equipment can be disassembled easily and can be transported easily from one place to another.

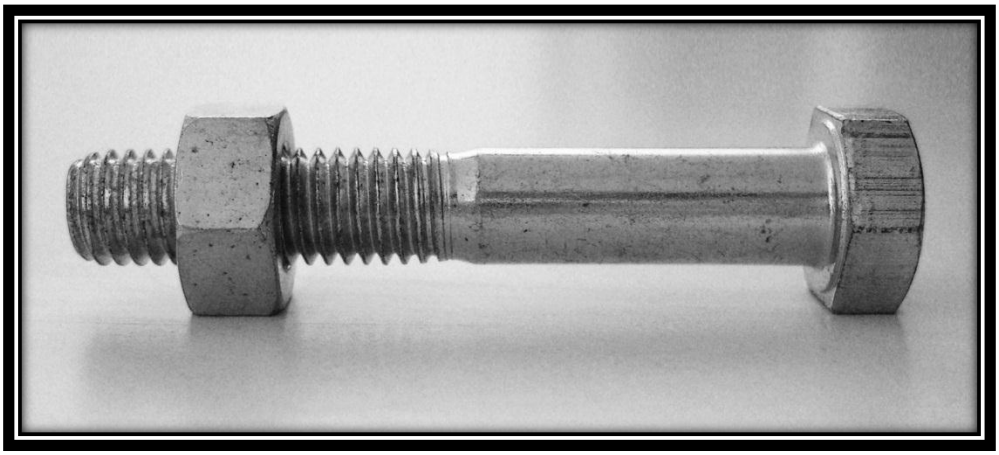


Figure 3.10: Nut and bolt

3.3.9 Scrapper

Scrapper is used to scrape the coconut. A mild steel cactus type circular small sheet is the main component of this device. Scrapper is powered by hand.

