Investigation of NOx in CI Engine and Reducing it by Water Mixing with Diesel

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Abstract

CI engine, usually called as the diesel engines is nowadays facing the challenges of controlling NOx emission. To come across emission norms, proper combustion and to control NOx emissions there is done a simulation software based analysis to find the percentage and to control on NOx by using water injection system inside combustion chamber with diesel.

Keywords — *NOx emission, Diesel Engines, Combustion Chamber, water mixing.*

1. INTRODUCTION

Diesel Engines has unmistakable points of interest of better efficiency, higher torque, and high unwavering quality over the other engines. For many SUV and Commercial vehicles, for the most part diesel engine is utilized as the prime mover and it will keep up its predominance for a long time to come. Be that as it may, these motors require exceptionally complex after-treatment devices to meet stringent outflow focuses for NOx and residue. In the cutting edge turbocharged, High CRDI engines with retarding ignition timing, the greater part of NOx in the cycle is created in the post burning gasses after peak pressure. In the actually suctioned Engine with long start delays and adequate time accessible for premixing of fuel and air, the commitment of premixed burning to NO arrangement is thought to be significant. The theory that the majority of NOx in diesel engine is formed in the burned gases produced by combustion at near stoichiometric conditions.

However NO and NO2 are ached together as NOx, there are some individual differences between these two pollutants. NO is a colourless and odourless gas, while NO2 is a reddish brown gas with bitter odour. Both gases are reflected as toxic; but NO2 has a level of toxicity 5 times greater than that of NO. Although NO is basically formed from oxidation of NO, attention has been given on how NO can be controlled before and after combustion. NO is occurred through the post flame combustion process at high temperature. The main source of NO development is oxidation of nitrogen present in atmospheric air. The nitric oxide development chain reactions are started by atomic oxygen, which forms from the separation of oxygen molecules at the high temperatures reached during the combustion process.

The principal reactions major the development of NO from molecular nitrogen are,

N2 + O NO + N,
N +O2 NO + O,
N + OH NO + H.

NO formed in the flame zone can be rapidly converted to NO2 via reactions such as,

NO + HO2 NO + OH.

Successively, conversion of this NO unless the NO2 to NO occurs via

NO2+ O NO + O2

Formed in the flame is reduced by mixing with cooler fluid. This clarification is reliable with the highest NO2=NO ratio occurring at high load in diesels, when cooler areas which could reduce the conversion back to NO are general.

The engine design and operating conditions too affect the NOx formation process.

Formation of Nitrogen Oxides

- Thermal NO: - By oxidation of atmospheric nitrogen at high temperatures in the post-flame burned gases
- Prompt No: - Formed At The Flame Visible Within The Flame Response Zone.
- Fuel No: - Oxidation Of Fuel-Bound Nitrogen At Comparatively Less Temperatures

Diesel engines exhausting gaseous emission and particulate problem have long been observed as one of the major air pollution sources, particularly in urban areas, and have been a source of thoughtful public anxiety for a long time. There has been various research in the field of reduction of these pollutants subsequently diesel engines originated to major use. Major emissions from a diesel engine are NOx, SOx, CO and soots among these pollutants CO and Sox are some amount of particulate matters that are reduced by after treatment methods, in the catalytic converter etc. unlike these NOx can't be oxidized to get some clean product. Nowadays NOx emissions are reduced by selective catalytic reduction.

Using a mixing of diesel in water as a fuel has been a recent field of study in this field. Water/diesel (W/D) combined preparations are stated to reduce the emissions of NOx, SOx, CO and particulate matter (PM) without recompensing the

engine's performance. In this work a new kind of mixture is prepared by spray formation with diesel. .

A. Diesel-Water Mixing

When mixed right, diesel being a lighter liquid than water comes to the top and water slowdown in the bottom. By using a suitable surfactant the molecules of water and diesel can be bound together. The stability of the emulsion made is very important, because if it's not stable for an appreciable period of time it won't be practically useful. Using water mixing agent with diesel has many benefits on different ways. It has been describe in many previous researches that it reduces the flame temperature thus reducing the NOx emissions considerably. Mixing of water also improves atomization and mixing which is attributed to droplet micro emulsion. The better mixing is due to the improved vaporized jet fuel momentum giving air more way to get into the fuel jet. This also supports in reduction in NOx from diffusive burning portion of combustion event as well as reducing the carbon formation. This results along with the chemical consequence of water results in increase in ignition delay. There is also an extensive proof that mixing water to diesel can reduce the soot particulates and smoke emission.

