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Comparison of Alternative Fuels in Single Cylinder Diesel Engine Using CFD

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Abstract. Biodiesel is a fuel substitute for conventional fuel made from natural and renewable resources, such as vegetable oils not intended for human use. The world's fuel consumption has increased dramatically, particularly in developing nations. There are many ways to consume domestic non-perishable oil while enhancing our energy security as diesel costs are on the verge of record increases and will decline within a few decades. The agricultural sector will be supported, and there will be more job opportunities in the fields and in food processing, among other economic advantages. This article covers an effort to categorise and rank the relative relevance of fluid movements in the cylinder and fuel injection signals as factors impacting the combustion of high-speed diesel engines, when bulk swirling is not present. This assessment offers a concise yet detailed

INTRODUCTION

Any substance that may be made to react with other substances to release energy as heat or to utilise it for work is referred to as a fuel. The idea was initially restricted to substances able to produce chemical energy, but it has subsequently been expanded to include other thermal energy sources like nuclear energy (via nuclear fission and nuclear fusion) [1].

A heat engine known as an internal combustion engine (ICE or IC engine) burns fuel and an oxidizer, usually air, in a combustion chamber that is a part of the working fluid flow circuit. Internal combustion engine parts are directly impacted by the expansion of the high-temperature, high-pressure gases created by combustion. Usually, the force is exerted on a rotor, a piston, turbine blades, or a nozzle. This force moves the component across a distance by propelling or driving it. It does this by transforming chemical energy into usable kinetic energy, which is then used to move or power whatever the engine is connected to. The term "internal combustion engine" is frequently used to describe an intermittently burning engine, including the more prevalent four- and two-stroke piston engines as well as variants like the six-stroke piston engine [2].

On the other hand, energy is transferred to a working fluid that is not made up of, combined with, or contaminated

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by combustion products using external combustion engines like steam or Stirling engines. Air, hot water, pressurised water, or even liquid sodium heated in a boiler are used as working fluids in external combustion engines [3].

Typically, fossil fuels like natural gas or petroleum products like gasoline, diesel fuel, or fuel oil are used to power ICEs. In CI engines, renewable fuels like biodiesel are used, whereas ETBE (ethyl tert-butyl ether), which is generated from bioethanol, is used in SI engines. There is often a mix of fossil and renewable fuels. A limited resource, hydrogen can be created using fossil fuels or renewable energy [4].

Discussion of ICE Fuel

In IC engines, the fuel is burned (oxidised) inside the combustion chamber to convert the chemical energy it contains into mechanical power. The chemical reactions that happen inside the cylinder cause heat to be created. The fuel-air mixture must stay in the cylinder long enough for the chemical reactions to finish taking place (this is the working fluid prior to combustion).

Fuel costs are skyrocketing daily, and fossil fuel reserves will run out over the next few decades. Since our nation does not have its own reliable energy supply, a significant amount of money is spent annually to meet energy needs. Therefore, we should concentrate on discovering new alternative energy sources, and the government has taken measures and made financial investments in the study and development of unconventional energy sources like solar, wind, biogas, biomass, and biodiesel.

India is currently transitioning slowly from regular gasoline and diesel to gasoline alcohol and bio-diesel. Particularly diesel has a high rate of fuel consumption. Currently, a variety of resources are used to make bio-diesel. For instance, waste cooking oil, rice bran, turmeric leaf oil, palm oil, and coconut oil. The closest equivalent for diesel fuel in diesel engines is thought to be biodiesel fuel because of its similar qualities. Fossil fuel use is becoming more popular, which poses a greater threat to the environment because burning them produces pollutants such CO2, CO, SOx, NOx, and particulate matter. These emissions are currently the main cause of pollution in the world. The negative effects of engine exhaust pollutants, the sharp rise in the price of petroleum products, and the unpredictability of their supply have all rekindled interest among academics in finding viable alternative fuels [5].

Aim and Objective

The objective of reducing the pollution emissions from internal combustion engines, the characteristics of alternative fuels that can be used without requiring structural changes to SI and CI engines, such as hydrogen, natural gas, acetylene, and ethanol, and their impact on engine performance. The discharge of harmful gases is one of the biggest problems with the use of internal combustion engines nowadays. Numerous studies have been done as a consequence to reduce emissions while maintaining engine performance in new ICE applications. These engine applications improve thermal efficiency while reducing emissions of nitrogen oxide and soot as compared to conventional engines.

Diesel fuel made from petroleum can be swapped out for biodiesel. Greater lubricity, a better cetane rating, cleaner emissions, reduced global warming, and increased rural development are some of its advantages. Jatropha oil has the potential to be utilised in place of conventional fuels. But this oil won't reduce our dependency on foreign oil in any foreseeable future. A more dependable energy supply might be possible with the use of this and other alternative energy sources. Major manufacturing hubs comparable to modern petroleum refineries have not yet materialised. When compared to conventional petroleum resources, the economics of biodiesel fuels are marginal; public policy must be changed to favour development.

Every day, the globe grows more advanced and industrialised. As a result, there are more cars and engines on the road, but the available energy sources for powering them are constrained and progressively declining. The need for an alternative fuel for diesel engines is caused by this problem. An alternative fuel for diesel engines is biodiesel.

About Turmeric Leaf Oil: An Alternate Form of Diesel

Farmers' removal of turmeric plants results in turmeric leaves as a byproduct. From the discarded leaves, oil is extracted using the hydro distillation process. Turmeric leaves can catch fire. Oil extraction provided the power for four-stroke engines. The engine uses turmeric leaf oil as opposed to fuel and diesel to lessen the amount of pollutants that are harmful to the environment.

Additionally, this study may reduce our reliance on fossil fuels, which will help to gradually but steadily alleviate the global crisis. India produces a lot of turmeric, therefore using the oil from the leaves can help keep foreign currency

safe. Purer and more oil may be extracted more profitably when the extraction process is conducted on a larger scale.

In order to use biodiesel instead of fuel derived from petroleum, no modifications to the engine are required. Any ratio of biodiesel to petroleum-based fuel is acceptable. This interest is fueled in part by the biodegradability, domestic renewable source of biodiesel, potential to reduce exhaust emissions, and biodegradability of biodiesel. Energy use and development are currently significantly impacted by climate change. Biodiesel is said to as "climate neutral" since all of the carbon dioxide produced during consumption was removed from the atmosphere during crop development. Utilizing biodiesel decreased emissions of carbon monoxide, particulate matter, and unburned hydrocarbons. Additionally, the use of biodiesel increased the efficiency of catalytic converters in reducing particle emissions [5,6].

Some crucial factors, such as volumetric ratio, types of reactants, and catalytic activity, were chosen in order to produce a high-quality biodiesel fuel that complies with the requirements of standard techniques (ASTM D 6751 & EN 14214). The maximum output of biodiesel, or about 99.5%, was achieved under ideal conditions, which included a volumetric oil-to-methanol ratio of 1:6, a catalyst concentration of 1%, a reaction temperature of 40 °C, and a stirring speed of 320 rpm. The results showed that there were no significant variations in the production of biodiesel at WCO. The study showed that biodiesel produced under ideal conditions from WCO had good quality and could be utilised as diesel fuel, which is regarded as a renewable energy source and an environmentally friendly recycling technique from leftover frying oil. Because it is renewable, eco-friendly, and cost-effective, biodiesel fuel makes sense as a diesel substitute.

In comparison to traditional diesel, which can contain up to 500 ppm SO2 and 20–40 wt% aromatic compounds, biodiesel is superior since it has a low sulphur content, is non-toxic, renewable, and sustainable, and has low emission profiles. Given that the transportation sector contributes significantly to overall gas emissions, these benefits could be a vital strategy for reducing the issue of urban pollution. Diesel fuel dominates among vehicle fuels in terms of SO2 and black smoke particulate emissions, and it also accounts for one-third of all greenhouse gas emissions related to transportation.

By using biodiesel, it will be possible to strike a balance between environmental protection, economic growth, and agriculture. The mono-alkyl ester of long-chain fatty acids produced from renewable liquid sources is what biodiesel is known as chemically. The term "biodiesel" refers to a number of oxygenated fuels with ester bases made from renewable biological sources. It needs little to no modification in order to be used in CI engines. According to the poll above, biodiesel has taken a leading role in the development of alternative fuels, despite the fact that there are numerous issues with utilising it directly in CI engines. As a result of clogged orifices, carbon buildup, oil ring sticking, and other lubrication issues, fuel atomization may not take place as intended or may even be stopped. These include choking and trumpet development on the injectors.

The high viscosity of biofuels, which is roughly 11–17 times more than that of diesel fuel, and lower volatilities, which lead to deposits forming in engines as a result of incomplete combustion and improper vaporisation properties, are further drawbacks to using them. The usage of blended biodiesel is a possibility. Less work has also been done on the general characteristics of biodiesel and its blends as a fuel for CI engines. Technically possible, economically viable, environmentally acceptable, and widely accessible are the requirements for alternative fuels. In this study, single-cylinder, four-stroke CI engines were used to test biodiesel fuel blends generated from used cooking oil.

FUNCTION OF EXISTING ELEMENT OF TEST RIG

An integral component of the power transmission system is the crankshaft. where the connecting rod is used to transform the piston's reciprocating motion into a rotational motion. Crankpins, crank webs (also known as crank arms or cheeks), balancing weights, and main journals make up a crankshaft. The connecting rod's big end is fastened to the crankshaft's crankpin. Half of the piston displacement is the distance from the centre of the crankpin to the centre of the crankshaft during a single stroke. Thus, two piston strokes are produced by a whole rotation of the crankshaft.

