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Performance and Emissions in IC Engine with Mango Seed Methyl Easter Blends

Srinivas, Abhimanyu R Posangiri

Abstract: ***Optimal study on IC engines needy at the present days to control the pollution, characteristics in performance as well as emission for bio diesel blends has its importance in replacement of diesel. Present study focuses on the simulative comparison with practical results obtained with mango seed bio diesel blends. The approaches of simulation for MSME blend mixtures for B10, B20 and B30. Load conditions consideration at null, 2,3,6,9 and 12 kgs, pressure conditions at 210,225 and 250 bar. Mathematical modelling has done in ANSYS Fluent to simulate CFD for comparative study with practical output. By comparing the results blend named as B20 MSME shown better results when compare with any other diesel blend in both methods. Even its clear that practical results are good affective than simulated in performance also.***

Keywords: ***MSME blends, bio-diesel, Ansys fluent, CFD, Emissions***

I. INTRODUCTION

`Studies have been made to control the automobile emissions for the environmental safety. Emissions mainly caused by the fossil fuels, according to the researches in past two decades fuel usage rate increasing rapidly which causes of lack of diesel and petro products up to the demand. In spite of considering all these consideration bio-diesel research becomes needy with natural resources, bio product of this kind leads to the tests on mango seed methyl easter blends. Present work focused on the comparative validation of simulative results with practical obtained out puts for much clarity.

`It is observed that most of the research paper reported that the use of biodiesel in diesel engine with various blend ratios increase the NOx emission but 2.5% of blend of biodiesel shows good performance and emission level. The present work focused on fuel additives blended methyl ester of mango seed oil.

In the global scenario, biodiesel productions are from animal fats, vegetable oils, recycled cooking, greases, and waste plastics. Biodiesel is defined by ASTM as a fuel comprising alkyl (methyl, ethyl, or propel) esters of long chain fatty acids derived from different animal fats and vegetable oils. The modeling of combustion engine processes is useful to carry out extensive parametric studies, rather than hardware development and Experimentation.

In engine environments, the combustible mixture is subject to a turbulent flow and, once mixed, undergoes subsequent elementary reactions which convert the fuel vapor to complete and incomplete combustion products with the accompanying release heat.

Simulation results revealed that peak cylinder pressure of the engine running on biodiesel blend is slightly higher than the engine running on pure diesel.

Biodiesel comprises of about 10-11% built-in oxygen and has higher cetane number that helps to improve combustion process. These characteristics of biodiesel results in reduced emissions in terms of carbon monoxide, hydrocarbon and particulate matter but increase the emission of nitrogen oxide. In addition, burning of biodiesel fuel does not contribute to net atmospheric CO_2 level; as such fuels are derived from agricultural materials which are produced through photosynthesis carbon fixation.

II. SCOPE FOR SIMULATION

Artificial nueral network methods used by **Mudgal et al. [1]** to predict emissions from engines used in transit buses experimentally with bio diesel runs. **Shivakumar et al. [2]** analyzed on four stroke C.I. engine operated on honge methyl ester. Multi-chamber piston atmotoring condition has been analyzed by **karthika[3]** through C.F.D using fluent software, simulative results compared with the base results obtain in C.I engine. Computational Fluid dynamics (CFD) code FLUENT is used to model complex combustion phenomenon **Umakant and Vivek [4]** on single cylinder and DI engine, with full load condition at constant speed of 1500 rpm. According to **Saurabh et al [5]** Vegetable oils are a suitable alternative to diesel in compression ignition (CI) engines. The use of vegetable oils in a C I engine results in low CO, HC and smoke opacity emissions compared to a conventional diesel fuel.

III. MODELING FUEL COMPOSITION AND ANSYS FLUENT CONTOURS

The fuels considered are diesel (D100) and 10% (B10), 20% (B20), 30% (B30) (by volume) blending of biodiesel from MSME with diesel. The diesel ($C_{10}H_{22}$) fuel available in FLUENT fuel library is used to represent pure diesel.

The calculated in-cylinder pressure and heat release rate are compared against experimental data for validation of the numerical model.

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The peak in-cylinder pressure, the general shape of pressure profile and the heat release rate are used as validation criteria. 3Dmodel developed with respect to piston aspects in Catia v20 version, the model subject to import in Ansys fluent for CFD analysis.

3.1 Steps involving CFD fluent

1. Import model to Ansys 2. Mesh the model with fine mesh 3. Methods are pressure based, 2D model with gravity enabled, axis symmetry selection enabled. 4. Energy equation also enabled with K-Epsilon turbulence, boundary conditions mass flow inlets for air fuel mix, outlet with pressure. 5. Materials are diesel and MSME diesel blends 10%, 20%, 30%. Solution initialised with Presto model, with minimum iterations of 4000.

Property	Diesel	Biodiesel B10	Biodiesel B20	Biodiesel B30
Specific gravity	0.8298	0.8512	0.8646	0.8796
Kinematic viscosity	2.57	3.80	4.42	5.18
Flash point ^{0}C	37	82	102	166
Fire Point ^{0}C	40	92	113	179
Power point ^{0}C		-3C	+3C	+5C
Gross calorific value in Kj/KG	44738	43230.775	42606.912	41924.008
Cetane number	50	52.2	51.8	51.6