There has been a developing importance in diesel fuel industry to produce and apply the diesel water combination as usable fuels for diesel engines. However its effect on the heat instability passage the combustion chamber components i.e. cylinder heads and cylinder liners, chamber temperature and thermal loading.

In the give work there is done a cfd analysis mixing diesel and water with 94.5 % diesel + 4.5% water + 0.5% of 20 + 0.5% span 20

Now a stable liquid was obtained. The liquid was milky white in colour and endured as it is for a very long period of time. This will used as a new fuel.

II. ANALYSIS OF NOX COMBUSTION

The all work is done by using 3D modelling and analysis software. Design of combustion chamber is shown.

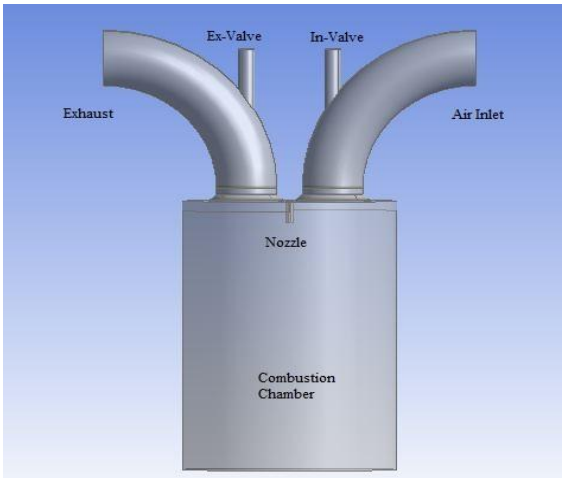

Fig. 1 A Basic Detail of Combustion Chamber

A. CFD Analysis of Nox

The boundary circumstances should be given after designing the geometry. In the analysis viscous standard k-e model is allowed for non-premixed combustion model. The detailed combustion analysis is shown in figure by giving it results.