A camshaft is nothing more than a shaft that has cams mounted on it. In most in-line engines, the camshaft is positioned on a bearing in the lower portion of the cylinder block. It is mounted on the cylinder head in some engines. A cam is a piece of equipment that converts the camshaft's rotating motion into the linear motion of the follower or filter. The cams have a lobe or high point. As the cam rotates, the follower attached to it will move either away from or toward the camshaft. The valves are opened by the camshaft. Two cams for each cylinder, one to move the inlet valve and the other to operate the exhaust valve, are included in a camshaft's length in addition to its many cams. Additionally, the camshaft contains a gear to drive the oil pump and ignition distributor as well as an eccentric to power the fuel pump.

The cylinder head, a distinct cast piece, seals the top of the cylinder in an engine. The upper portion of the cylinder block is where the cylinder head is fastened. A head gasket is used to seal this junction. A combustion chamber, spark plugs, and occasionally valves make up this component (in the I and F-heads). The cylinder head of

the majority of engines has passageways that supply fuel and air to the cylinders as well as openings for exhaust gas to depart. Typically, grey iron or an aluminium alloy is used to create the cylinder head. The benefits of aluminium are its light weight and great heat conductivity.

The air intake and exhaust valves are both located in the valve seat. It is the component that interacts with the valve and keeps the combustion chamber airtight. Numerous pieces of light-duty and industrial equipment, ranging in size from little grocery carts to enormous power plants, depend on bearings in one way or another to operate.

Bearings come in a wide range of shapes and sizes and are an essential tribological part of many different types of machinery. In a system that may be under static or dynamic loading, they can be described as a machine element that supports/permits only a particular form of motion (limitation of degrees of freedom).

A sliding door is one illustration. The door cannot be moved from its position or raised. It can only be opened by sliding. Bearings limit the range of motion to sliding motion.

A dynamometer, also known as a "dyno," is a tool used to measure both the torque and rotational speed (RPM) of an engine, motor, or other rotating prime mover at the same time. This allows the instantaneous power of the rotating prime mover to be calculated and is typically displayed by the dynamometer as kW or bhp.

Dynamometers serve a variety of purposes other than determining the torque or power characteristics of the machine being tested. Dynamometers are used in standard emissions testing cycles, such as those established by the US Environmental Protection Agency, to replicate road stress for either the engine (using an engine dynamometer) or the entire powertrain (using a chassis dynamometer). Dynamometers can be used as a testbed for a number of engine development operations, such as the calibration of engine management controllers, in-depth analyses of combustion behaviour, and tribology, in addition to simple power and torque measurements.

Hand-held dynamometers, as they are known in medicine, are used for initial and ongoing assessments of patients who have hand damage or dysfunction as well as routine grip and hand strength checks. Additionally, they are utilised to assess grip strength in patients who may have compromised cervical nerve roots or peripheral nerves. Force dynamometers are used to measure the back, grip, arm, and/or leg strength of athletes, patients, and workers in the fields of rehabilitation, kinesiology, and ergonomics in order to assess physical status, performance, and task demands. Typically, the force exerted to a lever or transmitted by a cable is calculated as a force, which is then multiplied by the angle between the force and the level's axis.

Among other related systems, pistons are found in reciprocating engines, reciprocating pumps, gas compressors, hydraulic cylinders, and pneumatic cylinders. It is the moving part that is enclosed in a cylinder and sealed off from the gas by piston rings. Its function in an engine is to use a piston rod and/or connecting rod to transmit force from the expanding gas in the cylinder to the crankshaft. For the goal of compressing or ejecting the fluid in the cylinder, the function is reversed in a pump, and force is transferred from the crankshaft to the piston. By closing and opening apertures in the cylinder, the piston can also function as a valve in some engines.

The investigation of the force that a fluid (liquid or gas) applies to a surface is known as pressure measurement. Usually, pressure is expressed as a force per unit of surface area. For the purpose of measuring pressure and vacuum, numerous methods have been devised. Pressure metres, pressure gauges, and vacuum gauges are all terms for instruments used to measure and show pressure in an integral unit. A manometer is a good illustration because it measures and displays pressure by using the weight and surface area of a liquid column. Similar to the widely used Bourdon gauge, which is mechanical, the most well-known gauge type measures as well as indicates. A vacuum gauge is a type of pressure gauge that is used to measure pressures that are lower than the atmospheric pressure in the surrounding area, which is set as the zero point (for example, total vacuum is equivalent to 15 psig or 760 mmHg). This type of reading is simply known as "gauge pressure" since the majority of gauges measure pressure relative to atmospheric pressure, which serves as the zero point. However, anything that is not a complete vacuum is considered to be under some type of pressure. A gauge that employs total vacuum as the zero point and provides pressure measurements on an absolute scale can be utilised for extremely accurate readings, especially at very low pressures.

A remote indication or control system can receive the pressure information from sensors used in other pressure measuring techniques.

A device created to transform one or more sources of energy into mechanical energy is known as an engine or motor. Energy can be obtained from a variety of sources, such as potential energy, heat energy, chemical energy, electric potential, nuclear energy, and potential energy from the Earth's gravitational field, which is used to generate hydroelectric power (from nuclear fission or nuclear fusion). Heat engines are particularly important since many of these processes use heat as an intermediary energy source. Atmospheric convection cells are one example of a natural process that transforms environmental heat into motion (e.g., in the form of rising air currents). In addition to playing a part in numerous industrial processes like cutting, grinding, crushing, and mixing, mechanical energy is particularly crucial for transportation.

Mechanical heat engines use a variety of thermodynamic methods to transform heat into work. Perhaps the most typical example of a chemical heat engine is the internal combustion engine, which uses heat from the combustion of a fuel to rapidly pressurise the gaseous combustion products in the combustion chamber. This causes the products to expand and drive a piston, which turns a crankshaft. A response engine (like a jet engine) generates thrust by expelling reaction mass in accordance with Newton's third law of motion, unlike internal combustion engines. Electric motors, pneumatic motors, and clockwork motors in wind-up toys, in addition to heat engines, transform electrical energy into mechanical motion. The molecular motors in biological systems, such as the myosin in muscles, employ chemical energy to produce forces and, eventually, motion (a chemical engine, but not a heat engine).

Chemical heat engines which utilise air (ambient atmospheric gas) as a part of the fuel reaction are regarded as airbreathing engines. Although there are super-oxidizers suitable for use in rockets, such as fluorine, a more powerful oxidant than oxygen itself, they are required for chemical heat engines designed to operate outside of Earth's atmosphere (e.g., rockets, deeply submerged submarines); otherwise, the application must obtain heat by non-chemical means, such as through nuclear reactions.

Exhaust gases are produced by all chemically powered heat engines. The cleanest engines merely release water. Strict zero-emissions often refers to the absence of all emissions besides water and water vapour. By a precise definition, only heat engines that burn pure hydrogen as the fuel and pure oxygen as the oxidizer are considered to have zero emissions (in practice, one type of rocket engine). In all air-breathing engines, burning hydrogen with air causes a side reaction between ambient oxygen and nitrogen that produces negligible emissions of NO x, which is harmful even in small amounts. When a hydrocarbon (such alcohol or gasoline) is burned as fuel, copious amounts of CO2, a powerful greenhouse gas, are released into the atmosphere. A fuel cell may convert hydrogen and oxygen from the air into water without producing NO x as a byproduct, however this engine is an electrochemical one rather than a heat engine [7.8].

SUSTAINABLE GOALS

Human health and wellbeing depend on a clean environment. On the other side, poor management of waste and hazardous chemicals, contamination of the air and water, and these factors all work against good health. Natural disasters and other environmental shocks can have a significant negative influence on one's health, resulting in long-lasting disruptions in the provision of healthcare services as well as deaths, illnesses, injuries, and impairments.

Every day, renewable energy sources get more affordable, dependable, and effective. We must alter how we create and use energy because our current reliance on fossil fuels is unsustainable and bad for the environment. To combat climate change, one of the largest risks to our own survival, it is imperative that these new energy alternatives be put into place as soon as feasible.

The foundation of the global economy, which is based on production and consumption on a worldwide scale, is the continued exploitation of the planet's natural resources and environment.

Environmental deterioration has accompanied economic and social advancement throughout the past century, jeopardising the very systems that are essential to human survival and continued development.

Several numbers and facts:

• It is estimated that 1.3 billion tonnes, or almost $1 trillion, of the food produced each year ends up decaying in the dumpsters of consumers and retailers or spoiling as a result of inefficient harvesting and transportation methods.

• The globe might save US$120 billion a year if everyone converted to energy-efficient light bulbs.

• If there are 9.6 billion people on the earth by 2050, it might take almost three planets' worth of natural resources to support existing lifestyles.

The COVID-19 pandemic gives nations the chance to create recovery strategies that will buck the trend and alter our consumption and production habits in order to move toward a more sustainable future.

Sustainable production and consumption emphasise getting more done with fewer resources. It also aims to promote sustainable lifestyles, improve resource efficiency, and uncouple economic growth from environmental deterioration. In addition to helping to reduce poverty and accelerate the shift to low-carbon and green economies, sustainable consumption and production can have a significant positive impact.

Extreme weather events like heat waves, droughts, floods, and tropical cyclones are becoming more frequent and more intense as a result of climate change. These events are also worsening water management issues, decreasing agricultural output and food security, raising health risks, causing critical infrastructure to be damaged, and disrupting the delivery of essential services like water and sanitation, education, energy, and transportation.

Any substance that may be produced to react with other substances to release energy as thermal energy or to be used for work is referred to as a fuel. The idea was initially only applied to substances that could release chemical

energy, but it has subsequently been expanded to include other types of thermal energy, such as nuclear energy (via nuclear fission and nuclear fusion).