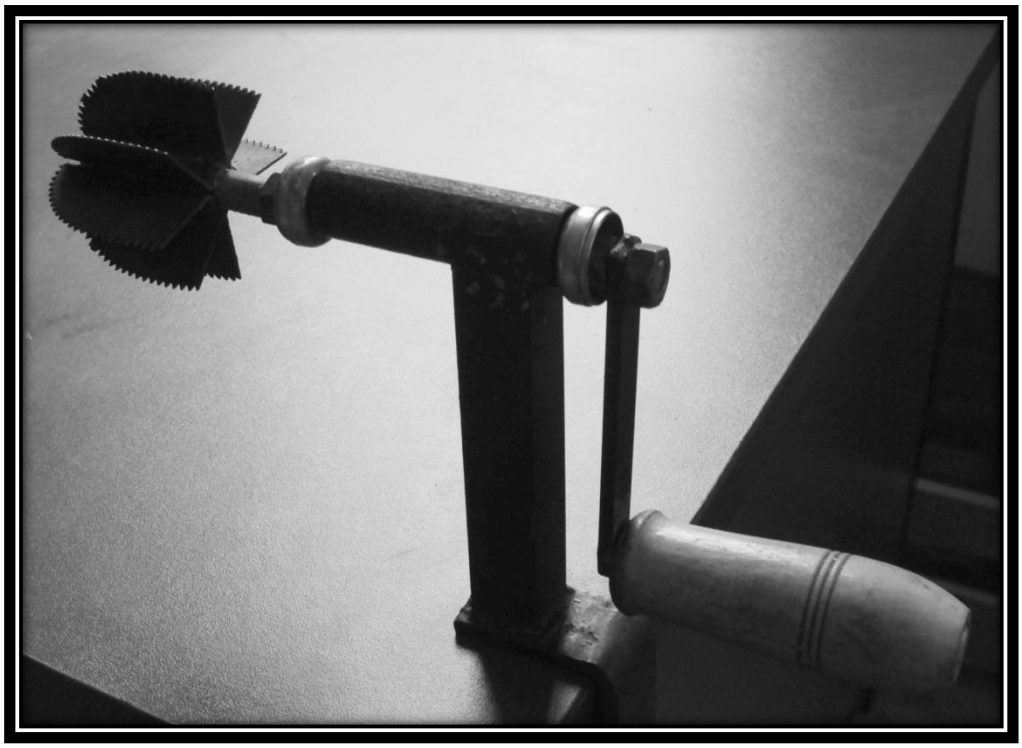


Figure 3.11: Scrapper

3.4 Part Catalogue

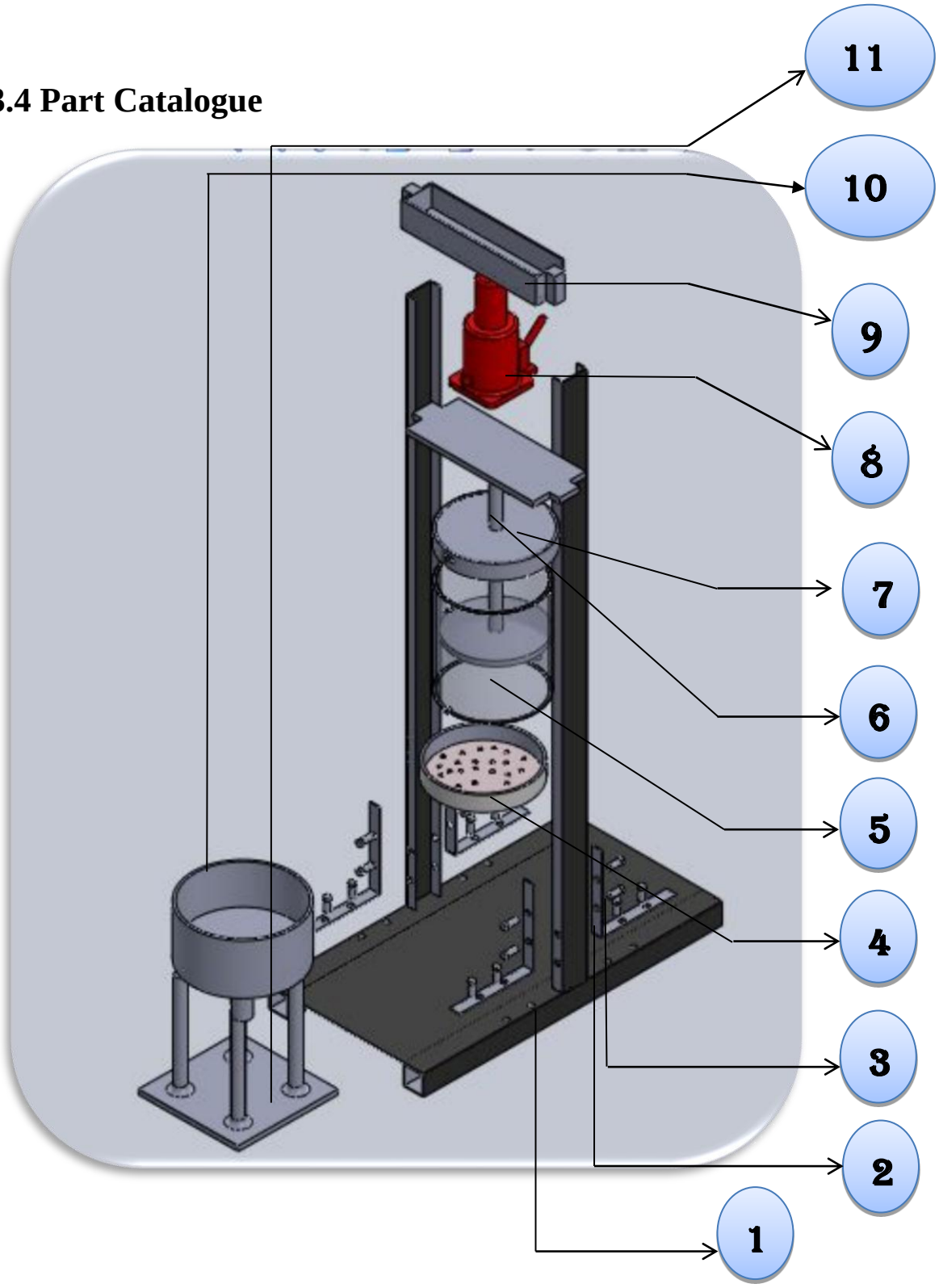


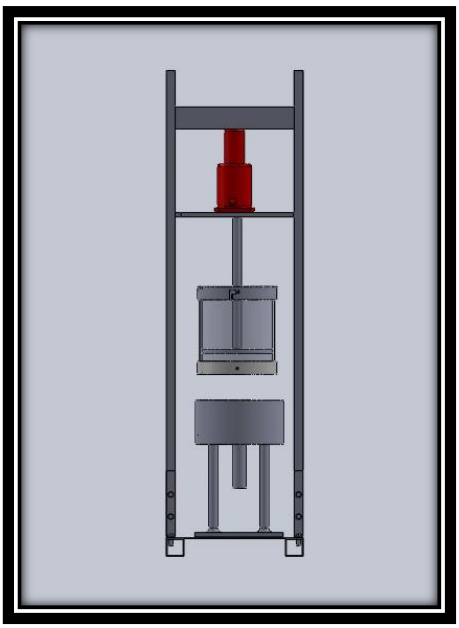
Figure 3.12: Part catalogue

3.4.1 Components of Machine

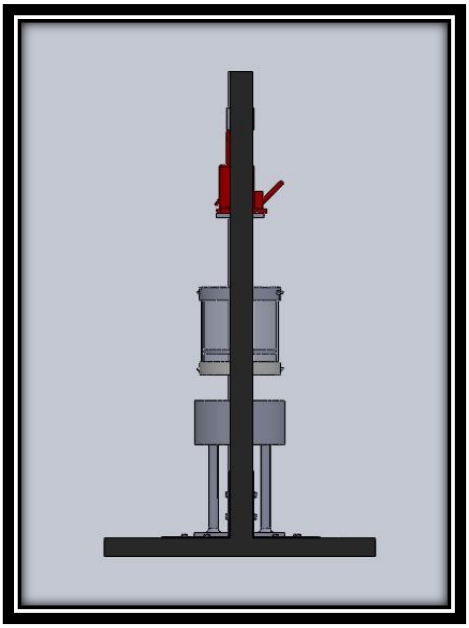
Serial No.	Component Name	Quantity	Material
1	Basement with vertical bar	1	Mild steel
2	Angle bar	4	Gray cast iron
3	Nut and bolt	16	Cast iron
4	Lower cap of the cylinder	1	Stainless steel
5	Cylinder	1	Stainless steel
6	Piston	1	Stainless steel
7	Upper cap of the cylinder	1	Stainless steel
8	Hydraulic jack	1	Iron
9	Upper strip	1	Stainless steel
10	Collector	1	Stainless steel
11	Stand	1	Cast iron

Table 3.1: Components of machine

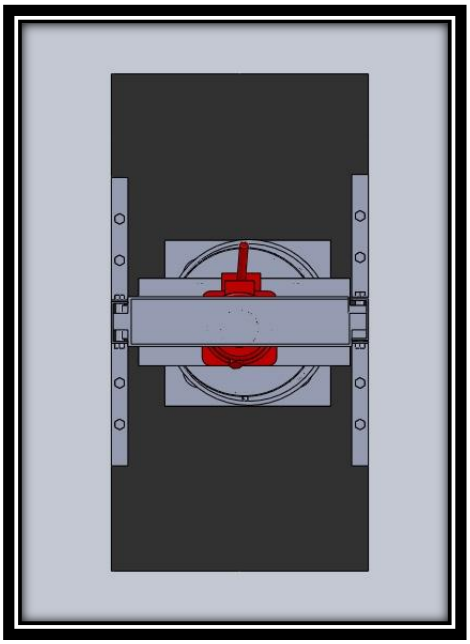
3.5 Different Types of View of the Machine



Front side view



Right side view



Top side view

Figure 3.13: Front side, Right side and Top side view

Production Process of Coconut Oil and Analysis

4.1 Production Process of Coconut Oil

To produce oil it is required to use raw coconut or copra except the baby coconut. Complete oil producing processes have four steps as follows:

- Scraping of coconut meat
- Drying scrapped coconut
- Pressing
- Filtering

4.1.1 Scrapping Coconut Meat