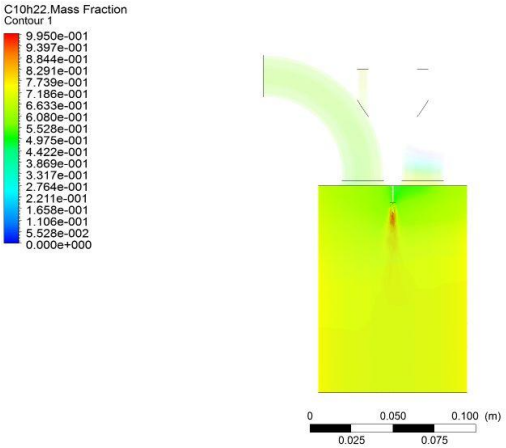

Fig. 2 Fuel Spray

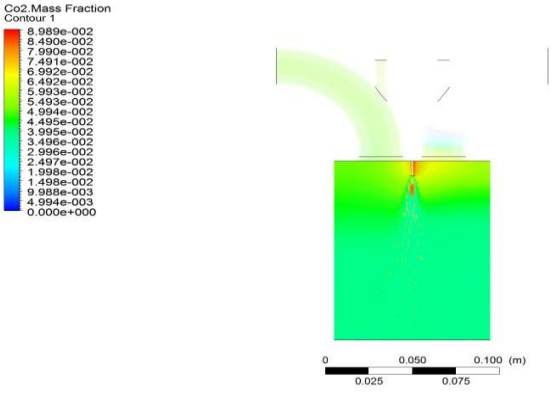

Fig. 3 CO2 Formation

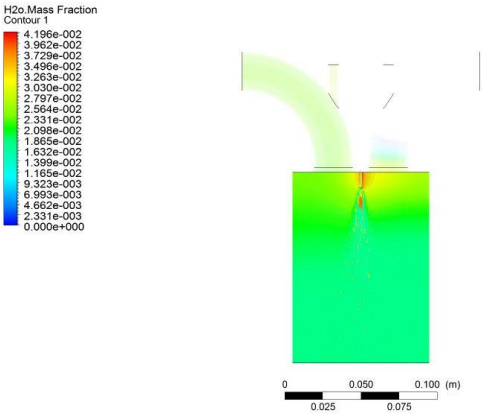

Fig. 4 H2o Formation

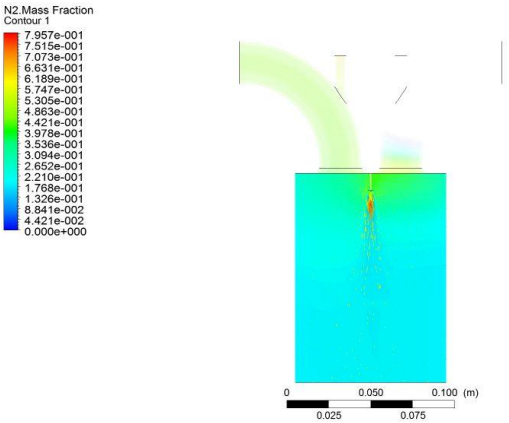

Fig. 5 Formation of N2

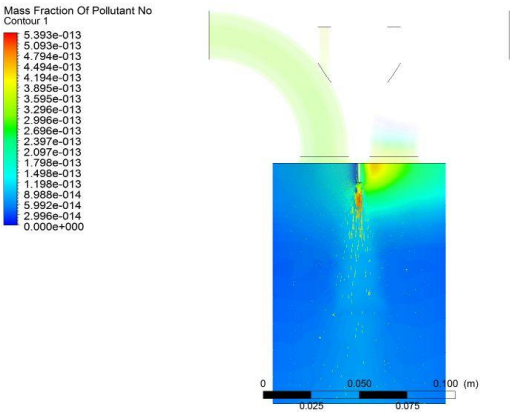

Fig. 6 Formation of No

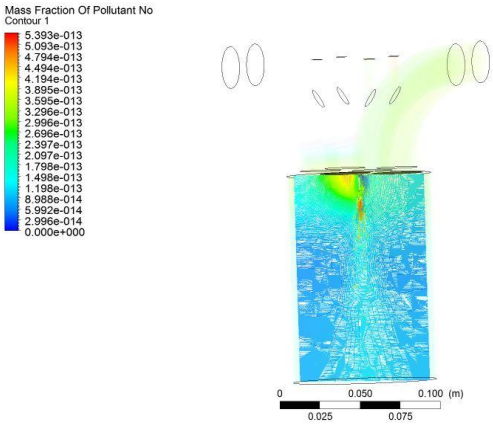

Fig. 7 Formation of No

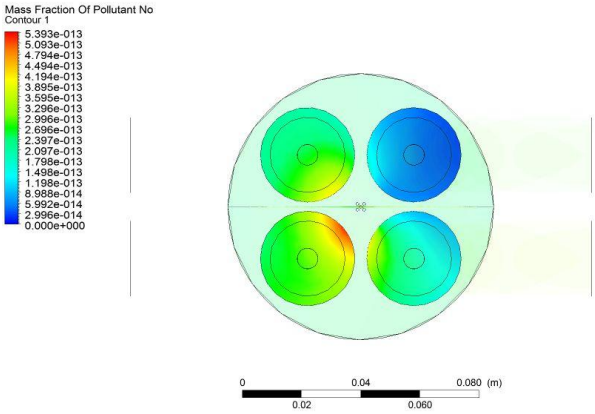