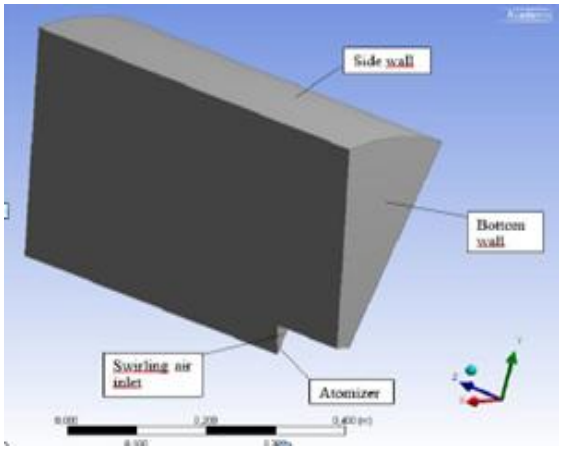


Figure3.1Model import CFD for porous medium

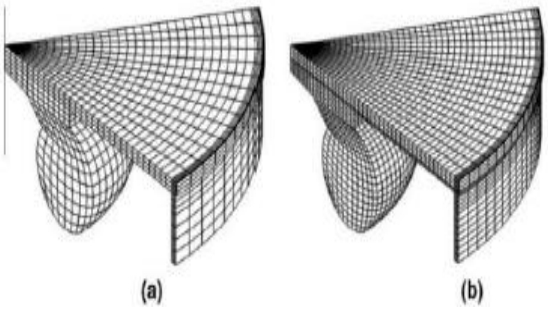


Figure 3.2 a and b shows normal mesh to fine mesh

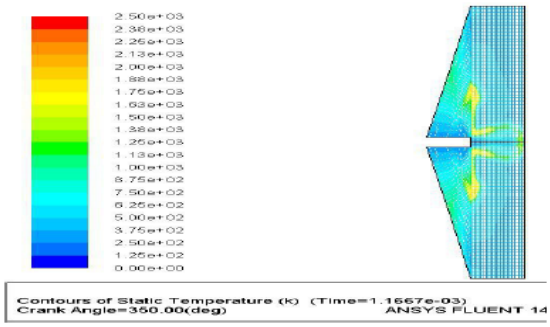


Figure 3.3 shows the static temperature for diesel contour

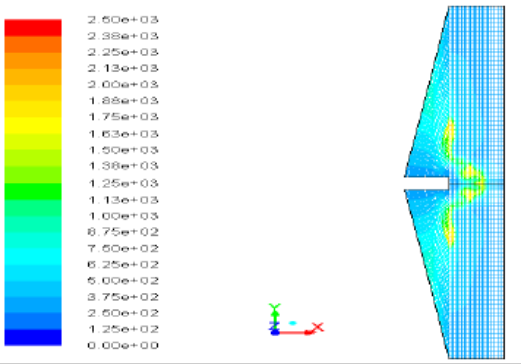


Figure 3.4 shows the static temperature of MSME

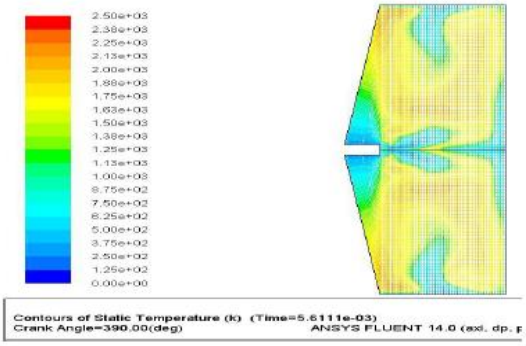


Figure 3.5shows the static temperature of diesel

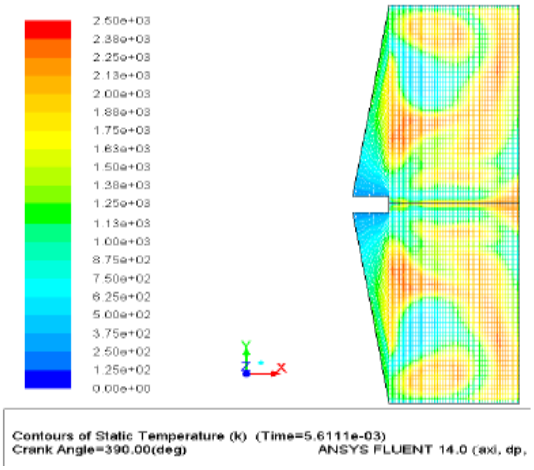


Figure 3.6 shows the static temperature of MSME at contours

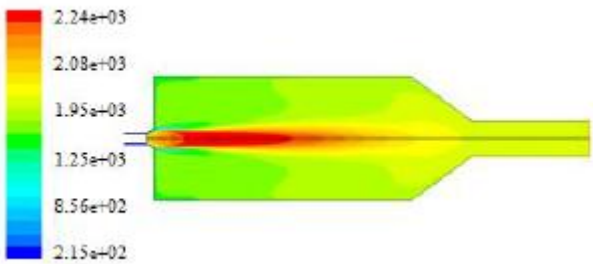


Figure 3.7 Total temperature contours in premixed

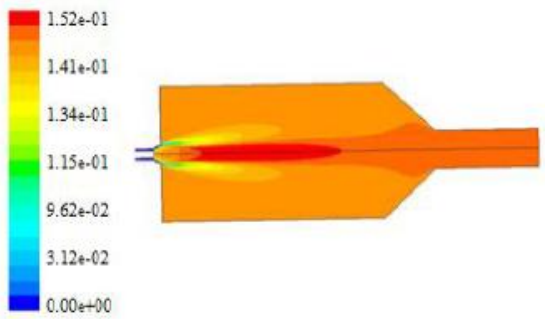


Figure 3.8 Mass fraction of CO2 in Premixed

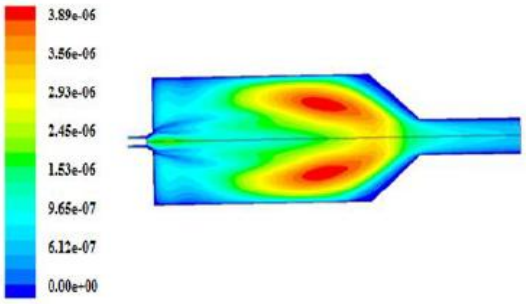
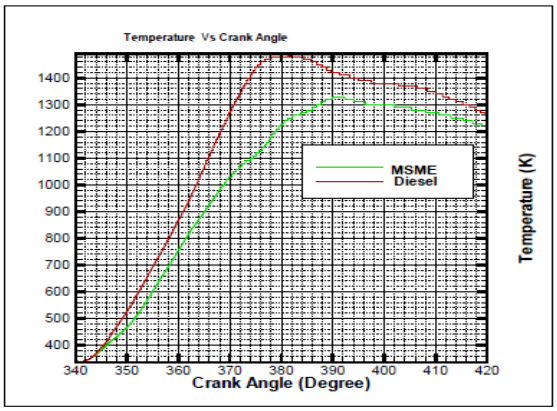


Figure 3.9 Mass fraction of NOX in Premixed

IV. Results and Discussions

The results obtained through CFD analysis of combustion characteristics of various blends of biodiesel derived from MSME with diesel are presented.
The results are comparable which are obtained both simulated and experimentally

CFD modeling and simulation has therefore become an attractive alternative for engine analysis in place of full experimental test bed study in recent years. In this research work, the performance of a single cylinder four stroke diesel engine was investigated. Commercial simulation software ANSYS Forte was used to study the combustion and emission characteristics of a diesel engine, in order to establish strategies for improvement of in-cylinder combustion and emission control.

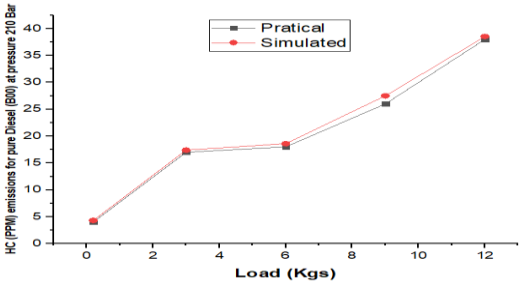


Graph showing the temperature on contour area comparison between diesel and B20 MSME blend

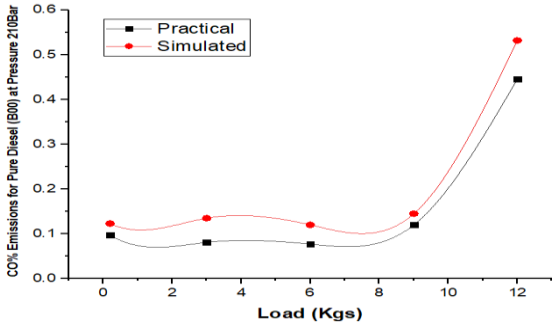
Pressure 210: Table 4.1 shows HC emissions

Load	B00 – HC(PPM)	
	Practical	Simulated
0.2	4	4.3
3	17	17.4
6	18	18.6
9	26	27.5
12	38	38.53

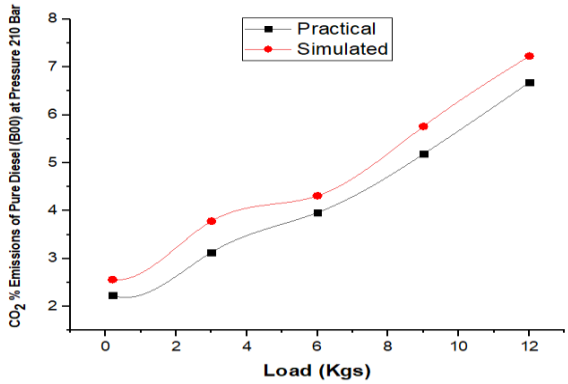
Validations for Pure diesel at practical and Simulation at Pressure 210Bar



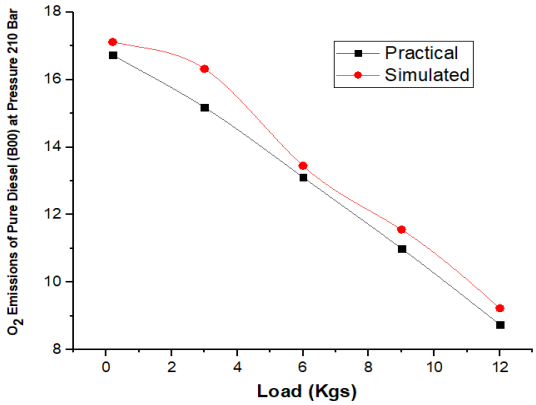
Graph 4.1 HC (PPM) emissions for pure diesel at pressure 210Bar.