Firstly the husk is removed from the coconut. Then the coconut water is removed by breaking it into two similar parts which can be easy to use in scrapper machine. Also the cleanliness of the coconut is ensured which is going to be used in scrapper machine before starting the scrapping. While scrapping only the meat part of the coconut is scrapped.

Figure 4.1: Scrapped coconut meat

4.1.2 Drying Scrapped Coconut

In scrapped coconut meat it contains 3% moisture which is not suitable for extracting process. The scrapped coconut meat is dried by direct sunlight. For drying, a tin sheet tray is used and then coconut meat is scattered properly all over the tray and kept it in the sunlight. It is required to dry the coconut for about three to four hours. For better drying process it requires scattering the coconut meat time to time within the drying period.

Figure 4.2: Drying of scrapped coconut

4.1.3 Pressing

The dried coconut meat is put into the cylinder chamber in extracting machine and the hydraulic jack is placed for the operating process. Gradually the pressure is applied on the coconut meat. With the application of proper pressure the oil comes out from the coconut meat and deposited in the container kept at the bottom. Sudden pressure should not be applied otherwise the oil might be spoiled.

Figure 4.3: Pressing of dry coconut meats.

4.1.4 Filtering

For better quality and preservation it is required to filter the extracted oil. For this purpose filter papers are used. After filtration the oil appears transparent like water.

