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The Numerical analysis of Biodieselapplying in IC engine

[1]T Banu, [2]P.Saranya, [3]Rosy Subha Hannah

[1,2,3]Assistant Professor, Department of Aeronautical Engineering, Nehru Institute of Technology, Coimbatore.

nits.shibin@nehrucolleges.com[1]

Abstract: Most of the vehicles around us are using the diesel to propel them. Developing highly efficient engine is very much complicated. Development procedure involves so many experimental and CFD works. When the experiments go towards to find out the usage of karonja, waste cooking oil blended with Biodiesel in diesel engine, the role of CFD is so much important. This work involves the simulation of Diesel Engine with Diesel and Bio-diesel like B20. B20 (20% & biodiesel,80% petroleum diesel) is the most common biodiesel blend in the United States. B20 is popular because it represents a good balance of cost, emissions, cold-weather performance, materials compatibility, and ability to act as a solvent. Cylinder pressure and temperature between the petroleum diesel and B20 will be investigated through CFD. ANSYS FLUENT will be used for this purpose. Grid generation will be done by ICEMCFD. K-Ɛ turbulence model will be used. Computer simulations of the working process of internal combustion engine are usually performed using multi-dimensional computational fluid dynamics (CFD) and/or advanced one-dimensional gas dynamics and thermodynamic models.

Introduction

Due to the increase in scarcity of petroleum resources all over the world, we are driven to search for some alternative fuels to meet the demand of fuels among the various alternative fuels like LPG, bio diesel, hydrogen, ethanol, battery etc, bio diesel finds a remarkable and significant position.

Bio diesel (fatty acid alkyl esters) is a cleaner burning diesel replacement fuel made from natural, renewable sources such as new and used vegetable oils and animal fats, just like petroleum diesel, bio diesel operates in compression-ignition engines. Blends of up to 20% bio diesel (mixed with petroleum diesel fuels) can be used in nearly all diesel equipment and are compatible with most storage and distribution equipment these low-level blends (20% and less) generally do not require any engine modification, however, users should consult their OEM (original equipment manufacturers) and engine warranty statement. Bio diesel can provide the same payload capacity and as diesel.
Bio diesel is simple to use, biodegradable, nontoxic, and essentially free of simpler and aromatics.

Emissions

Using bio diesel in a conventional diesel engine substantly reduces emissions of unburnt hydrocarbons, carbon monoxide, sulfates, polycyclic aromatic hydrocarbons and particulate matter. These reductions increase as the amount of bio diesel blended into diesel fuel increases. The best emission reductions are seemed with B-100.

Problem identification

Most of the vehicles around us are using the diesel to propel them. Developing highly efficient engine is very much complicated. Development procedure involves so many experimental and CFD works. Cost of fuel is increasing in day to life. And also the high calorific value fuels will produce more emission.so we are in the need of using alternate fuels. the alternate fuels are available with low cost and also which produce low amount of emission.

Biodiesel

Biodiesel is the name of a clean burning alternative fuel, produced from domestic, renewable resources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics. Biodiesel is made through a chemical process called transification whereby the glycerin is separated from the fat or vegetable oil.

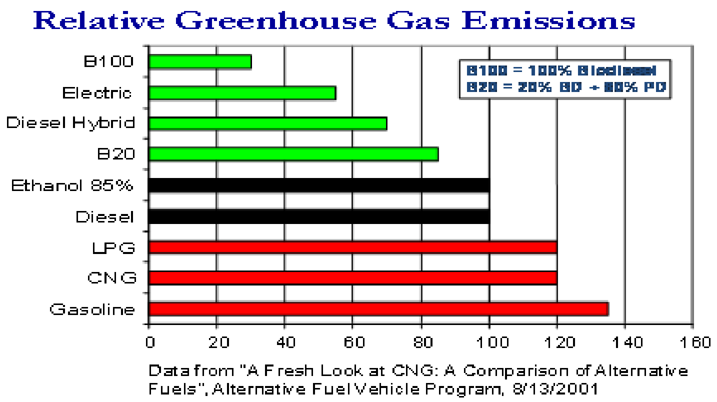

Figure: 1 Emission comparison of alternative fuels

Biodiesel generally refers to the mono-alkyl esters of fatty acids, and can be derived from a variety of vegetable oils and animal fats. Stated simply, it is the product of a chemical reaction between the basic feedstock (vegetable oil or animal fat) and alcohol (in commercial applications usually methanol) in the presence of a catalyst (usually sodium or potassium hydroxide) (Gerpen). The reaction results in a compound called fatty acid alkyl ester (the biodiesel product) and a byproduct called glycerol.