Graph 4.2 CO% emissions for pure diesel at pressure 210Bar

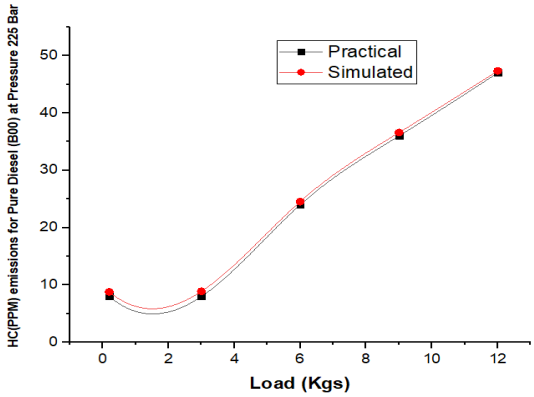


Graph 4.3 CO_2 emissions for pure diesel at pressure 210Bar

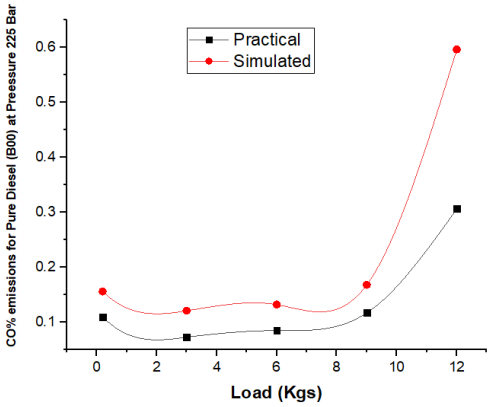


Graph 4.4 O_2 emissions for pure diesel at pressure 210Bar
NO_x emissions for pure diesel at pressure 210Bar

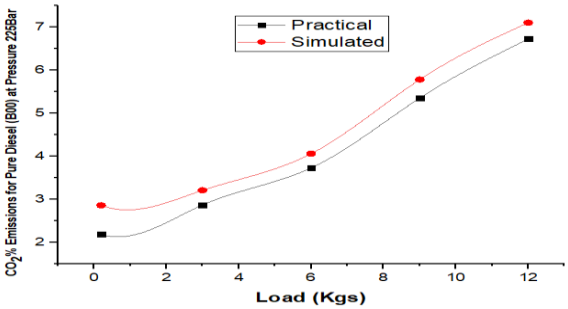
Validations for Pure diesel at practical and Simulation at Pressure 225Bar



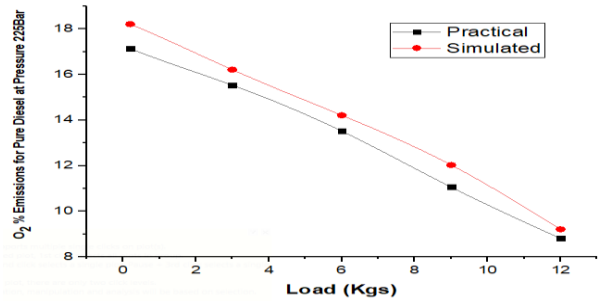
Graph 4.5 HC (PPM) emissions for pure diesel at pressure 225Bar



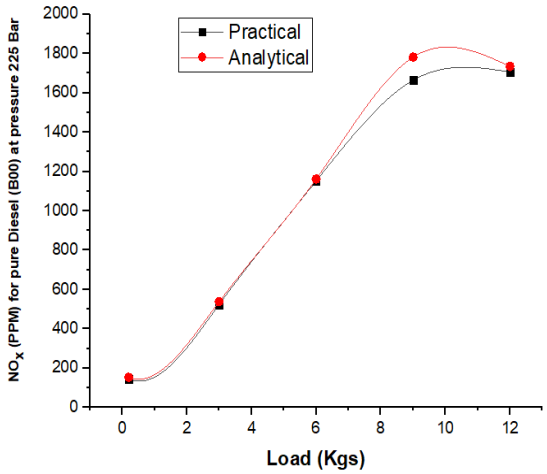
Graph 4.6 CO % emissions for pure diesel at pressure 225Bar



Graph 4.7 CO_2% emissions for pure diesel at pressure 225Bar

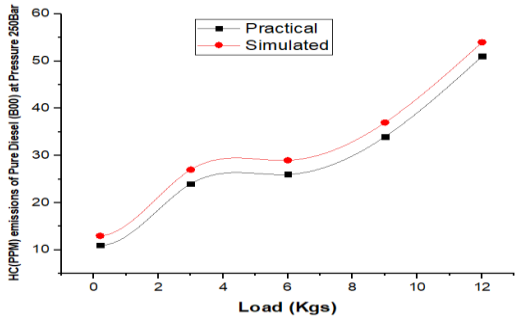


Graph 4.8 O_2% emissions for pure diesel at pressure 225Bar

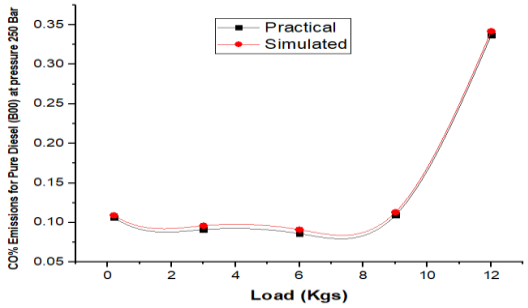


Graph 4.9 NO_x% emissions for pure diesel at pressure 225Bar

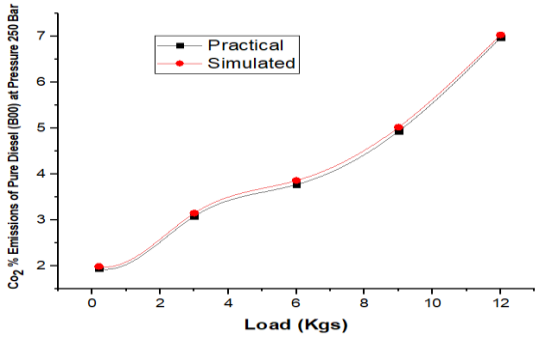
Validations for Pure diesel at practical and Simulation at Pressure 250Bar