The combustion of a fuel takes place with the help of an oxidizer (often air) in a combustion chamber that is a crucial component of the working fluid flow circuit in an internal combustion engine (ICE or IC engine). In an internal combustion engine, a component is subjected to direct force as a result of the expansion of the high-temperature and high-pressure gases produced during combustion. Usually, the force is applied to a rotor, a piston, a turbine blade, or a nozzle. This force propels, moves, or powers whatever the engine is coupled to by converting chemical energy into useable kinetic energy across a distance.

The term "internal combustion engine" typically refers to an intermittently burning engine, such the more well-known two- and four-stroke piston engines, as well as variations like the six-stroke piston engine.

In contrast, energy is given to a working fluid that does not contain, is mixed with, or is contaminated by combustion products in external combustion engines like steam or Stirling engines. For external combustion engines, the working fluids can be air, hot water, pressured water, or even heated liquid sodium.

Natural gas or petroleum-based fuels like gasoline, diesel, or fuel oil are the most common sources of energy for ICEs. Compression ignition (CI) engines use biodiesel as a fuel, while spark ignition (SI) engines use bioethanol or ETBE (ethyl tert-butyl ether), which is made from bioethanol. Frequently, fossil fuels and renewable energy are combined. Rarely utilised hydrogen can be supplied from renewable energy sources or fossil fuels.

PREPARATION OF BIODIESEL

Natural gas, coal, and other conventional energy sources have limited reserves and aren't projected to last for very long. There is a growing interest in non-polluting, non-petroleum fuels due to the finite global reserves of fossil fuels and raw materials. Given that diesel and gasoline engines are the primary means of producing energy and moving people about, it is vital to find suitable substitute fuels that can be utilised in SI and CI engines without modification due to the accumulating effects of environmental pollution.

Recently, turmeric leaf oil has demonstrated promise as a biofuel. The qualities that are similar to regular diesel include higher calorific value and low viscosity. This report describes an experimental investigation into the performance evaluation of a CI engine running on magnetic fuel energizer and turmeric leaf oil. Oil is obtained from the discarded leaves of turmeric using the steam distillation technique. In addition to using 1 and 2 magnetic fuel energizers to test the performance of single cylinder, 4 stroke engines coupled to eddy current dynamometer loading with computerised result displays, three blends of turmeric leaf oil with diesel were made. While B10 and B20 mixes appeared to function well in certain areas, B30 with two magnetizers was shown to perform best overall among the blends.

The need for alternate and renewable energy sources has been sparked by the rapid depletion of petroleum ores, drastically rising fuel prices, and environmental issues. Developing nations like India are experiencing an even worse predicament. India currently holds the second-largest population in the world and comes in second on the list of countries that consume the most petroleum. India spends about 30% of its foreign currency on gasoline imports, which account for 70% of the country's fuel needs. In addition, the transportation and agricultural sectors are the main users of fossil fuels and producers of pollution. In order to avoid the negative effects of using conventional fuels, people have been compelled to look for alternatives. Many studies have been conducted recently to assess the effectiveness of various alternatives and determine whether they can replace conventional fuels whole or partially. Even though many alternatives have been studied, including ethanol, alcohols, cottonseed oil, palm oil, jatropha oil, mustard oil, etc., there has yet to be a viable replacement for diesel, leaving a vast amount of room for research in this field. This study describes yet another experimental endeavour to look for a good diesel substitute. It consists of diesel and turmeric leaf biodiesel combined in different amounts with different compression ratios. The analysis of numerous performance characteristics based on changing load situations and its impact on emissions makes up the results. The performance of neat diesel is then compared to these findings to demonstrate its viability [5,6].

Production of Turmeric

The analysis of numerous performance characteristics based on changing load situations and its impact on emissions makes up the results. The performance of neat diesel is then compared to these findings to demonstrate its viability.

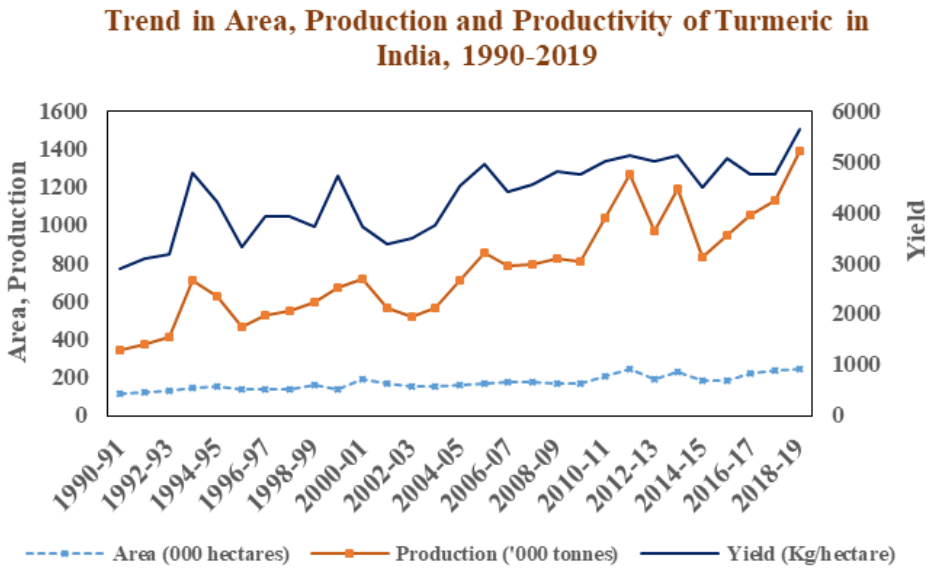

FIGURE 1. Trend of production of turmeric in India.

One pharmacy student promoted the use of turmeric leaf oil as a potential biodiesel substitute. When he discovered that the leaves could burn readily, he posted a related article. It suddenly occurred to me that the turmeric leaves might contain some oil. The viscosity of the turmeric leaf oil is lower than that of gasoline. As a result, it can burn even more effectively than gasoline, perhaps improving performance.

Extraction of Turmeric Leaf Oil

Construction

1] Boiler: A boiler is a piece of machinery that functions as a closed vessel to create steam from the water inside. Combustion is used to transform chemical energy from a fuel source, such as oil or gas, into heat in order for this to occur. The water inside is then heated, which raises the pressure and eventually turns the liquid state of the water into steam.

2] A mechanical device known as a burner controls the burning of a gas or liquid fuel.

3] Wire Mesh: To ensure that the most surface area is exposed to the steam, the turmeric leaves are kept spread out in the wire mesh.

4] Water Supply Cock: This device provides the system with fresh water.

5] Water Level Indicator: This device shows the amount of water in the boiler.

6] Temperature Gauge: The temperature gauge displays the boiler's current temperature. Because we don't want the temperature to rise above the oil's flash point. It might result in a dangerous accident.

7] Pressure Gauge: Pressure gauges, pressure metres, and vacuum gauges are all terms for instruments used to measure and show pressure in an integral unit.

8] Pressure Relief Valve: If pressure in a system builds up, it could disrupt processes, cause instrument or equipment failure, or even start a fire. Relief valves, also known as pressure relief valves (PRV), are used to manage or limit the pressure in a system. By enabling the pressured fluid to exit the system through an auxiliary path, the pressure is reduced.

9] Steam Control Valve: A control valve is a valve that is used to regulate fluid flow by changing the size of the flow path in response to instructions from a controller. This makes it possible to directly manage flow rate and, as a result, process variables like pressure, temperature, and liquid level.

10] Condenser: A condenser is a heat exchanger used in systems requiring heat transfer to condense a gaseous substance into a liquid condition via cooling. By doing this, the substance releases its latent heat and transfers it to the environment.

11] Steam Carrying Pipe: In the system, steam is transported through these pipes.

12] Tank: After the condenser completes its task, the tank is utilised to store the cooled water and oil mixture. Due to variances in densities, the oil and water separate in it.

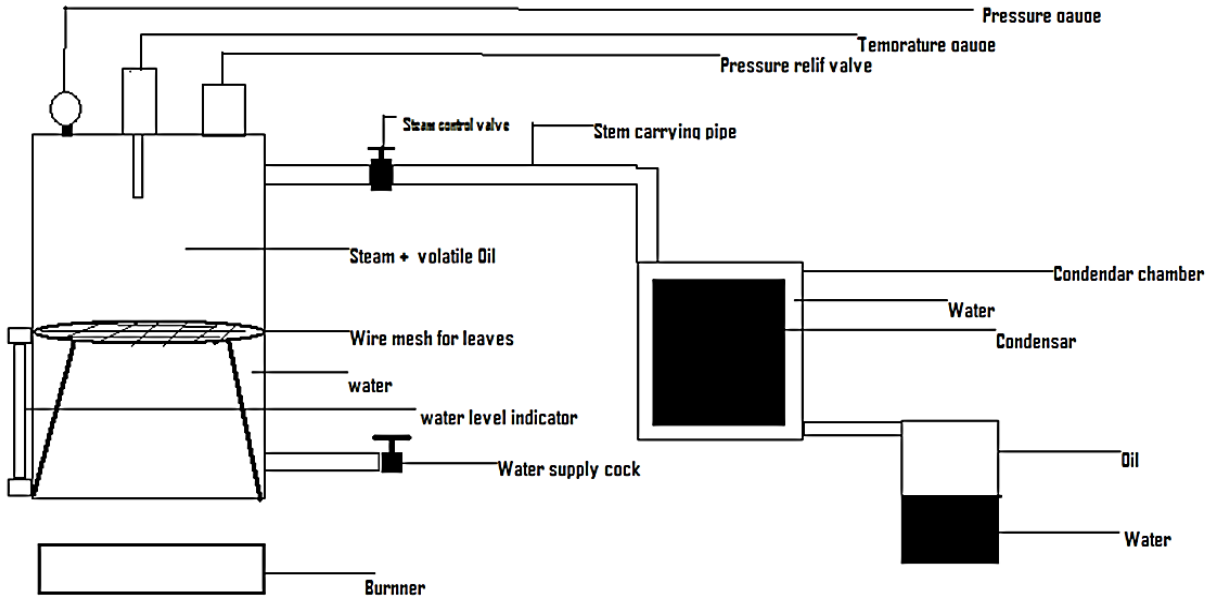

FIGURE 2. Construction of Turmeric leaf oil extraction plant.

