CFD ANALYSIS OF 4 STROKE CI ENGINE USING DIESEL FUEL AND TURMERIC FUEL

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Abstract: In this present generation, the computer has evolved a major requirement to solve complex problems. Computational fluid dynamics (CFD) has found more and more applications in diesel engine research, design and development. Using these experimental tests to reduce the number of investigated parameters as well as time and thus costs. The various successful applications have proven the reliability of using CFD tools to assist combustion in diesel engine research. By using CFD tools effectively it is easy to predict and analyze various details that are technically difficult like in cylinder process of diesel engine combustion, temperature & pressure contours, emissions etc.

Combustion is one of the most complicated process in CI engine. The combustion causes rise in the temperature in the combustion chamber, due to the high temperature various parts of the engine are subjected to thermal stresses which cause failure of these components. In order to avoid various failures, it is necessary to make a study of combustion. So, the preventive measures can be taken. In this project, analysis of combustion is done using diesel and turmeric fuel is also used for combustion analysis replacing diesel. Alternate fuel is used, as there is only 30% of conventional fuel is left in our planet. This study is done using CFD tools and got temperature and pressure contours. An engine is modeled in CATIA, meshed using ANSYS ICEM 15.0 and analysis of combustion is done in ANSYS FLUENT 15.0

***IndexTerms* -** Computational Fluid Dynamics (CFD), combustion, turmeric fuel, diesel fuel.

I. INTRODUCTION

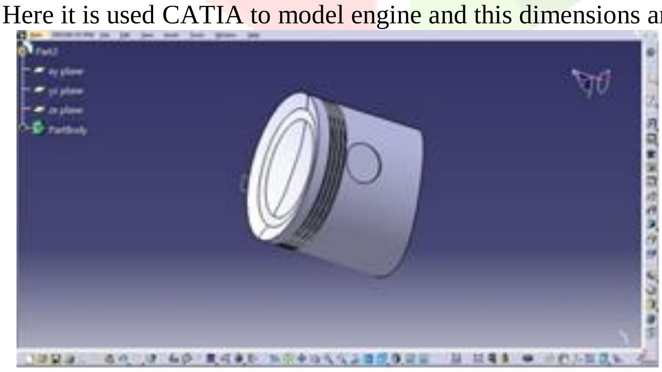
Nowadays analysis has become a more essential because of new designs and more failure in the real world. To overcome these issues mathematical analysis is suitable in real time world analysis, using this technique the real time analysis can be done this method is known as CFD (computational fluid dynamics).In this technique, we can examine the fluid flow such as (air, water, chemicals. etc.) these fluid flow on the body can analyze the design, thermal resistivity, conduction, convection, combustion analysis….etc. In this Fluid (gas and liquid) flows are governed by partial differential equations which represent conservation laws for the mass, momentum, and energy. Computational Fluid Dynamics (CFD) is the art of replacing such PDE systems by a set of algebraic equations which can be solved using digital computers.[1,2] In this paper the analyzation is going to done on both turmeric and diesel by getting various contours ,graphs and shows the difference between diesel and turmeric by comparing them.

II. CFD ANALYSIS ON 4 STROKE CI ENGINE WITH TURMERIC AND DIESEL FUEL

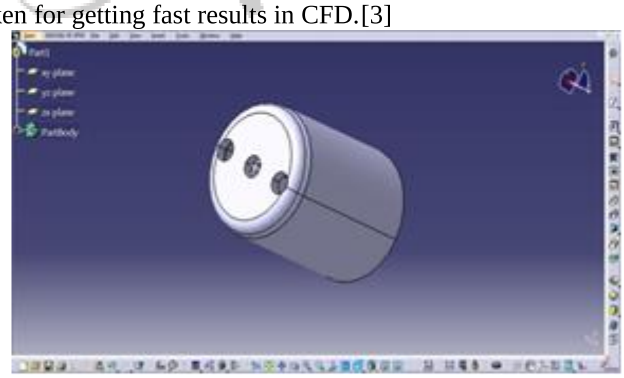
In the present work, the turmeric and diesel fuel is used to analyze the various combustion properties in the CI engine.

