Rate of emission by changing the injection time for different crown material addition for bronze coated and non-coated by CFD Approach

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ABSTRACT:

In recent years, due to increasing demand for fuel economy and tightening legislation for emissions, there has been growing requirement to develop more efficient and cleaner engines in a shorter time scale. Computational Fluid Dynamics, as a rapid and cost effective tool, is being increasingly used in different stages of engine design and optimization. By using CFD tools effectively it is easy to predict and analyze various details that are technically difficult like in cylinder process of fuel combustion , temperature & pressure distribution and emissions etc.
prior to experimental tests to reduce the number of investigated parameters as well as time and thus cost. Here in our approach we have used Species Transport Model of ANSYS to find the complex phenomenon of in cylinder process of combustion, temperature and pressure distribution, NO_x, CO_2, HC, CO emissions etc. The process is carried out at different injection timing of the Diesel liquid, the cases considered are

1. Injection at 2 degree after TDC,
2. Injection at 5 Degree b TDC,
3. Injection at 10 Degree b TDC. Once we get an optimized value of Injection than ethanol, methanol and diesel are added in order to increase the efficiency of the combustion and thus still reduce the NOx, CO_2, HC, CO emissions in bronze coated and non coated piston

Keywords- fuel combustion FLUENT 14.5, NOx, CFD, CO_2, HC, CO emission, Combustion modeling, Ethanol, methanol and diesel

Introduction:

The Internal Combustion C.I engines assume a vital part in the fields of transportation of products and travelers, farming furthermore, industry. They create control by devouring valuable non-renewable energy sources and cause contamination. Among distinctive sorts of motors, the immediate infusion (DI) diesel motor shows the best efficiency along with least motor out outflows. Endeavors have been put to enhance debilitate outflows and mileage consistently. The perplexing errand of enhancing C.I engines, which have achieved a higher level of advancement, can be accomplished by mix of propelled tests and computational investigations. Current techniques for test examinations are being created to give more understanding. The demonstrating of burning motor procedures is valuable to complete broad parametric examinations, as opposed to equipment advancement and Experimentation. Contingent upon the different conceivable applications, distinctive sorts of models for motor ignition forms have been created. Quick Increase in contamination levels, increment of fuel costs, and consumption of hydrocarbon stores of the world have constrained the designers to search for fitting innovation and option fills to give to the consistently expanding requests of vitality.

The combustion simulation of CI engine was developed using fluent software ANSYS and the various equations of the multidimensional model were solved by the software automatically. The main inputs include engine speed, injection details, bore, stroke, connecting rod length, initial pressure and temperature. The program concerning the simulation model predicts the cylinder pressure, cylinder temperature, heat release rate, emission etc. The results including graphs and various contours (temperature, pressure etc) were generated by fluent software as outputs to the program for given inputs.

Literature review

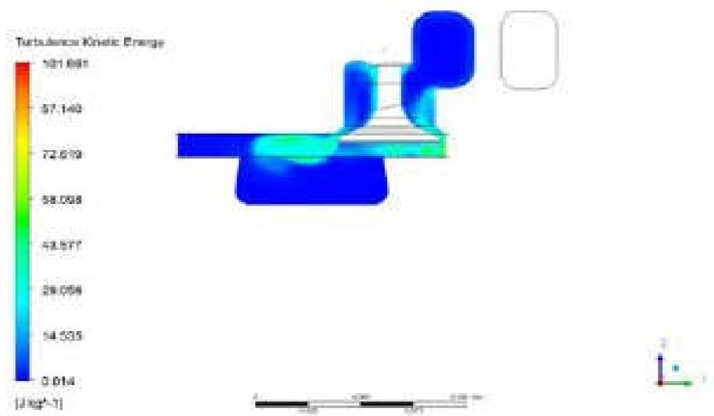
From the review of literature, it can be noted that, design of inlet manifold configuration and piston geometry is very important in a CI engine. Hence, this study looks up on the effect of helical-spiral combined configuration with different piston configurations on the induced mean swirl velocity in the piston bowl at TDC, swirl ratio during suction and compression stroke, turbulent kinetic energy variation and volumetric efficiency at engine speed 1000 rpm.

