EXPERIMENTAL INVESTIGATION OF CI ENGINE FUELED WITH DIESEL AND KEROSENE BLEND WITH COTTON SEED OIL

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ABSTRACT

Bio-fuel is renewable engine fuel that can be used directly in any existing, unmodified diesel engine. Bio-fuels create new markets for agricultural products and stimulate rural development because bio-fuels are generated from crops; they hold enormous potential for farmers. In the near future two-thirds of the people in the developing world will derive their income from agricultural products. In this study, the performance of a direct injection diesel engine has been investigated experimentally using 1st generation bio fuel (cottonseed oil) blends with fossil fuel like kerosene and diesel. The first generation bio-fuel (cottonseed oil) has been produced without transesterification reaction and we have made few blends samples of Cottonseed oil & Kerosene with Diesel fuel from literature review. First Flow analysis for various fuel blend which designed we have designed is carried out in this research work by using CFD software. Fuel Flow for various blends through injector of diesel engine is simulated and it gives the Density, velocity, pressure and volume distribution of fuel in combustion chamber. First analysis is done for pure diesel sample. Pure diesel results will be used to compare the results obtained in simulation of optimum fuel Blend. Optimum blend combinations are interpreted from the results obtained from CFD analysis then these optimum blends are tested on C.I. engine test rig. After that Comparison of flow characterizes of pure diesel with Blend sample will justify the technical feasibility of fuel blend which will conclude that the fuel blend sample can be used in single cylinder diesel engine without modification.

Keyword: - *CFD, Fuel Blend, Flow Analysis, Cottonseed Oil, Kerosene.*

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1. INTRODUCTION

The India is presently confronted with the twin crises of fossil fuel depletion and environmental Degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources. The search for alternative fuels, which promise a harmonious correlation with sustainable development, energy conservation efficiency and environmental preservation, has become highly pronounced in the present context. The fuels of bio-origin can provide a feasible solution to this worldwide petroleum crisis. By extending the research in the need of getting the optimum combination of fuel blend which we can use in direct injection diesel engine without going for the change in mechanical system of engine.

Many researchers have explored several alternative energy resources which have the ability to quench the ever increasing energy thirst. There resources are environment friendly. But the all resources are needed to be evaluated on the case to case basis for their Advantages, Disadvantages and their specific applications. Hence for we have decided to select a particular bio diesel fuel named 'COTTONSEED OIL' (CSO) and it will be blended with diesel in various different proportions. Performance of these different samples will be evaluated and tested in single cylinder CI engine. After evaluating the performance of Optimum fuel blend sample the complete flow analysis is being done for the blend sample. The results of blend sample are compared with samples of pure diesel and pure Cottonseed Oil.

1.1 NON-EDIBLE OIL AS AN ALTERNATIVE FUEL

The performance of I.C. engine using Karanja bio-diesel blended with diesel at various blending ratios has been evaluated. The test results indicated that the dual fuel combination of B40 can be used in diesel engine without making any engine modification [69]. Experimental investigation on waste frying oil and disclosed that the waste frying oil requires heating temp of 135°C to bring down the viscosity like diesel at 30°C. It was also observed that the performance was improved and carbon monoxide and smoke emissions were reduced using preheated waste frying oil and concluded that the waste frying oil preheated to 135° C could be used as a biodiesel for short term engine operation [71].

1.2 VEGETABLE OIL AND ITS BLENDS

Tests on some properties shows that viscosities were significantly higher and densities were marginally higher compared to diesel, vegetable oil has lower calorific values [8]. Both vegetable oils and alcohols such as Methanol, Ethanol are biomass derived renewable sources, but vegetable oils have properties more suitable to compression ignition engines compared to Alcohols. More than 30 different types of non edible oils are used in compression ignition engines. Blending of vegetable oils with some percentage of diesel fuel was a suitable method to reduce choking and for extended engine life [9].

2. METHODOLOGY

2.1 PROPERTIES OF TEST FUELS

Cottonseed oil can be easily mixed with diesel and kerosene in any proportion and can be used to partially substitute diesel. From the literature review the blend samples of cottonseed oil (CSO), Diesel (D) and Kerosene (Ke) are CSO10-D90, CSO20-D80, CSO25-D75, CSO30-D70, CSO35-D65, CSO40-Ke60, CSO10-Ke90, CSO20-Ke80, CSO25-Ke75, CSO30-Ke70, CSO35-Ke65, CSO40-D60 and D100 are being tested for properties like Kinematic Viscosity, Density, Flash Point, Cetane Number and Calorific Value are as follows**:**

Table -1: Properties of test fuels

Test Performed	**Diesel**	**Cotton Seed Oil**	**Kerosene**	**CSO10-D90**	**CSO20-D80**	**CSO25-D75**	**CSO30-D70**	**CSO35-D65**	**CSO40-D60**	**CSO10-Ke90**	**CSO20-Ke80**	**CSO25-Ke75**	**CSO30-Ke70**	**CSO35-Ke65**	**CSO40-Ke60**
Kinematic Viscosity (mm^2/s)	3.32	34.57	1.85	6.53	9.81	11.59	12.92	14.74	16.17	5.26	8.68	10.16	11.91	13.53	15.21
Density (kg/m^3)	823	934	783	836	847	856	861	867	883	801	817	827	832	841	852
Flash Point (^0C)	56	198	43	73	86	92	101	106	114	59	77	85	92	102	108
Cetane Number	49.38	-	47.13	43.54	38.51	36.39	33.84	31.43	28.62	41.67	36.94	34.23	31.52	29.76	27.91
Calorific Value (KJ/Kg)	42843	39687	43386	42483	42119	41916	41782	41672	41506	42976	42513	42348	42105	42981	42843