MODELLING

Here it is used CATIA to model engine and this dimensions are taken for getting fast results in CFD.[3]

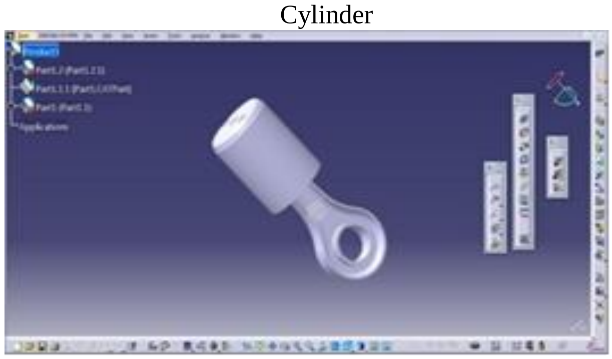


Piston



Cylinder

Connecting rod



Assembly

Fig.1 Various Engine Parts and Assembled View

The various parameters taken into consideration in modelling the different parts of engine as shown in Fig.1

Diameter of piston: 56mm

Height: 52.34mm

Diameter of cylinder: 56mm

Height of cylinder: 75mm

Inlet of air valve: 10mm, fuel inlet valve: 10mm, outlet valve: 10mm

MESHING

IMPORTING THE MODEL INTO ICEM SOFTWARE**:**

Step1: Import the model into ICEM software by selecting import software from file menu.
Step2: Click on the apply button.
Step3: Create parts (inlet and outlet) by right clicking on parts.

MESHING THE MODEL

Step1: Scale factor and max elements is given as 1 and 500 respectively.
Step2: Global mesh size is applied.

SHELL MESHING PARAMETERS

Step1: In shell meshing, mesh type is selected as 'All Tri'.
Step2: Mesh method is selected as 'patch independent'.
Step3: Shell mesh is applied.

VOLUME MESHING

Step1: Mesh type is selected as 'tetra/mixed'.
Step2: Mesh method is selected as 'Quick (Delaunay)'.
Step3: Volume meshing is applied.

PRISM MESHING PARAMETERS

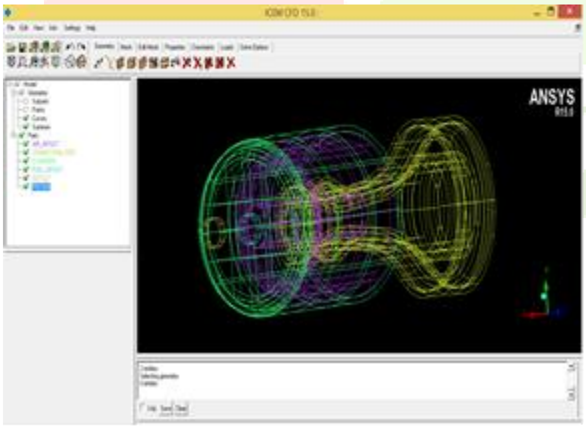
Step1: Initial height is given as 10 and number of layers as 1.
Step2: Select the prism areas (piston, cylinder, inlets and outlets).
Step3: Prism meshing parameters are applied.

SURFACE MESH SETUP

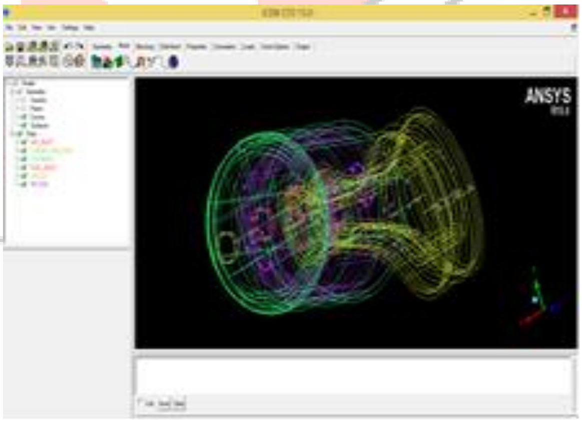
Step1: Surfaces of design need to be meshed is selected.
Step2: Maximum size is given as 0.0015 and everything else is zero.
Step3: Surface mesh is applied.