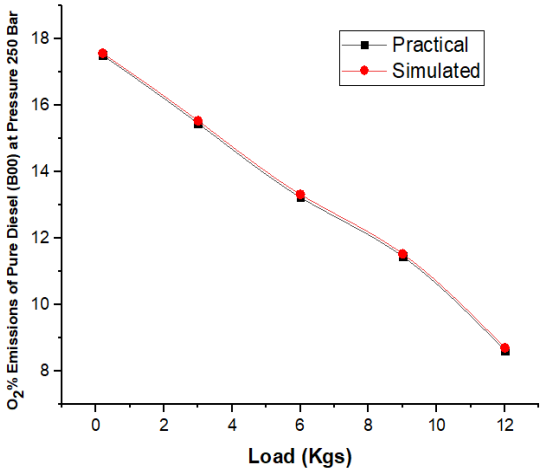
Graph 4.10 HC (PPM) emissions for pure diesel at pressure 250Bar



Graph 4.11 CO% emissions for pure diesel at pressure 250Bar

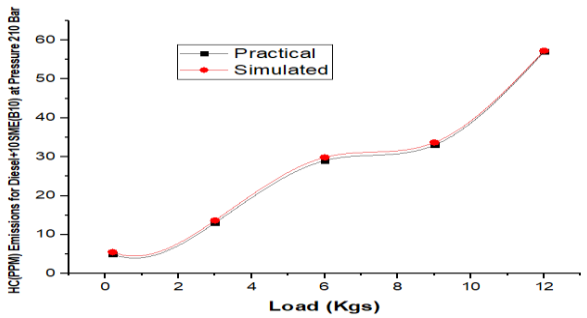


Graph 4.12 CO_2% emissions for pure diesel at pressure 250Bar

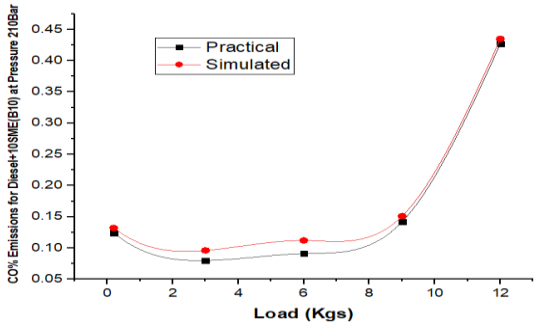


Graph 4.13 NO_x (PPM) emissions for pure diesel at pressure 250Bar

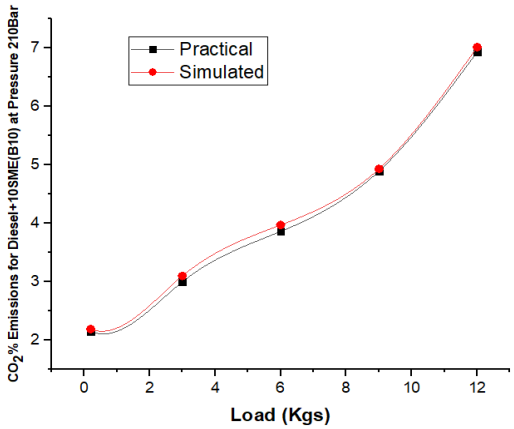
Validations for Diesel +10%MSME with practical and Simulation at Pressure 210Bar:



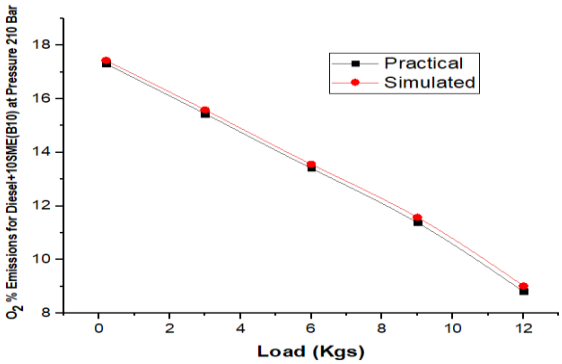
Graph 4.14 HC (PPM) emissions for Diesel+10%MSME at pressure 210Bar



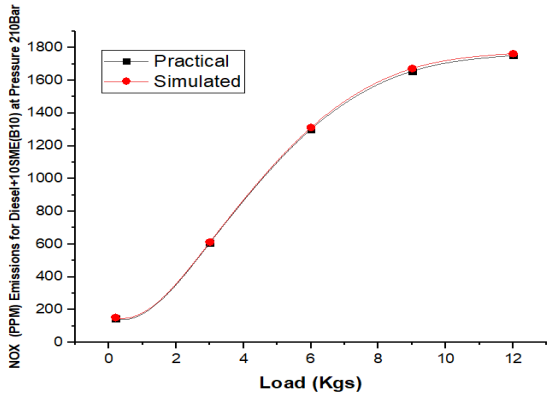
Graph 4.15 CO% emissions for Diesel+10%MSME at pressure 210Bar



Graph 4.16 CO_2% emissions for Diesel+10%MSME at pressure 210Bar

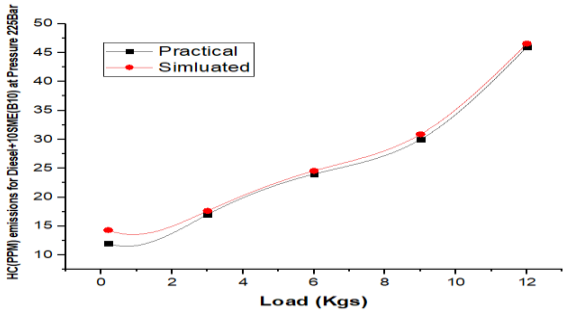


Graph 4.17 O_2% emissions for Diesel+10%MSME at pressure 210Bar

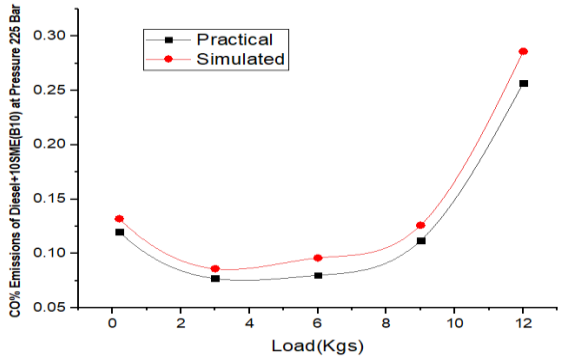


Graph 4.18 NO_x (PPM) emissions for Diesel+10%MSME at pressure 210Bar

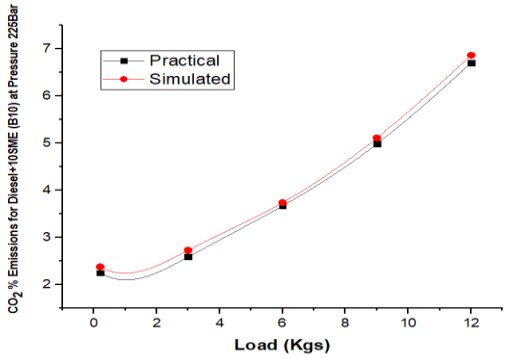
Validations for Diesel +10%MSME with practical and Simulation at Pressure 225Bar:



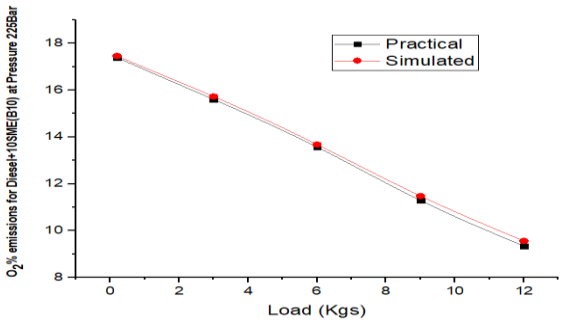
Graph 4.19 HC (PPM) emissions for Diesel+10%MSME at pressure 225Bar