2.2 FLOW ANALYSIS

Flow analysis of fuel flow from injector nozzle Geometry has prepared in ICEM CFD ANSYS Version 16. Considering Fuel injector nozzle layout 2D Geometry has prepared and discredited in ICEM CFD. Mesh file imported in Fluent Solver to simulate it for flow pattern with the help of pressure and velocity. The boundary conditions are the properties of blend samples i.e. Kinematic Viscosity (mm^2/s), Density (Kg/m^3), Flash Point (^oC), Cetane Number & Calorific value (KJ/Kg) are used for simulation. The fuel blends from CFD analysis compared with pure diesel sample on the basis of spray cone angle are as follows:

Table -2: CFD analysis result for spray cone angle of test fuels

Samples	**Diesel**	**CSO 10-D90**	**CSO 20-D80**	**CSO 25-D75**	**CSO 30-D70**	**CSO 35-D65**	**CSO 40-D60**	**CSO 10-Ke90**	**CSO20-Ke80**	**CSO25-Ke75**	**CSO 30-Ke70**	**CSO 35-Ke65**	**CSO 40-Ke60**
Spray Cone Angle (deg)	8.4	7.9	7.1	6.7	5.1	4.6	4.1	8.7	8.1	7.8	7.5	6.2	5.3

It is found that an optimum blend with Cottonseed oil with Diesel is CSO25-D75 and for Cottonseed oil with Kerosene is CSO30-Ke70. These optimum blends are further tested in C.I engine for performance analysis to find best suitable blend which can be further use in C.I Engine

3. EXPERIMENTATION

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading as shown in figure 1. The engine specifications are given in Table 3. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ-PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator, rotameters are provided for cooling water and calorimeter water flow measurement.

Table -3: Specification of engine

Manufacturer	Kirloskar Oil Engines Ltd., India
Model	TV1
Type	Vertical, Double cylinder, Water cooled, Four Stroke cycle, Compression Ignition Diesel Engine
Bore/stroke	87.5mm/110 mm
compression ratio	17.5 :1

Speed	1500 rpm
Eddy Current, Water Cooled	With Loading unit
Orifice	Diameter of orifice = 0.02m Coefficient of discharge of Orifice Cd = 0.62

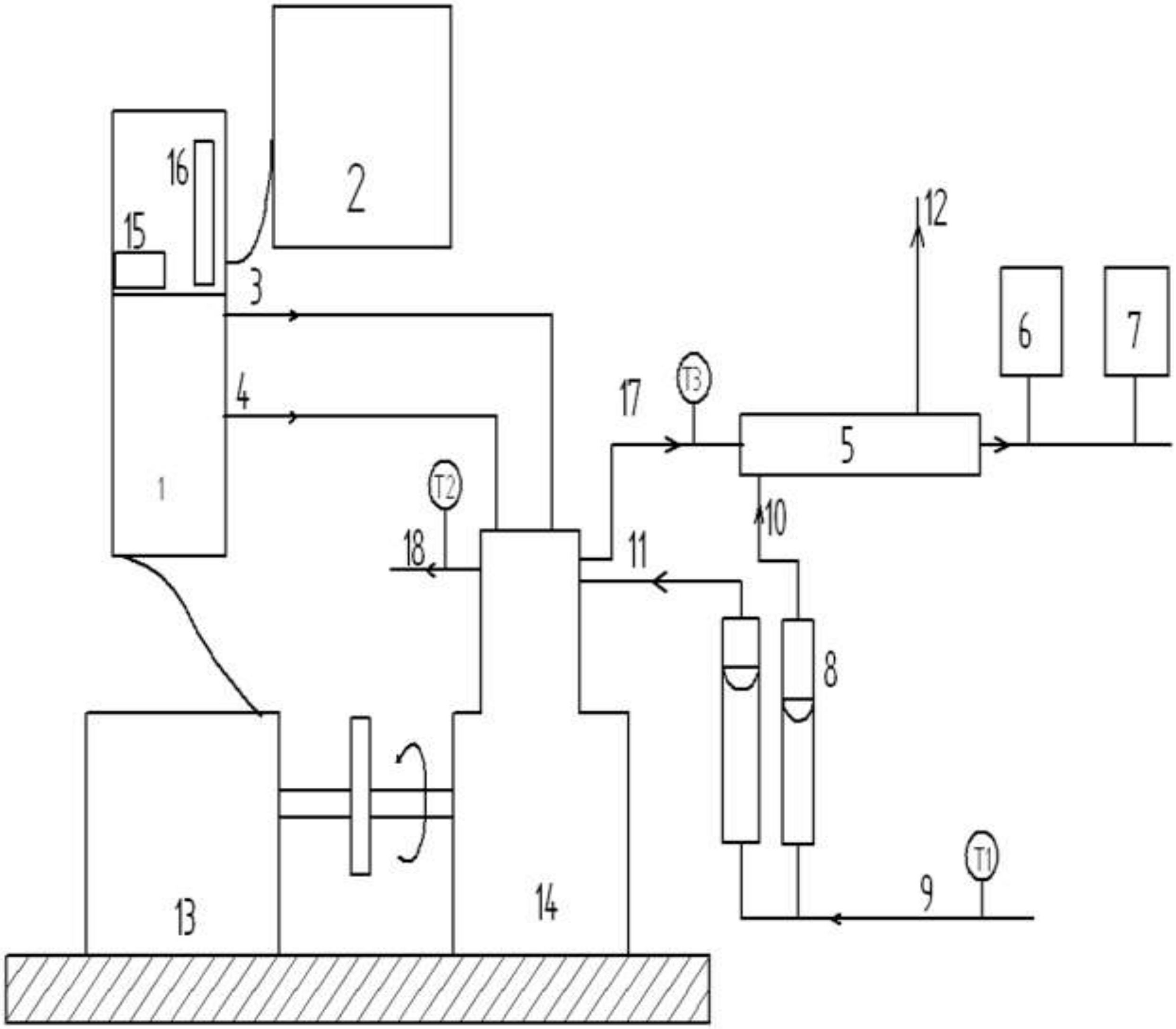


Fig -1: Schematic diagram of experimental setup

1 = Control Panel, 2 = Computer system, 3 = Diesel flow line, 4 = Air flow line, 5 = Calorimeter, 6 = Exhaust gas analyzer, 7 = Smoke meter, 8 = Rotameter, 9 = Calorimeter inlet water temperature, 10 = Calorimeter outlet water temperature, 11 = Dynamometer, 12 = CI Engine, 13 = Speed measurement, 14 = Burette for fuel measurement, 15 = Exhaust gas outlet, 16 = Outlet water temperature, T1= Inlet water temperature, T2 = Outlet water temperature, T3 = Exhaust gas temperature.

