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Performance Analysis of Diesel Blended Insulating Oil In A Ci Engine

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Abstract: ***Insulating oil other wise called as transformer oil is oil that is stable at high temperatures and has excellent electrical insulating properties. It is used in oil-filled transformers, some types of high-voltage capacitors, fluorescent lamp ballasts, and some types of high-voltage switches and circuit breakers. Insulating oil which is used in transformers after a prolonged use becomes waste and is disposed of. The disposal of used insulating oil causes an environmental pollution. The used insulating oil has properties very similar to that of diesel. By taking advantage of this, insulating oil can be used as an alternative fuel in diesel engines. Experiments were conducted to evaluate the performance of insulating oil blended with diesel in the ratio ranging from 20% to 40% of insulating oil at a regular interval of 10% by volume basis was used. Increase in thermal efficiency was found for insulating oil blends when compared to that of diesel. Among those IO40 (40% insulating oil in diesel) was found to be an optimum blend. The results were analysed and compared with that of diesel operation. Increase in thermal efficiency was found higher for blended fuels than diesel. The components in emission were nearly similar for blended fuels and diesel.***
Keywords: ***insulating oil, diesel, blended fuels, thermal efficiency, emission***

I. INTRODUCTION

Energy consumption is increasing year by year, energy consumption in terms of oil and other energy sources is growing drastically, and the growing demand is caused by exponential increase in population. The electrical energy is expected to increase every year, this will lead to increase in number of electrical transformers, generally oil cooled transformers are in use, the insulating oil used for cooling in these transformers after undergoing thermal and electrical cycles it degrades and has to be disposed. The disposed insulating oil after proper treatment can be used as an alternative fuel in diesel engines, because it has characteristics similar to that of diesel.

The import of crude oil to India is very high .The use of alternative fuels would reduce the crude oil consumption and will also reduce the import bills by a large amount. Nowadays alternative fuels are given great importance, the contribution of fuels derived from waste is not very significant but it can reduce environmental problems considerably.

The present research is aimed at exploring the feasibility of using used insulating oil blended with diesel in a diesel engine without any major engine modifications.

Performance parameters were determined by load test both diesel and used insulating oil blends, exhaust gas analysis were also carried out . Initially diesel engines were tested using biodiesel and alcohols. Investigations were also carried out using lpg, cng, biogas and producer gas. Literature survey reveals that oils such as waste lubricating oil and, waste plastic oil have also been investigated for their use as alternative fuels in CI engines. Waste plastic oil has properties similar to that of diesel and can be used as an alternative fuel in CI engines without any engine modifications. The experimental results have shown that waste plastic oil has a stable operation and comparable thermal efficiency than diesel.

The experiment is very novel. The collected details regarding used insulating oil as an alternative fuel is very less. But used insulating oil has properties very similar to that of diesel, the use of used insulating oil as an alternative fuel is a promising one.

The electrical transformers are an essential piece of equipment used in transmission and distribution of electrical energy. It is also used in arc welding equipment and electromotive units in trains. Mineral oils, synthetic oil esters, and silicone oils are used as feed stocks for production of insulating oils.

Insulating oils can be produced with different base oils. The insulating oils suffers from continuous deterioration and degradation due to electrical and thermal stresses due to loading and climatic conditions, continuous monitoring of insulating oil is need to avoid degradation after long use it becomes unusable. The life of insulating oil is determined by its properties such as dielectric strength, fire point, flash point, moisture content, viscosity anddensity.

The principle mechanism of insulating oil degradation is oxidation. By detecting colour insulating oil is considered to be scrapped, the new insulating oil is very clear and the extremely degraded ones look dark brown in colour.

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Filtering of used insulating oil:

Pure transformer oil→use in electrical transformers→settling→filtering

Settling- foreign particles and sediments settle down at the bottom

Filtering-filtering is done using a fabric filter paper

II. METHODOLOGY OF EXPERIMENTATION

Load test to analyse the performance on the CI engine using diesel and used insulating oil blended with diesel as fuel is done for the analysis purpose. A four stroke single cylinder air cooled direct injection diesel engine was used for the experimental analysis.

Insulating oil was collected to remove the impurities and foreign particles.

two main process are done

Settling-process in which impurities present in the oil is settled at the bottom.

