Investigating the Characteristics of Diesel Engine With Modified Piston Profile Using Alcohol Fuel Blends

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Abstract: *The purpose of the experiment is to improve the performance and decreasing emission characteristics of the engine. In the future generations search for the alternative fuels increased because of the petroleum crisis and also for its cost. Alcohols are best alternate fuels because these are available from renewable sources. In India we can produce alternate fuels because cultivation is more. In present work hemispherical shaped piston used because of its high burning character. Acetaldehyde blended diesel is used as fuel in all these configurations to find out the performance and emission characteristics of a C.I engine. In this experimental work acetaldehyde is blended into the diesel about 5%,10%,15%,20% (i.e., A5, A10, A15, A20).*

Keywords: **Acetaldehyde, Diesel engine, Emissions, hemispherical shaped piston, efficiency.**

1. Introduction

Energy is outlined because the capability of a system to cause external action in step with Max plank.Energy resources are important, that is sensible to persue those that are most ample. The economic competitiveness in trendy, industrial society and increase demands the required policies to supply reasonable , reliable and secured energy offer the developing nations. The emission management necessities have created the development of fuel consumption tougher. So as to sustain the long run of the globe with a clean atmosphere and non-depletive energy resources, renewable energy is that the absolute alternative.

Acetaldehyde chemical formula is CH_3CHO & molecular weight of 44.06 gram/mol.

- It is colorless i.e,flammable & miscible with water.
- The odor threshold of acetaldehyde is 0.05 parts per million (ppm) (0.09 mg/m 3).
- Acetaldehyde vapour pressure is 740 mm Hg at 20 °C & has a log octanol/water partition coefficient (log K_{ow}) of 0.43.

2.Materials & Methods

Acetaldehyde, diesel fuel, 4-stroke single cylinder water cooled computerized diesel test setup, hemispherical piston and exhaust gas analyzer.

All experiments were done on Kirloskar AV1 type Single cylinder 4-stroke, constant speed, and water-cooled, direct injection LHR C.I. engine. Initially engine made

to run for 15 minutes in order to get its steady state. Then the calibration of various instruments like eddy current dynamometer, exhaust gas analyzer etc, were carried out to evade any interference in test results. Then engine was fitted with 20µm thickness YSZ coated piston and cylinder and leaks were checked.



Figure 2.1. Experimental setup



Acetaldehyde

3. Results

- B.P = 2.43 kW
- T.F.C = 12.635*10-3 kg/min
- S.F.C = 4.68*10-3 kg/min
- F.U = 9.49 kW
- Actual air intake = 7.145*10-3 kg/sec
- Theoretical air intake = 9.71*10-3 kg/sec
- I.P = 5.13 kW
- Indicated thermal η = 54.97%
- Brake thermal. η = 25.12%
- Mech. η = (B.P / I.P) = 47.34%
- Vol. η = (Actual / Theoretical air in-take)*100
- Air to fuel ratio = (Actual air intake / T.F.C) = 33.52

4. Tables

Table 4.1. Performance of Pure Diesel

Load	B. P	T.F.C $*10^{-3}$	S. F. C $*10^{-3}$	Fuel power	I.P	Indicated thermal H	Brake thermal η	Mechanical η	Air intake $*10^{-3}$	
									Actual	Theoretical
Kilogram	watts	Kg /hour	Kilogram/ Hour	Watt	Kilo Watt	٪	٪	٪	Kilogram /minute	kilogram /minute
2	600	544.93	681.18	6861	3500	51	12	23	452.7	575.46
4	1060	579.81	460.14	7300	3960	54.2	17.76	32	452.7	575.46

6	1490	635.58	376.08	8000	4390	54.9	22	39	452.7	575.46
8	2060	717.72	332.28	9040	4860	53.8	24	44.8	452.7	575.46
10	2430	770.1	292.8	9690	5330	55	27.01	50.0	452.7	575.46

Table 4.2. Performance of Blended Fuel (5% Acetaldehyde)