5. RESULTS AND DISCUSSIONS

5.1 FLOW ANALYSIS RESULTS

The flow analysis of fuel spray through the fuel injector is analyzed. As the viscosity of new blend samples are varied as compared to the pure Diesel sample. Velocity is the function of viscosity. Maximum Flow velocity occurred at bends in all blend samples. To predict the effect of viscosity on the fluid flow velocity distribution is obtained for D100, CSO25-D75 and CSO30-KE70. Penetration velocity of pure diesel sample i.e.3680 m/s is nearer to CSO30-KE70 sample i.e.4250m/s.

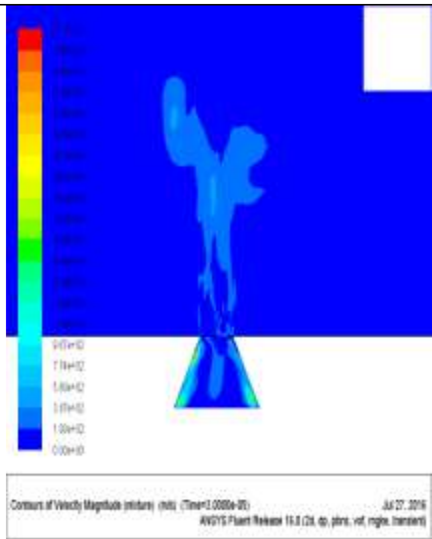
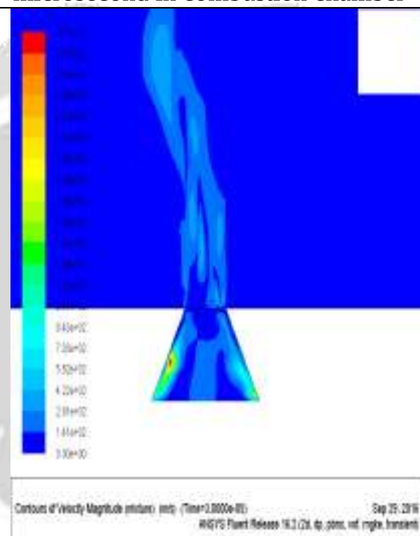
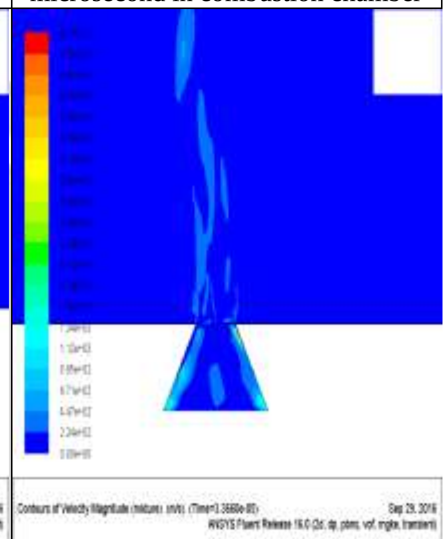
Velocity Distribution of air- Pure diesel mixture at 30 microsecond in combustion chamber	Velocity Distribution of air-Fuel blend of CSO25-D75 at 30 microsecond in combustion chamber	Velocity Distribution of air-Fuel blend of CSO30-KE70 at 30 microsecond in combustion chamber
		
Velocity of mixture was max at entrance of combustion chamber with value 3680 m/s	Velocity of mixture was max at entrance of combustion chamber with value 2670 m/s	Velocity of mixture was max at entrance of combustion chamber with value 4250 m/s

Fig -2: Comparison of Velocity Distribution Profiles for fuel blends inside combustion chamber.

5.2 EXPERIMENTAL RESULT

Different experimental results like brake specific fuel consumption, brake thermal efficiency, etc are compared with load as shown below:

5.2.1 Brake thermal efficiency

The brake thermal efficiency plots in chart 1 show an increase of brake thermal efficiency with increase in the engine load as the amount of diesel in the blend increases. Maximum brake thermal efficiency of CSO30-KE70 is 41.53%, CSO25-D75 is 36.01% and for pure diesel is 43.16%. The comparison of brake thermal efficiency of Cottonseed oil-diesel and Cottonseed oil -kerosene blend with diesel which indicates that brake thermal efficiency increases with increasing load in all cases. CSO30-KE70 blend gives result slightly more than the pure diesel.