Figure 4.4: Filtration

4.2 Production Rate and Cost Analysis

For measuring the production rate of the coconut oil extracting machine, six coconuts are used. It can produce about four hundred and fifty milliliters of oil. Therefore to produce one liter of coconut oil it is required thirteen and half coconut.

4.2.1 Production Cost and Comparison with Other Coconut Oil

If the coconut is purchased from local market, then each coconut costs Tk. 30. Considering the calculation of the cost of oil produced from six coconuts.

The number of coconut × cost of each coconut = 6 × Tk. 30 = Tk. 180.00

Six coconuts can produce about 450 ml of oil.

Then, each 100 ml coconut oil costs = (180 × 100)/450 = Tk. 40.00

If the coconut can be purchased from whole sale market, then each coconut costs from

Tk. 15 to Tk. 20. Taking the average cost Tk. 18 for each coconut,

Total cost for six coconuts = 6 × Tk. 18 = Tk. 108.00

Hence, each 100 ml oil costs = (108 × 100)/450 = Tk. 24.00

The market price of different coconut oil is assessed. The comparison of the price is shown below:

Name of the oil	Quantity (ml)	Price (Taka)
Coconut oil (local market)	100	38
Parachute coconut oil	96	48
Manufactured coconut oil	100	40

Table 4.1: Cost comparison of different coconut oil available in the market with the manufactured coconut oil.

4.3 Visibility testing

By comparison of oil color it was observed that extracted coconut oil is clear like water. But other oil specimens color is not clear as extracted oil due to it may have subjected to heating effects, adding preservatives or chemicles.

Figure 4.5: Different specimen of coconut oil

4.4 Extracted Oil Quality and Nutrition value

Due to lack of time it could not be possible to test the quality of the extracted oil using laboratory facilities. But it was understood clearly by visual inspection and smell, that extracted oil is having better quality comparing to other coconut oils which are available in the market. There is no chemical, preservative or any other substance mixed with the oil during production. This causes a high nutrition value of extracted coconut oil.

4.5 Exhaust Gas Analysis of Diesel Fuel and Coconut Oil Mixture

Exhaust gas analysis of diesel and coconut oil mixture is done in a single cylinder diesel engine.At first pure diesel fuel was used to analyze the exhaust gas. The followings are the result obtained from the exhaust emission analysis of diesel fuel

Serial no	Speed (rps)	O_2 (%)	CO_2 (%)	CO (ppm)	NO (ppm)	NO_2 (ppm)	SO_2 (ppm)
1	10	18.2	7.3	162	170	8	7
2	20	17.5	7.54	178	135	16	8
3	30	17.53	8.23	240	102	9	8
4	40	17.53	8.45	262	156	14	9
5	50	17.53	8.63	325	210	14	15
6	60	17.53	8.84	610	225	8	16

Table 4.2: Experimental Data of exhaust gas analysis of diesel fuel

To evaluate the exhaust gas emission of coconut oil blend with diesel fuel, a mixture was produced using 15 % coconut oil and 85% diesel fuel. This mixture was used directly in the diesel engine. The outcome of the analysis is given below

Serial No	Speed (rps)	O_2 (%)	CO_2 (%)	CO (ppm)	NO (ppm)	NO_2 (ppm)	SO (ppm)
1	10	19.75	6.23	243	252	13	4
2	20	19.43	5.05	457	221	27	6
3	30	19.15	4.79	1380	142	40	54

Table 4.3: Experimental Data of exhaust gas analysis of diesel and coconut oil mixture

Using the experimental data obtained from the analysis is plotted to different graphs. Followings are the charts showing the performance characteristics curves of diesel fuel mixture of diesel fuel blended with coconut oil.