Objective of the present study:

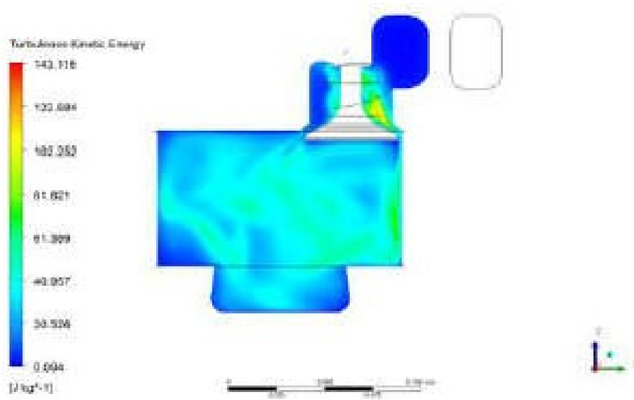
- Perform CFD Simulation of the CI engine with inlet valve, intake manifold (Helical-spiral combination) and piston using dynamic mesh approach.
- Study the effect of different piston head configurations on the in-cylinder flow-(only intake and compression stroke).
- Compare effect of different piston head configurations on volumetric efficiency, turbulence and swirl and tumble ratio in the engine.

Materials and methods for CFD approach

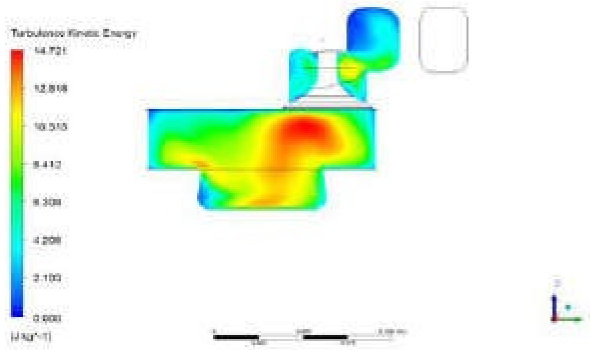
CFD flow analysis of engine piston with diesel as fluid:



Turbulent kinetic energy at 60^0 crank angle

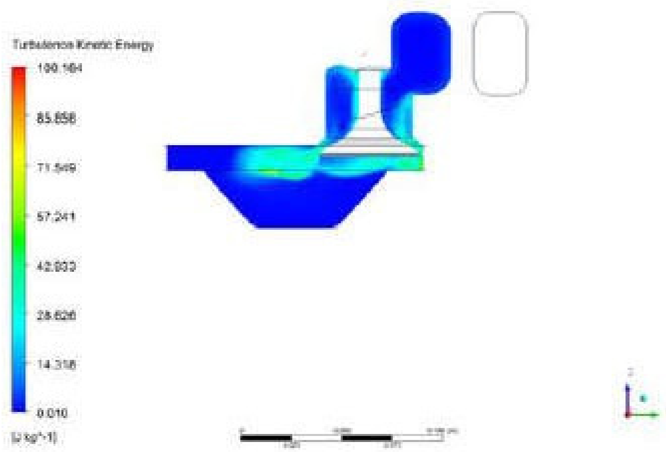


Turbulent kinetic energy at 160^0 crank angle

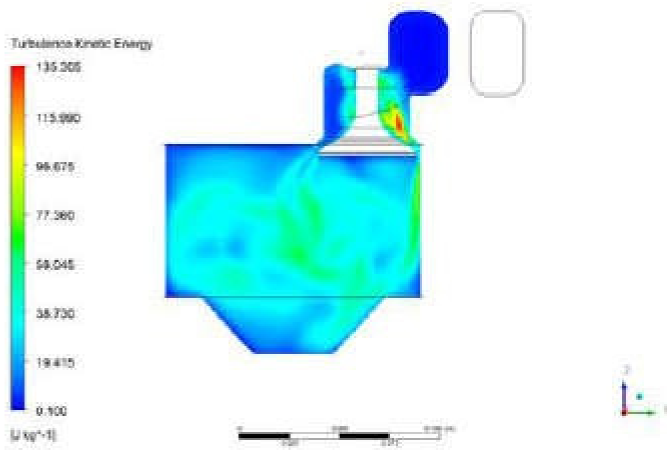


Turbulent kinetic energy at 240^{0}crank angle

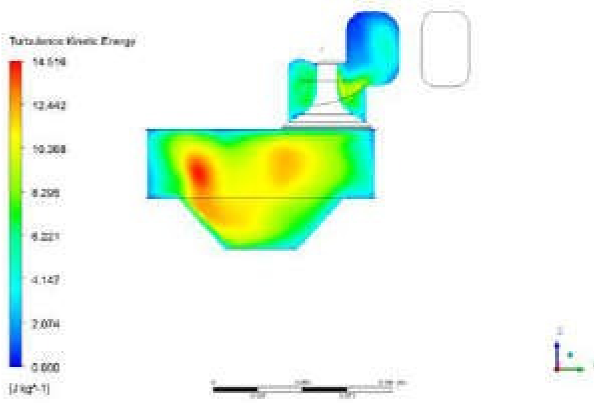
CFD flow analysis of engine piston with methanol as fluid:



Turbulent kinetic energy at 60^{0}crank angle

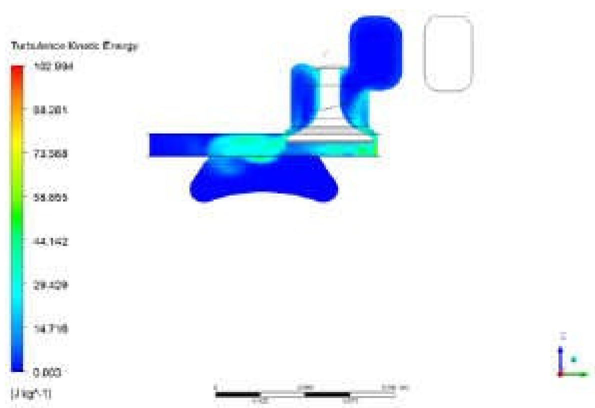


Turbulent kinetic energy at 160^{0}crank angle

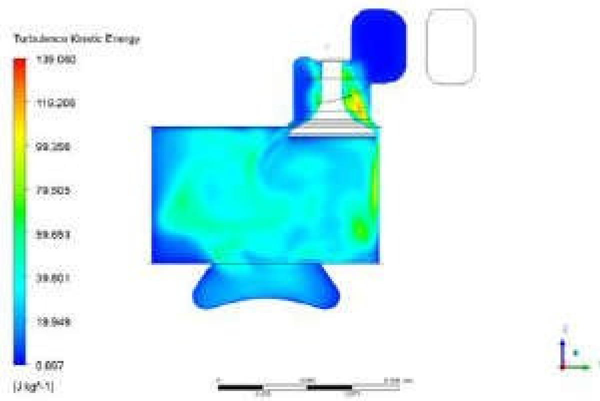


Turbulent kinetic energy at 240^{0}crank angle

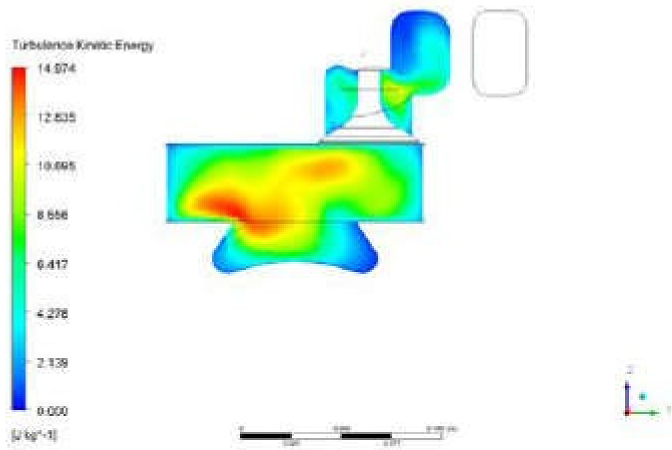
CFD flow analysis of engine piston with ethanol as fluid:



Turbulent kinetic energy at 60^{0}crank angle



Turbulent kinetic energy at 160^{0}crank angle



Turbulent kinetic energy at 240^{0}crank angle

Table shows the NOx emissions released at different points due to diesel as fuel used

Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	minimum	Maximum
Diesel	0.014	101.061	0.094	143.118	0	14.271

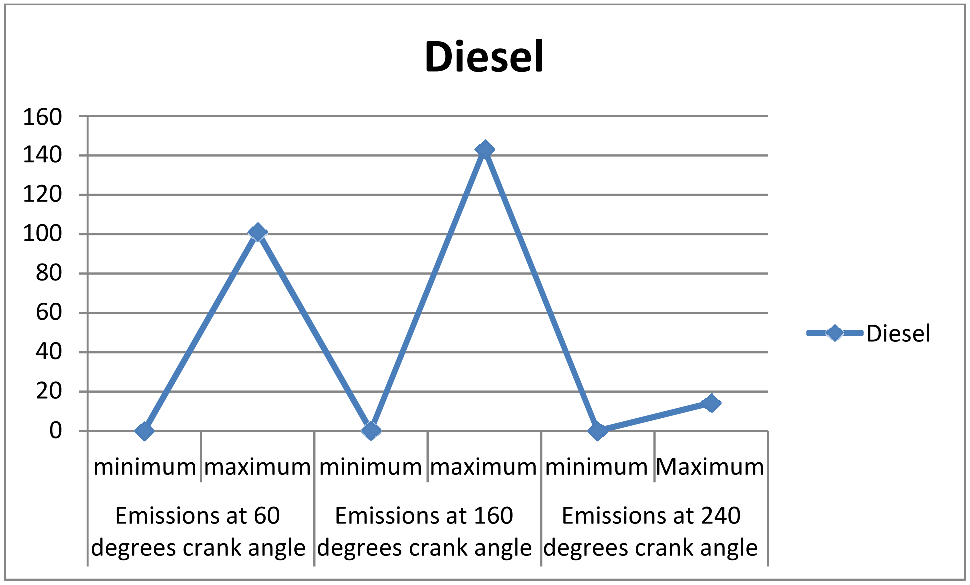


Table shows the NOx emissions released at different points due to methanol as fuel used

Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	minimum	Maximum
Methanol	0.001	100.164	0.1	135.005	0	14.518

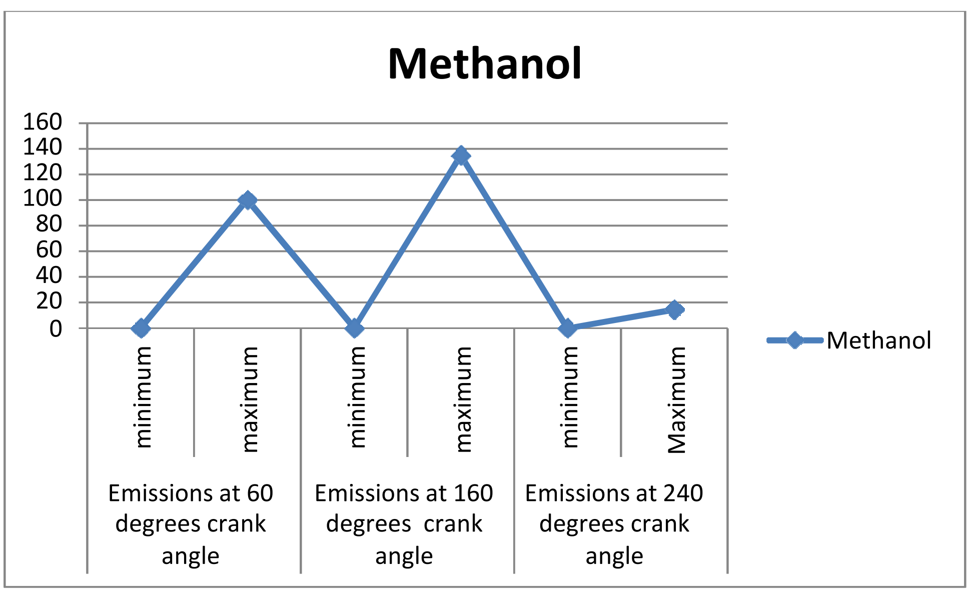


Table shows the NOx emissions released at different points due to ethanol as fuel used

Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	Minimum	maximum	minimum	Maximum	minimum	Maximum
ethanol	0	102.004	0.007	139.093	0	14.974

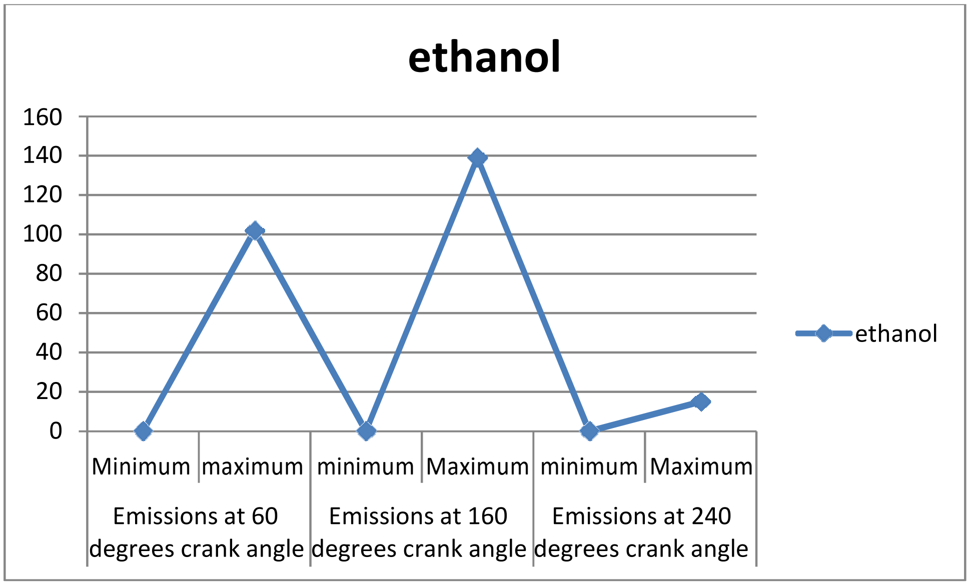
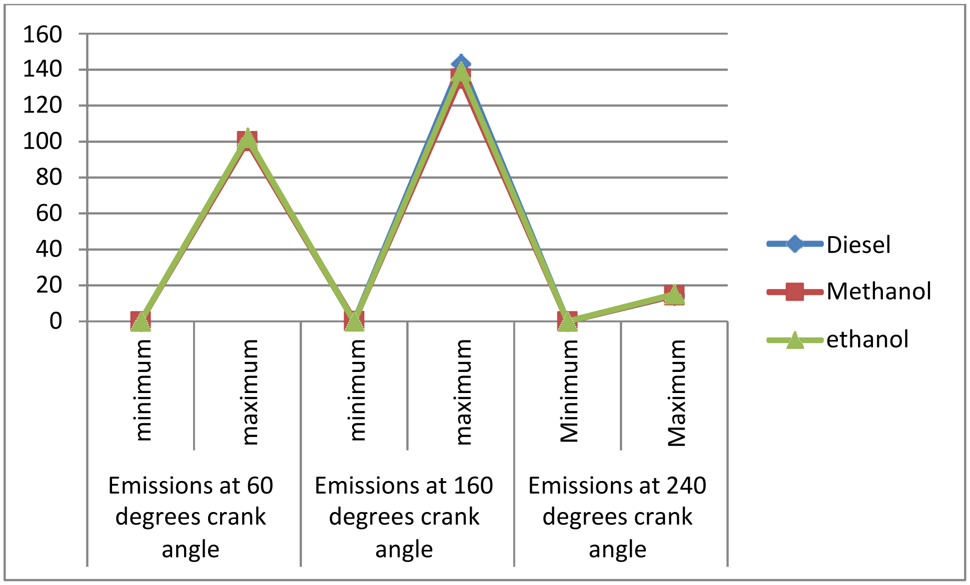