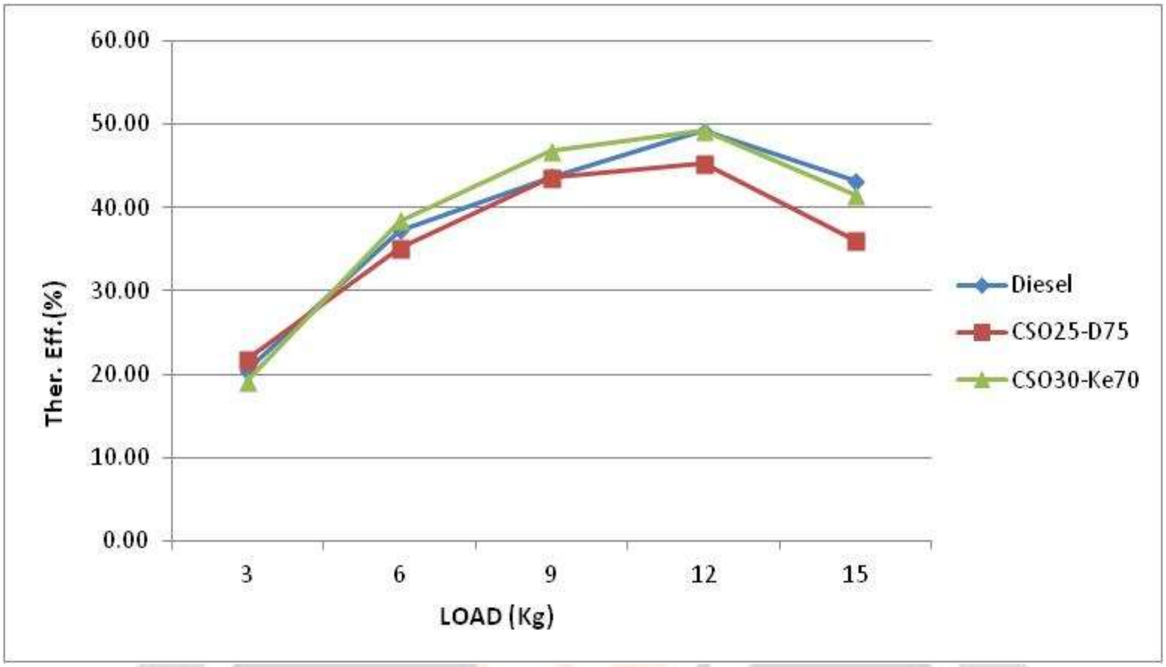


Chart -1: Comparison of Brake Thermal Eff. of CSO-Diesel-Kerosene bends with load

5.2.2 Brake specific fuel consumption (BSFC)

The brake specific fuel consumption for pure diesel is 0.19 (Kg/KW-Hr), CSO30-KE70 is 0.21(Kg/KW-Hr) and CSO25-D75 is 0.24 (Kg/KW-Hr) From chart 2 it shows the comparison of brake specific fuel consumption (kg/KW-hr) of Cottonseed oil-diesel and Cottonseed oil -kerosene blends with load. Chart indicates that BSFC reduces with increase in load in all cases. This may due to higher viscosity and lower calorific value. CSO30-KE70 blend gives result much equivalent to pure diesel.

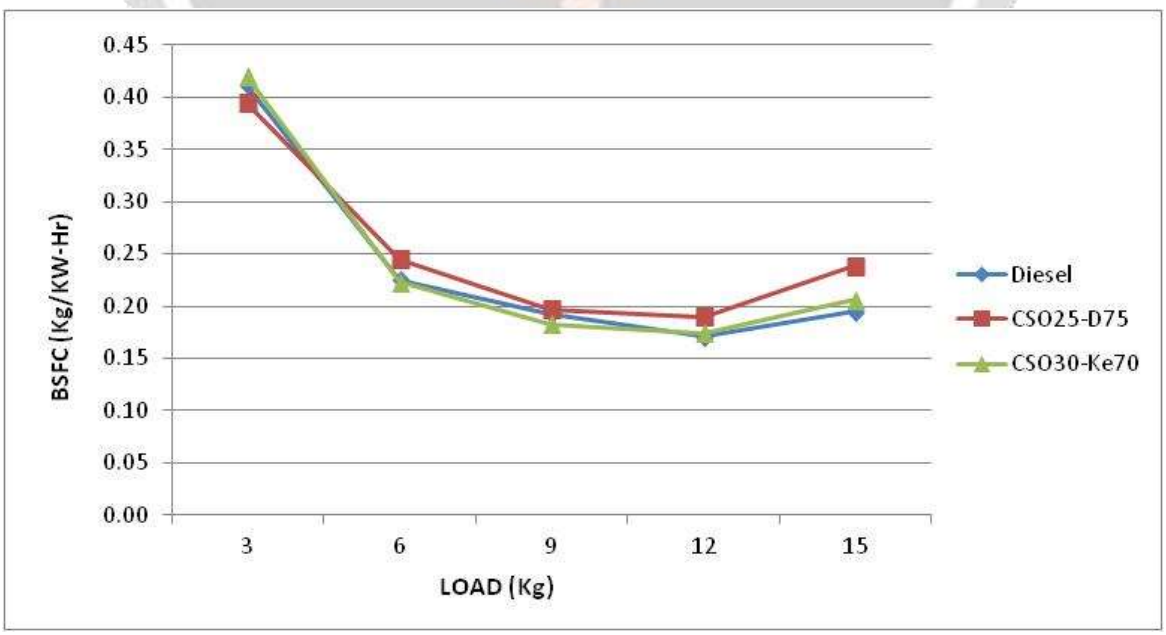


Chart -2: Comparison of BSFC of CSO-Diesel-Kerosene bends with load

4. CONCLUSIONS

The CFD analysis and graphical results show that diesel has better performance characteristics than biodiesel and biodiesel blends. The best performance as good alternative fuel and evaluated the good results to prove the better performance of cottonseed oil and kerosene and compared with diesel then the conclusion are review from them.