In general, the energy yield of the biodiesel process is significantly greater than that of other bio-fuels (for example, ethanol). Current technology yields about 3.2 units of energy for every unit of energy consumed in the production process. In comparison, the return from ethanol production is less than 1.5 units of energy for each unit consumed in the manufacturing process.

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The general conversion of feedstock to biodiesel is:

100 lbs. of feedstock + 10 lbs. of methanol → 100 lbs. of biodiesel + 10 lbs. of glycerol

1. •Bio diesel is the most efficient and valuable alternative source of diesel engine fuel.
2. •It is eco-friendly and its performance is exactly similar to the petro-diesel.
3. •It can be produced from renewable biological sources like edible and non-edible oils.
4. •Fuels derive from renewable biological resources for use in diesel engines are known as Biodiesel Fuels.
5. •Animal fats, virgin and recycled vegetable oils derived from crops such as soybeans, canola, corn, sunflower, and some 30 others can also be used in the production of biodiesel fuel. Tall oil produced from wood pulp wastes is yet another possible feedstock source.
6. •Biodiesel is a pure 100% fuel conforming to ASTM Specifications D 6751.
7. •It is referred to as B100 or "neat" biodiesel. A biodiesel blend is pure biodiesel blended with petrol diesel. Biodiesel blends are referred to as BXX. The "XX" indicates the amount of biodiesel in the blend.

In India, Jetropha, Karanja and Mahua trees has great potential for production of bio-fuels like bio-ethanol and biodiesel. The annual estimated potential is about 20 million tones per annum. In India, out of cultivated area ,about 175 million hectares are classified as waste and degraded land, We can cultivate these crops very easily on this land. Biomass can be converted directly into liquid fuels. I.e .transportation needs (cars, trucks, buses, airplanes, and trains).The two most common types of biofuels are ethanol and biodiesel.

The petroleum products play on important role in our modern life. The costs of these products depend on international markets and petroleum reserves are limited to nearly 30 years. India is projected to become the third largest consumer of transportation fuel in 2020, after the USA and China, with consumption growing at an annual rate of 6.8% from 1999 to 2020. India's economy has often been unsettled by its need to import about 70% of its petroleum demand from the highly unstable and volatile world oil market (India, 2004). The acid rain, global warming and health hazards are the results of ill effects of increased polluted gases like Sox, CO and particulate matter in atmosphere.

Selection of fluids

Karanja oil

Karanja oil was collected from a private firm Rural Community Action Centre, Erode and filtered for solid impurities. The karanja oil was transesterified using methanol in the presence of sodium hydroxide in the pilot biodiesel plant. Free Fatty Acid of karanja oil used in the pilot biodiesel plant was less than 5 per cent. The molar ratio and sodium hydroxide amount used for biodiesel production were 1:6 and 0.8 (w/w), respectively surveying it.

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Figure:2 Karanjaoil

Production of fluids

The production processes for bio-diesel are well known. There are three basic routes to bio-diesel production.

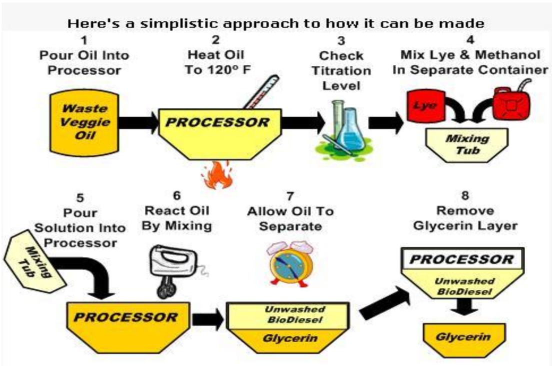

Figure: 3 Biodiesel production (stage 1)

Biodiesel is commonly produced by the transification of the vegetable oil or animal fat feedstock. There are several methods for carrying out this transification reaction including the common batch process, supercritical processes, ultrasonic methods, and even microwave methods.Chemically, transesterified biodiesel comprises a mix of mono-alkyl esters of long chain fatty acids. The most common form uses methanol (converted to sodium methoxide) to produce methyl esters as it is the cheapest alcohol available, though ethanol can be used to produce an ethyl ester biodiesel and higher alcohols such as isopropanol and butanol have also been used. Using alcohols of higher molecular weights improves the cold flow properties of the resulting ester, at the cost of a less efficient transificationreaction.A lipid transification production process is used to convert the base oil to the desired esters. Any Free fatty acids (FFAs) in the base oil are either converted to soap and removed from the process, or they are esterified (yielding more biodiesel) using an acidic catalyst. After this processing, unlike straight vegetable oil, biodiesel has combustion properties very similar to those of petroleum diesel, and can replace it in most current uses .A by-product of the transification process is the production of glycerol. For every 1 tonne of biodiesel that is manufactured, 100 kg of glycerol are produced. Originally, there was a valuable market for the glycerol, which assisted the economics of the process as a whole. However, with the increase in global biodiesel production, the market price for this crude glycerol (containing 20% water and catalyst residues) has crashed. Research is being conducted globally to use this glycerol as a chemical building block. One initiative in the UK is The Glycerol Challenge. Usually this crude glycerol has to be purified, typically by performing vacuum distillation. This is rather energy intensive. The refined glycerol (98%+ purity) can then be utilized directly, or converted into other products. The following announcements were made in 2007:

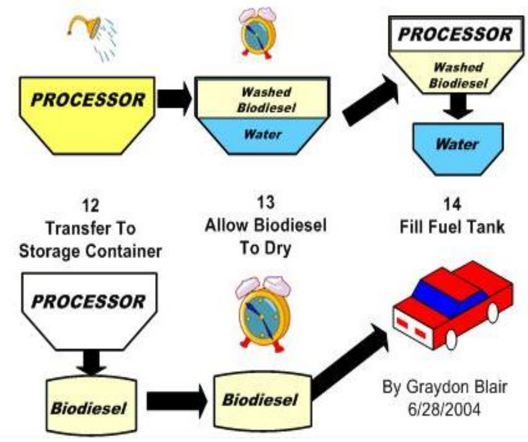

Figure: 4 Biodiesel production (stage 2)

A joint venture of Ashland Inc. and Cargill announced plans to make propylene glycol in Europe from glycerol and Dow Chemical announced similar plans for North America. Dow also plans to build a plant in China to make epichlorhydrin from glycerol. Epichlorhydrin is a raw material for epoxy resins.
Different methodologies used for production of Biodiesel are:

1.Direct use/Blending,
2.Bio diesel reaction,
3. Bio diesel properties selecting.
4. Transification.

From oils and fats

* Base catalyzed transification of the oil.
* Direct acid catalyzed transification of the oil.
* Conversion of the oil to its fatty acids and then to bio-diesel.

Most of the bio-diesel produced today is done with the base catalyzed for several reasons:

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* It is low temperature and pressure.
* It yields high conversion (98%) with minimal side reactions and reaction time.
* It is direct conversion to bio-diesel with no intermediate compounds.
* No toxic materials of construction are needed.

Bio-diesel reaction

$$CHOCOR + 3ROH \rightarrow CH_2OH + RCOOR$$

Where, R indicates fatty acids chains associated with oil or fat.

1. ROH is alcohol normally methanol or ethanol.
2. RCOOR indicates the Bio-diesel
3. CH_2OH indicates the glycerin

The reaction is carried out 65°C, with vigorous stirring to obtain good results.

Bio-diesel properties

Power

One of the major advantages is the fact that it can be used in existing engines and fuel injection equipment (no modification required) without negative impacts to operating performances.

Fuel availability/economy

Virtuallythe same MPG rating as petro-diesel and the only alternative fuel for heavy weight vehicles is requiring no special dispensing and storage equipment.

Storage

Readily blends and stays blends with petro-diesel so it can be stored and dispensed whenever diesel is stored or sold .Bio-diesel has a very high flash point (300°F) making it one of the safest of all alternative fuels.

Lubricity

The only alternative fuel that can actually extend engine life because of its superior lubricating properties.

Selection properties given fluids

Given the results to producing the testing values assigned in journal .

Table 1: Fuel properties

FUEL	Density (Kg/m^3)	Calorific Value (KJ/Kg)
Diesel	822	42200
Waste cooking oil	surveying	surveying
B20-WCO	surveying	surveying
B40-WCO	surveying	surveying
B60-WCO	surveying	surveying
B80-WCO	surveying	surveying
Karanja	861.25	36120
B20-K	837.85	33400
B40-K	843.7	32779
B60-K	849.55	31199
B80-K	855.4	30300

Computational fluid dynamics (CFD)

Computational fluid dynamics analysis

1. The physical aspects are governed by three factors
   a) Mass of conserved
   b) Newton's Second law is observed.
   c) Energy is conserved.

2. These factors are expressed in terms of equation which is either integrals or differential equations.
3. CFD is the art of study of replacing theses integrals or differential equations in terms of discredited algebraic forms which in turn are solved to obtain number for slow field's values at discrete point in time or space.
4. The final product of study of CFD is collection of number in contrast to closed form analytical solution which is applicable in practical solution.
5. Flows and related phenomenon can be described by partial differential equation, which cannot be solved analytically except in some special cases.
6. To obtain the approximate solution, we have to use a discritization techniques which approximated the differential equation which can be later be solved by computer.