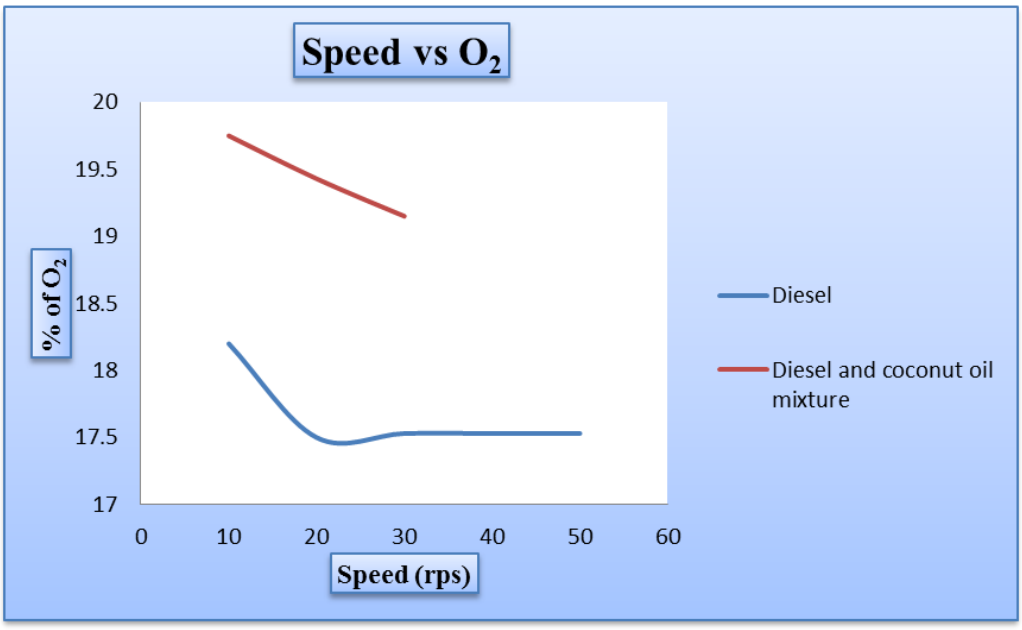


Chart 4.1: Percentage of O_2 in Exhaust gas emission

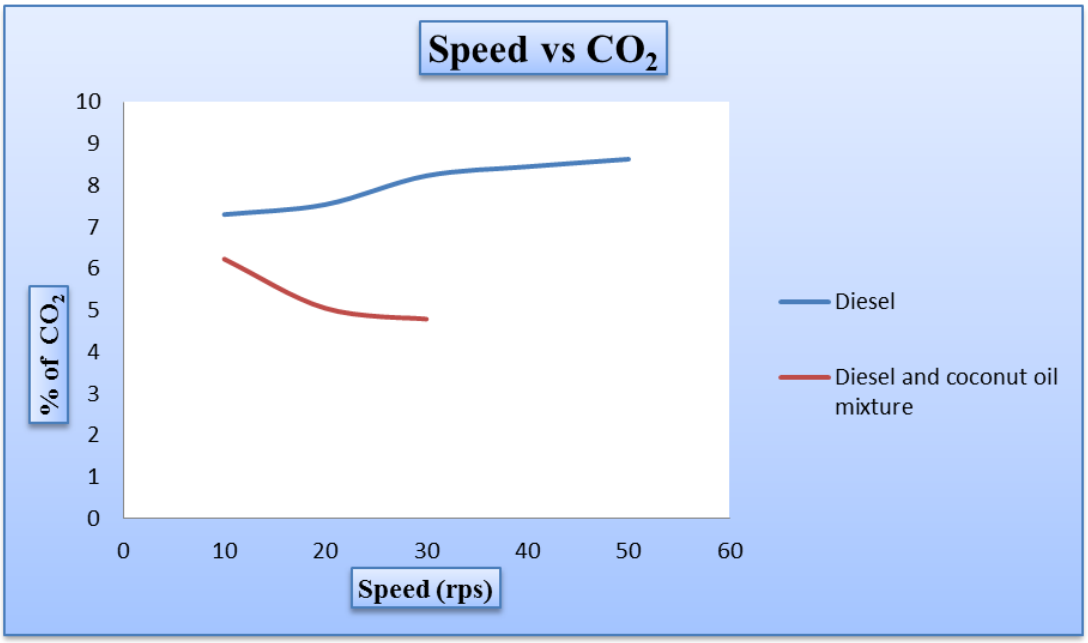


Chart 4.2: Percentage of CO_2 in Exhaust gas emission

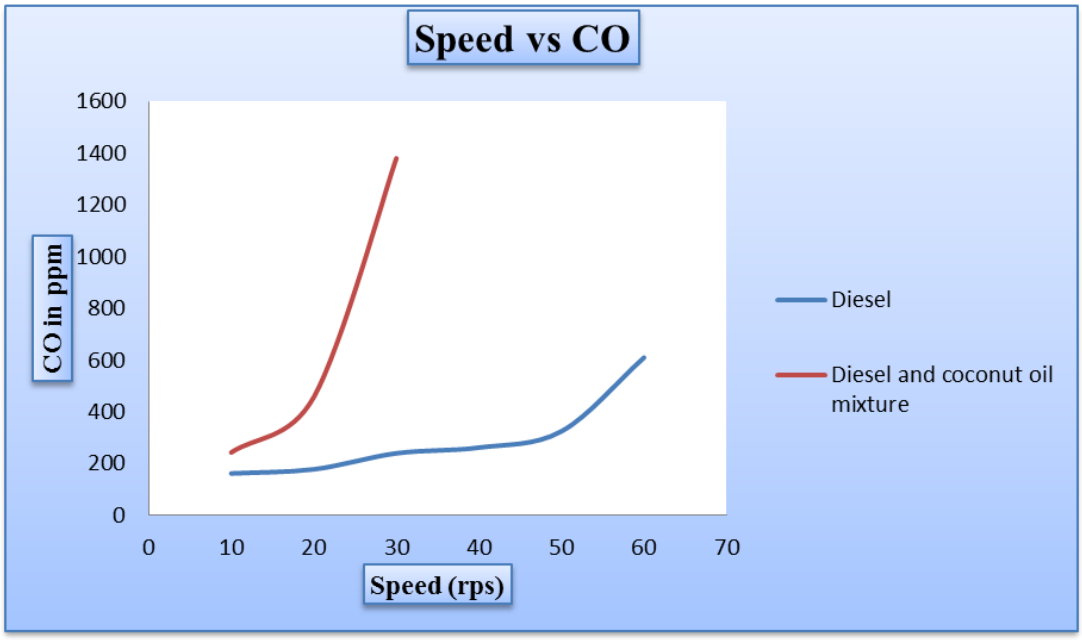


Chart 4.3: Amount of CO in ppm in Exhaust gas emission

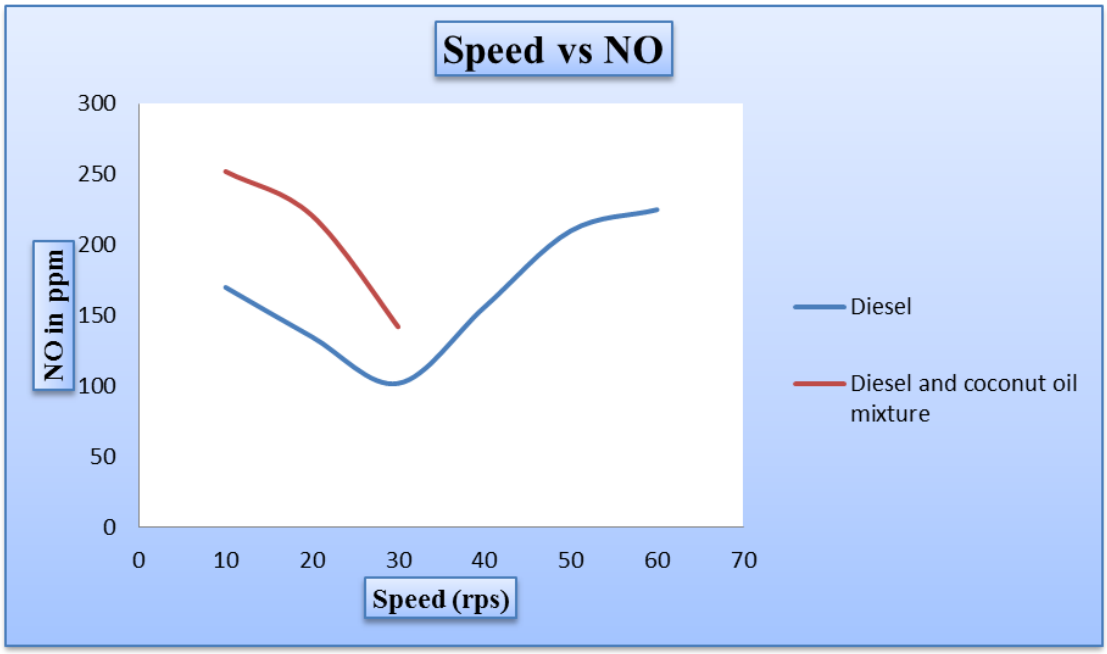