Load	B. P	T. F. C $*10^{-3}$	S. F. C $*10^{-3}$	F.P.	I. P	Indi. th. η	Br.th. η	Mech. η	Air intake $*10^{-3}$	
									Actual	Theoretical
kilogram	Watts	kilogram /hour	Kilogram /hour	Watts	Watts	%	%	%	Kilogram /minute	kilogram /minute
2	8120	509.52	627.48	6473	3562	55	13	23	452.7	575.17
4	1236	561.54	454.32	7133	3986	55.68	17.67	32.77	452.7	575.17
6	1709	623.16	364.62	7196	4459	56.47	22	38.4	452.7	575.17
8	2145	689.16	321.24	8755	4895	55.7	24.8	44	452.7	575.17
10	2618	759.6	290.1	9649	5368	55.99	28.12	49	452.7	575.17

Table 4.3. Performance of Blended Fuel (10 % Acetaldehyde)

Load	B. P	T. F. C $*10^{-3}$	S. F. C $*10^{-3}$	Fuel power	I. P	Indi. the η	Br.th. η	Mech. η	Air intake $*10^{-3}$	
									Actual	Theoretical
Kilogram	Watts	kilogram /hour	kilogram /hour	Watts	Watts	%	%	%	Kilogram /minute	kilogram /minute
2	800	509.7	642.8	6509	2781	43.1	11.76	31	452.7	575.17
4	1236	567.1	477.1	7469	3233	43.8	16.9	37.7	452.7	575.17
6	1673	672.4	398.1	8366	3674	43.9	21.2	44.9	452.7	575.17
8	2109	733.6	347.2	9288	4109	44.1	24.1	52.8	452.7	575.17
10	2569	782	302.3	9872	4568	46.0	27.8	56.5	452.7	575.17

Table 4.4. Performance of Blended Fuel (15 % Acetaldehyde)

Load	B. P	T. F. C $*10^{-3}$	S. F. C $*10^{-3}$	Fuel power	I. P	Indi. th. η	Br.th. η	Mech. η	Air intake $*10^{-3}$	
									Actual	Theoretical
Kilogram	Watts	kilogram /hour	kilogram /hour	Watts	Watts	%	%	%	kilogram /minute	Kilogram /minute
2	8021	501.2	637.8	6473	3562	54.99	13	23	452.7	575.17
4	1145	551.4	464.2	7133	3986	55.68	17.67	32.77	452.7	575.17
6	1687	603.6	344.2	7196	4459	56	22	38.4	452.7	575.17
8	2132	677.1	351.4	8755	4895	55.7	24.8	44	452.7	575.17
10	2600	749.6	360.1	9649	5368	55.99	28.56	49	452.7	575.17

Table 4.5. Performance of Blended Fuel (20 % Acetaldehyde)

Load	B. P	T. F. C $*10^{-3}$	S. F. C $*10^{-3}$	Fuel power	I. P	Indi. th. η	Br.th. η	Mech. H	Air intake $*10^{-3}$	
									Actual	Theoretical
Kilogram	Watts	kilogram /hour	kilogram /hour	Watts	Watts	%	%	%	kilogram /minute	kilogram /minute
2	800	512.7	640.8	6513	2779	43	12.76	29	452.7	575.17
4	1236	588.18	475.86	7472	3237	43.4	17	38.79	452.7	575.17
6	1673	659.58	394.26	8379	3674	44	20	45.75	452.7	575.17
8	2109	730.86	346.5	9284	4111	44.77	23.01	51.63	452.7	575.17
10	2569	780	300	9865	4570	46.02	26.44	56.03	452.7	575.17

Table 4.6. Exhaust Emissions

Responses	Diesel	A5	A10	A15	A20
Net temperature °C	52	74	58	59	51
CO_2 %	0.49	0.43	0.40	0.39	0.39
Flue gas temperature °C	80	102	86	89	80
Ambient temperature °C	30	29.9	29.9	30	29.8
CO ppm	24	58	72	76	88
NOx ppm	25	44	51	62	71