1. The spray cone angle for the blends CSO-DI (25-75) i.e. 6.7 deg and CSO-KE (30-70) i.e. 7.5 deg.is lesser than pure diesel i.e. 8.4 deg caused by higher density of biodiesel blends than base diesel. The possible reason is that spray cone angle is a main function of charge density, which directly relates with the in-cylinder pressure.
2. Poor air entrainment was caused by biodiesel having higher viscosity. Air entrainment increases because of high penetration distance. Air entrainment is more in case of biodiesel blends than base diesel as penetration distance is more for CSO-KE (30-70).
3. Volume fraction distribution profiles for CSO-KE (30-70) i.e. 0.3% inside the cylinder with pure diesel i.e. 0.3% from which it is found that Profiles of Cottonseed oil 30% with Kerosene70% fuel blend profiles matched to greatest extent.
4. Technical Feasibility like BSFC and Break Thermal Efficiency for CSO-KE (30-70) i.e. 0.21 (Kg/KW-Hr) and 41.53% for CSO-DI (25-75) i.e. 0.24 (Kg/KW-Hr) and 36.01% compared with pure diesel i.e. 0.19 (Kg/KW-Hr) and 43.16% respectively, hence Cottonseed oil 30% with Kerosene70% blend is validated and found matching with diesel fuel.
5. Spray characteristics for Fuel blend are calculated and compare it with pure diesel sample, Also Density, Velocity, Volume fraction & Injection pressure distribution profiles created in CFD fluent for Fuel Blend samples Comparing the profiles conclude that **Cottonseed Oil 30% - Kerosene70%** is most similar blend to pure diesel**.**
6. Behavior of blend properties for sample of diesel, cottonseed oil & kerosene blend inside combustion chamber is studied.

From the flow analysis of different samples an optimum blend found from the CFD analysis on the basis of pressure, density, volume and velocity is selected for the experimentation on C.I. engine.

The results for BSFC and Break Thermal Efficiency are found from the experimentation is nearly matched with the CFD analysis

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6. REFERENCES

[1]. Paul Hellier, Nicos Ladommatos, Talal Yusaf "The Influence Of Straight Vegetable Oil Fatty Acid Composition On Compression Ignition Combustion And Emissions" International Journal Of Science Direct/Elsevier/Fuel 143 (2015) 131–143

[2]. B M Kulkarni, B G Pujar & Shanmukhhapa "Invesgation Of Acid Oil As A Fuel" Indian Journal Of Chemical Technology, Vol. 15, September 2008, Pp. 467-471.

[3]. Is 14309 (1995): Blended Edible Vegetable Oils [Fad 13:Oils And Oilseeds] Is 14309 : 1995, Reaffirmed 2001.

[4]. Nandkishore D.Rao, Dr.B. Sudheer Premkumar & Dr. M.Yohan "Study Of Different Methods Of Using Vegetable Oil As A Fuel For Compression Ignition Engine" Global Journal Of Researches In Engineering Mechanical And Mechanics Engineering Volume 12 Issue 4 Version 1.0 2012.

[5]. S.S. Sidibe, J. Blin, G. Vaitilingom, Y. Azoumah “Use Of Crude Filtered Vegetable Oil As A Fuel In Diesel Engines State Of The Art: Literature Review” Renewable And Sustainable Energy Reviews 14 (2010) 2748–2759.

[6]. Alain Liennard, Daniel Pioch, Nathalie Chirat, Paul Lozano And Gilles Vaitilingom “Energy Generation From “Neat” Vegetable Oils” Physico-Chemistry Of Processes And Bioenergy Labratory Cirad-Amis / Agri-Food Systems Programme Ta 40/16.

[7]. Sam Jones And Charles L. Peterson “Use Of Raw Vegetable Oils As Diesel Fuel Replacements” Bioenergy 2002 In Boise, Idaho, September 2002.

[8]. M. Nematullah Nasim1, Ravindra Babu Yarasu2 And Jehad Yamin “Simulation Of Ci Engine Powered By Neat Vegetable Oil Under Variable Fuel Inlet Temperature” Indian Journal Of Science And Technology Vol. 3 No. 4 (Apr. 2010) Issn: 0974- 6846

[9]. R. Senthilkumar, R.Ramadurai “Evaluation Of Various Biodiesel On A Single Cylinder C.I Engine” International Journal Of Engineering Trends And Technology (Ijett) - Volume4 Issue6- June 2013

[10]. M. C. Navindgi, Maheswar Dutta And B. Sudheer Prem Kumar “Performance Evaluation, Emission Characteristics And Economic Analysis Of Four Non-Edible Straight Vegetable Oils On A Single Cylinder Ci Engine” Arpn Journal Of Engineering And Applied Sciences, Vol. 7, No. 2, February 2012, Issn 1819-6608.

[11]. Nandkishore D. Rao, B. Sudheer Premkumar And M. Yohan “Performance And Emission Characteristics Of Straight Vegetable Oil-Ethanol Emulsion In A Compression Ignition Engine” Arpn Journal Of Engineering And Applied Sciences, Issn 1819-6608, Vol. 7, No. 4, April 2012.

[12]. P. P. Sonune, H. S. Farkade “Performance And Emissions Of Ci Engine Fuelled With Preheated Vegetable Oil And Its Blends – A Review” International Journal Of Engineering And Innovative Technology (Ijeit) Volume 2, Issue 3, September 2012.

[13]. Rahul Patel, Kshitiz K. Jain, Satyam Sharma, Saurabh Barange “Performance And Emission Characteristics Of Diesel Engine Using Vegetable Oils And Its Blends With Diesel Fuel” International Journal Of Advanced Engineering Research And Studies E-Issn2249–8974.

[14]. L. Labecki, A. Cairns, J. Xia, A. Megaritis, H. Zhao, L.C. Ganippa “Combustion And Emission Of Rapeseed Oil Blends In Diesel Engine” International Journal Of Science Direct/Elsevier/Applied Energy 95 (2012) 139–146

[15]. T. Elango1, T. Senthilkumar “Performance And Emission Characteristic Of Ci Engine Fuelled With Non Edible Vegetable Oil And Diesel Blends” Journal Of Engineering Science And Technology Vol. 6, No. 2 (2011) 240 – 250.

[16]. Nandkishore D.Rao,Dr.B.Sudheer Premkumar “ Effect Ofethanoladdition To Straight Vegetable Oil On Performance And Emission Characteristics Of Compressionignition Engine” International Journal Of Scientific & Engineering Research Volume 3, Issue 10, October-2012, Issn 2229-5518

[17]. G.Sucharitha, A.Kumaraswamy “Experimental Analysis Of Using Neem Oil As An Alternative Fuel” International Journal Of Engineering Research And Applications (Ijera) Issn: 2248-9622 Www.Ijera.Com Vol. 3, Issue 1, January -February 2013, Pp.320-325.