COMPUTE MESH

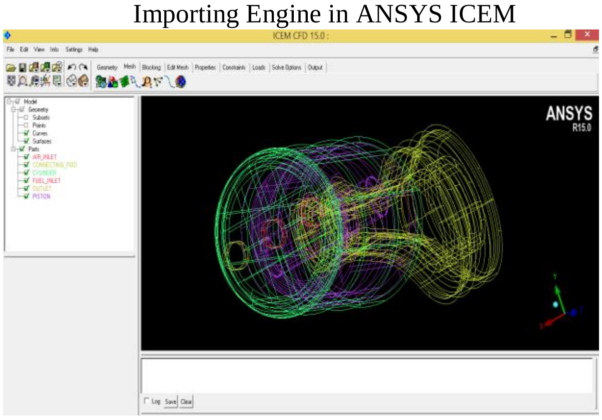
Surface mesh and volume mesh are computed from compute mesh option. After selecting prism layers, prism mesh is also computed as shown



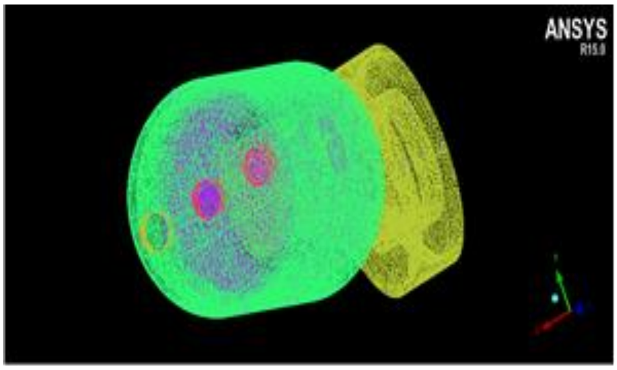
Importing Engine in ANSYS ICEM



After applying surface mesh



Before applying surface



After complete meshing

Fig.2 Different meshing conditions

III. SELECTING THE SOLVER IN OUTPUT

Step1: From output option, solver is selected as ansys fluent.
Step2: 'Write input' is selected and mesh file is opened.
Now the file is converted into mesh file and the mesh file will be imported into fluent.

FLUENT IMPORTING

Step1: Mesh file is imported into fluent using read mesh option as shown in Fig.3
Step2: Display option is selected to display the model.
Step3: Solver type is selected as pressure based, velocity formulation is absolute and time as steady. [4, 5]

MODELS

Step1: Energy equation is activated.
Step2: Viscous type is given as k-epsilon.
Step3: Radiation type is selected as P1.
Step4: Species button is selected and select non premixed combustion option.
Step5: Pdf table is generated, saved and applied as shown in Fig.4
Step6: From discrete phase, droplet option is selected.
Step7: x, y, z positions and velocities are given and applied.

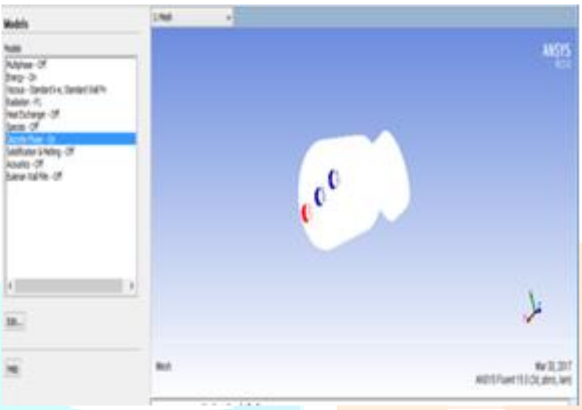


Fig.3 Mesh file and model selection in Fluent

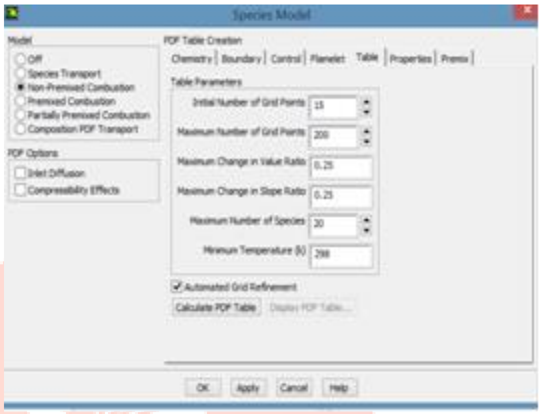


Fig.4 Pdf table generation

MATERIALS

Step1: Edit material option is selected.
Step2: Fluent database method is selected.
Step3: Diesel liquid ($C_{10}H_{22}$) and Turmeric fuel properties are applied as shown in Fig.5