Some of Discrimination methods used are

1. Finite volume method
2. Finite element method
3. Finite difference method
4. High resolution schemes.

Design concepts for creating 3 dimensional IC engine

When the collection a data's to be transfer solid modeling can design many different types of models in Solid works. However, before you begin your design project, you need to understand a few basic design concepts:

Design Intent— before you design your model, you need to identify the design intent.Design intent defines the purpose and function of the finished product based on product specifications or requirements. Capturing design intent builds value and longevity into your products. This key concept is at the core of the Solid works feature-based modeling process.

Feature-Based Modeling—Solid works part modeling begins with creating individual geometric features one after another. These features become interrelated to other features as you reference them during the design process.

Parametric Design— The interrelationships between features allow the model to become parametric. So, if you alter one feature and that change directly affects other related (dependent) features, then Solid works dynamically changes those related features. This parametric ability maintains the integrity of the part and preserves your design intent.

Associability—Solid works maintains design intent outside Part mode through associatively. As you continue to design the model, you can add parts, assemblies, drawings, and other associated objects, such as piping, sheet metal, or electrical wiring. All of these functions are fully associative within Solid works. So, if you change your design at any level, your project will dynamically reflect the changes at all levels, preserving design intent.

ICEM procedure

In this prompt, the dimension of the real part model has been scanned the related journal in the visual modeling using offline work constrained the works . Using this program, the real part model can be imported Solid works in to CAD modeling as *.prt file. Thus the imported *.prt file can be viewed by the modeling software i.e solid works.

In solid works, the 3D dimension of the imported part model has been converted into *.parasolid file. Now we can be able to set the actual dimension, appearances for the converted model file. After setting the require datas in solid works, the file can be imported to the analysis software i.e., ANSYS WORKBENCH. This part model may be imported in to ansys as *.IGES file for the purpose of analyzing using solid works. Thus the IGES file has been imported in ansys work bench.

In ansys workbench, the static structural analysis has been made on the IGES file. After the analysis process has been completed, the datas can been stored in workbench. Then it can be viewed in ansys workbench product launcher as a link to ansys product launcher. Thus the result can be generated in the general post processor using the ansys product launcher.
Now we can generate the plot results, result summary and fluid thermal stress values. Thus the water flow heat stress has been calculated. Finally the calculated output results from ansys work bench can be compared with the three dimensional discretization model done using FEA.

CFD problem description

In early days the IC Engine are made up with straight air flow analysis in laminar equation to solving in K-Epsilon formation . This type of IC Engine has high surface cylinder conduct with air flowing inside the round type duct. This results in the reduced total pressure drop across the IC Engine and also reduced heat transfer, fuel flow rate. Due to straight array of plates air flow passing in the straight direction there is no mixing between the airs flowing across the IC Engine and there is no secondary flow formation.

CFD codes are structured around the numerical algorithms that can tackle fluid flow problems. In order to provide easy access to their solving power all commercial CFD packages include sophisticated user interfaces to input problem parameters and to examine the results. Hence all codes contain three main elements.Pre-processor – Geometry ,Boundary conditions, MeshingSolver- Post-processor-plot generation

We briefly examine the function of each of these elements within the context of a CFD code.

Pre-processor

Pre processing consists of the input of a flow problem by means of an operator friendly interface and the subsequent transformation of this input into a form suitable for use by the solver. The user activity at the pre-processing stage involves,

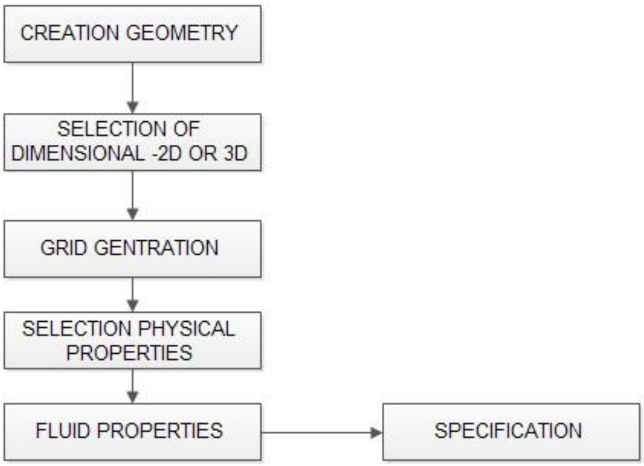

Figure: 5 Pre-Processor

Definition of the geometry of the region of the interest: the computational domain. Grid generation: the sub-division of the domain into a number of the smaller, non-overlapping sub-domains: a grid (or mesh) of cells (or control volumes or elements).The solution to a flow problem (velocity, pressure, temperature etc) is defined at nodes inside each cell. The accuracy of a CFD solution is governed by the number of cells the better the solution accuracy.
Both the accuracy of a solution and its cost in terms of necessary computer hardware and calculation time are dependent on the fineness of the grid. Optimal meshes are often non-uniform: finer in areas where large variations occur from point and coarser in regions with relatively little change. Efforts are under way to develop CFD codes with an adaptive meshing capability. Ultimately such programs will automatically refine the grid in area of rapid variations.