Filtering-insulating oil was filtered using a fabric filter paper of 30 microns.

A four stroke single cylinder air cooled direct injection diesel engine set up was used and made necessary modifications to do experiments.

Necessary setups to do the load test on the engine were arranged. Arrangements for measuring fuel consumption was also made.

Exhaust gas analyzer was used for Exhaust gas analysis to find the amount different components present in the exhaust gases of diesel and its blends with insulating oil.

III.RESULT AND ANALYSIS

A. Result

1) Load test on diesel engine::fuel type: diesel

TABLE I

Load test on diesel engine::fuel type: diesel

Sl no	Net load	Speed	Time (t)	TFC	Brake power	input power	SFC	Brake therma efficiency	Indicated power	Indicated thermal efficiency	Mechanical efficiency
	kg	rpm	sec	Kg/hr	KW	KW	Kg/KWhr	%	KW	%	%
1	0	1500	68.37	0.442	0	5.50	-	0	0.55	10.37	0
2	4	1500	46.28	0.6534	0.3790	8.14	1.7240	4.65	0.929	11.41	40.79
3	7	1500	36.52	0.8280	0.6633	10.30	1.2483	6.43	1.213	11.71	54.68
4	10	1500	27.14	1.1036	0.9476	13.73	1.1646	6.90	1.4976	10.9	63.27

2) Load test on diesel engine::fuel type: IO20

TABLE 2

Load test on diesel engine::fuel type: IO20

sl no	net load	speed	Time (t)	TFC	Brake power	Input power	SFC	Brake therma efficiency	Indicated power	Indicated thermal efficiency	Mechanical efficiency
	kg	rpm	sec	Kg/hr	KW	KW	Kg/KWhr	%	KW	%	%
1	0	1500	46.35	0.6532	0	7.88	-	0	5.5	19.03	0
2	4	1500	37.67	0.8037	0.379	9.70	2.120	3.90	10879	19.37	20.17
3	7	1500	35.10	0.8625	0.663	10.41	1.300	6.36	2.163	20.77	30.65
4	10	1500	28.81	1.050	0.947	12.67	1.108	7.47	2.447	19.31	38.70

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3) Load test on diesel engine::fuel type: IO30

TABLE 3
Load test on diesel engine::fuel type: IO30

Sl no	Net load	speed	time	TFC	Input power	Brake power	SFC	Brake thermal efficiency	Indicated power	Indicated thermal efficiency	Mechanical efficiency
	kg	rpm	sec	Kg/hr	KW	KW	Kg/KWhr	%	KW	%	%
1	0	1500	68.3	0.4466	5.40	0	-	0	0.55	10.18	0
2	4	1500	44.28	0.6889	8.33	0.379	1.8176	4.54	0929	11.15	40.49
3	7	1500	35.25	0.8654	10.46	0.663	1.3052	6.33	1.213	11.59	54.68
4	10	1500	29.65	1.0288	12.44	0.947	1.086	7.61	1.4976	12.03	63.27

4) Load test on diesel engine::fuel type: IO40

TABLE 4
Load test on diesel engine::fuel type: IO40

Sl no	Net load	speed	time	TFC	Input power	Brake power	SFC	Brake thermal efficiency	Indicated power	Indicated thermal efficiency	Mechanical efficiency
	kg	rpm	sec	Kg/hr	KW	KW	Kg/KWhr	%	KW	%	%
1	0	1500	62.68	0.4892	5.89	0	-	0	1.1	18.67	0
2	4	1500	49.44	0.6202	7.47	0.379	1.636	5.07	1.479	19.79	25.62
2	7	1500	42.62	0.7194	8.67	0.663	1.085	7.64	1.763	20.33	37.60
4	10	1500	36.78	0.8337	10.05	0.947	0.880	9.42	2.047	20.36	46.26