Table shows the variations in NOx emissions released at different points due to use of different fuel used

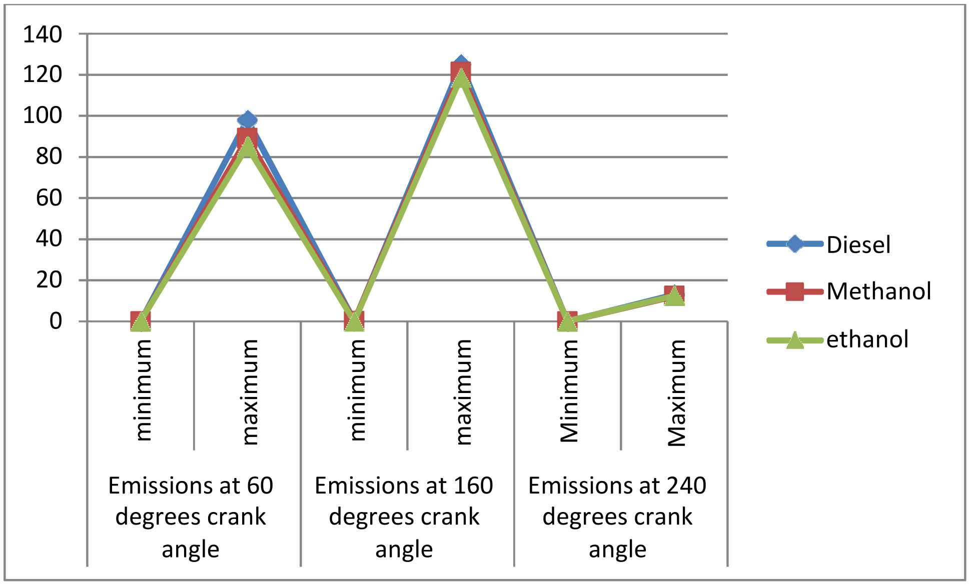
Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	Minimum	Maximum
Diesel	0.014	101.061	0.094	143.118	0	14.271
Methanol	0.001	100.164	0.1	135.005	0	14.518
ethanol	0	102.004	0.007	139.093	0	14.974



Variations in NOx emissions released at different points due to use of different fuels at different crack angles

Table shows the variations in CO_2 emissions released at different points due to use of different fuel used

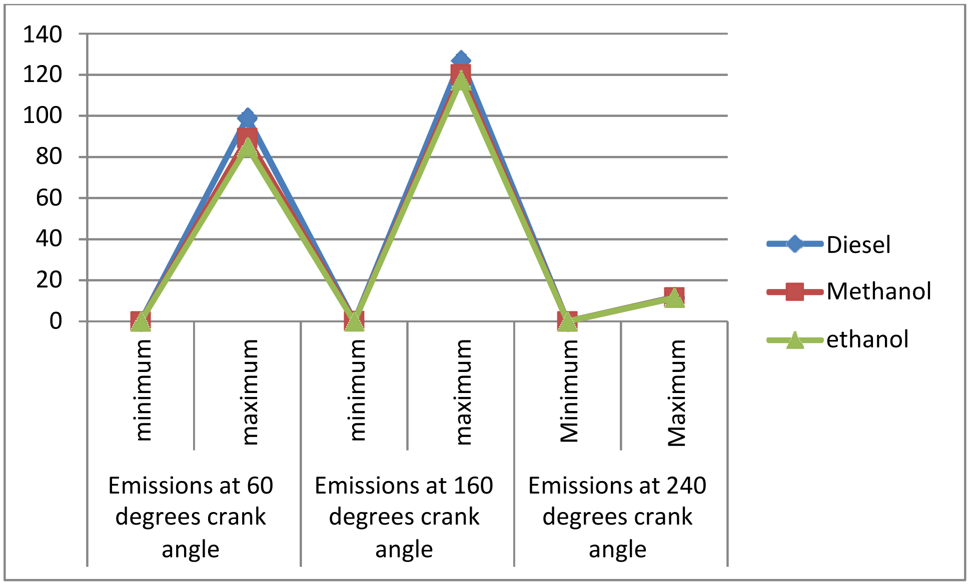
Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	Minimum	Maximum
Diesel	0.010	98.061	0.094	125.118	0	12.971
Methanol	0.001	89.164	0.1	121.185	0	12.18
ethanol	0	85.04	0.003	118.53	0	12.42