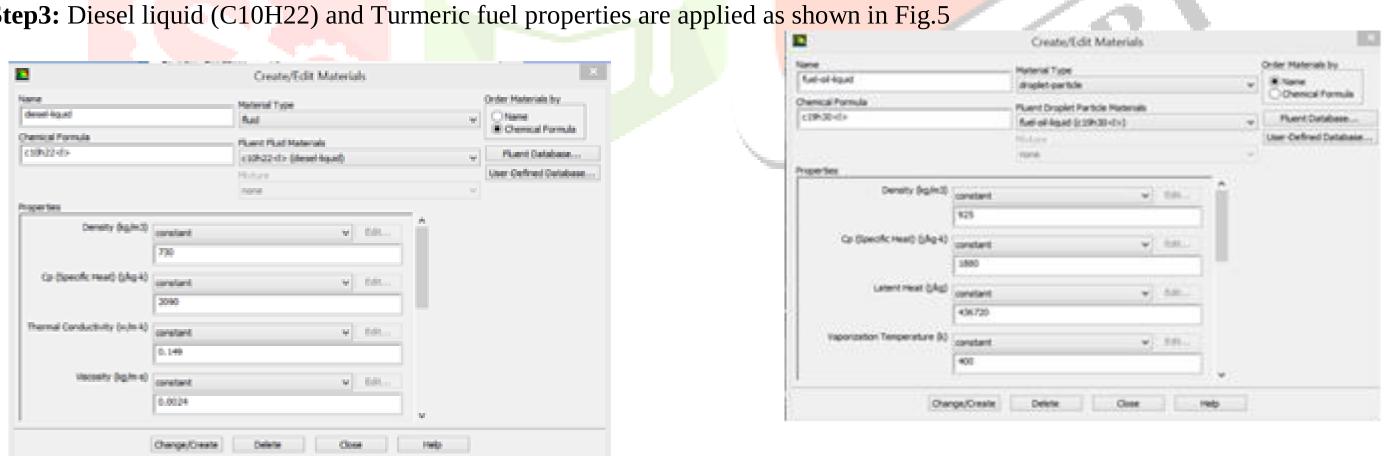


Fig.5 Applied diesel fuel and turmeric fuel properties

BOUNDARY CONDITIONS

Boundary conditions are applied as

Step1: Air Inlet valve is selected and gave type as mass flow inlet, mass flow rate is given as **100** and direction specification method is normal to boundary as shown in Fig.6.
Step3: Outlet valve is selected as pressure outlet.
Step4: Fuel inlet is selected and gave type mass flow inlet and mass flow as rate 500.
Step5: Piston type is selected as interior.
Step6: Cylinder is selected as wall.

SOLUTION INITIALISATION

Step1: Hybrid initialization is selected.
Step2: Solution is initialized as shown in Fig.7