5. Graphs

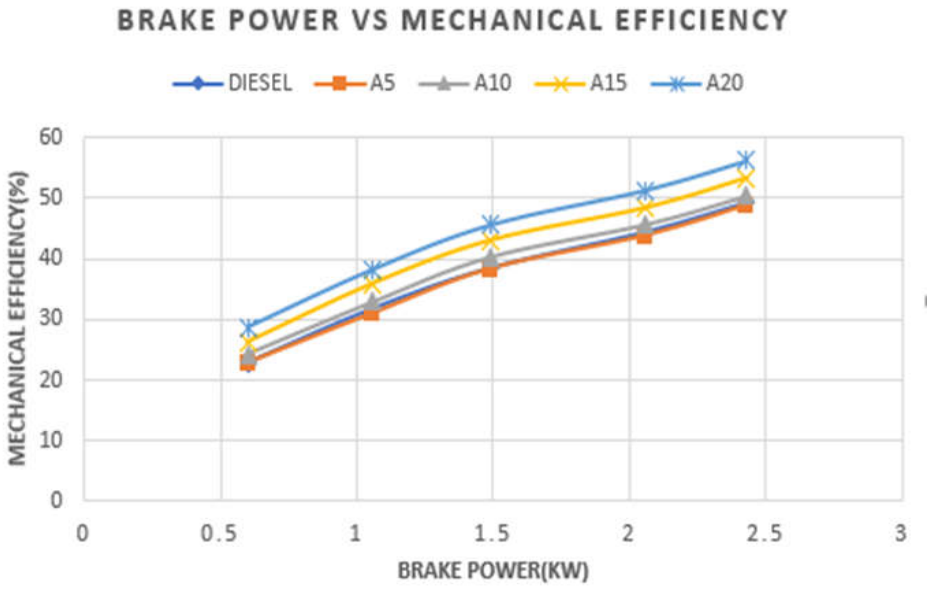

Figure 5.1. Brake power vs Mechanical efficiency

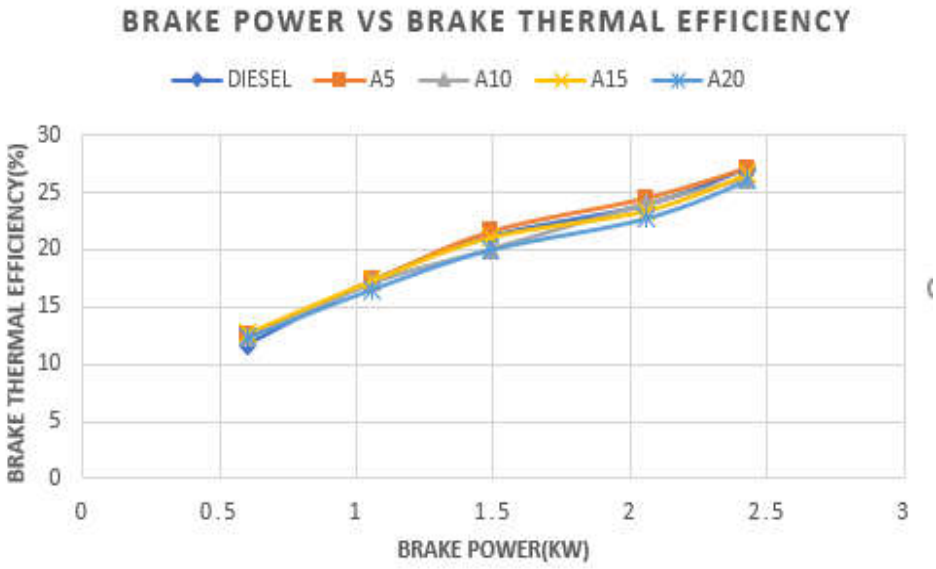

Figure 5.2. Brake Power vs Brake Thermal Efficiency

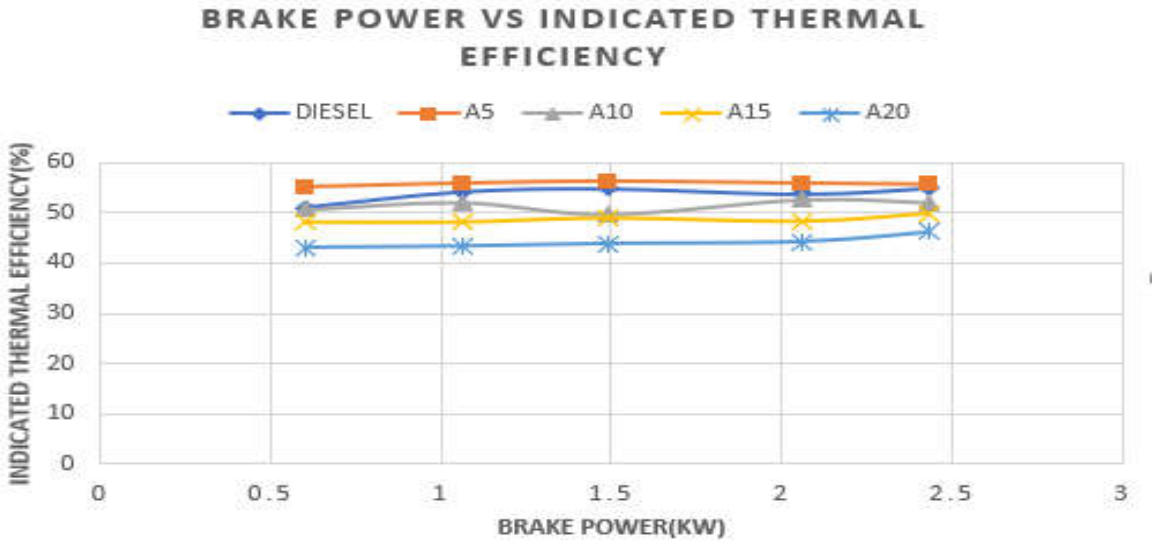

Figure 5.3. Brake Power vs Indicated Thermal Efficiency

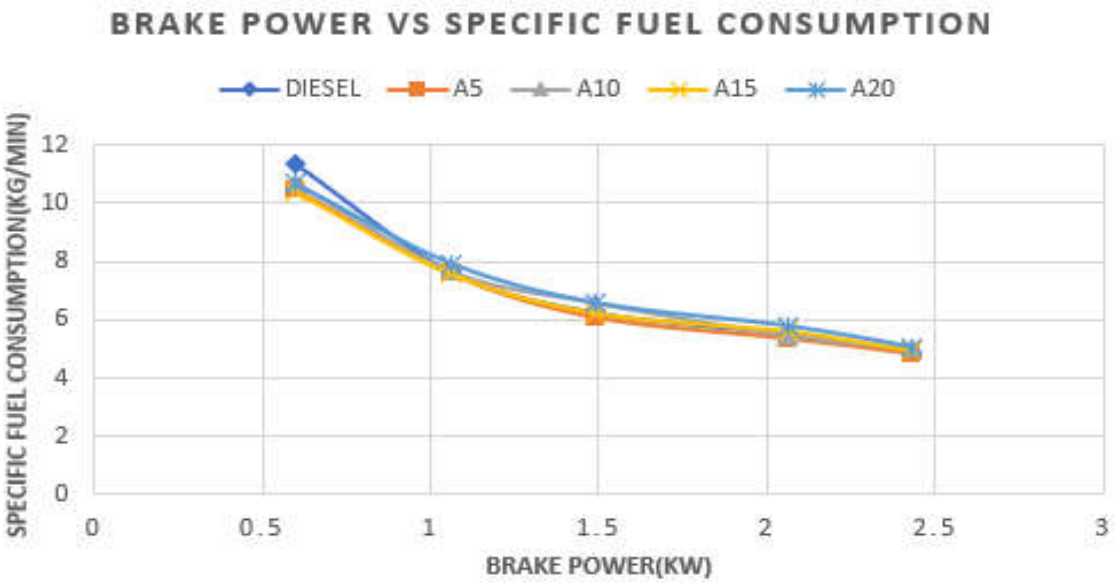

Figure 5.4. Brake Power vs Specific Fuel Consumption