Variations in CO_2 emissions released at different points due to use of different fuels at different crack angles

Table shows the variations in CO emissions released at different points due to use of different fuel used

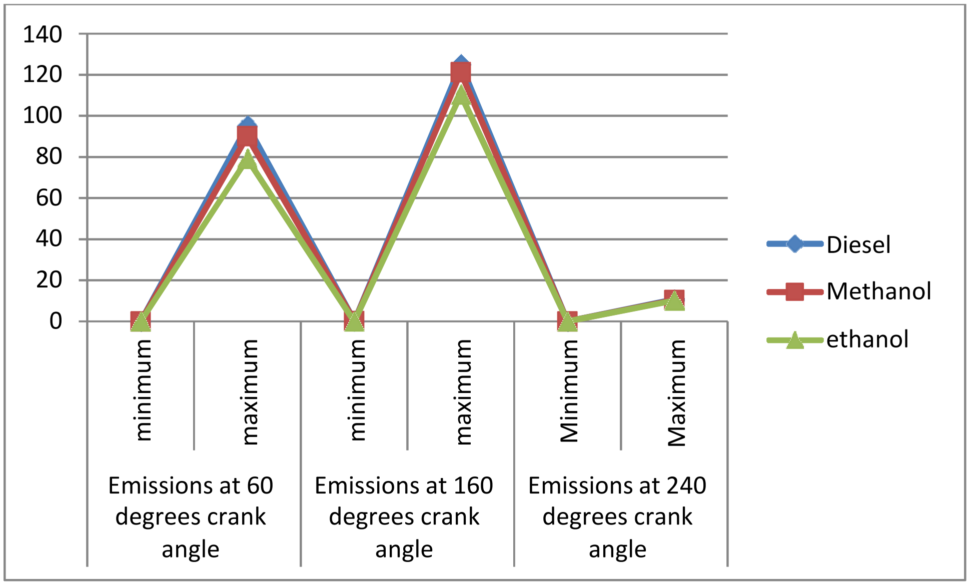
Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	Minimum	Maximum
Diesel	0.008	99.061	0.081	127.118	0	11.71
Methanol	0.001	89.164	0.1	120.185	0	11.69
ethanol	0	85.004	0.001	117.30	0	11.52



Variations in CO emissions released at different points due to use of different fuels at different crack angles

Table shows the variations in HC emissions released at different points due to use of different fuel used

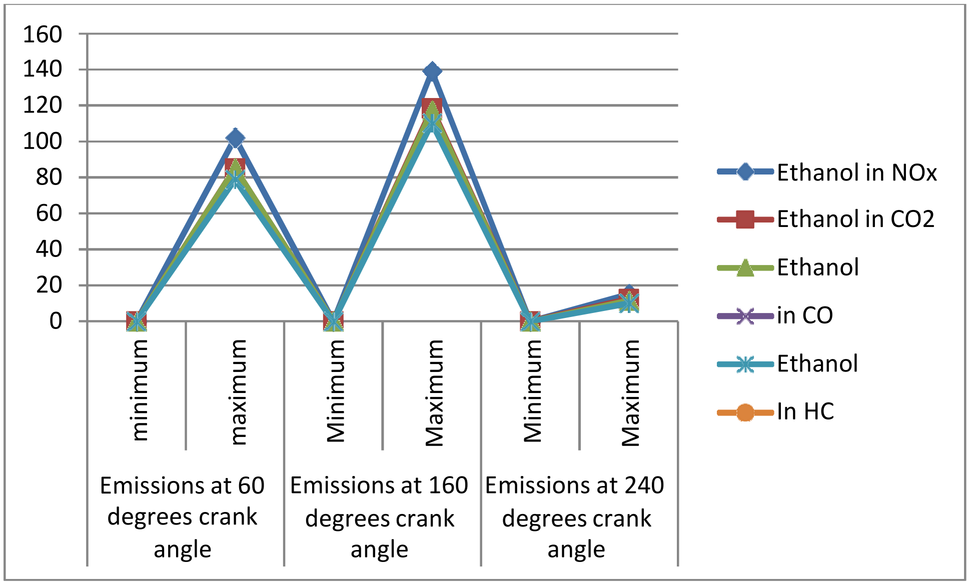
Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	minimum	maximum	Minimum	Maximum
Diesel	0.006	95.061	0.079	125.118	0	10.61
Methanol	0.001	90.164	0.1	121.185	0	10.39
ethanol	0	79.004	0.001	110.30	0	10.02