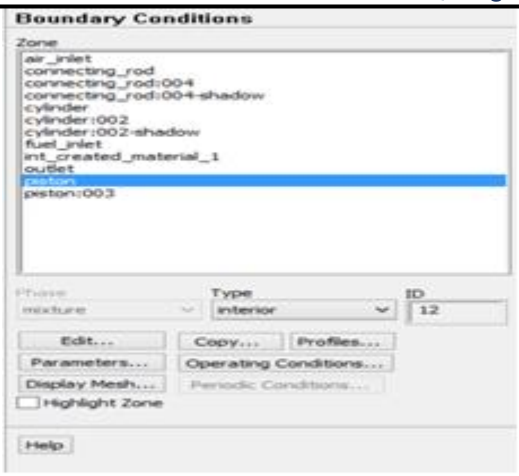


Fig.6 Boundary Conditions

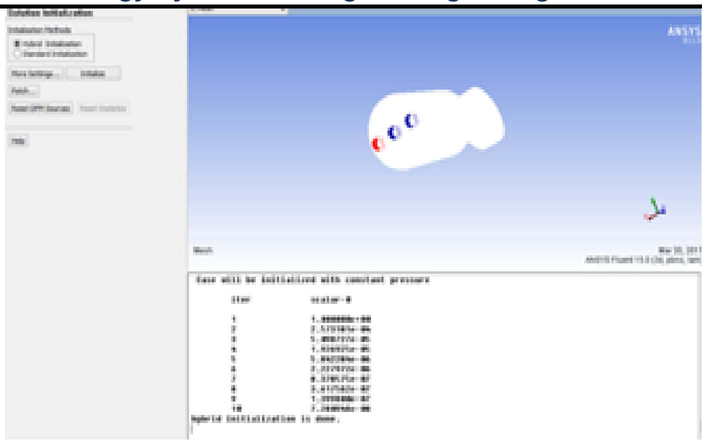


Fig.7 Solution initialization

RUN CALCULATION

In run calculation 50 iterations are given and selected calculate option

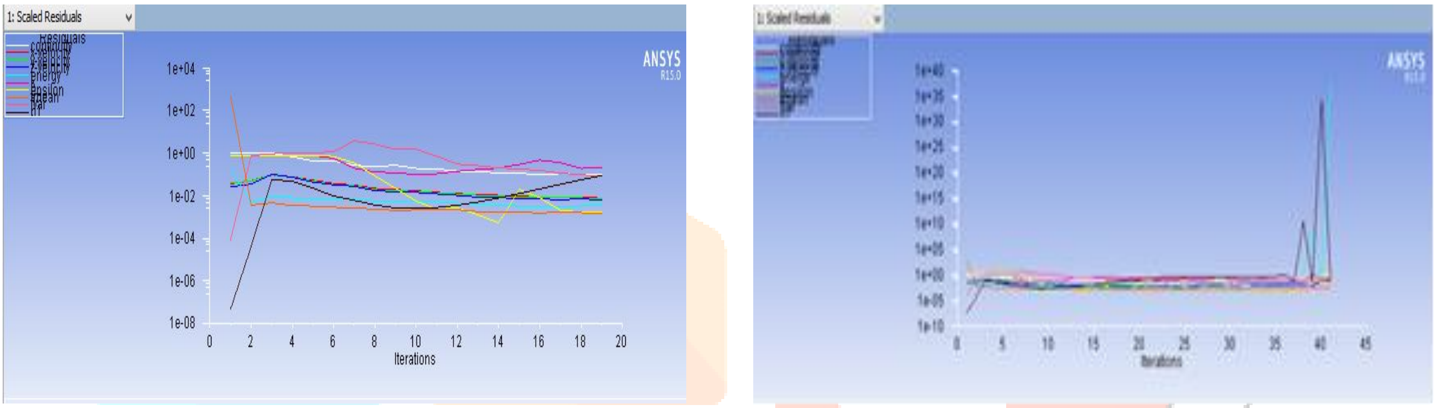


Fig.8 Before and after completing the calculation

IV. RESULTS AND DISCUSSION

Contours setup is selected from graphics and animation. Different types of contours can be obtained. Contours of temperature, pressure are obtained for both turmeric and diesel fuels. The properties obtained are compared between turmeric and diesel fuel.[6, 7]

CONTOURS AND GRAPH OF STATIC TEMPERATURE FOR DIESEL FUEL

Static temperature at starting of cylinder is 7.72e+02 (772K) and maximum temperature is 2.19E+03 (2190K). Maximum static temperature is at a distance of 20mm from top of the cylinder as described in Fig.9.