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B. Analysis

1) Brake power vs Total fuel consumption

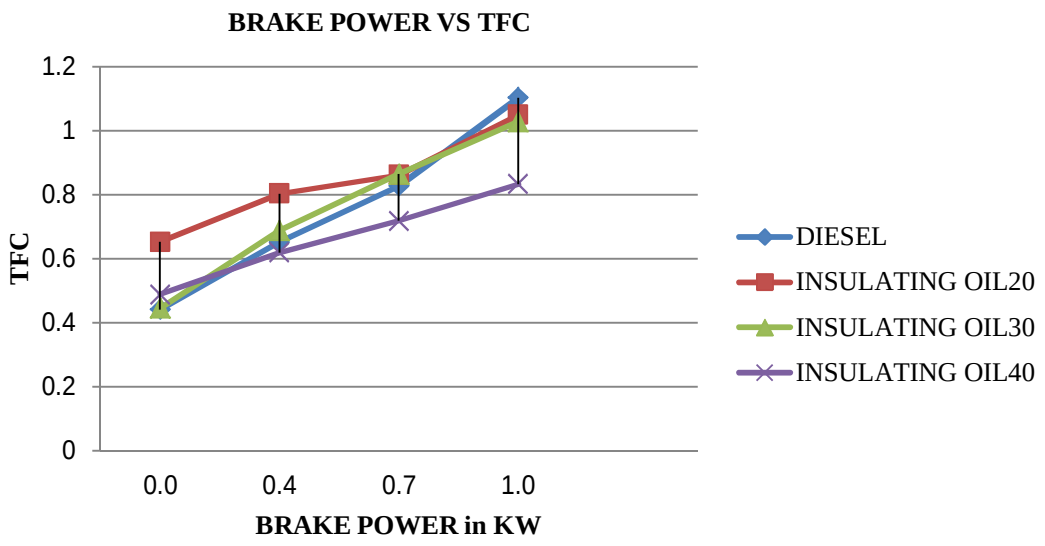

Fig 1 Brake power vs Total fuel consumption

The total fuel consumption vs brake power is shown in the figure. It is clear that for obtaining same amount of power, less fuel is consumed by the engine in case of IO40.

2) Brake power vs brake thermal efficiency

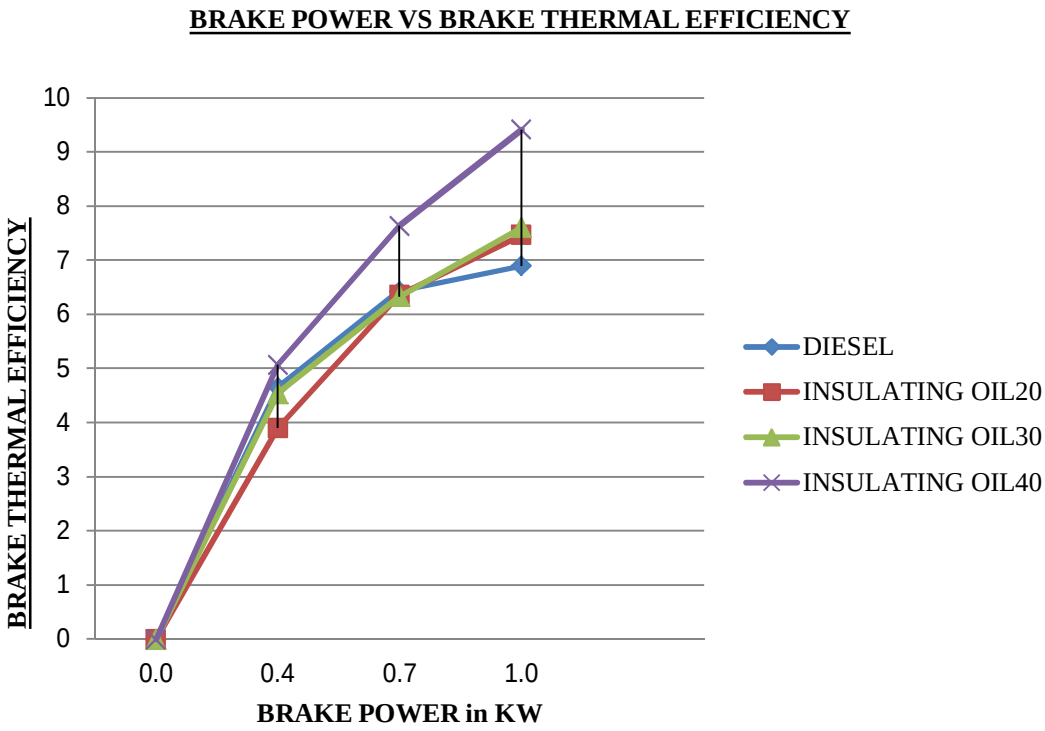

Fig 2: Brake power vs brake thermal efficiency

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It is clear from the graph that IO40 gives the higher values of brake thermal efficiency among the fuels tested.

