ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Experimental study of the Pressure and Power of the DI Diesel Engine with EGR 25%

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ARTICLE INFO

Article history:
Received 16 March 2015
Accepted 28 May 2015
Available online 22 June 2015

Keywords:
Diesel engine, Exhaust Gas Recirculation (EGR), Indicated mean effective pressure, Brake mean effective pressure, Indicated power

ABSTRACT

In this present work, Experiments were conducted to recovery of exhaust waste heat obtained from a diesel engine using a heat exchanger (HE). The preheated partial amount of exhaust gas from the heat exchanger was reused to operate the diesel engine. Tests were performed for different injection pressure like 190 bar, 200 bar, 210 bar, 220 bar and 230 bar. Heat transfer takes place between exhaust gas and oil (thermic fluid) at a different injection pressure, Indicated mean effective pressure, Friction means effective pressure, Brake mean effective pressure, Indicated power, Friction power and Brake power with the effect of engine loads were analyzed. It reveals that the pressure ranges from 1 bar to 10 bar and power ranges from 0.8 kW to 7 kW is acceptable ranges occurs as Exhaust Gas Recirculation EGR 25% condition

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To Cite This Article: Arumugam K, Senthilkumaar JS, Umanath K, Experimental study of the Pressure and Power of the DI Diesel Engine with EGR 25%. ***Aust. J. Basic & Appl. Sci.,*** *9(11): 916-921, 2015*

INTRODUCTION

Jianqin Fu *et al*. (2014) developed a device called steam assisted turbo charging to assist the exhaust turbo charger to recover the exhaust energy and stated that intake gas pressure reached their desired value and torque can be increased by 25%. Also slight improvements in pumping mean effective pressure and thermal efficiency. Choi, G. M., *et al*. (2002) Characteristics the nitric oxide formation in methane/air counter flow flames were studied to find basic data on extremely preheated air combustion in sensible industrial furnaces. It had been overlooked that the preheating of combustion air causes a heavy growth in gas emission as a solution of high fire temperatures. Yet, our recent experiments have demonstrated that the separated offer of fuel and preheated air into a chamber still as high-momentum injection will cut back gas emission effectively.. Combustion reactions happen simply even in air to a fault diluted with gas, as long as we have a propensity to use air preheated on top of the autoignition temperature of the fuel. Because the fraction of inert diluent, like element or greenhouse gas, within the diluted fuel or within the diluted air will increase, flame temperature, hence, the assembly of chemical element oxides decreases, yet if the formation mechanism of chemical element oxides is preserved. Further, the likelihood of destruction of gas was shown if there are high initial concentrations of gas contained in the flue gas used as diluent. Mohsen Ghazikhani *et al*. (2014) investigated diesel engine energy recovery double pipe counter flow heat exchanger and reported that energy increased with an increase in engine load and speed, reduction in brake specific fuel consumption nearly 10%. M. Hatami *et al*. (2014) reviewed the waste heat recovery technologies from diesel engines with the use of different types of heat exchangers and also proposed heat exchangers designs to enhance the heat recovery from the exhaust of diesel engines. Saiful bari *et al*. (2013) conducted an experiment to recover the waste exhaust heat from diesel engines with the use of heat exchangers and that they reported that power enlarged up to 23.7%. Wunning, J. A. (1997) and Flamme *et al*. (1992) investigation for a high-temperature method heating, a higher potency is usually accomplished by air preheating Energy from the exhaust gases is transferred back to the combustion air in restorative or regenerative heat exchangers. A negative result of air preheating is increased peak flame temperatures with a potent impact on the thermal NOx formation. To beat the trade-off between energy saving and NOx reduction, the temperature among the combustion zone must be as low as attainable. Staged combustion, exhaust gas recirculation, or alternative flame cooling ways are used to lower the combustion temperatures

Jianqin Fu *et al* (2013) planned a steam turbo charging technique to spice up IC engine intake