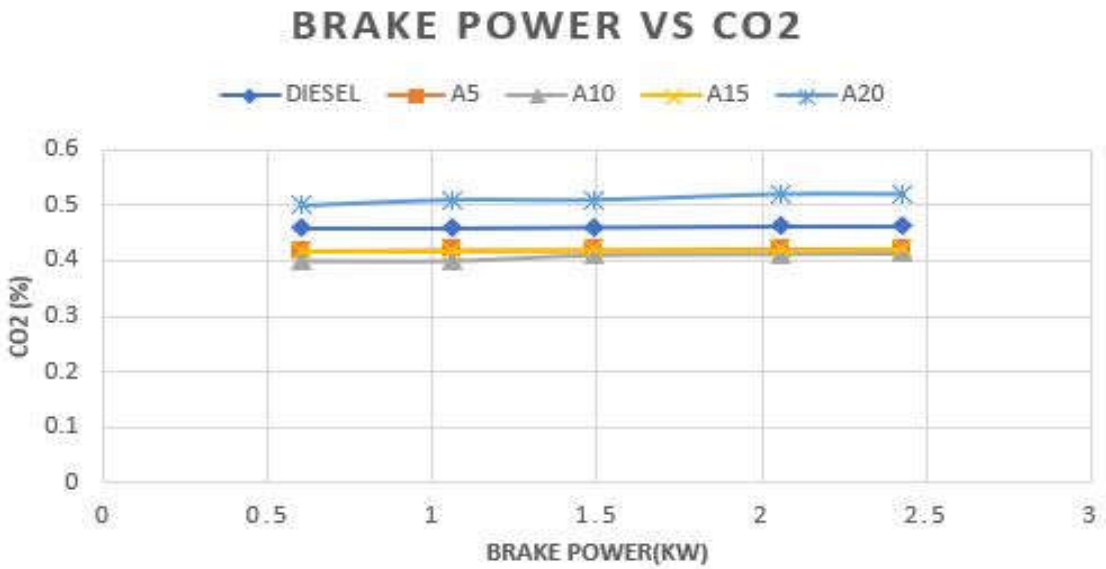

Figure 5.5. Brake Power vs CO2

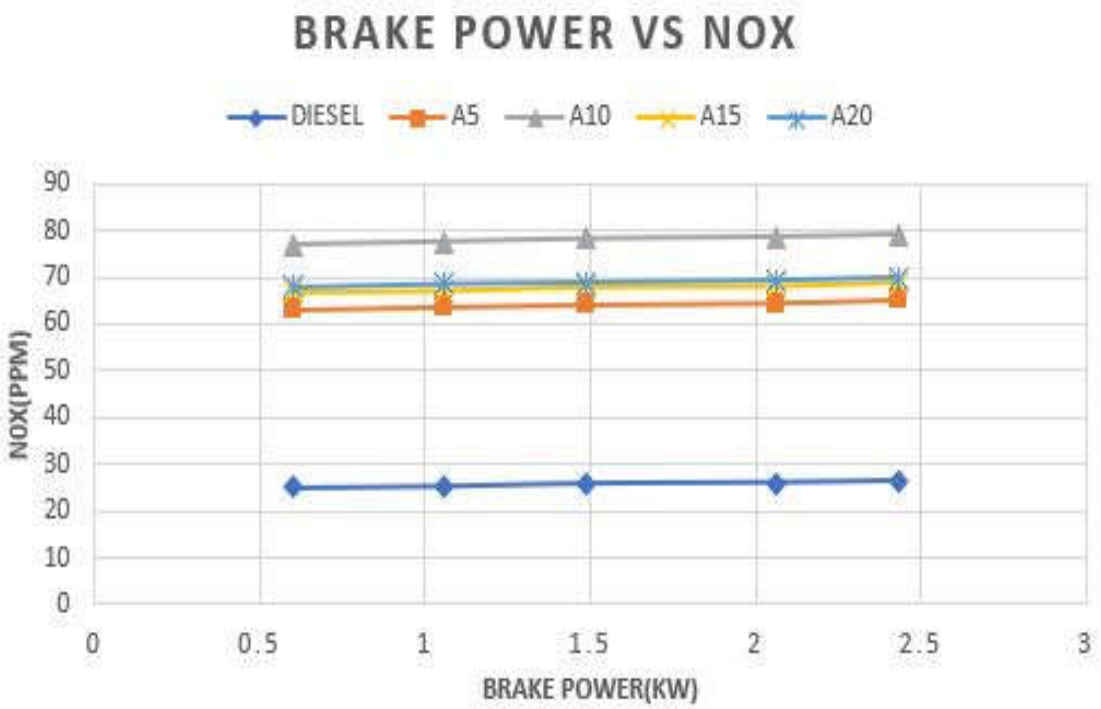

Figure 5.6. Brake Power vs NOx

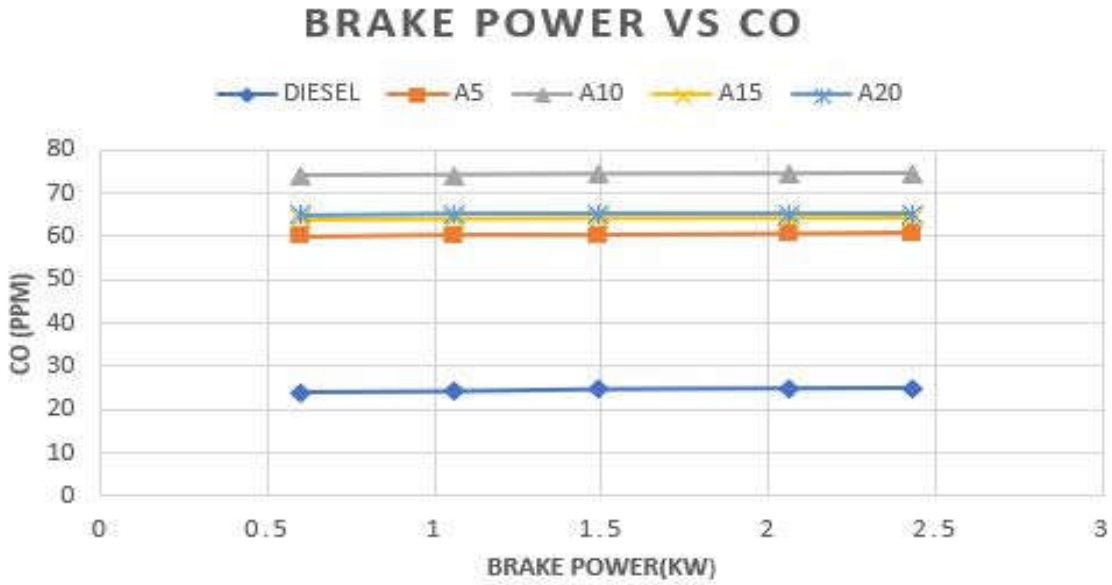

Figure 5.7. Brake Power vs CO

6. Conclusion

- The Mech. Efficiency is high (56.03%) for 20% blend of Acetaldehyde compared with diesel, A5, A10 and A15.
- Indicated - thermal efficiency is high (56.47%) for 5% blend of Acetaldehyde compared with diesel, A10, A15 and A20.
- The Brake -Thermal Efficiency is high (28.56 %) for 5% blend of Acetaldehyde compared with diesel, A10, A15, and A20.
- The specific fuel consumption is minimum for 5% blend of Acetaldehyde with diesel compared with diesel, A10, A15 and A20.
- The emission level of CO2 (0.40%) minimum for 10% blend of Acetaldehyde with diesel compared with diesel, A5, A15 and A20.
- The emission level of NOx (25ppm) minimum for diesel as compared with A5, A10, A15 and A20.
- The emission level of CO (24ppm) minimum for diesel as compared with A5, A10, A15 and A20.

7. References

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