Performance and Emission Characteristics of Direct Injection Diesel Engine by Water Emulsion Diesel

Dhaval.D.Patel[1], Vivek.B.Patel[2]

[1]Research Scholar, [2]Professor
Mechanical Engineering Department
LCIT, Bhandu

***Abstract*- Diesel engine is the most combustion-efficient engine because it gives better fuel to power conversion yield .Diesel engines exhausting gaseous emission and particulate matter have long been regarded as one of the major air pollution sources, particularly in metropolitan areas, and have been a source of serious public concern for a long time. The functioning of diesel engines produces emissions that contribute to the enhancement of the greenhouse effect, produce acid rains, deteriorates the ozone layer in the stratosphere, and affect the human respiratory health. The emulsification method is not only motivated by cost reduction but is also one of the potentially effective techniques to reduce exhaust emission from diesel engines. Water/diesel (W/D) emulsified formulations are reported to reduce the emissions of NO_X, SO_X, CO and particulate matter (PM) without compensating the engine's performance [7].Water/Diesel emulsion is most appropriate method from all proposed methods for introduce water into the combustion chamber because they require no engine retrofitting [3].**

Water/Diesel emulsion fuels are prepared by mixing varying contents of water and diesel with specific surfactants. In this work the effect of the water-in-diesel fuel emulsion (in different range v/v) on a four stroke single cylinder diesel engine performance and emission characteristics are experimentally analyzed at various load and use 10% w/d ,20%w/d,30%w/d emulsions. NO_X is reduced in all load condition than diesel. The exhaust gas temperature also decreases. Bsfc of emulsion increases than diesel. Co emission also reduces with increase in load.

I. INTRODUCTION

The use of water in fuel emulsion has been stated as the most universal and effective method that enable simultaneous reduction of the engine smoke level and nitrogen oxides (NO_X).In water emulsion diesel water is mixed homogeneously with the base diesel fuel on volume basis, typically in presence of an appropriate surfactant that helps to produce stable emulsion fuel. Water emulsion diesel is a convenient renewable fuel option as the existing engine does not require any prior or post modification. Water/Diesel emulsion also advantage for additional momentum in jet behaviour which may assist better mixing of fuel and air[4].
Generally there are two diesel water emulsion types.

(1) Water in Diesel emulsion type.

(2) Diesel in water emulsion type.

A system that consists of water droplets dispersed in an diesel phase is called a water in diesel or W/D emulsion. A system that consists of diesel droplets dispersed in an aqueous phase is called diesel in water or D/W emulsion.Water in diesel type is best suited type of fuel for diesel engine rather than diesel in water type due to the micro explosion phenomenon of droplet of water, which causes a large fragmentation of the diesel and less change in viscosity with water content. A surfactant can reduce the diesel and water surface tension, activate their surfaces, and maximize their superficial contact areas to make diesel in water or water in diesel two phase emulsions. A surfactant is also called an emulsification agent because it can stabilize emulsions when it exists along the interface between water and diesel.

II. PROPERTIES OF WATER-DIESEL EMULSION SAMPLES

Diesel Conditions	D	D+S+10%W	D+S+20% W	D+S+30% W
Density,15^0C (kg/m^3)	825	811	805	794
Dynamic viscosity (MPa.sec)	31.56	40	60.5	70.26
Stability(%)	100	92.44	86.55	80.03

III. METHOD AND MATERIAL

Four methods for introducing water into the combustion zone are as below.[3].

(i) Direct injection into the engine through separate injectors (DWSI)

(ii) Hybrid injection, using a single injector or as a stratified diesel-water-diesel fuel injection by means of a specially modified nozzle (HDWI)

(iii) Fumigating the water into the engine intake air (FWIA)

(iv) Diesel/Water emulsions (DWE)

Upper all the methods proposed to introduce water into the combustion chamber, but diesel oil emulsions appear to be the most appropriate, because they require no engine retrofitting [3].