[18]. R. Ganapathi, Dr. B. Durga Prasad, B. Omprakash “Experimental Investigations On 4–Stroke Low Heat Rejection C.I. Engine Using Alternative Fuels” International Journal Of Research In Aeronautical And Mechanical Engineering, Vol.1 Issue.7, November 2013. Pgs: 95-107.

[19]. S.M. Ibrahim, K.A. Abed And 2m.S. Gad “Experimental Investigation Of Diesel Engine Performance Burning Preheated Jatropha Oil” World Applied Sciences Journal 31 (7): 1231-1236, 2014, Issn 1818-4952 © Idosi Publications, 2014.

[20]. M. Nematullah Nasim, Ravindra Babu Yarasu And R. H. Sarda "Experimental Investigation On Compression Ignition Engine Powered By Preheated Neat Jatropha Oil" Journal Of Petroleum Technology And Alternative Fuels, Vol. 4(7), Pp. 119-114, July 2013.

[21]. Kazi Mostafijur Rahman, Mohammad Mashud, Md. Roknuzzaman And Asadullah Al Galib "Biodiesel From Jatropha Oil As An Alternative Fuel For Dieselengine" International Journal Of Mechanical & Mechatronics Engineering Ijmme-Ijens Vol:10 No:03.

[22]. K.Srinivas, N. Ramakrishna, Dr.B.Balu Naik, Dr.K.Kalyani Radha "Performance And Emission Analysis Of Waste Vegetable Oil And It's Blends With Diesel And Additive" N.Ramakrishna Et Al.Int. Journal Of Engineering Research And Applications Www.Ijera.Com Issn : 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013, Pp.473-478

[23]. Md A. Hossain, Shabab M. Chowdhury, Yamin Rekhu, Khandakar S. Faraz, Monzur Ul Islam "Biodiesel From Coconut Oil: A Renewable Alternative Fuel For Diesel Engine" International Journal Of Environmental, Chemical, Ecological, Geological And Geophysical Engineering Vol:6, No:8, 2012

[24]. A. B. M. S. Hossain, A. N. Boyce, A. Salleh And S. Chandran "Impacts Of Alcohol Type, Ratio And Stirring Time On The Biodiesel Production From Waste Canola Oil" African Journal Of Agricultural Research Vol. 5(14), Pp. 1851-1859, 18 July, 2010

[25]. Brajesh Kumar Mishra, Rajesh Kumar, Dr. Rajat Kumar "Eco-Friendly Biodiesel As An Alternative Fuel For Diesel-Engine" Iosr Journal Of Applied Chemistry (Iosr-Jac) Issn: 2278-5736. Volume 2, Issue 4 (Sep. – Oct. 2012), Pp 41-45

[26]. Jiantong Song, Jvbiao Yao, Jiangyi Lv And Chunhong Zhu "Experimental Study On A Diesel Engine Fueled With Soybean Biodiesel" Research Journal Of Applied Sciences, Engineering And Technology 6(16): 3060-3064, 2013 Issn: 2040-7459; E-Issn: 2040-7467

[27]. Ayush Kumar Raghuvanshi, C P Singh " Extraction Of Biodiesel From Jatropha Oil And Performance Study Of Diesel Engine With Biodiesel Fuels" International Journal Of Scientific And Research Publications, Volume 4, Issue 10, October 2014, Issn 2250-3153

[28]. Hossein Noureddini, B C. Teoh, L Davis Clements "Densities Of Vegetable Oils And Fatty Acids" (1992). Papers In Biomaterials.Paper 14.

[29]. Abere, Julius, Oluwadare, Benjamin "Investigation Into The Use Of Vegetable Oil As Industrial Fluid-Automatic Transmission Fluid" International Journal Of Mechanical & Mechatronics Engineering Ijmme-Ijens Vol:14 No:03.00-20.

[30]. Tizane Daho, Gilles Vaitilingom, Salifou K. Ouiminga, Bruno Piriou, Augustin S. Zongo, Samuel Ouoba, Jean Koulidiati "Influence Of Engine Load And Fuel Droplet Size On Performance Of A Ci Engine Fueled With Cottonseed Oil And Its Blends With Diesel Fuel" Applied Energy 111 (2013) 1046–1053

[31]. Palash M. Mendhe, Mirzamunawwar Baig And Chetan D. Madane " Cottonseed Oil Used As Analternative Fuel Fortheperformance Characteristics Ofci Engine Byblending With Diesel" International Journal For Research In Emerging Science And Technology Volume-2, Special Issue-1, March-2015.

[32]. Miss.J.M. Phate, Prof.A.V.Kulkarn, Dr.R.S.Jahagirdar "Experimental Investigation Of The Suitability Of Orange Peel Oil As A Blend With Cotton Seed Oil As Alternate Fuel For Diesel Engines" International Journal Of Scientific And Research Publications, Volume 5, Issue 9, September 2015 1 Issn 2250-3153.

[33]. Raghuvaran S, Sarala R "Performance And Emission Analysis Of Diesel Engine (Di) Using Cotton Seed Oil Methyl Ester" International Journal Of Core Engineering & Management (Ijcem) Volume 1, Issue 12, March 2015

[34]. Leenus Jesu Martin. M, Edwin Geo. V, Prithviraj. D "Effect Of Diesel Addition On The Performance Of Cottonseed Oil Fuelled Di Diesel Engine" International Journal Of Energy And Environment, Volume 2, Issue 2, 2011 Pp.321-330

[35]. M. Martin, D. Prithviraj "Performance Of Pre-Heated Cottonseed Oil And Diesel Fuel Blends In A Compression Ignition Engine" 2011 Jordan Journal Of Mechanical And Industrial Engineering. All Rights Reserved - Volume 5, Number 3 (Issn 1995-6665)

[36]. Tejrao Ghormade, Kiran Thekedar "Cottonseed Oil As An Alternative Fuel For C.I. Engine" International Journal Of Modern Trends In Engineering And Research (Ijmter), Volume 02, Issue 02, [February - 2015] E-Issn: 2349-9745, P-Issn: 2393-816.