Process

Selective distillation underlies the extraction of turmeric oil. The steps that are taken are as follows: -

1. To start burning charcoal, wood is placed into the chamber, lit, and allowed to develop a strong, steady flame.
2. According to the need, water is poured into the boiler until the desired level is reached.
3. Following completion of this step, layers of turmeric leaves are added to the wire mesh.
4. Water that has been heated past the boiling point turns into steam. The layers of turmeric leaves atop wire mesh will then let this steam pass through them.
5. The oil pods in the leaves will be broken and exposed by the hot steam. The oil will be turned into fumes because it is a volatile substance.
6. This hot steam and oil vapour mixture will now travel through pipes to the condenser, where it will be condensed.
7. In the collection chamber, water and oil are combined after condensation. Water and oil are now kept apart due to the variations in their densities. They could be recovered independently in the future.

Preparation of Waste Cooking Oil

Vegetable oil has fatty acids, water, sterols, phospholipids, odorants, and contaminants when it is taken from the resources. Direct injection into a diesel engine could result in a variety of serious issues. High viscosity, low volatility, and poor cold low characteristics could all contribute to this. These could cause piston ring sticking, injector choking, engine deposits, etc. As a result, in order to make the oil suitable for the engine without modifying the current components, several chemical treatments must be performed on it. Various chemical techniques are employed for this aim. The following are the efficient techniques employed to achieve the goal:

1) Pyrolysis
2) Micro-emulsification
3) Dilution
4) Trans-esterification

Trans-esterification Process

As seen in the image, there are a variety of reactions and processes involved in the trans-esterification process. The following are the steps that make up the trans-esterification process:

1) Mixing the alcohol and catalyst: A flask is filled with a specific amount of methanol and a measured amount of

NaOH, which serves as the catalyst.

2) Reaction: After adding this mixture, the appropriate vegetable oil is added, and the mixture is heated to between 60 and 80 degrees Celsius. The lipids become esters as a result of this process. It is occasionally possible to add more fuel to ensure that all of the lipids are converted to esters.

3) Biodiesel and glycerin are separated after the reaction is complete, leaving two products: biodiesel and glycerin. The kind and quantity of vegetable oil affects how much glycerin is present.

4) Alcohol removal: The biodiesel and glycerin mixture is heated to 60 °C, creating steams that separate the glycerol from the mixture. Because it is sufficiently dry, methanol may be pumped back into the reaction.

5) Glycerin neutralisation: The glycerin byproduct needs to be neutralised with an acid since it includes an excessive amount of catalyst and soap.

6) Methyl ester wash: This step guarantees that all undesirable components have been completely removed from the biodiesel, preparing it for use in diesel engines.

Only when the amount of free fatty acids (FFA) in vegetable oil is less than 4% is the single-phase technique appropriate. The mixture is heated to 65°C and kept there using a determined amount of methanol as the alcohol and NaOH as the catalyst. Double phase technique is appropriate when there are more than 4% of fatty acids present. It entails taking a mixture of H2SO4 and methanol, adding and supplying it to the esterification process, and then heating and maintaining it at 65°C. The trans-esterification procedure is then carried out when this is passed on.

PERFORMANCE EVALUATION USING CFD

Computational fluid dynamics (CFD) is a field of fluid mechanics that analyses and resolves issues involving fluid flows by using numerical analysis and data structures. The computations necessary to simulate the fluid's free-stream flow and its interactions with surfaces constrained by boundary conditions (both liquids and gases) are done on computers. Better answers can be found with high-speed supercomputers, which are frequently needed to address the most challenging issues. Software that enhances the precision and speed of complicated modelling scenarios, such as transonic or turbulent flows, is the result of ongoing research. Initial testing of such software is frequently carried out with the use of experimental equipment like wind tunnels. Additionally, a comparison can be made using analytical or empirical examination of a specific topic that has already been completed. Full-scale testing, like flight tests, are frequently used for a final validation [8].

Aerodynamics and aerospace analysis, hypersonics, weather simulation, natural science and environmental engineering, industrial system design and analysis, biological engineering, fluid flows and heat transfer, engine and combustion analysis, and visual effects for movies and video games are just a few of the research and engineering problems to which CFD is applied.

The Navier-Stokes equations, which define many single-phase (gas or liquid, but not both) fluid flows, serve as the fundamental foundation for almost all CFD problems. To obtain the Euler equations, these equations can be made simpler by getting rid of terms that describe viscous actions. The full potential equations can be obtained through further simplification by omitting variables that describe vorticity. Finally, these equations can be linearized to get the linearized potential equations for minor perturbations in subsonic and supersonic flows (but not transonic or hypersonic).

In the past, techniques were initially created to resolve the linearized potential equations. In the 1930s, conformal transformations of the flow around a cylinder to the flow around an air foil were used to develop two-dimensional (2D) approaches.

Lewis Fry Richardson's calculations, which used finite differences and separated the physical space into cells, are among the earliest types of computations that resemble current CFD. Despite their spectacular failure, these calculations laid the groundwork for contemporary CFD and numerical meteorology, along with Richardson's book Weather Prediction by Numerical Process. In reality, early CFD simulations performed with an ENIAC in the 1940s used techniques very similar to those described in Richardson's 1922 book.

The advancement of three-dimensional techniques was accelerated by the power of the computers. In the T3 group at Los Alamos National Lab, modelling fluid flow as it is governed by the Navier-Stokes equations most likely began. Francis H. Harlow, who is regarded as one of the founders of CFD, served as the group's leader. This group created several numerical simulation techniques for transient two-dimensional fluid flows between 1957 and the late 1960s, including the particle-in-cell method, the fluid-in-cell method, the vorticity stream function method,[8] and the marker-and-cell method. Strongly contorting incompressible flows were initially handled by Fromm's vorticity-stream-function technique for 2D, transient, incompressible flow [9,10].

Using computer assisted design, the problem's geometry and physical boundaries can be determined during pre-processing (CAD). From there, the fluid volume (or fluid domain) can be derived when the data has been appropriately processed (cleaned-up).

Separate cells make up the fluid's portion of the volume (the mesh). The mesh may be organised or unstructured, uniform or non-uniform, and composed of a mix of hexahedral, tetrahedral, prismatic, pyramidal, or polyhedral pieces.

The definition of physical modelling includes, for instance, the equations for fluid motion, enthalpy, radiation, and species conservation.

Conditions for boundary are specified. This entails defining the behaviour and characteristics of the fluid at each boundary of the fluid domain. The initial conditions are also specified for situations that are momentary.

The equations are iteratively solved as a steady-state or transient as the simulation begins.

The analysis and visualisation of the final solution are done using a postprocessor.

The premier Computational Fluid Dynamics (CFD) programme, Ansys Fluent, is renowned for its accurate and advanced physics modelling.

• Create a high-quality mesh utilising the task-based meshing procedures offered by Fluent.

Drag and drop, keyboard shortcuts, and text user interface commands increase productivity. Best practises, hints, and tricks enhance your entire simulation experience. Quick simulation setup with optimised application workflows and an immersive GUI. Interactive post-processing.

A Computational Fluid Dynamics (CFD) code called Ansys Fluent is used to simulate chemical reactions, heat transfer, and fluid flow. Interfaces to other pre- and post-processing software are included in the FLUENT package.

Engineers and analysts utilise computational fluid dynamics (CFD) simulation tools to make informed predictions about the behaviour of liquids and gases. CFD offers deeper understanding of fluid flow design performance while reducing the demand for physical prototypes.

Results from ANSYS fluid dynamics solutions can be trusted. The method offers effective parallel calculations from a few to thousands of processor cores and is extremely scalable. The full-featured ANSYS CFD-Post post-processing tool can be used with Fluent or CFX to do extensive quantitative analysis or produce stunning visualisations and animations.

Geometry (using solid works)

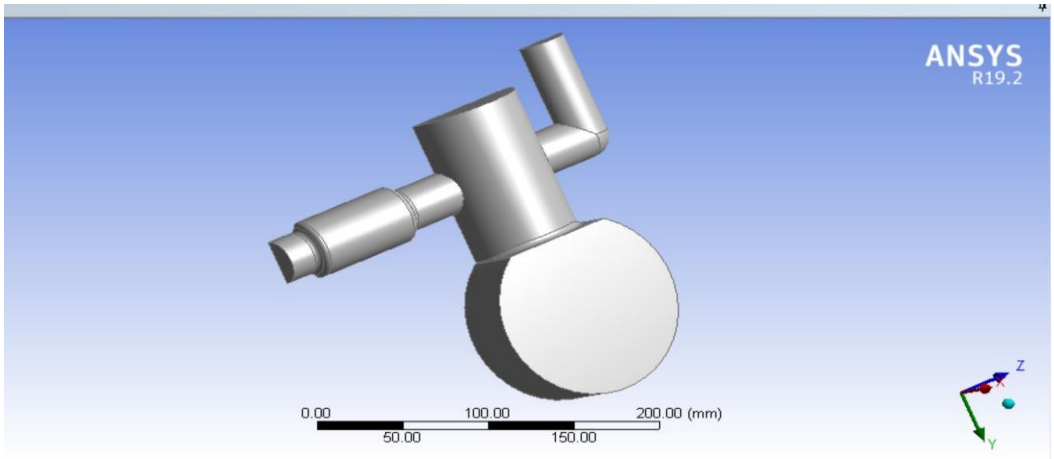

FIGURE 3. Geometry of Single Cylinder Engine

Solidworks software was used to build the geometry (3D model). One CAD (Computer Aided Design) programme for 3D part modelling for mechanical design is Solid Works. The popular mechanical design automation software Solid Works enables designers to swiftly sketch out concepts, play with features and measurements, and create models and in-depth drawings.