The various proportion of Water/Diesel emulsion to be used are as follows:
1. ED10 (10% Water + 90% (Petroleum Diesel+ emulsified agent)) (V/V)
2. ED20 (20% Water + 80% (Petroleum Diesel+ emulsified agent)) (V/V)
3. ED30 (30% Water + 70% (Petroleum Diesel+ emulsified agent)) (V/V)

IV.EXPERIMENTAL SETUP DESCRIPTION

A single-cylinder, 4-Stroke, water-cooled diesel engine of 5 hp rated power is considered for the experimentation.

Experimental Setup of Diesel Engine

Fig 1.-Experimental Setup of Diesel Engine

Engine Specification

Parameter	**Details**
Engine	Single Cylinder High Speed Diesel Engine
Cooling	Water cooled
Bore × Stroke	80 mm × 110 mm
Compression ration	16 : 1
Maximum Power	5 hp or 3.7 kW
Rated speed	1500 rpm
Capacity	553CC

Table1. Engine Specification

Parameters required for prediction:-
Input Parameters:
1. Water/Diesel emulsion (%)
2. Engine Load (kg)
Output Parameters:
1. BSFC (Brake Specific Fuel Consumption)
2. Mechanical Efficiency
3. BTE (Brake Thermal Efficiency)
4. ITE (Indicated Thermal Efficiency)
5. CO (Carbone monoxide)
6. NO_X (Nitrogen Oxide)

V. CALCULATION OF PARAMETERS

Using Diesel

Sr.No	Load (kg)	F.C (Kg/hr)	B.P (kw)	B.S.F.C (kg/kw-hr)	F.P (kw)	I.P (kw)	M.E (η m%)	B.T.E (η bth%)	I.T.E (η ith%)	CO%	NO_X (ppm)
1	2	0.47	0.43	1.09	1.8	2.23	19.28	7.74	40.19	0.06	107
2	4	0.60	0.87	0.68	1.8	2.67	32.58	12.28	37.69	0.06	140
3	6	0.67	1.3	0.51	1.8	3.1	41.93	16.43	39.19	0.05	181
4	8	0.84	1.73	0.48	1.8	3.53	49	17.44	35.59	0.06	309

Using Diesel+ 10%Water

Sr.No	Load (kg)	F.C (Kg/hr)	B.P (kw)	B.S.F.C (kg/kw-hr)	F.P (kw)	I.P (kw)	M.E (η m%)	B.T.E (η bth%)	I.T.E (η ith%)	CO%	NO_X (ppm)
1	2	0.48	0.43	1.11	1.3	1.73	24.85	8.51	34.26	0.06	102
2	4	0.62	0.87	0.71	1.3	2.17	40.09	13.50	33.67	0.06	135
3	6	0.74	1.3	0.56	1.3	2.6	50	16.73	33.47	0.06	180
4	8	0.91	1.73	0.52	1.3	3.03	57.09	18.27	32.01	0.05	290

Using Diesel + 20%Water

Sr.No	Load (kg)	F.C (Kg/hr)	B.P (kw)	B.S.F.C (kg/kw-hr)	F.P (kw)	I.P (kw)	M.E (η m%)	B.T.E (η bth%)	I.T.E (η ith%)	CO%	NO_X (ppm)
1	2	0.49	0.43	1.13	1.5	1.93	22.27	9.84	43.35	0.06	100
2	4	0.60	0.87	0.68	1.5	2.37	36.70	15.95	50.07	0.05	130
3	6	0.82	1.3	0.63	1.5	2.8	46.42	17.44	37.58	0.05	172
4	8	0.90	1.73	0.52	1.5	3.23	53.56	21.15	39.50	0.05	280

Using Diesel+ 30%Water

Sr.No	Load (kg)	F.C (Kg/hr)	B.P (kw)	B.S.F.C (kg/kw-hr)	F.P (kw)	I.P (kw)	M.E (η m%)	B.T.E (η bth%)	I.T.E (η ith%)	CO%	NO_X (ppm)
1	2	0.46	0.43	1.06	1.13	1.56	27.56	11.98	43.49	0.05	90
2	4	0.59	0.87	0.67	1.13	2	43.5	18.91	43.47	0.05	111
3	6	0.73	1.3	0.56	1.13	2.43	53.49	22.84	42.69	0.05	145
4	8	0.92	1.73	0.52	1.13	2.87	60.62	24.11	40.01	0.04	250