[37]. D.N. Basavarajappa, N. R. Banapurmath, S.V. Khandal, G. Manavendra " Performance Evaluation Of Common Rail Direct Injection (Crdi) Engine Fuelled With Uppage Oil Methyl Ester (Uome)" Int. Journal Of Renewable Energy Development 4 (1) 2015: 1-10

[38]. P. K. Halder, N. Paul And M. R. A. Beg "Prospect Of Pongamia Pinnata (Karanja) In Bangladesh:A Sustainable Source Of Liquid Fuel" Hindawi Publishing Corporation Journal Of Renewable Energy Volume 2014, Article Id 647324.

[39]. P.V.K.Murthya, M.V.S. Murali Krishnab, A.Sitarama Rajuc, N. Janarthanband P.Ushasrid "Performance Evaluation Of A Low Heat Rejection Diesel Engine With Jatropha Oil Based Bio-Diesel" International Journal Of Renewable Energy, Vol. 8, No. 1, January - June 2013

[40]. D. Srikanth, M.V.S. Murali Krishna, P.Ushasri And P.V. Krishna Murthy "Comparative Studies On Medium Grade Low Heat Rejection Diesel Engine And Conventional Diesel Engine With Crude Cotton Seed Oil" International Journal Of Innovative Research In Science, Engineering And Technology Vol. 2, Issue 10, October 2013

[41]. K.F. Mustafa A, S. Abdullah, M.Z. Abdullah, K. Sopian, A.K. Ismail "Experimental Investigation Of The Performance Of A Liquid Fuel-Fired Porous Burner Operating On Kerosene-Vegetable Cooking Oil (Vco) Blends For Micro-Cogeneration Of Thermoelectric Power" Science Direct /Renewable Energy 74 (2015) 505e516

[42]. Swarup Kumar Nayaka, Bhabani Prasanna Pattanaika "Experimental Investigation On Performance And Emission Characteristics Of A Diesel Engine Fuelled With Mahua Biodiesel Using Additive" 4th International Conference On Advances In Energy Research 2013, Icaer 2013/ Energy Procedia 54 (2014) 569 – 579.

[43]. Shyam Kumar Ranganathan, Anil Gandamwad & Mayur Bawankure "Performance Evaluation Of C.I. Engine With Cotton Seed Oil" International Journal Of Instrumentation, Control And Automation (Ijica) Issn: 2231-1890, Vol-1 Iss-3,4, 2012

[44]. S. Naga Sarada, M.Shailaja, A.V. Sita Rama Raju, K. Kalyani Radha "Optimization Of Injection Pressure For A Compression Ignition Engine With Cotton Seed Oil As An Alternate Fuel" International Journal Of Engineering, Science And TechnologyVol. 2, No. 6, 2010, Pp. 142-149.

[45]. Naseer Salman Kadhim "Study The Effect Of Blending Kerosene With Diesel Fuel On The Performance And Emissions Of Diesel Engine" International Journal Of Engineering Sciences & Research Technology, [Kadhim, 4(8): August, 2015] Issn: 2277-9655 (I2or), Publication Impact Factor: 3.785.

[46]. B. K. Venkanna, C. Venkataramana Reddy "Performance, Emission And Combustion Characteristics Of Di Diesel Engine Running On Blends Of Honne Oil/Diesel Fuel/Kerosene/Dmc" September, 2011 Int J Agric & Biol Eng Open Access At Vol. 4 No.3.

[47]. K. R.Patil And S. S.Thipse "Characteristics Of Performance And Emissions In A Directinjection Diesel Engine Fuelled With Kerosene/Diesel Blends" International Journal Of Automotive And Mechanical Engineering (Ijame) Issn: 2229-8649 (Print); Issn: 2180-1606 (Online); Volume 10, Pp. 2102-2111, July-December 2014

[48]. S. M. Ameer Uddina, A. K. Azadb, M. M. Alamc And J. U Ahamed "Performance Of A Diesel Engine Run With Mustard-Kerosene Blends" 6th Bsme International Conference On Thermal Engineering (Icte 2014)/ Procedia Engineering 105 (2015) 698 – 704.

[49]. Anil Kumar Sarma And D. Konwer "Feasibility Studies For Conventional Refinery Distillation With A (1:1) W/W Of A Biocrude Blend With Petroleum Crude Oil" Energy & Fuels 2005, 19, 1755-1758.

[50]. P.V.K.Murthy And M.V.S.Murali Krishna "Experimental Investigations On Cotton Seed Biodiesel Fuelled Di Diesel Engine With Low Heat Rejection Combustion Chamber" Issn 2320-5407 International Journal Of Advanced Research (2015), Volume 3, Issue 7, 1439-1459.

[51]. Athanasios Balafoutis, Spyros Fountas, Athanasios Natsis And George Papadakis "Performance And Emissions Of Sunflower, Rapeseed, And Cottonseed Oils As Fuels In An Agricultural Tractor Engine" International Scholarly Research Network Isrn Renewable Energy Volume 2011, Article Id 531510, 12 Pages

[52]. M.Harinathareddy, Dr P.Nageswara Reddy, Dr.K.Vijayakumar Reddy "Experimental Investigation Of Compressed Ignition Engine Using Cotton Seed Oil Methyl Ester As Alternative Fuel" International Journal Of Engineering And Science Isbn: 2319-6483, Issn: 2278-4721, Vol. 2, Issue 1 (January 2013), Pp 06-10

[53]. K.Dilip Kumar, P.Ravindra Kumar "Experimental Investigation Of Cotton Seed Oil And Neem Methyl Esters As Biodiesel On Ci Engine" International Journal Of Modern Engineering Research (Ijmer), Vol.2, Issue.4, July-Aug 2012 Pp-1741-1746 Issn: 2249-6645.