Chart 4.4: Amount of NO in ppm in Exhaust gas emission

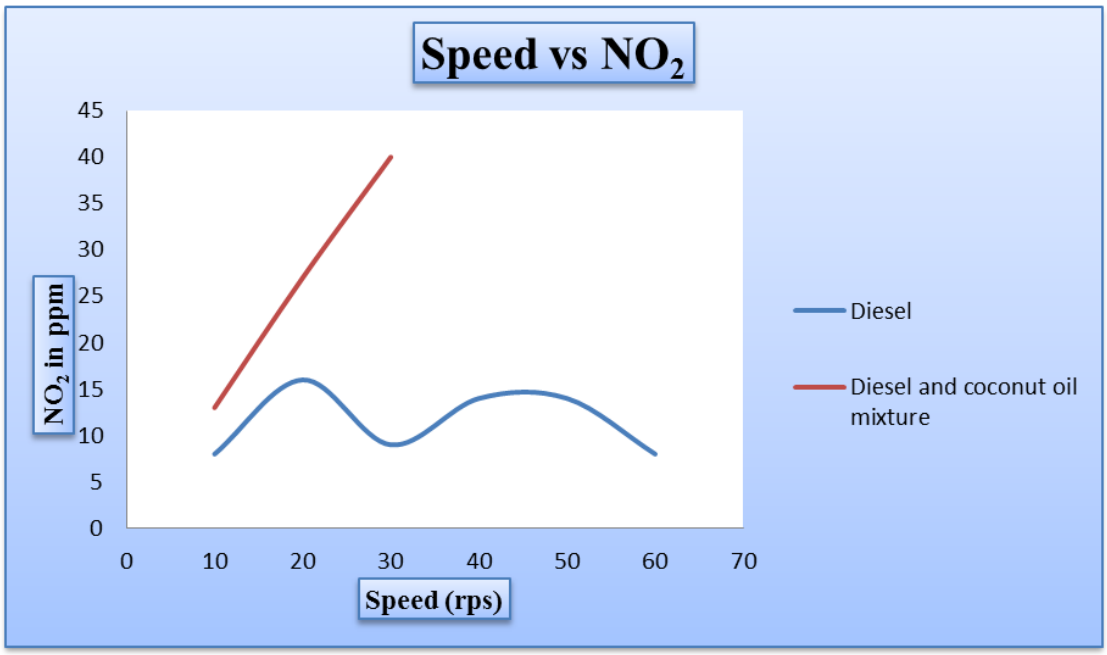


Chart 4.5: Amount of NO_2 in ppm in Exhaust gas emission

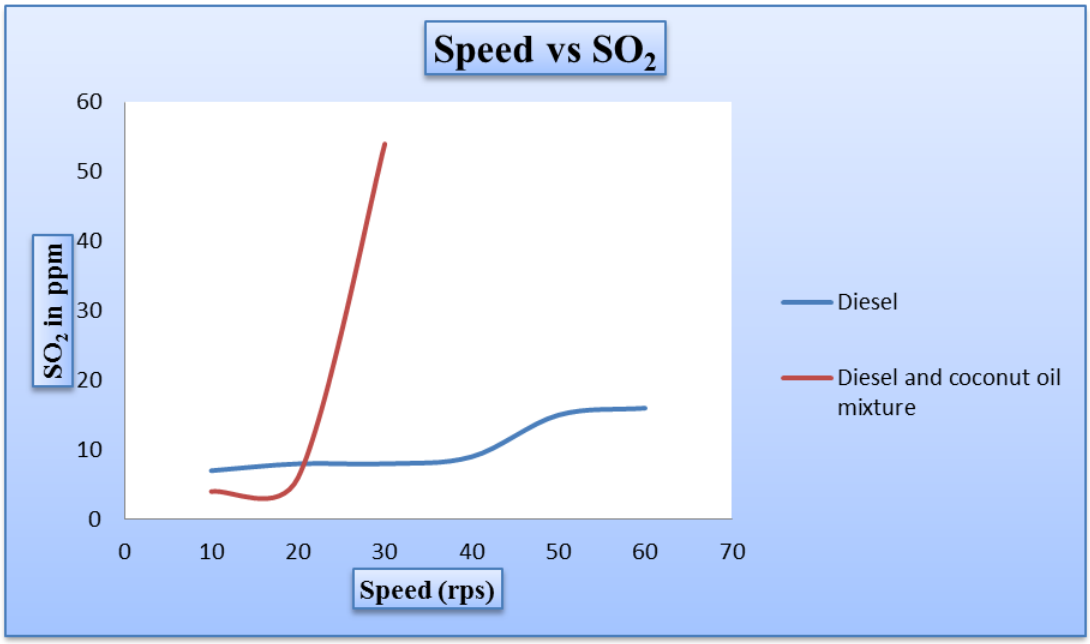


Chart 4.6: Amount of SO_2 in ppm in Exhaust gas emission

4.5.1 Summary of the Comparison

By comparing the graphs it is observed that amount of CO_2, NO is less emitted and O_2 emission is more, when mixture of coconut oil is used with diesel fuel. But in higher speeds it is observed that emission of SO_2, NO_2 and CO is increased. Therefore the coconut oil and diesel fuel mixture is suitable for operating low speed engines.