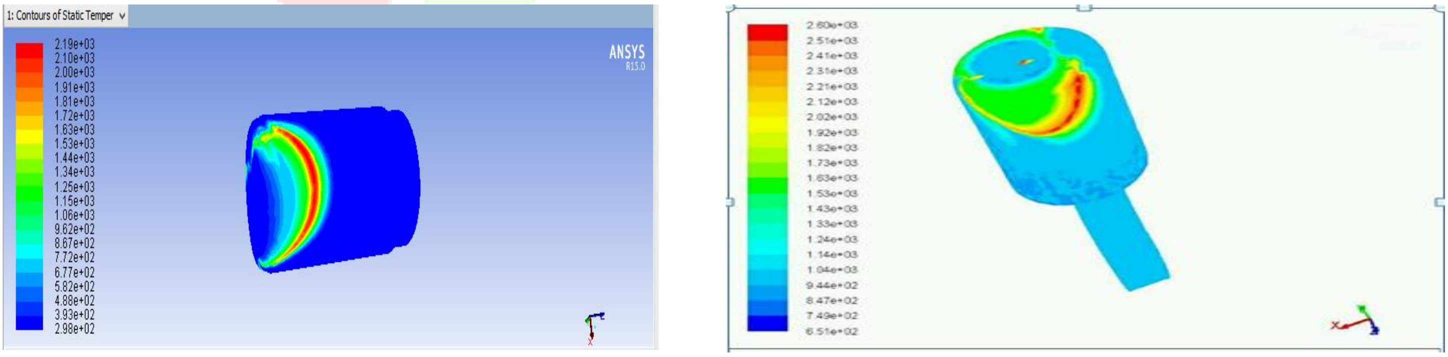


Fig.9 Contours of static temperatureand total temparature for diesel

CONTOURS AND GRAPH OF TOTAL TEMPERATURE FOR DIESEL FUEL

Total temperature at starting of cylinder is 1.53E+03 (1530K) and maximum temperature is 280E+03 (2800K). Maximum temperature is at a distance of 25mm from top of the cylinder and Change of static temperature and total temparature against length of cylinder for diesel as described in Fig.10.

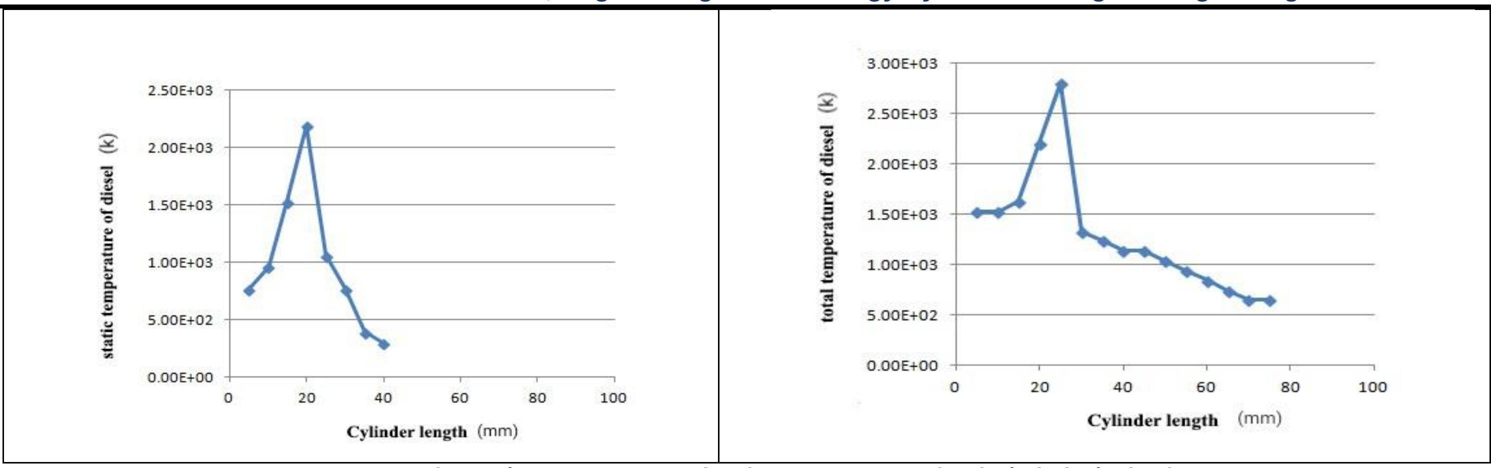


Fig.10 Change of static temperature and total temparature against length of cylinder for diesel