Fig. 8 Formation of No_top view

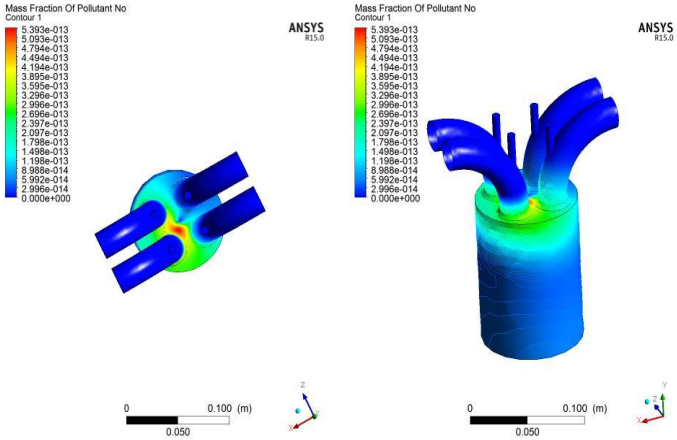

Fig. 9 Formation No_top2

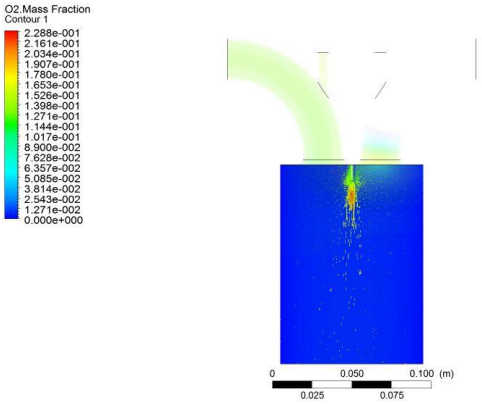

Fig. 10 Formation of O2

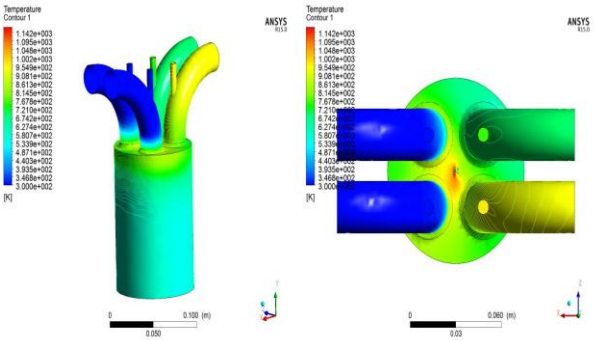

Fig. 11 Temperature

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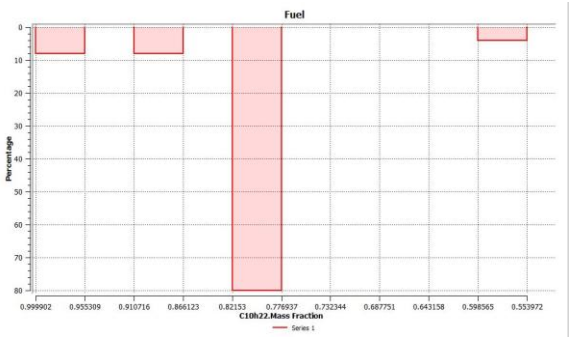
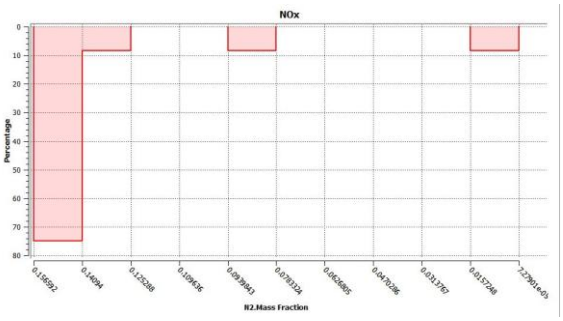
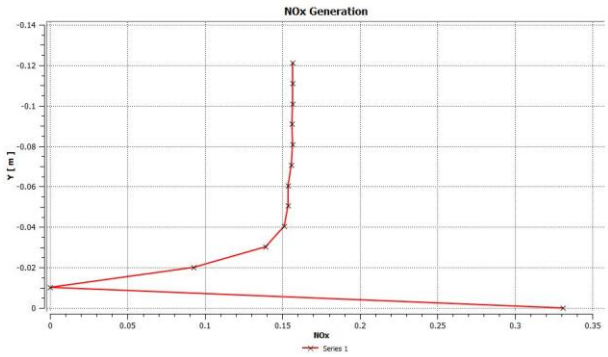