Solid Works is a user-friendly programme that makes it simple to design any geometry. The mechanical engineering and design fields make extensive use of this 3D modelling CAD software.

Meshing

Meshing is the process of transforming amorphous shapes into "elements," which are more discernible volumes. To start the simulation process, you must upload a geometry or CAD model into a programme like Ansys Mechanical before you can start meshing.

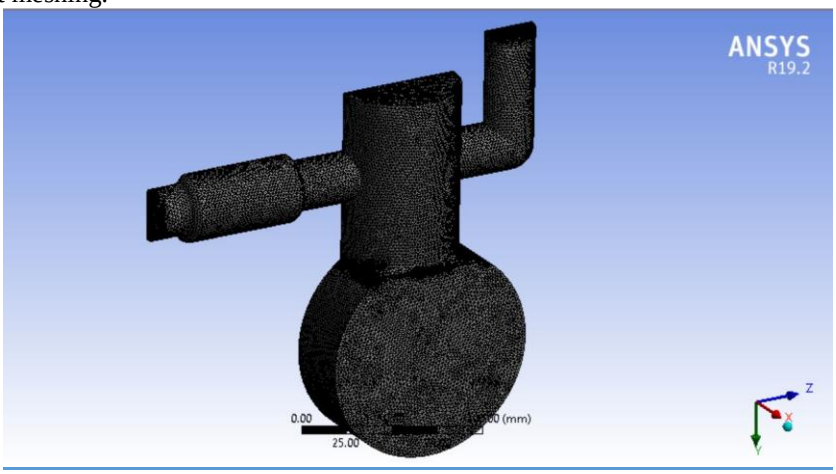

FIGURE 4. Meshing Of Geometry

Analysis on Waste Cooking Oil

In Batu Pahat, Johor, Malaysia, waste cooking oil has always been a problem for the environment. The WCO can be changed into biodiesel to solve this issue. This initiative will reduce costs as well as environmental impact.

Since feedstock prices account for roughly 70–95% of the total cost of producing biodiesel, biodiesel made from waste cooking oil (WCO) can lower production costs. There are at least five factors that support the development of biodiesel, despite the fact that it cannot completely replace diesel fuel made from petroleum.

• It reduces, though won't completely eliminate, the nation's reliance on imported petroleum.

• It offers a market for excess production of vegetable oils and animal fats.

• Because of its closed carbon cycle, biodiesel is renewable and does not cause global warming. When compared to diesel fuel made from petroleum, biodiesel's overall CO2 emissions were reduced by 78%, according to a life cycle analysis.

• When compared to conventional diesel fuel, biodiesel emits less carbon monoxide, unburned hydrocarbons, and particle pollutants. It can transform fuel with poor lubricating characteristics, such as contemporary ultra-low-sulphur diesel fuel, into acceptable fuel when added to standard diesel fuel in an amount equating to 1-2%.