CONTOURS AND GRAPH OF PRESSURE FOR DIESEL FUEL AND TURMERIC FUEL

Total pressure at starting of cylinder is 1.17E+03 (1170 pascal) and maximum pressure is 4.13E+03 (4130 pascal). Maximun cylinder is at end of the cylinder.Total pressure at starting of cylinder is 1.00E+03(1000 pascal) and it is the maximum temperature as shown in Fig.11

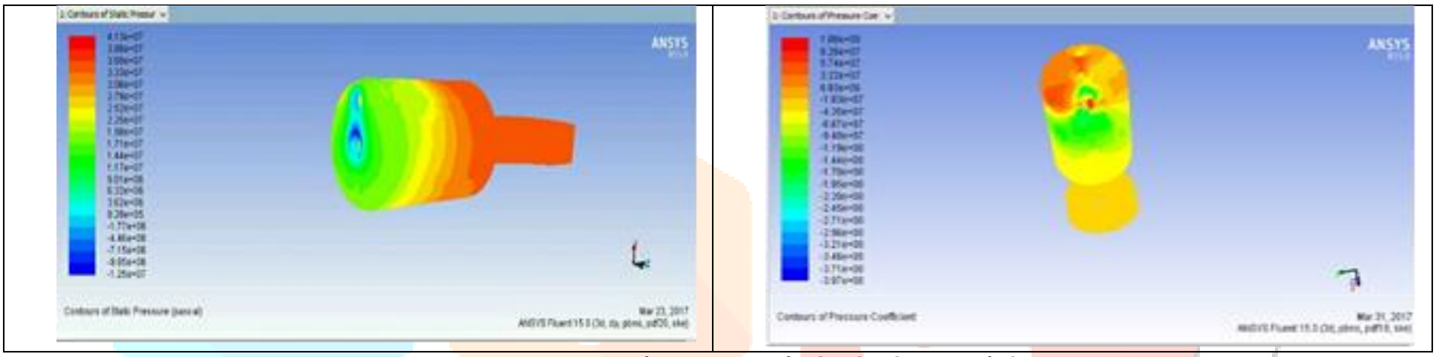


Fig.11 Contours of static pressure for diesel and turmeric fuel

The corresponding change of pressure against length of cylinder for diesel and turmeric fuel is observed and shown in Fig.12

Fig.12 change of pressure against length of cylinder for diesel and turmeric fuel

CONTOURS AND GRAPH OF STATIC TEMPARATURE, TOTAL TEMPERATURE FOR DIESEL AND TURMERIC FUEL

Total temperature at starting of cylinder is 1.98E+03 (1980K) and maximum temperature is 2.19E+03 (2190K). Maximum temperature is at distance of 30 mm from top of the cylinder. Total temperature at starting of cylinder is 8.01E+02 (801K) and maximum temperature is 2.31E+03 (2310K). Maximum temperature is at distance of 40 mm from top of the cylinder as described in Fig.13