VI. CONCLUSION

In this study of water-in-Diesel emulsions investigated the effect of water emulsification on the Diesel engine performance and exhaust gases emissions. Emulsified diesel fuels of 10,20 and 30 water/Diesel ratios by volume, were used in four stroke single cylinder direct injection Diesel engine.The Engine oprerate at various load condition. The results indicated that the addition of water to diesel in the form of emulsion improves combustion efficiency. The engine torque, power and brake thermal efficiency increase as the water percentage by volume in the emulsion increases. The average increase in the brake thermal efficiency for 30% water emulsion is approximately 5% over the use of diesel for the engine speed ranges studied. The particulate matter,CO and NOx emissions decrease as the percentage of water in the emulsion increased to 30%. So that, the benefits of adding water to diesel fuel, results in substantial reductions in nitrogen oxides and particulates.

VII. ACKNOWLEDGMENT

I am humbly expressing thanks to my respected guide Prof.Vivek.B.Patel, Assistant Professor, Department of Mechanical Engineering, Laljibhai Chaturbhai Institute of Technology, Bhandu, for his valuable time and constant help given to me.

REFERENCES

1. Ali M.A. Attia, A.R.Kulchitskiy. ,(2013), “Influence of the structure of water-in-fuel emulsion on diesel engine performance” ,Fuel 116(2014)703-708.
2. Angela Chiosa, Dan Scarpete, Raluca-Cristina Buturca.,(2013),“An overview on combustion and performance characteristics of diesel engine using diesel water emulsion”, University “Dunarea De Jos” of Galati,Romania,2013.

3. Prof .Dr .Eng .Dan Scarpete.,(2013) "Diesel-Water emulsion, an alternative fuel to reduce diesel engine emissions", University "Dunarea De Jos" of Galati,Romania,2013.
4. M.Ebna Alam Fahd, Yang Wenming, P.S. Lee, S.K. Chou, Christopher R. Yap.,(2012) "Experimental investigation of the performance and emission characteristics of direct injection diesel engine by water emulsion diesel under varying engine load condition",Applied Energy 102(2013)1042-1049.
5. NiteshKumar Singh.,(2012), "Experimental investigation of diesel emulsion as fuel in small direct injection compression ignition engines", MIT international journal of mechanical engineering,Vol.2.NO.1,Jan.2012,pp.(39-44).
6. Omar Badran ,Sadeq Emeish , Mahmoud Abu-Zaid ,Tayseer Abu-Rahma ,Mohammad Al-Husan, Muminn Al-Ragheb.,(2011)," Impact of Emulsified Water/Diesel Mixture on Engine Performance and Environment",Int.J.of Thermal and Environmental engineering Volume3,No.1(2011)1-7.
7. M.Nadeem, C.Rankuti, K.Anur, M.R.U.Haq, I.B.Tan, S.S.Shah.,(2006), "Diesel engine performance and emission evaluation using emulsified fuels stabilized by conventional and gemini surfactants",Fuel 85 (2006)2111-2119.
8. Niko Samec, Breda Kegl, Robert W.Dibble.,(2002), "Numerical and experimental study of water/oil emulsified fuel combustion in a diesel engine",Fuel 81 (2002)2035-2044.
9. United States Environmental Protection Agency.,(2002), "Impacts of Lubrizol's Puri NO_X Water/Diesel Emulsion on Exhaust Emissions from Heavy-Duty Engines(Draft Technical Report)",EPA420-P-02-007,December 2002.
10. Mohamed Y. E. Selim, Mamdouh T. Ghannam , "Performance and Engine Roughness of a Diesel Engine Running on Stabilized Water Diesel Emulsion", Paper Offer#07NAPLES-163.