Variations in HC emissions released at different points due to use of different fuels at different crack angles

Table shows Ethanol emissions at different crank angles for different gases like NOx, CO_2, HC, CO

Types of fluids	Emissions at 60 degrees crank angle		Emissions at 160 degrees crank angle		Emissions at 240 degrees crank angle	
	minimum	maximum	Minimum	Maximum	Minimum	Maximum
Ethanol in NO_x	0	102.004	0.007	139.093	0	14.974
Ethanol in CO_2	0	85.04	0.003	118.53	0	12.42
Ethanol in CO	0	85.004	0.001	117.30	0	11.52
Ethanol In HC	0	79.004	0.001	110.30	0	10.02



Variations in Ethanol emissions released at different points of crank angle due to use of different gases

Conclusions:

From the above Results we can conclude that the Maximum emissions in occurs when the fuel is injected at least 160 degree Crank angle for Diesel. Ethanol is giving the better result in reducing the emissions while in all cases of crank angles in all the cases of emissions considered for the gases such as NOx, CO_2, HC, and CO and Ethanol is giving lesser emissions HC so from our analysis we found that the ANSYS was helpful in giving good results for the combustion modeling. The addition of Ethanol has been has that has reduced emission. So in future if India implemented ethanol as fuel will be consider to be more effective than the neat diesel in every aspect. It has also been considered according to the production, and supply of the ethanol in India.

References:

[1] Aita S, Tabbal A, Munck G, Montmayeur N, Takenaka Y, Aoyagi Y, et al. . Numerical recreation of twirling portvalve-barrel stream in Diesel motor. SAE 910263, 1991

[2] Benny Paul1, V. Ganesan, Flow field advancement in an immediate infusion diesel motor with various manifolds, International Journal of Engineering, Science and Technology Vol. 2, No. 1, 2010.

[3] Celik I, Yavuz I, Smirnov A. Substantial swirl reproductions of in-chamber turbulence for inward burning motors: A Review. Int J Engine Res 2001;2(2):119– 48.

[4] Chen A, Veshagh A, Wallace S. Admission stream expectations of a straightforward DI Diesel motor. SAE 981020, 1998.

[5] Dillies B, Ducamin A, Lebrere L, Neveu F. Coordinate infusion Diesel motor recreation: a consolidated numerical and exploratory approach from optimal design to burning. SAE 970880, 1997

[6] F. Payri , J. Benajes, X. Margot , A. Gil, CFD displaying of the in-chamber stream in coordinate infusion Diesel motors, CMT-Motores Termicos, Universidad Polite cnica de Valencia, Camino de Vera s/n, 46022 Valencia, Spain.

[7] IC Engines by V Ganesan-Tata McGraw-Hill Education, 2002

[8] J. David Rathnaraj and Prof. T. Michael. N. Kumar, "Concentrates on factor whirl consumption framework for DI diesel motor utilizing CFD", ISSN 0973-4562 volume 2, number 3 (2007)

[9] Patankar VS. Numerical warmth exchange and liquid stream. Washington: Hemisphere Publishing Corp; 1980