[54]. D. Srikanth, M.V.S. Murali Krishna, P.Ushasri P.V. Krishna Murthy "Performance Evaluation Of A Diesel Engine Fuelled With Cotton Seed Oil In Crude Form And Biodiesel Form" Journal Of International Academic Research For Multidisciplinary Impact Factor 1.393, Volume 1, Issue 9, October 2013.

[55]. Azeem Hafiz P, Naveen Sankar G, Murali Mohan R, Bilal Mohammed " Experimental Analysis Of The Performance Characteristics Of Single Cylinder Diesel Engine Fueled Using Kerosene-Diesel Blend" International Journal Of Research In Mechanical Engineering Volume 4, Issue 3, May-June, 2016, Pp. 70-74

[56]. Amol Patil, H M Dange And Vishal Patil "Study Of Cottonseed Oil And Maize Oil Biodiesel As A Fuel For C I Engine" Volume : 3 | Issue : 9 | September 2014 • Issn No 2277 - 8179

[57]. O. Obodeh And F. O. Isaac "Investigation Of Performance Characteristics Of Diesel Engine Fuelled With Diesel-Kerosene Blends" Journal Of Emerging Trends In Engineering And Applied Sciences (Jeteas) 2 (2): 318-322, 2011 (Issn: 2141-7016)

[58]. Xiaohu Fan, Xi Wang, Feng Chen, Daniel. Geller And Peter J. Wan "Engine Performance Test Of Cottonseed Oil Biodiesel" The Open Fuels & Energy Science Journal, 2008, 1, 40-45.

[59]. Ajay V. Kolhe, R.E.Shelke, S.S.Khandare "Performance, Combustion And Emission Characteristics Of A Diesel Engine With Biodiesel From Cotton Seed Oil As Alternate Fuels" International Journal Of Engineering Research & Technology (Ijert) Vol. 2 Issue 11, November – 2013, Ijertijert, Issn: 2278-0181

[60]. K. Suresh Kumar, A. Nandith Reddy, M. Narendhar Baba, K. Lavanya "Performance And Emission Evaluation Of Di Diesel Engine Using Cotton Seed Oil As Alternative Fuel" International Journal Of Engineering Research & Technology (Ijert) Ijertijert, Issn: 2278-0181,Vol. 3 Issue 7, July – 2014.

[61]. A.P. Sathiyagnanam, Member, Iaeng And C.G. Saravanan "Experimental Studies On The Combustion Characteristics And Performance Of A Direct Injection Engine Fueled With Biodiesel/Diesel Blends With Scr" Proceedings Of The World Congress On Engineering 2011 Vol Iii Wce 2011, July 6 - 8, 2011, London, U.K.

[62]. Atul Dhar, Avinash Kumar Agarwal "Effect Of Karanja Biodiesel Blends On Particulate Emissions From A Transportation Engine" Science Direct Fuel 141 (2015) 154–163

[63]. Schlick, M.L., Hanna, M.A., Schinstock, J.L., Soybean And Sun Flower Oil Performance In A Diesel Engine. Trans. Asae 31 (5), 1345±1349

[64]. T. K. Bhattacharya, Ram Chandra And T. N. Mishra. "Performance Characteristics Of A Stationary Constant Speed Compression Ignition Engine On Alcohol-Diesel Microemulsions. Agricultural Engineering International: The Cigr E Journal." Manuscript Ee04002. Vol. Viii. June, 2006.

[65]. Can Has-Imoglu, Murat Ciniviz, I˙Brahim O¨ Zsert, Yakup I˙C-Ingu¨ R, Adnan Parlak, M. Sahir Salman. “Performance Characteristics Of A Low Heat Rejection Diesel Engine Operating With Biodiesel”. Renewable Energy 33.2008.Pp. 1709–1715.

[66]. P. Mahanta, S.C Mishra And Y.S Kushwah, A Comparative Study Of Pongamia Pinnata And Jatropha Curcus Oil As Diesel Substitute, International Energy Journal, Vol 7, No.1, March 2006.

[67]. Rakopoulos, C.D., K.A Antonopoulos And D.O Rakopoulos, "Comparative Performance And Emission Study Of A Direct Injection Diesel Engine Using Blends Of Diesel Fuel With Vegetable Oils Or Bio Fuels Of Various Origins", Science Direct, Energy Conversion And Management, 47, 3272-3287.

[68]. Venkateswara Rao, T., G. Prabhakar Rao And K. Hema Chandra Reddy, "Experimental Investigation Of Pongamia, Jatropha And Neem Methyl Esters As Biodiesel On C.I. Engine" Jordan Journal Of Mechanical And Industrial Engineering, 2(2), 117-122

[69]. Stalin, N. And H.J. Prabhu, (2007), "Performance Test On I.C. Engine Using Karanja Biodiesel Blending With Diesel",Aprn Journal Of Engg And Applied Sciences,Vol. 2, No. 5.

[70]. Masjukia, S. Mekhilefd, “A Comprehensive Review On Biodiesel As An Alternative Energy Resource And Its Characteristics” Renewable And Sustainable Energy Reviews, Volume 16, Issue 4, Pages 2070–2093, May 2012.

[71]. Pugazhvadivu, M. And K. Jayachandran , "Investigations On The Performance And Exhaust Emissions Of A Diesel Engine Using Preheated Waste Frying Oil As Fuel" Renewable Energy 30, 2189-2202.

[72]. Wang, Y.D., T. Al-Shemmeri, P. Eames, J. Mcmullan, N. Hewitt, Y. Huang And S. Rezwani, "An Experimental Investigation Of The Performance And Gaseous Exhaust Emissions Of A Diesel Engine Using Blends Of Vegetable Oil", Science Direct, Applied Thermal Engineering 26, 1684-1691.