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pressure to avoid wasting the energy and that they reported engine power was improved in theory at the most by 7.2%. Suzukawa, Y. *et al* Regenerative combustion systems are currently ready to raise the preheated air temperature up to 1600 K, as a result of the recent development in their style, within which a ceramic honeycomb is employed as a heat data-storage medium within the regenerator. Extremely preheated air combustion will increase the heating potential of flue gas and cuts fuel expenditure. Nevertheless, extremely preheated air combustion will increase the potential of NOx, emission. Therefore, the upshot of a coffee NOx, burner is needed for the contrivance of this technology for business usage. During this report, a fresh developed low NOx, regenerative burner is broken. Additionally, mentioned are the theoretical and mathematical analyses of fuel saving in extremely preheated air combustion. Jianqin Fu *et al*. (2014) developed a tool referred to as steam power-assisted turbo charging to help the exhaust turbo charger to recover the exhaust energy and explicit that intake gas pressure reached their desired worth and torque will be increased by 25th. Additionally, slight enhancements on pumping mean effective pressure and thermal efficiency. [9] Jianqin Fu *et al*. (2014) performed a comparative study among exhaust turbo charging, steam turbo charging and steam power-assisted turbo charging. [10] Mohsen Ghazikhani *et al*. (2014) investigated diesel motor energy recovery double pipe counter flow device and reported that energy enlarged to increase in engine load and speed, reduction in brake specific fuel consumption nearly 100 percent. Yuan, Jand Naruse, I. Investigated, the Modeling of combustion characteristics and NOx, emission in extremely preheated and diluted air combustion. This report introduces a mathematical investigation into gas diffusion combustion in a very regenerative chamber with extremely pre-heated and diluted air. The extremely pre-heated air combustion possesses high combustion intensity and high grade temperature, but the NOx, emission additionally has an unwanted high level. Decreasing the oxygen concentration inside the extremely pre-heated air might decrease the NOx, emission and improve the uniformity of temperature distribution within the bedroom. The burning characteristics of extremely preheated and diluted air combustion are considered, as well as temperature distribution, soot formation, OH radical distribution, still as NOx, emission. The influence of the pre-heated air temperature, the oxygen concentration and additionally the air diluent has also been looked into. The best combos of the preheated air temperature and thus the oxygen concentration are called within the event of flue gas recirculation that might make the best attainable temperature within the Combustion. M. Hatami *et al*. (2014) reviewed the waste heat recovery technologies from diesel engines with the use of various forms of heat exchangers and additionally planned heat exchangers styles to boost the warmth recovery from the exhaust of diesel engines. Shekh Nisar Hossain *et al*. (2013) conducted Associate in Nursing experiment to leave the exhaust heat from 40 kW diesel generators with use of series and parallel heat exchangers. They reported that optimized device turn out 11% additional further power and 12-tone system improvement in brake specific fuel consumption (BSFC). The present work was carried out to measure the engine performance and combustion characteristics with the combined effects of EGR 25% on a single cylinder diesel engine.

Experimental Work:

The experiments were carried out to check the energy recovery system on a single cylinder 4.4 kW water cooled DI diesel is shown in Fig. 1. And the specifications of the engine are shown in Table 1. K-type thermocouple want to measure the exhaust gas temperature, water inlet and outlet temperature. Electrical Ergometer five KVA AC generator (220 V, 1500 rpm) was coupled to the engine by versatile coupling for measuring the brake power of the engine. Panel board consists of meter, meter switches and fuse, load cell indicator and temperature indicator. A baffled shell and tube kind device with counter current flow was designed to get the higher heat transfer is shown in Fig. 2. DAQ system was connected by laptop to record the output information. Engine speed was lived with the aid of PNP device and the cargo cell electrical device was wanting to measure the engine force. The existing cylinder liner was replaced with changing liner connected with thermocouple junction to live combustion values in a precise manner is shown in Fig. 3. DI diesel tests were conducted at 5 completely different injection pressures like 190 bar, 200 bar, 210 bar, 220 bar and 230 bar conditions. For every injection pressure completely different engine masses 25th, 50%, 75th and 100% were applied at 1500rpm. The specification of the warmth exchanger design is listed in Table 2.