3) Brake power vs mechanical efficiency

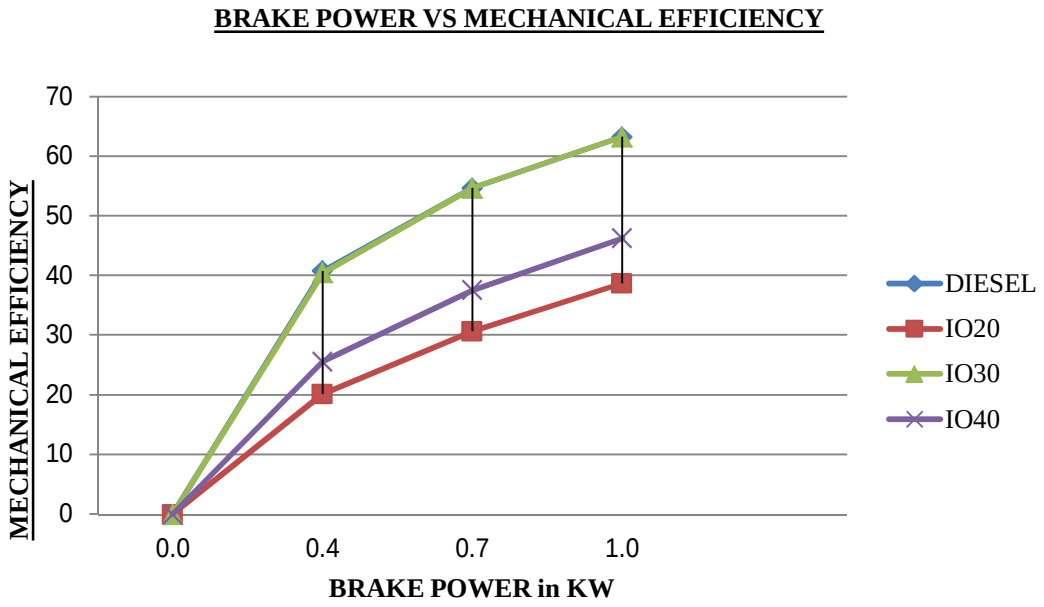

Fig 3: Brake power vs mechanical efficiency

In the above graphs mechanical efficiency of insulating oil blended fuels has been compared with that of diesel fuel at various loads. It is observed that mechanical efficiency of IO30 is same as that of diesel fuel and is comparatively higher than other blended oils.

TABLE 5
Comparison of exhaust emission

Gas	Prescribed Std	Measured Level Diesel Fuel	Measured Level IO20	Measured Level IO30	Measured Level IO40
CO (%)	3.5	0.000	0.257	1.332	1.363
HC(ppm)	4500	0000	00003	0004	0000
CO_2 (%)		00.01	00.4	00.4	00.02
O_2 (%)		21.48	19.84	18.97	20.94

In the exhaust gas analysis in the engine, results have shown that the even though the percentage of CO emission is 1.363 % for IO40 and is higher than diesel, in case of HC, CO_2 and O_2 IO40 is preferable. The percentage of O_2 is the highest for diesel fuel of 21.48%. IO40 also gave 20.94% of O_2 followed by IO20 which gave 19.84% of O_2. IO30 gave the lowest oxygen percentage of 18.97 % among the blends tested. CO_2 emissions were higher for IO20 and IO30 which showed 0.4%. CO_2 emissions were least for diesel with 0.01%. The blend IO40 showed a CO_2 emission levels marginally lower than other IO blends.

IV. CONCLUSION

The performance and emission characteristics of a single cylinder, four stroke air cooled direct injection diesel engines fuelled with insulating oil blended with diesel in varying proportions of insulating oil was analysed and compared with those of diesel. The following conclusions were made:

A slight increase in thermal efficiency is observed for insulating oil blended with diesel fuel than those of diesel and IO40 gives the higher values of brake thermal efficiency among the fuels tested.

Fuel consumption is also much lesser for IO40 for corresponding brake power compared to diesel and its other blends.