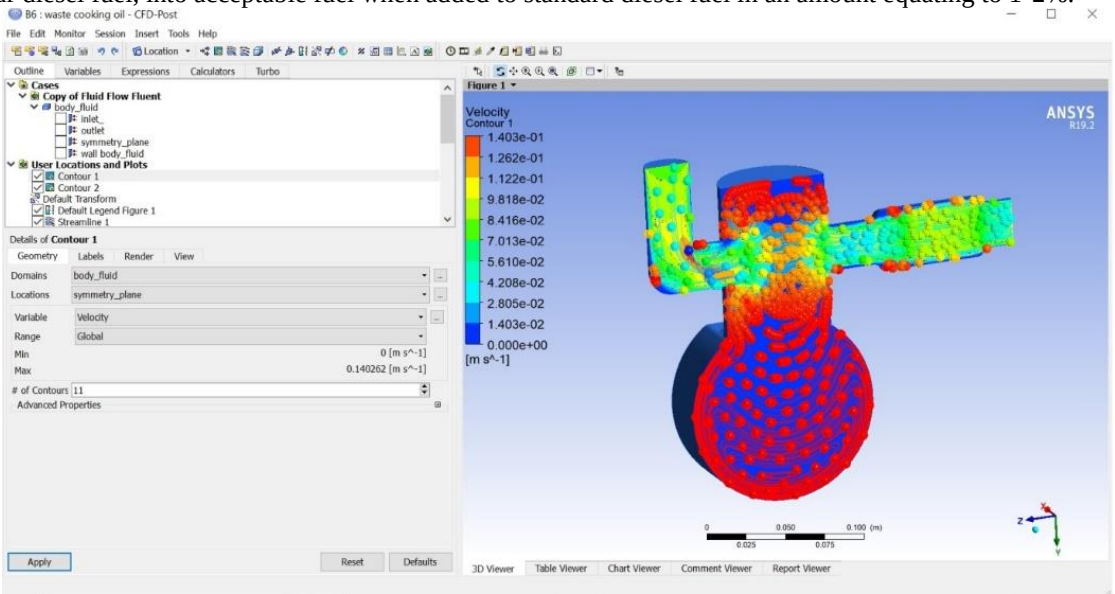

FIGURE 5. waste cooking oil in velocity distribution

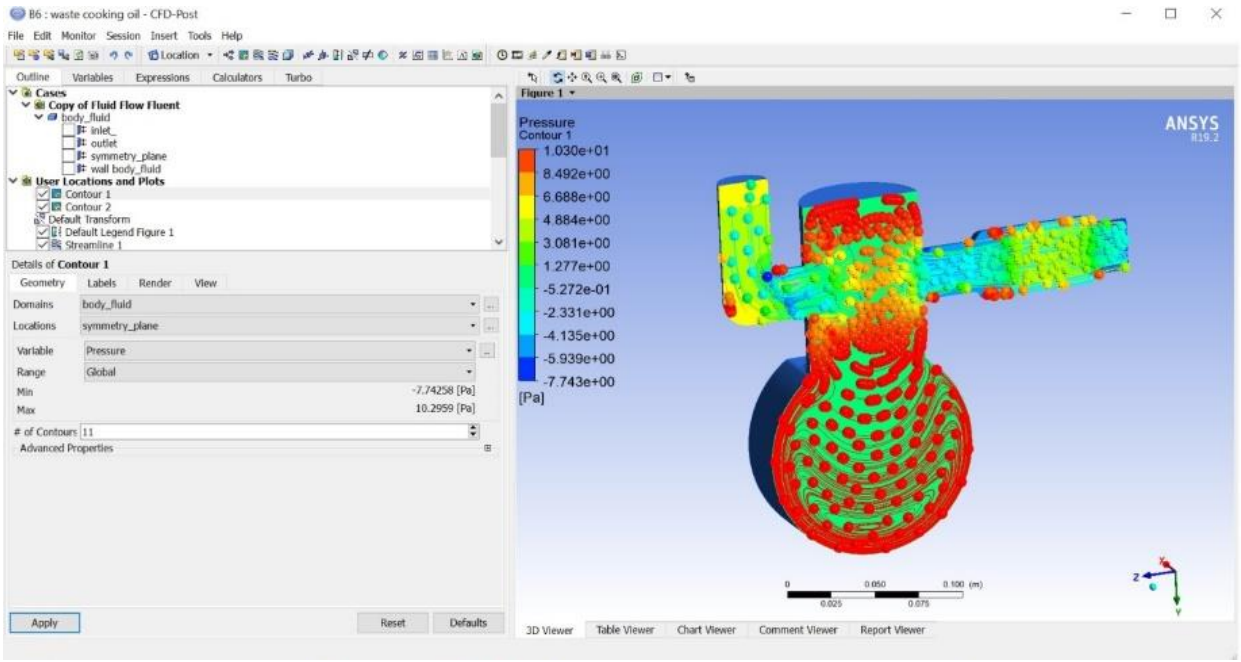

FIGURE 6. waste cooking oil in pressure distribution

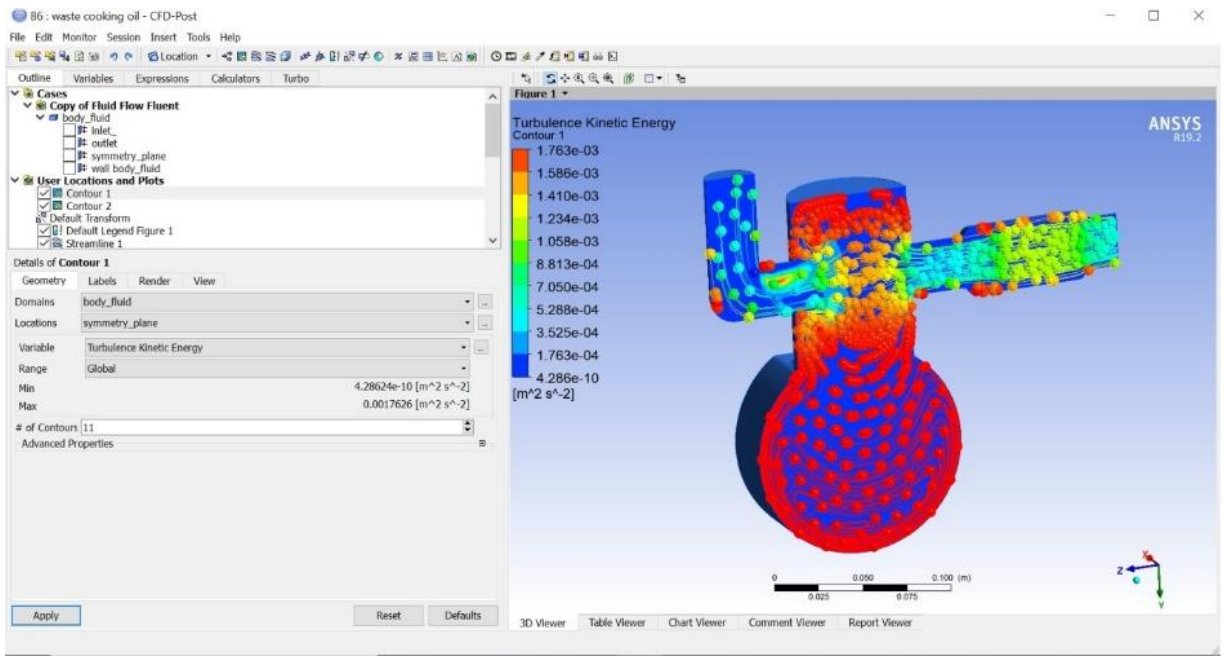

FIGURE 7. waste cooking oil in kinetic energy

Analysis on Turmeric Leaf Oil

After removing the turmeric rhizome, farmers are left with the waste product of turmeric leaves. In the current study, hydro distillation was used to extract oil from the leaves of Curcuma longa L. (Family - Zingiberene). For preliminary physicochemical and phytochemical analyses, the extracted oil was examined.

Terpenes were found in the turmeric leaf oil after a phytochemical analysis. Oil from the extracted turmeric leaf was used in two- and four-stroke engines. When using turmeric oil instead of gasoline, an engine removes fewer environmentally damaging products. The usage of turmeric leaf oil as a substitute biofuel for gasoline has been determined.

Since it is made from the leaf, which farmers discard after collecting the rhizomes, and water is used as the extraction solvent, turmeric leaf oil is particularly cost-effective. Second, turmeric leaf oil can be securely stored at room temperature since it is less flammable and volatile.

Consequently, turmeric oil can be utilised as a substitute biofuel for gasoline. To boost oil yield and investigate its use as biofuel, more research and scientific studies must be conducted.

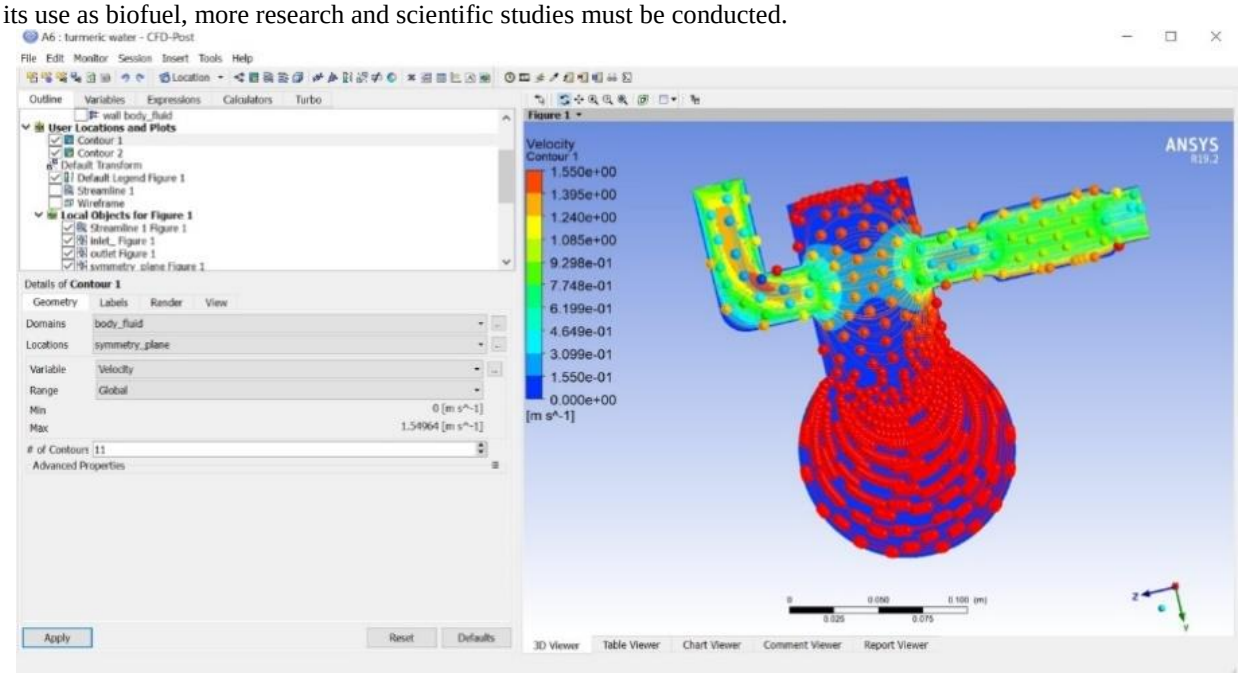

FIGURE 8 Turmeric leaf oil in velocity distribution

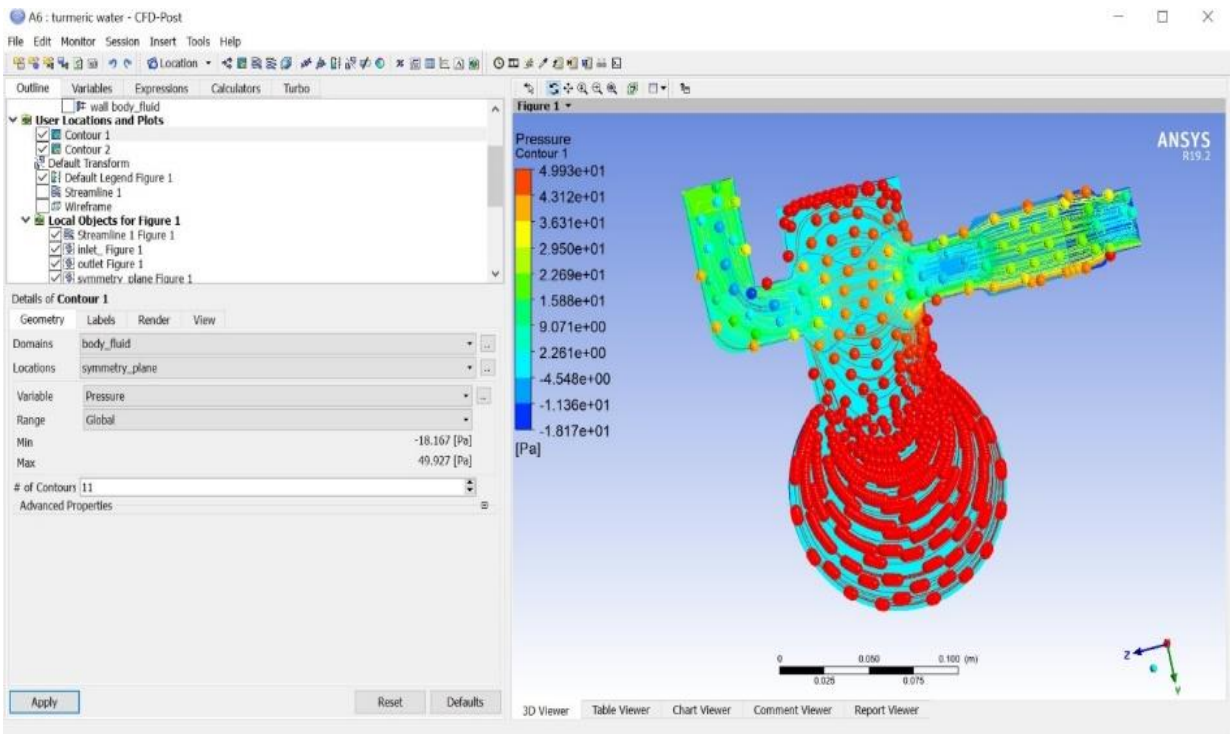

FIGURE 9 Turmeric leaf oil in pressure distribution

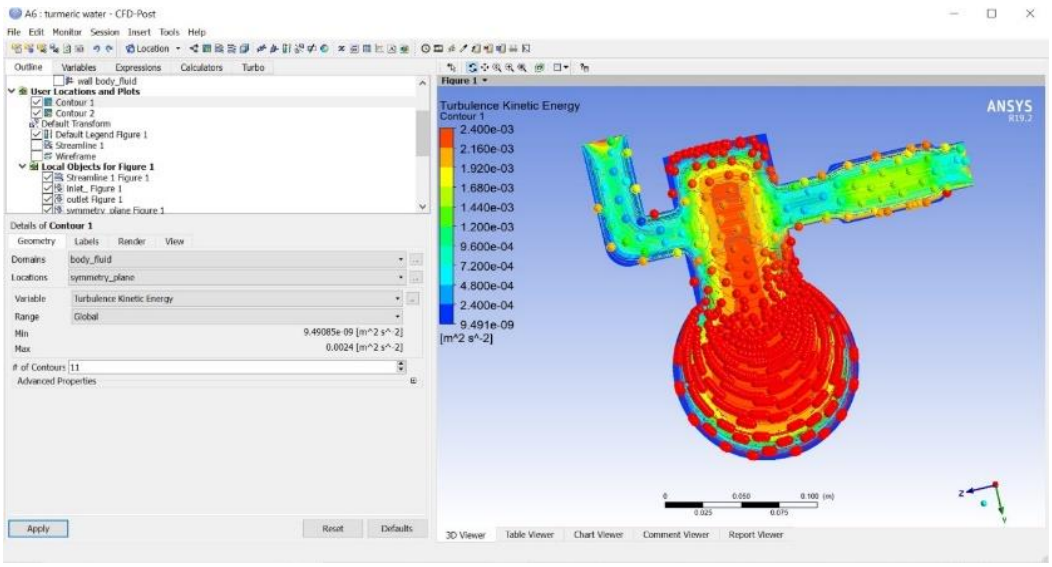

FIGURE 10 Turmeric leaf oil in kinetic energy

Analysis on Diesel Fuel

The most popular type of diesel fuel is a particular fractional distillation of petroleum fuel oil, however non-petroleum alternatives including biodiesel, biomass to liquid, and gas to liquid diesel are being researched and accepted more frequently. In some academic circles, petroleum-derived diesel is increasingly referred to as Petro diesel to distinguish these varieties.