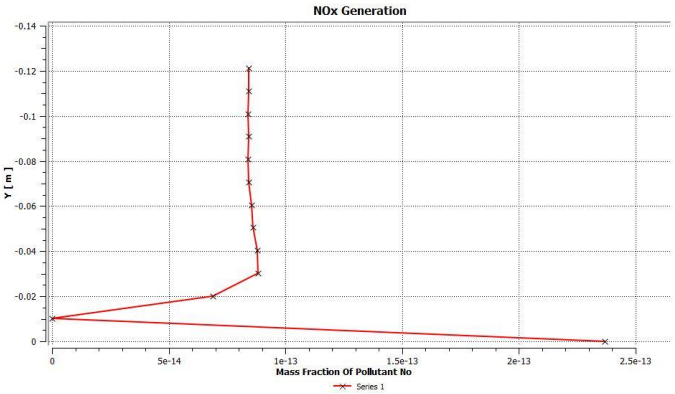
Graph 1. Fuel spray



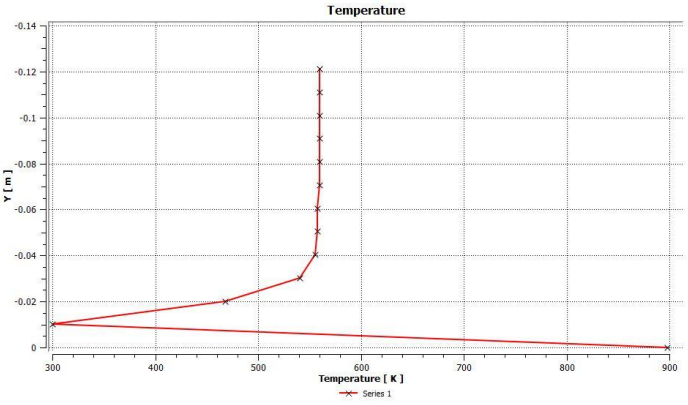
Graph 2. Generation of NOx



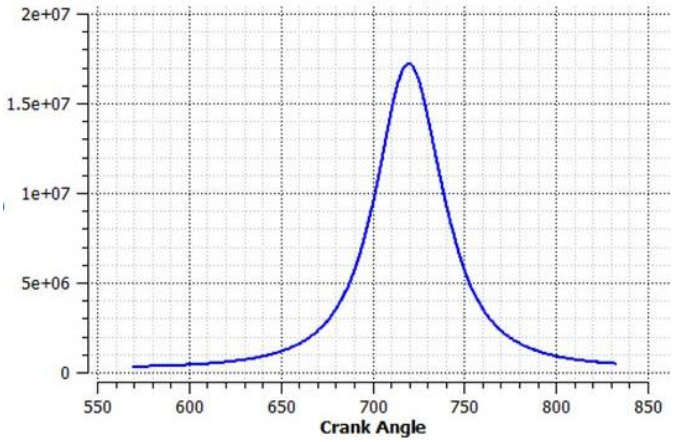
Graph 3. Generation of NOx



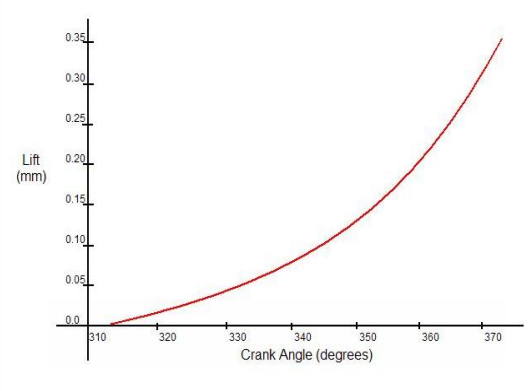
Graph 4. Pollution of NOx



Graph 5. Temperature rise



Graph 6. Crank Angle



Graph 7. Actual Valve Opening

Table 1: Engine Parameters

Bore		80mm
Stroke		144.5
Injector nozzle size		0.3 mm
Nozzle type		5 point
Pressure	**Inlet valve**	182.7 Kpa
	Exhaust valve	182.7 Kpa
Temperature	**Bottom Chamber**	567 K
	Top Chamber	567 K
	Top face	602 K
Engine Speed		7.5 KW @ 1500rpm
Turbulence		0.1
Compression ratio		17.5
Fuel		C10H22 with 5% water
Density		831 kg/m3
Calorific value		41380kJ/kg

Table 2 : Calculated Results

Mass fraction of pollution NO	3.86133e-13
Mass fraction of N2	0.786109
Mass fraction of O2	0.23
Pressure inside chamber	6555.2 pa
Temperature rise	656.58°C

III. CONCLUSIONS

The specific fuel consumption was experiential to decrease with increase in the percentage of water in diesel. It show that specific fuel consumption is decreased by 5 % to 7.5 %, when concentration of water is increased. But at higher loads the fuel consumption is more for combinations then diesel.

The NOx emission is brought down by 32% - 45 % by use of diesel water combination. This tendency goes on increasing with increase in amount of water in the combination.

At low speed the hydrocarbon emissions are lesser for combination as compared to diesel, though when the speed increased HC emissions are higher for emulsions.

Carbon monoxide and carbon dioxide emissions increase with increase in water percentage in diesel. This is due to the fact that most of the hydrocarbons are burnt at low speed.

For ideal results usage of diesel water combination with 7.5% water content will have the finest results in terms of performance and emissions.

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