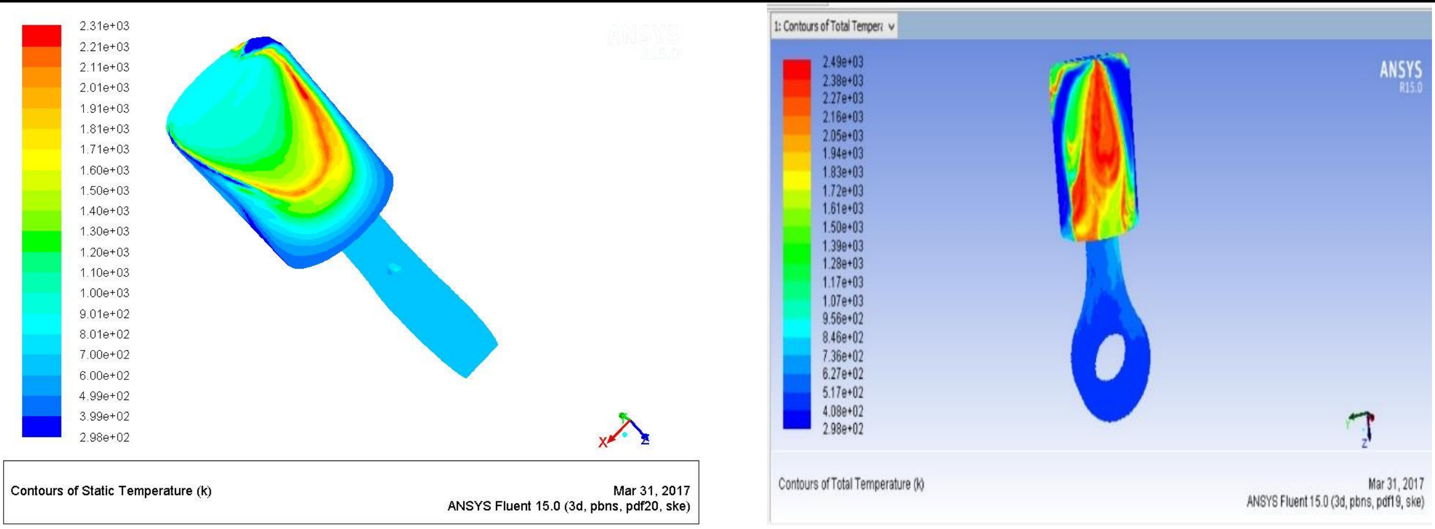


Fig.13 Contours of static temperatureand total temparaturefor turmeric fuel

The corresponding change of static of static and total tempatarute against length of cylinder for turmeric fuel is observed and is shown in Fig.14

Fig.14 change of static and total temperature against length of cylinder for turmeric fuel

COMPARISION

The below Fig.15 gives the comparison between the conventional diesel fuel and non-conventional turmeric fuel.

	Diesel			Turmeric fuel		
cylinder length	static temperature	total temperature	static pressure	total temperature	static pressure	static temperature
5	2.19E+03	2.80E+03	4.13E+07	2.49E+03	1.08E+08	2.31E+03
10	2.10E+03	2.51E+03	3.86E+07	2.38E+03	8.26E+07	2.21E+03
15	2.00E+03	2.41E+03	3.60E+07	2.27E+03	5.74E+07	2.11E+03
20	1.91E+03	2.31E+03	3.33E+07	2.16E+03	3.22E+07	2.01E+03
25	1.81E+03	2.21E+03	3.06E+07	2.05E+03	6.93E+07	2.91E+03
30	1.72E+03	2.12E+03	2.79E+07	1.94E+03	-1.83E+07	1.81E+03
35	1.63E+03	2.02E+03	2.52E+07	1.83E+03	-4.35E+07	1.71E+03
40	1.44E+03	1.92E+03	2.25E+07	1.72E+03	-6.87E+07	1.60E+03
45	1.34E+03	1.82E+03	1.98E+07	1.61E+03	-9.40E+07	1.50E+03
50	1.25E+03	1.73E+03	1.71E+07	1.50E+03	-1.19E+08	1.40E+03
55	1.15E+03	1.63E+03	1.44E+07	1.39E+03	-1.44E+08	1.30E+03
60	1.06E+03	1.53E+03	1.17E+07	1.28E+03	-1.70E+08	1.20E+03
65	9.82E+02	1.43E+03	1.44E+07	1.17E+03	-1.95E+08	1.10E+03
70	8.87E+02	1.33E+03	1.17E+07	1.07E+03	-2.20E+08	1.00E+03
75	7.72E+02	1.24E+03	9.01E+07	9.56E+02	-2.45E+08	9.01E+02

Fig.15 Values of temperature and pressure along the length of the cylinder for diesel and turmeric fuel.

V. CONCLUSION

The CFD code fluent was used to simulate the combustion characteristics of CI engine fuelled with diesel and turmeric fuel. Temperature contours for diesel and turmeric fuel are obtained. Pressure contours for diesel and turmeric fuel are obtained. Comparisons of pressure and temperature contours are done. For diesel fuel maximum static temperature is 2190K while for turmeric fuel it is 2310K. Maximum total temperature is 2800K for diesel and 2190K for turmeric fuel. It is varying linearly in turmeric fuel. Maximum pressure for diesel is 4130 pascal and for turmeric fuel it is 1000pascal. As all the maximum values for diesel and turmeric fuel is nearly same, turmeric fuel can be used as alternate fuel for diesel.

VI. REFERENCES

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