Advantages and Limitation of Manufactured Machine

5.1 Advantage of Manufactured Machine

- The coconut oil extracting machine is entirely mechanical. No electrical instruments have been used. Hence there is no possibility of malfunctioning.
- The machine is medium in size and weight. So it is transportable and can be kept in a place wherever convenient.
- Easy to assemble and disassemble, small in size.
- All the machine parts are bolted together. If any part is broken, it can be easily replaced.
- The cost of manufacturing the coconut oil extracting machine is less.
- It is easy to operate the machine (the operating procedure is discussed earlier).
- Quality of coconut are never been destroyed into our machine.
- Production cost is low.
- Directly coconut meat is used into the machine, but all other coconut oil machine use only copra for oil production.
- Small pressure is necessary for oil extraction.
- The operation is not time consuming. As the pressure is given by the hydraulic jack to the piston, the oil begins to come out instantly.
- Color of the coconut oil never been destroyed in this machine.
- It is required to dry the scrapped coconut before it is put in the cylinder of the machine. The coconut is dried out by using sunlight, which is a natural resource. This is the reason the coconut oil color is transparent like water. This is due to the moisture content is being evaporated. If another source of energy is used to dry the coconut the color may appear different (ex: heating).
- The oil produced by coconut oil extracting machine is pure. No chemical or preservatives are added with the product during the extracting process. It smells natural and its color is like water.

5.2 Limitations

- The base of our coconut oil extraction machine is made of mild steel material. It is better to use stainless steel material to sustain a long time against the high pressure of the hydraulic jack.
- One of the main criteria of our project is sunlight. After scrapping the coconut meat, at first it is needed to evaporate the moisture content of the coconut by drying it under the sun. During the rainy and winter season it gets really difficult to get sunlight continuously and the production of oil may hamper.
- The maximum capacity of the cylinder is to hold the meat of twelve coconuts.
- The piston disc made to give the pressure to the coconut by hydraulic jack has much smaller diameter than the cylinder i.e. the clearance is more than it is needed. So it gives less pressure on the coconut than its capacity.
- We need to filter the oil separately after extracting the oil. It is better to filter the oil at the time when the oil is pouring from the cylinder, if possible. Again it is time consuming to filter the oil using filter paper.

Conclusion and Recommendation

6.1 Conclusion

Coconut oil is consumed in tropical countries for thousands of years. Studies done on native diets high in coconut oil consumption show that this population is generally in good health. Coconut oil has a long shelf life and is used in baking industries, processed foods, pharmaceuticals, cosmetics and as hair oil. The oil is known to have antiviral and antibacterial effects and excellent healing properties. Coconut oil is vastly used for health benefits. It include hair care, skin care, stress relief, maintaining cholesterol levels, weight loss, increased immunity, proper digestion and metabolism, relief from kidney problems, heart diseases, high blood pressure, diabetes, HIV and cancer, dental care, and bone strength. Most important thing is the method that we used in manufactured machine does not affect any kind of physical or chemical change on extracted oil. So it is given the status as "100% pure coconut oil" to our product.

While the use of extracted coconut oil is certainly feasible to run diesel engines specially, if one is not very discriminating on its effect to engines, its use can be better maximized if it is converted to coco biodiesel. Even though there is quite some evidence of the environmental benefits using coconut oils as a fuel. Motorists have successfully blended coconut oil with diesel to decrease costs per km. This helps to reduce consumption quantity of diesel fuel.

As an alternate fuel, coconut oil is mixed with diesel fuel to run low speed running engines. With the help of IMR machine it is tested and observed that less CO_2 and more O2 emits in the exhaust gases. Whereas it is proved that mixed fuel is very much suitable to use in low speed engines. Produced coconut oil is more crystal clear rather than other oil which is made locally.

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6.2 Recommendations

Research in the field of coconut oil as various use is going in many countries of the world.It requires more research in this field and its various uses. For future work in this project and thesis; recommendation are as follows:

- Due to shortage of time we couldn't produce biofuel from extracted coconut oil and test the exhaust emission in IMR tester. It is recommended to do same, because biofuel is much more efficient than the mixture of diesel and coconut oil.
- Also unable to test the nutrition value of extracted oil due to lack of time and it is required to test in BSTI (Bangladesh Standard and Testing Institution) for better validation for project.
- To increase the machine efficiency or production rate it can be modified with an electric operated hydraulic jacks or some other mechanism instead of Mechanical hydraulic jack.
- For more strength and higher durability of machine set up, it can be modified the basement and other structural parts with stainless steel instead of mild steel.