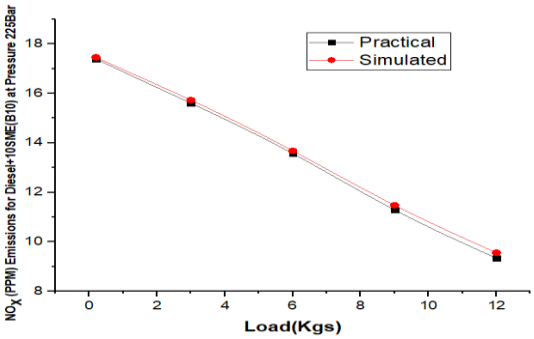
Graph 4.20 CO% emissions for Diesel+10%MSME at pressure 225Bar



Graph 4.21 CO_2% emissions for Diesel+10%MSME at pressure 225Bar

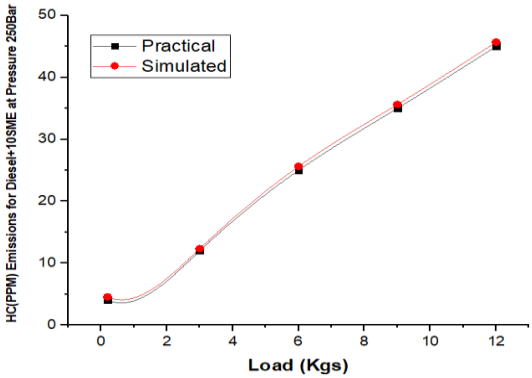


Graph 4.22 O_2% emissions for Diesel+10%MSME at pressure 225Bar

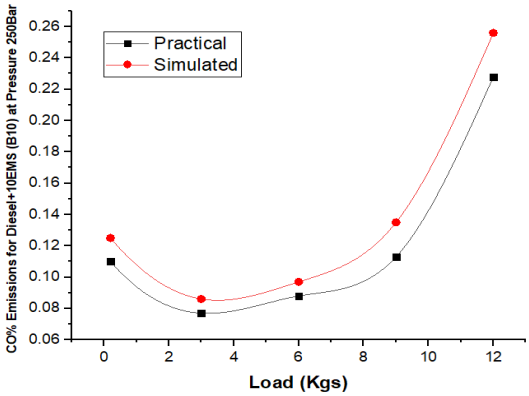


Graph 4.23 NO_x (PPM) emissions for Diesel+10%MSME at pressure 225Bar

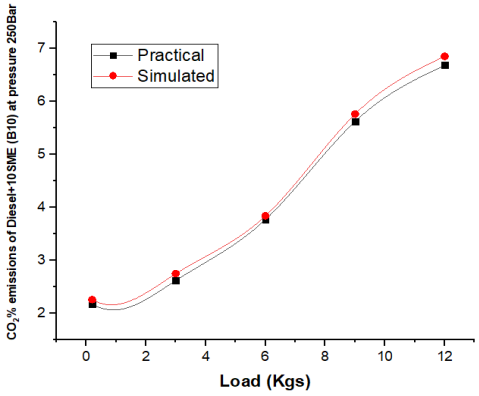
Validations for Diesel +10%MSME with practical and Simulation at Pressure 250Bar:



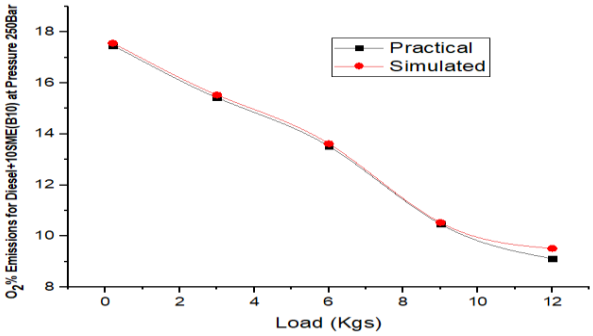
Graph 4.24 HC (PPM) emissions for Diesel+10%MSME at pressure 250Bar



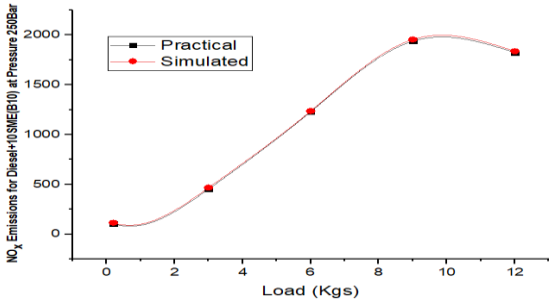
Graph 4.25 CO% emissions for Diesel+10%MSME at pressure 250Bar



Graph 4.26 CO_2% emissions for Diesel+10%MSME at pressure 250Bar

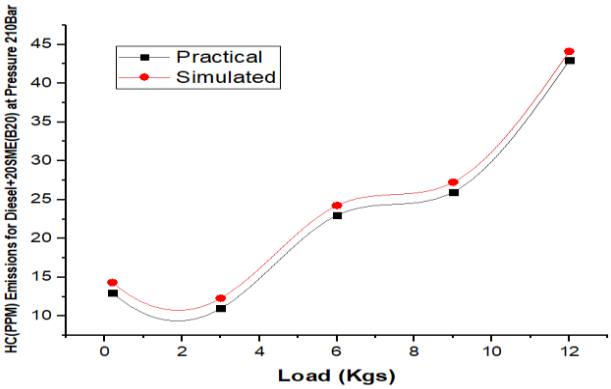


Graph 4.27 O_2% emissions for Diesel+10%MSME at pressure 250Bar

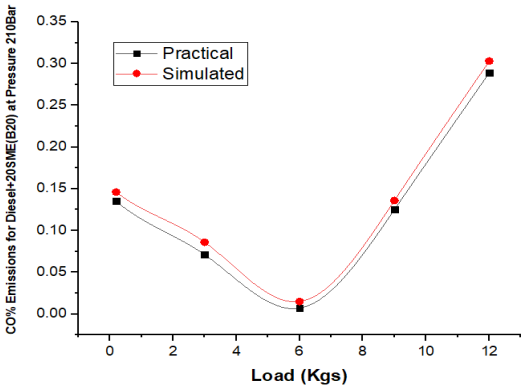


Graph 4.28 NO_x (PPM) emissions for Diesel+10%MSME at pressure 250Bar

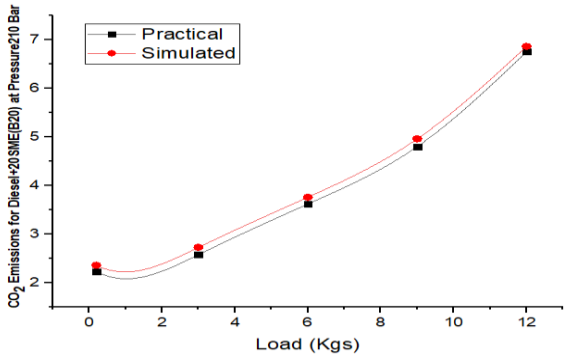
Validations for Diesel +20%MSME with practical and Simulation at Pressure 210Bar:



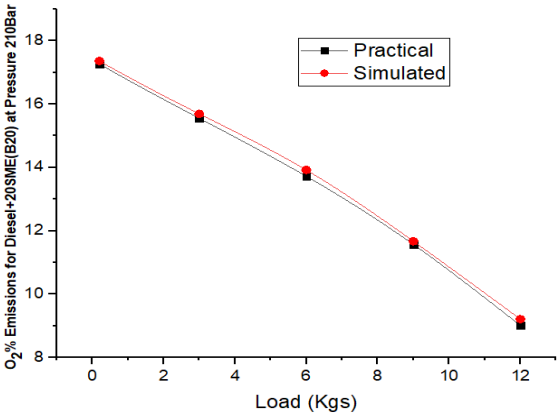
Graph 4.29 HC (PPM) emissions for Diesel+20%MSME at pressure 210Bar



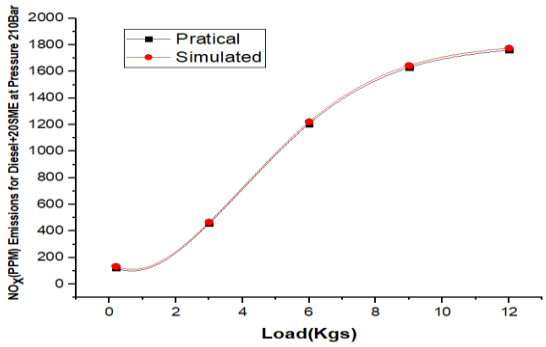
Graph 4.30 CO% emissions for Diesel+20%MSME at pressure 210Bar



Graph 4.31 CO_2% emissions for Diesel+20%MSME at pressure 210Bar

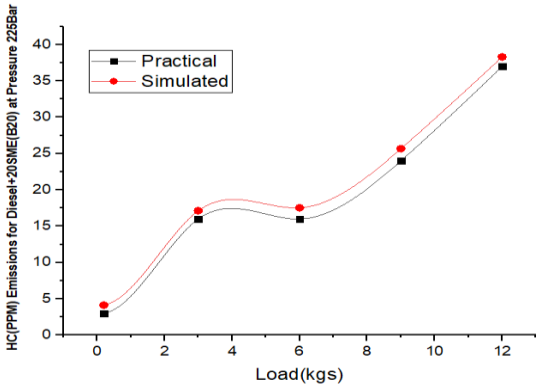


Graph 4.32 O_2% emissions for Diesel+20%MSME at pressure 210Bar

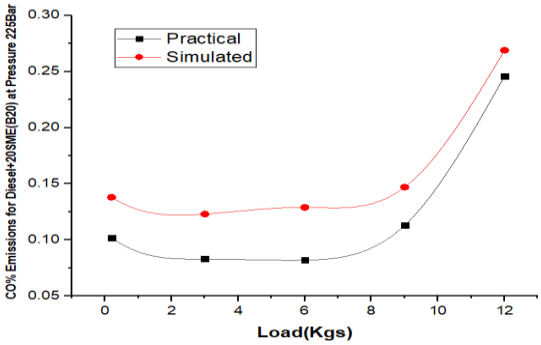


Graph 4.33 NO_x (PPM) emissions for Diesel+20%MSME at pressure 210Bar

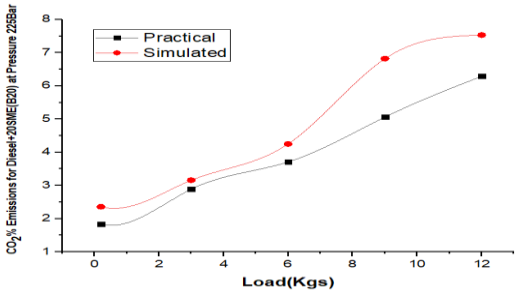
Validations for Diesel +20%MSME with practical and Simulation at Pressure 225Bar:



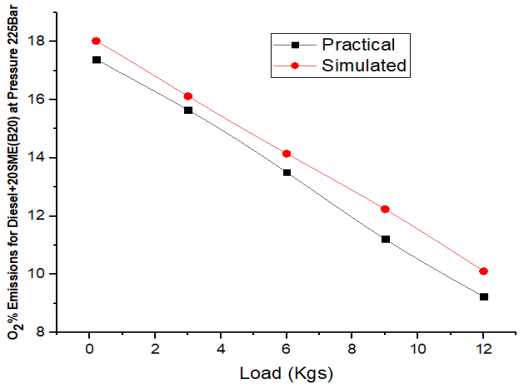
Graph 4.34 HC (PPM) emissions for Diesel+20%MSME at pressure 225Bar



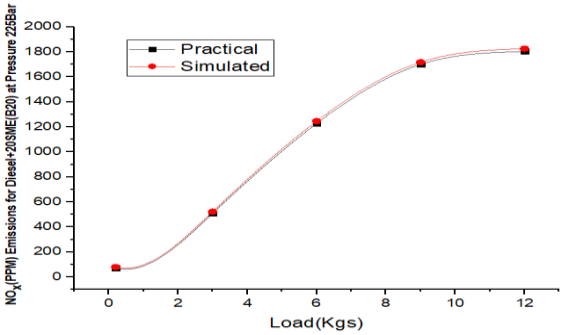
Graph 4.35 CO% emissions for Diesel+20%MSME at pressure 225Bar



Graph 4.36 CO_2% emissions for Diesel+20%MSME at pressure 225Bar

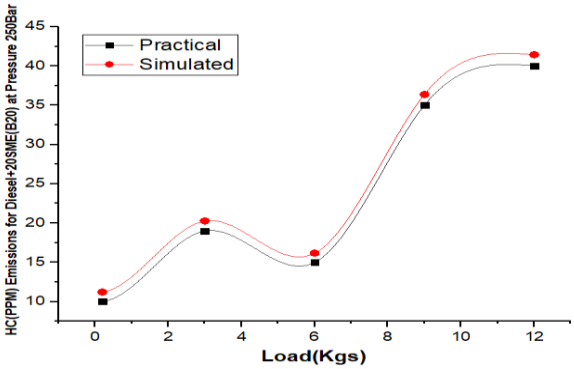


Graph 4.37 O_2% emissions for Diesel+20%MSME at pressure 225Bar

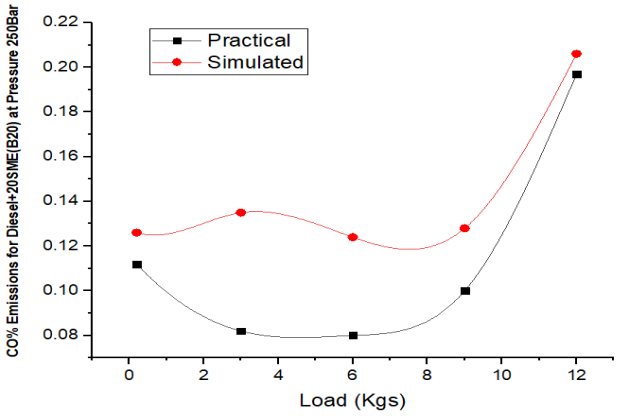


Graph 4.38 NO_x (PPM) emissions for Diesel+20%MSME at pressure 225Bar

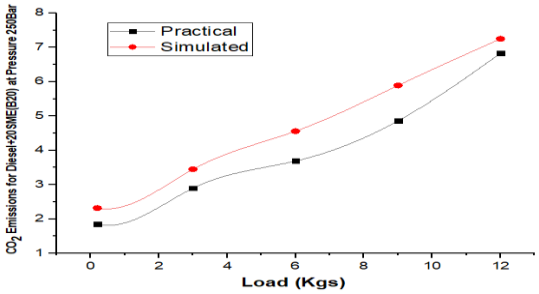
Validations for Diesel +20%MSME with practical and Simulation at Pressure 250Bar:



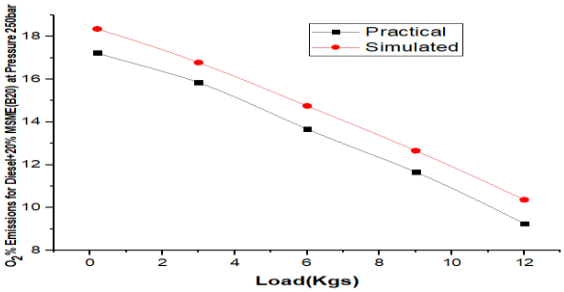
Graph 4.39 HC (PPM) emissions for Diesel+20%MSME at pressure 250Bar



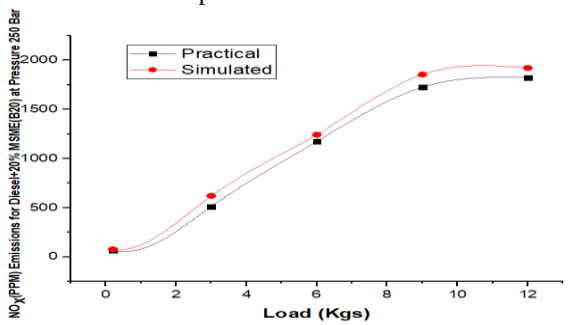
Graph 4.40 CO% emissions for Diesel+20%MSME at pressure 250Bar



Graph 4.41 CO_2% emissions for Diesel+20%MSME at pressure 250Bar

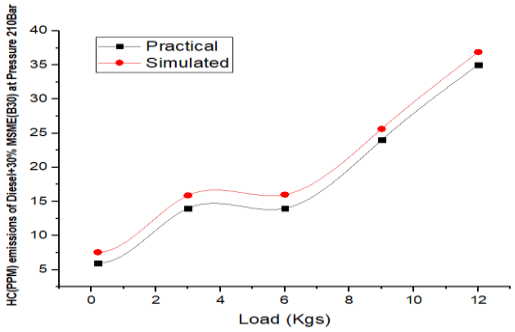


Graph 4.42 O_2% emissions for Diesel+20%MSME at pressure 250Bar

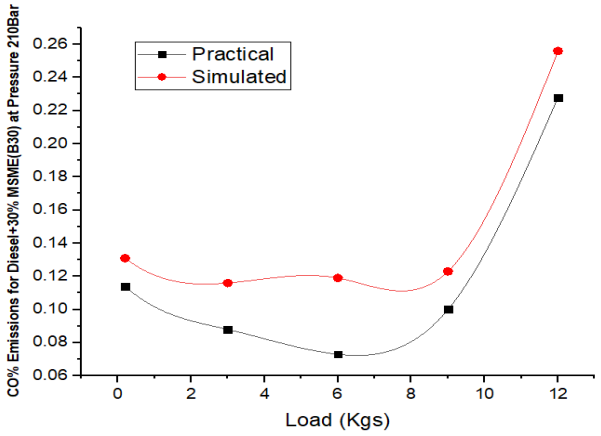


Graph 4.43 NO_x (PPM) emissions for Diesel+20%MSME at pressure 250Bar

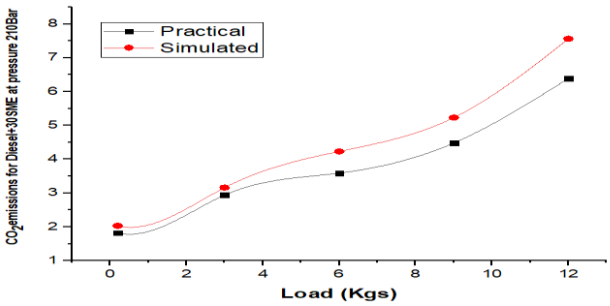
Validations for Diesel +30%MSME with practical and Simulation at Pressure 210Bar:



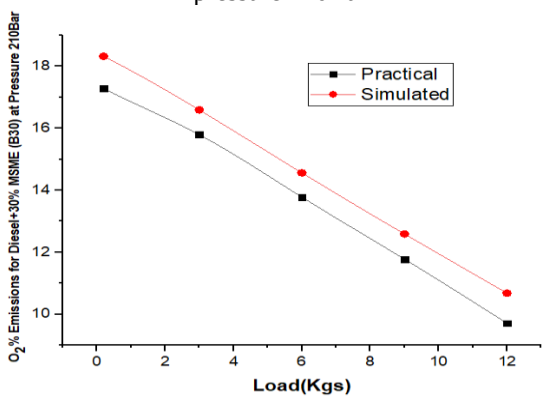
Graph 4.44 HC (PPM) emissions for Diesel+30%MSME at pressure 210Bar



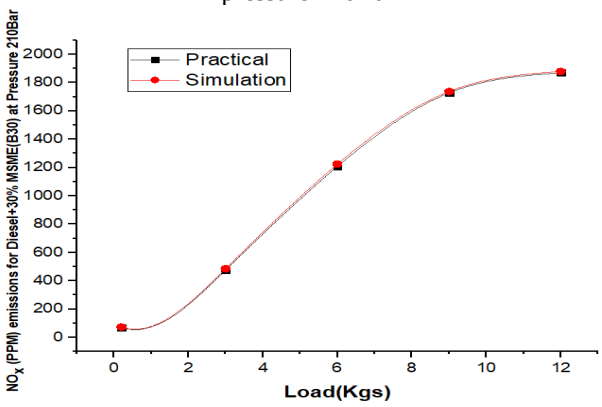
Graph 4.45 CO% emissions for Diesel+30%MSME at pressure 210Bar



Graph 4.46 CO_2% emissions for Diesel+30%MSME at pressure 210Bar

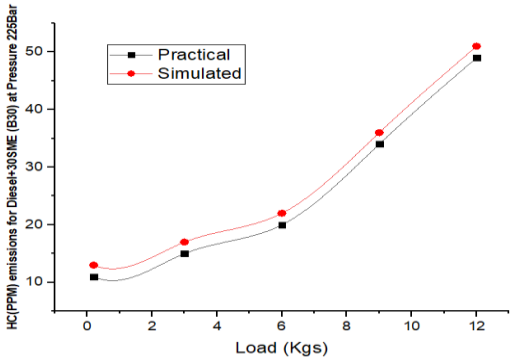


Graph 4.47 O_2% emissions for Diesel+30%MSME at pressure 210Bar

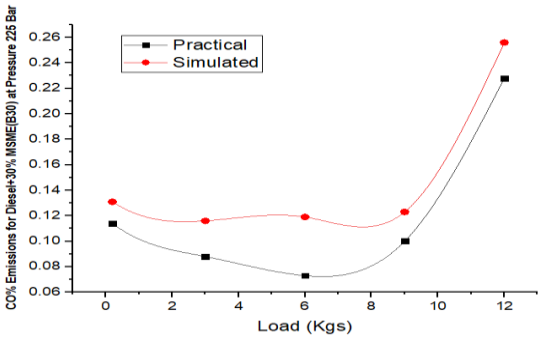


Graph 4.48 NO_x (PPM) emissions for Diesel+30%MSME at pressure 210Bar

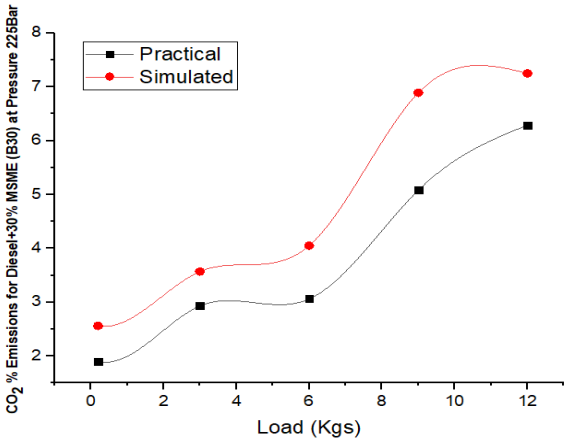
Validations for Diesel +30%MSME with practical and Simulation at Pressure 225Bar:



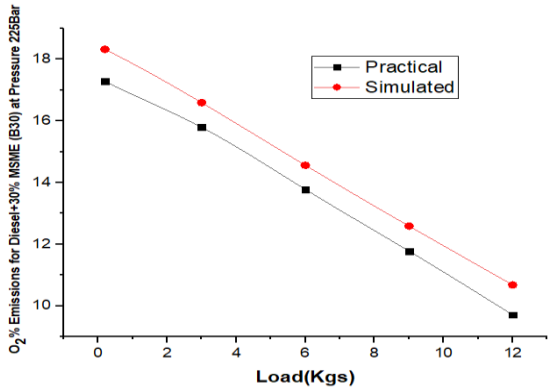
Graph 4.49 HC (PPM) emissions for Diesel+30%MSME at pressure 225Bar



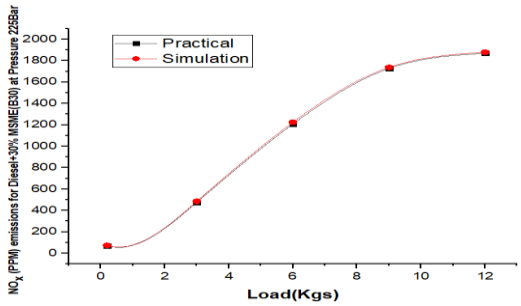
Graph 4.50 CO % emissions for Diesel+30%MSME at pressure 225Bar



Graph 4.51 CO_2% emissions for Diesel+30%MSME at pressure 225Bar

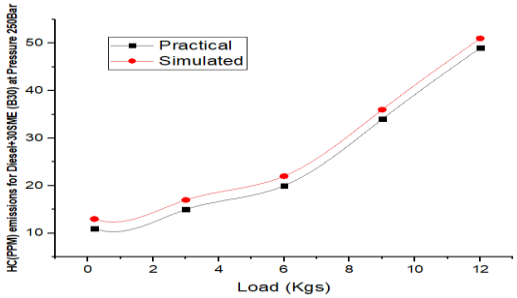


Graph 4.52 O_2% emissions for Diesel+30%MSME at pressure 225Bar

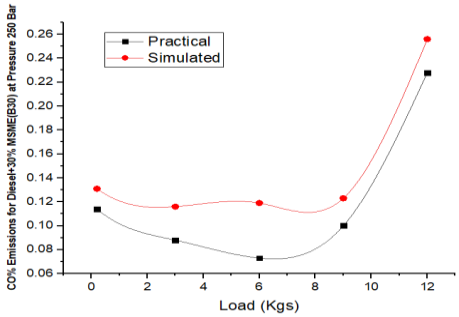


Graph 4.53 NO_x (PPM) emissions for Diesel+30%MSME at pressure 225Bar

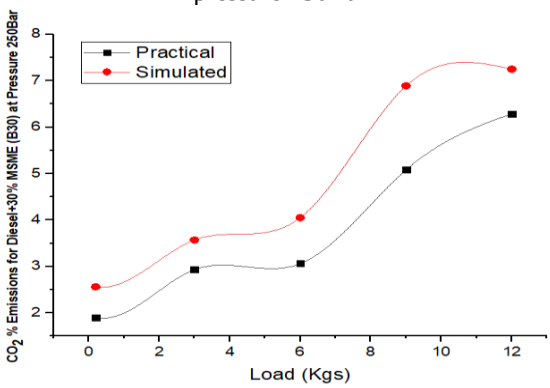
Validations for Diesel +30%MSME with practical and Simulation at Pressure 250Bar:



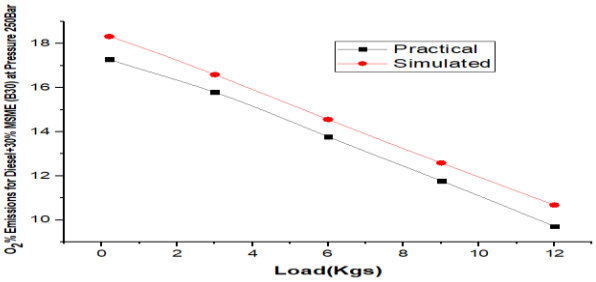
Graph 4.54 HC (PPM) emissions for Diesel+30%MSME at pressure 250Bar



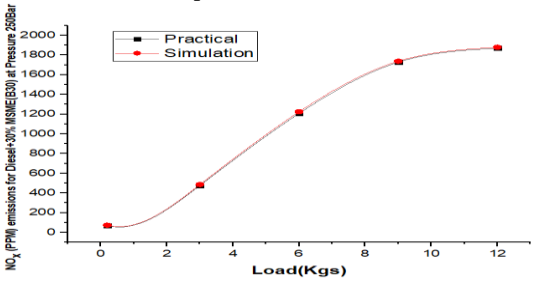
Graph 4.55 C0% emissions for Diesel+30%MSME at pressure 250Bar



Graph 4.56 CO_2% emissions for Diesel+30%MSME at pressure 250Bar



Graph 4.57 O_2% emissions for Diesel+30%MSME at pressure 250Bar



Graph 4.58 NO_x (PPM) emissions for Diesel+30%MSME at pressure 250Bar

Discussions

By checking all the results obtained practically and by simulative it is clearly showing that comparatively emissions in the practical results are less than analyzed. Most of the difference in all emissions simulated given a 5 to 10% variation, much variation found in B30 blend and more over the B10 blends also given much different result compare with pure diesel and B20.

According to performance the variation in temperature for pure diesel and B20 is almost similar, the ignitions difference are not much vary the values found to be much suitable when compared with other blends. The below table shows the deviation between practical to experimental at 225 bar pressure with coated piston at 6 kg load comparison for pure diesel and B20 blend.

Blend type	HC	CO_2	NOX	CO	O_2
B00-pure diesel	0.56	0.33	7	0.047	0.69
B20-20%MSME	1.53	0.54	18	0.047	0.5

V. CONCLUSIONS

- By cheeking the temperature sustainability coated piston maintain temperature zone at static working condition, ignition consideration coated piston is reliable than normal piston.
- By comparing the emissions practical losses in active in simulation the emissions are a bit difference and more than pure diesel when simulate with MSME blends.
- Little deviation mostly NOX emissions found to be a variation of 5% in simulation than practical.
- All emissions observed at different load conditions found to be equal difference in B20 MSME blend when compare with other blends.
- Performance of diesel engine with emission rate also found a difference of 4-6% found with diesel and MSME blend B20.

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