Diesel fuel comprises hydrocarbons with boiling points between 180 and 360 degrees Celsius (356 and 680 degrees Fahrenheit), making it generally easier to refine from petroleum than gasoline. Sulfur removal requires further refining, which occasionally results in greater costs.

Although not all diesel engines require diesel fuel, high-speed diesel engines, particularly those found in motor vehicles (such as cars and trucks), tend to use it. For instance, heavy fuel oils are often used in place of diesel fuel in big two-stroke watercraft engines, and some types of diesel engines

Diesel fuel viscosity requirements are typically given at 40 °C. Diesel fuel has a drawback in cold areas because it becomes more viscous as the temperature drops and becomes a gel (see Compression Ignition - Gelling) that prevents it from flowing through fuel systems. Additives are used in special low-temperature diesel to keep it liquid at lower temperatures.

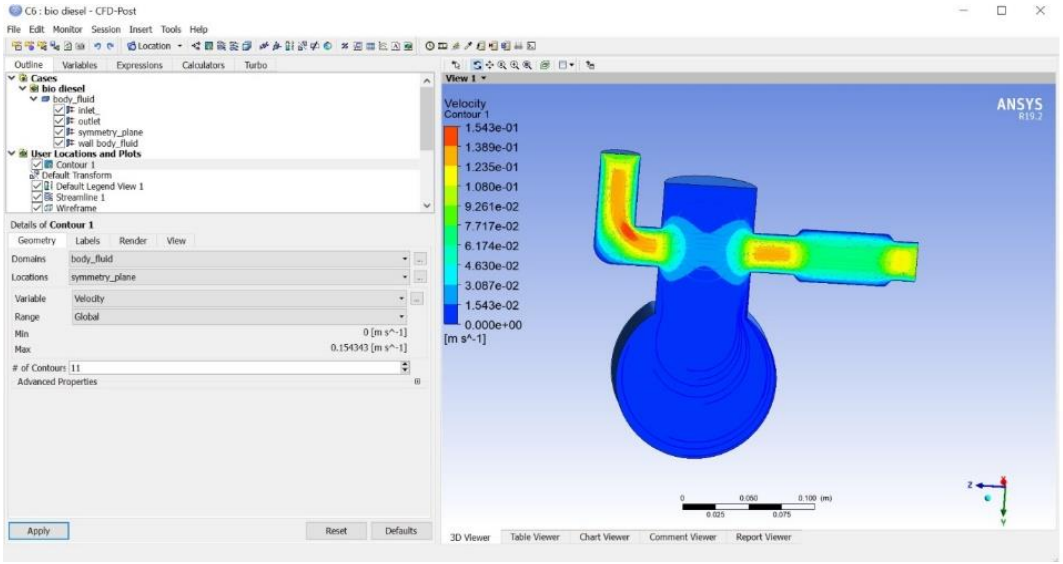

FIGURE 11 Diesel in velocity distribution

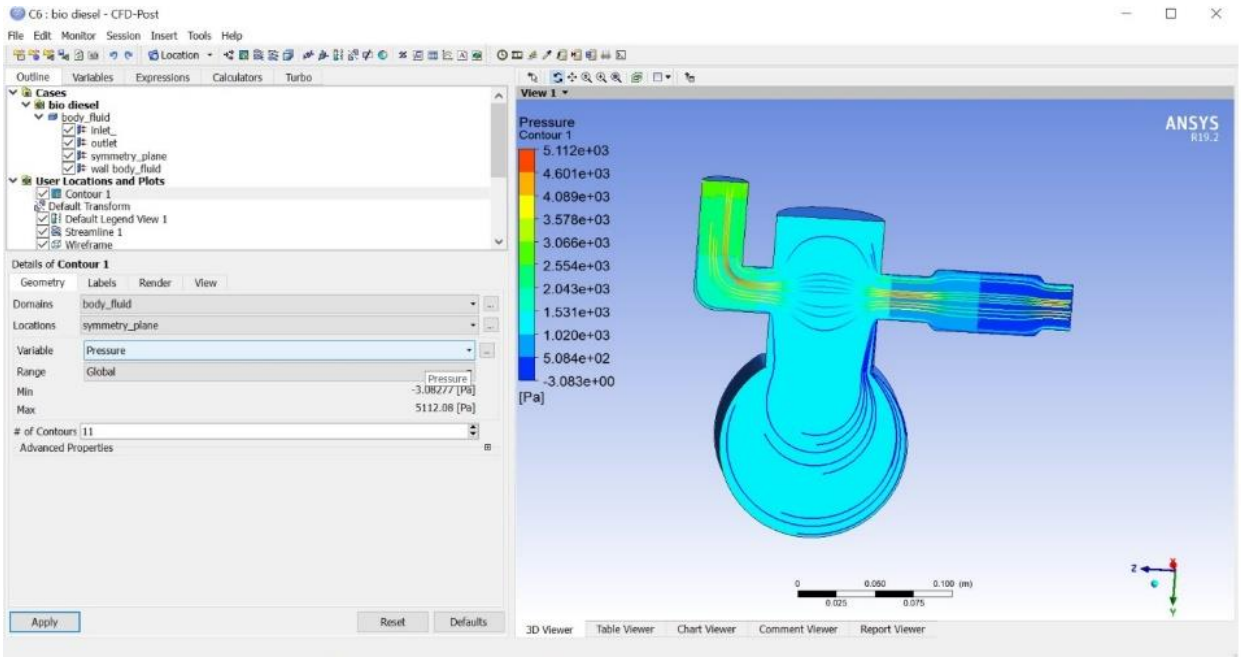

FIGURE 12 Diesel in pressure distribution

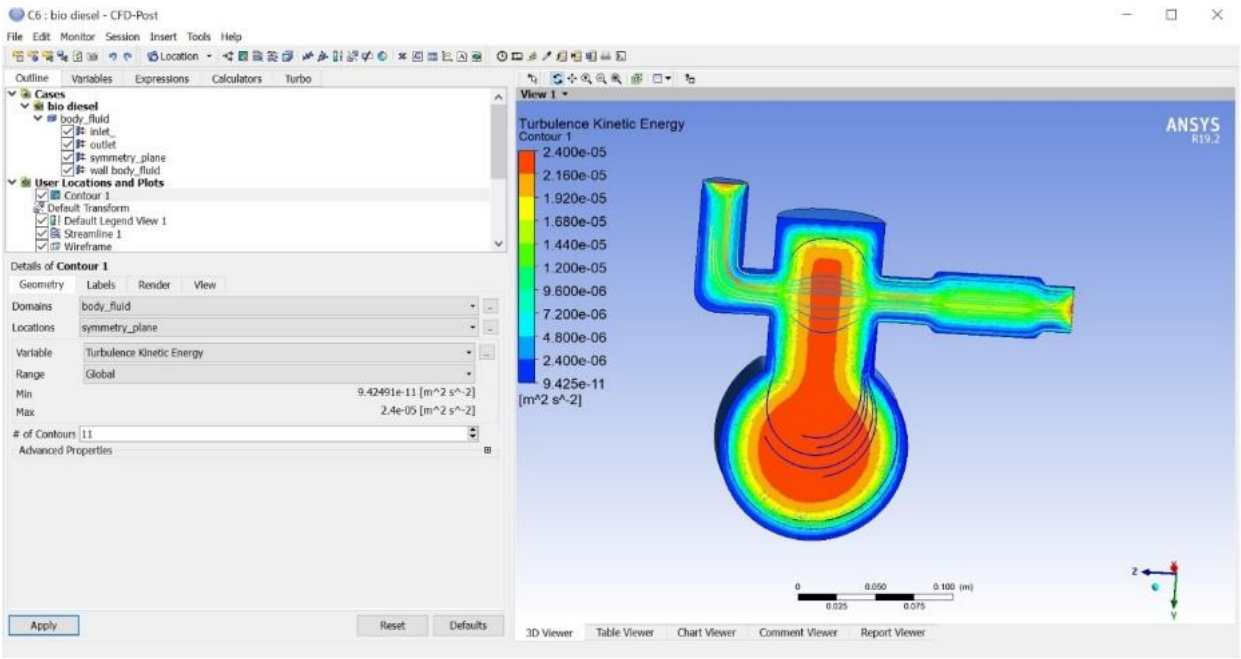

FIGURE 13 Diesel in kinetic energy

RESULT AND DISCUSSION

Kinetic Energy

- Fig. 14 Gives information how kinetic energy varies in different types of fuels (namely Diesel, Turmeric Leaf Oil, Waste Cooking Oil).
- In Fig. 14 it shows maximum amount of Kinetic energy during the flow is of Turmeric leaf oil.
- There is maximum variation in Turmeric leaf oil.