A substantial amount of basic development work still needs to be done before these techniques are robust enough to be incorporated into commercial CFD codes. At present it is still up to the skills of the CFD user to design a grid that is a suitable compromise between desired accuracy and solution cost.

Solver

There are three distinct streams of numerical solution techniques:

Finite difference, finite element and spectral methods. In outline the numerical methods that form the basis of the solver perform the following steps,

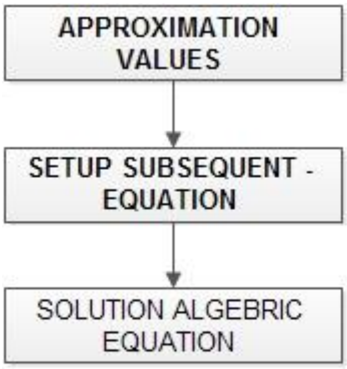

Figure: 5 Solver

Approximation of the unknown flow variables by means of simple functions. Discretizations by substitution of the approximations into the governing flow equations and subsequent mathematical manipulations.Solution of the algebraic equations.The main differences between the three separate streams are associated with the way in which the flow variables are approximated and with the diseretizations processes.

Post processor

As in pre-processing a huge amount of development work has recently taken place in the post-processing field. Owing to the increased popularity of engineering workstations, many of which have outstanding graphics capabilities, the leading CFD packages are now equipped with versatile data visualization tools. These include,

More recently these facilities may also include animation for dynamic result display and in addition to graphics all codes produce trusty alphanumeric output and have data export facilities for further manipulation external to the code. As in many other branches of CAE the graphics output capabilities of CFD codes have revolutionized the communication of ideas to non-specialist

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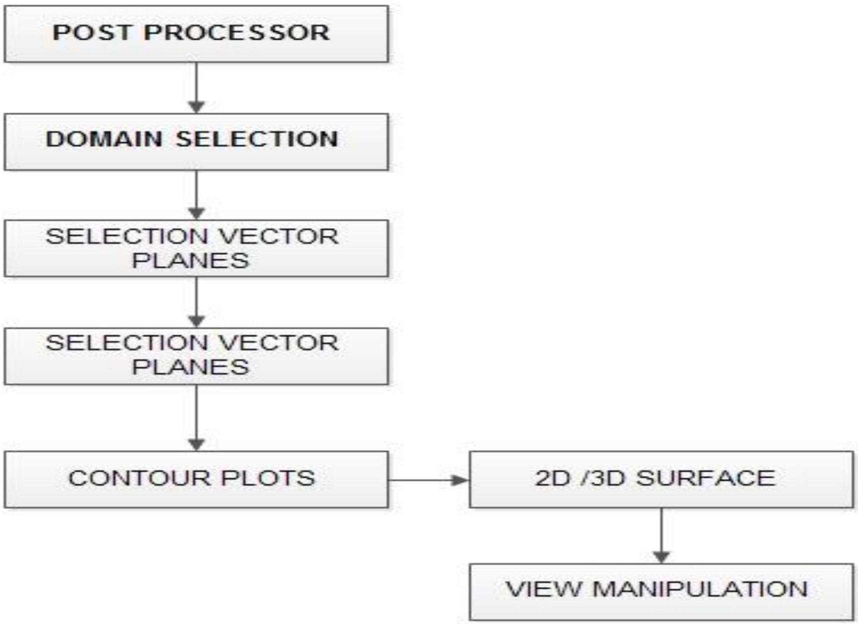

Figure: 6 Post Processor

Conclusion

This chapter focuses on the conclusions of this thesis, the contributions made to the mechanical engineering field to set next generation in alternate fuels propose IC engine analyses - computational fluid dynamics basis recommendations are Introducing.

A reaction of heat transfer with momentum emission analyzing assessment basis to make it the progress in our project its construing take two fuels in karonja and waste cooking oil with different blending ratios to inserting IC engine - Computational fluid dynamics Conception process only progressed.

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