In case of mechanical efficiency it is observed that IO30 is same as that of diesel fuel and is comparatively higher than other blended oils.

In case of exhaust gas analysis even though the percentage of CO emission for IO40 is higher than diesel, in case of HC, CO_2 and O_2, IO40 is preferable.

Considering the economic point of view, the cost of insulating oil is just Rs 25 per litre. By using insulating oil as an alternative fuel in diesel engine will help to bring the fuel costs down by a great margin.

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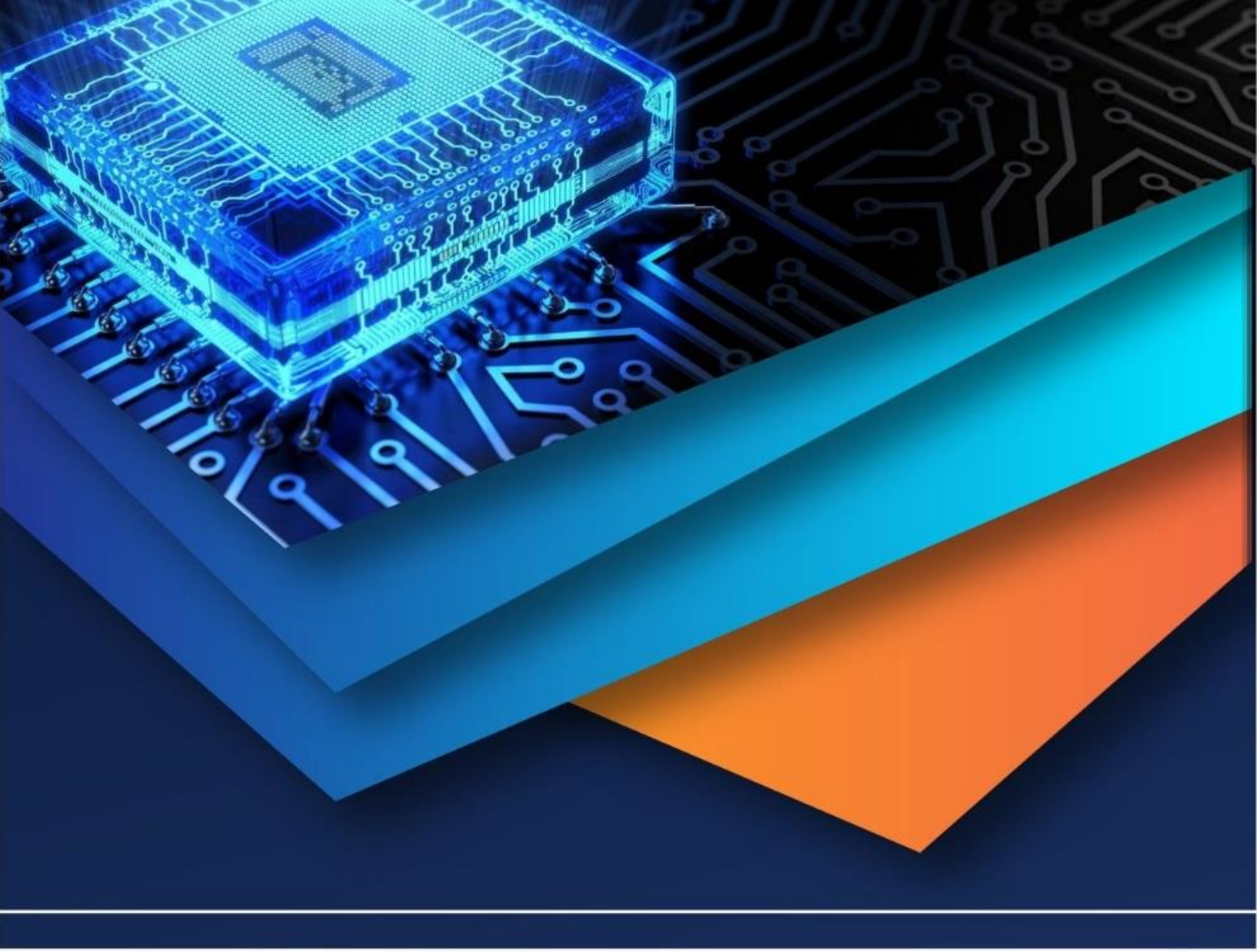

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