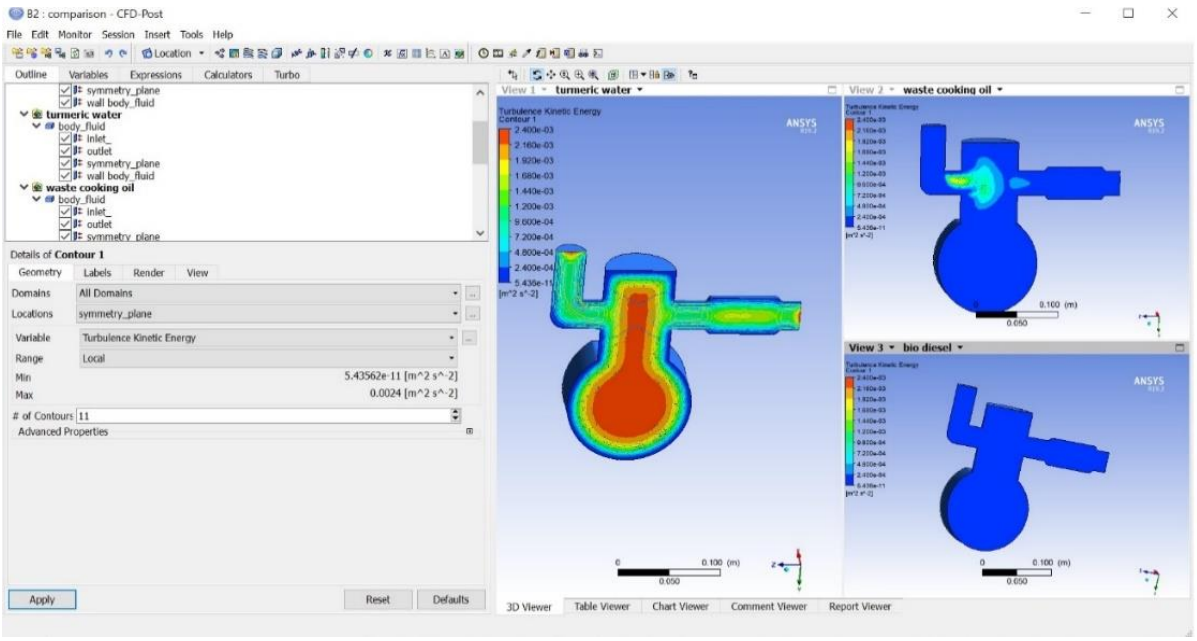

FIGURE 14 Comparision of kinetic energy

Pressure

• Fig. 14 illustrates the differences in kinetic energy between various fuel types (namely Diesel, Turmeric Leaf Oil, Waste Cooking Oil).
• The largest quantity of kinetic energy during the flow of turmeric leaf oil is shown in Fig. 14.
• Turmeric leaf oil has the most variety.

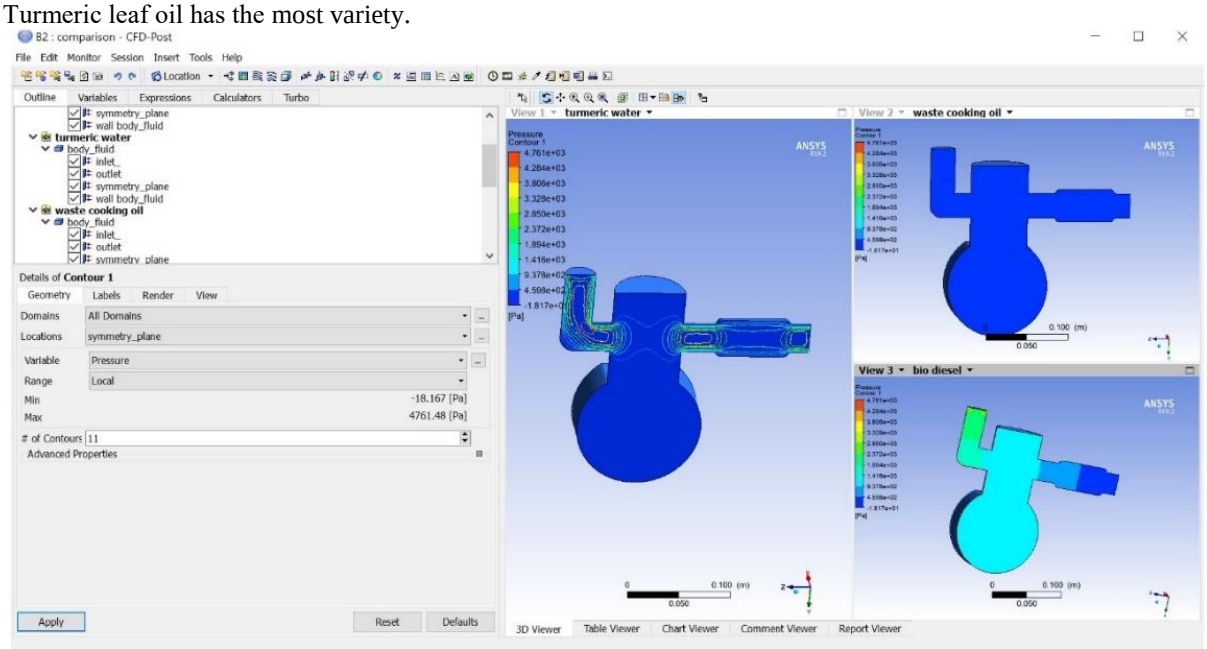

FIGURE 15 Comparision of pressure

Velocity

• Fig. 16 illustrates the fluid flow inside a single-cylinder diesel engine.
• It essentially provides information on how the velocities of various fuel kinds are compared.
• The velocity of diesel and turmeric leaf oil has a striking similarity in pattern.
• Due to its numerous similarities to diesel during flow, it may be argued that turmeric leaf oil is the fuel that can best replace it.

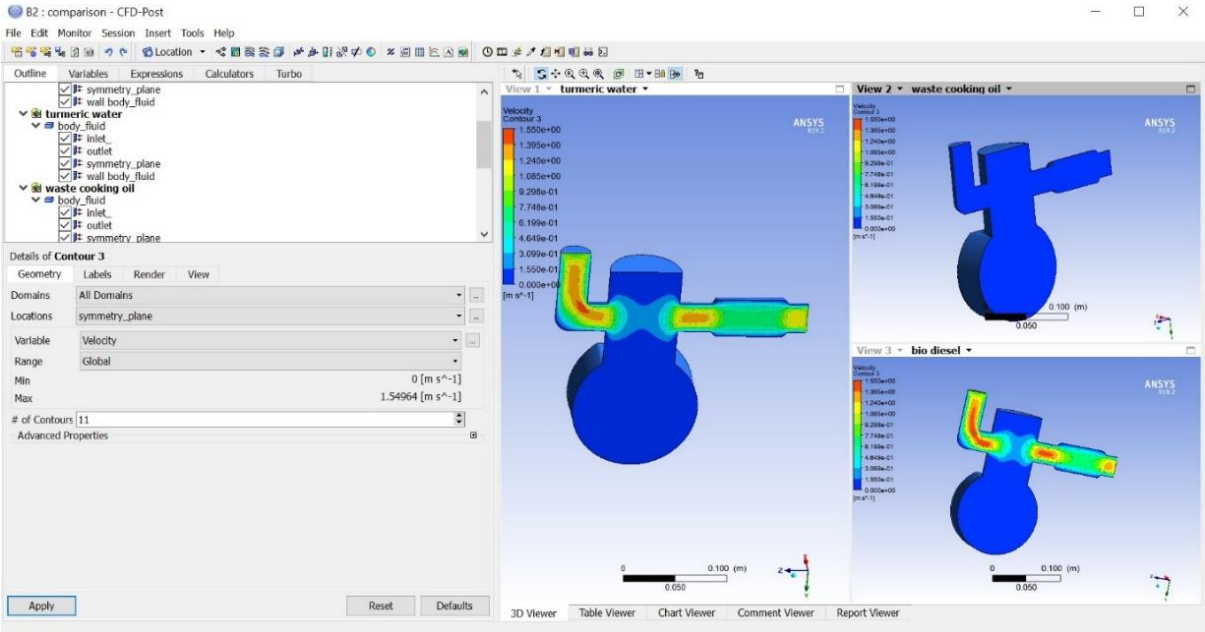

FIGURE 16 Comparison of velocity

CONCLUSION

The single-cylinder diesel engine is subjected to an analytical analysis. Diesel, turmeric leaf oil, and used cooking oil were the three types of fuels that received the most attention during the analysis. The analysis produced results for Kinetic Energy, Pressure, and Velocity for each of the three fuels. When a fluid of different density and viscosity is flown through a geometry (single cylinder diesel engine), through which different results are received, this study essentially indicates numerous parameters.

The major goal of this work was to identify the optimum replacement for the currently used conventional resource, diesel. The best oil that can substitute diesel, based on all of the comparisons made above of different factors, is turmeric leaf oil.

Diesel and Turmeric Leaf Oil both have similar flows in terms of speed. Additionally, Turmeric Leaf Oil has an advantage over other oils due to its higher kinetic energy.

As a result of the analysis above, it can be concluded that turmeric leaf oil, which exhibits many similarities during flow, is the fuel that can best substitute diesel.

Engines in automobiles generate a lot of power. The car can be driven easily and at high speeds because to this power. Techniques to recover power are crucial in the modern world of reduced fuel usage and attempts to recover every watt of power lost in the vehicle.

The following changes can be made to the current work to significantly improve the output:

- Flow is demonstrated using an exact duplicate of the engine.
- Working on the engine practically makes concepts and results more understandable.

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