Table 1: DI Diesel engine specifications.

Engine	Specification
Make & Engine type	Kirloskar 4 stroke diesel engine
Type of cooling	Water cooled
Bore and stroke (mm)	87.5 & 110
Compression ratio	17.5:1
Maximum power	4.4 KW at 1500 rpm
Load type	Eddy current dynamometer
Ignition type	Compression ignition

Engine speed	1500 rpm
Maximum torque	28 N-m at 1500 rpm
Start of fuel injection	23°bTDC

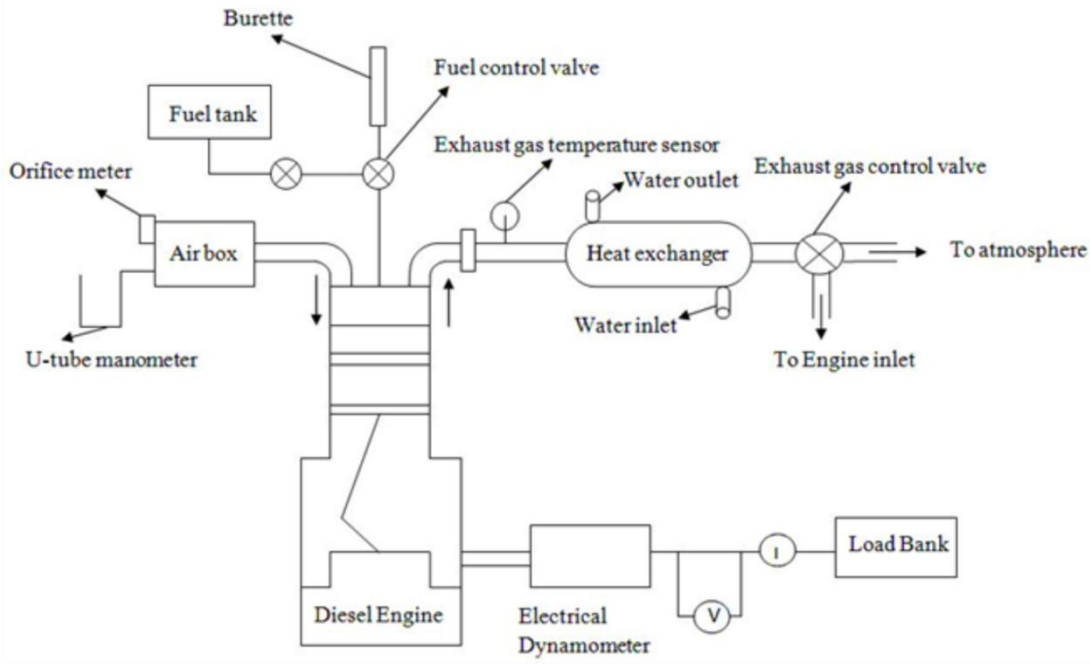


Fig. 1: Schematic diagram of the experimental setup.

Table 2: Heat exchanger specifications.

Heat exchanger type	Shell and tube counter flow
Shell thickness	6 mm
Operating temperature range	Upto 280°C
Shell material	Mild steel
Shell outer diameter	200 mm
Tube material	Copper
Tube outer diameter	12.5 mm
Tube thickness	1.65 mm
Length of shell	1200 mm
No of tubes inside the shell	25
Type of tube layout	Square layout
Baffles	50% cut baffles, no of baffles 5
Thermal conductivity of copper	388 W/m K
Density	861 Kg/m^3
Flash point	188°C

Table 3.3: Performance values of DI diesel engine with EGR

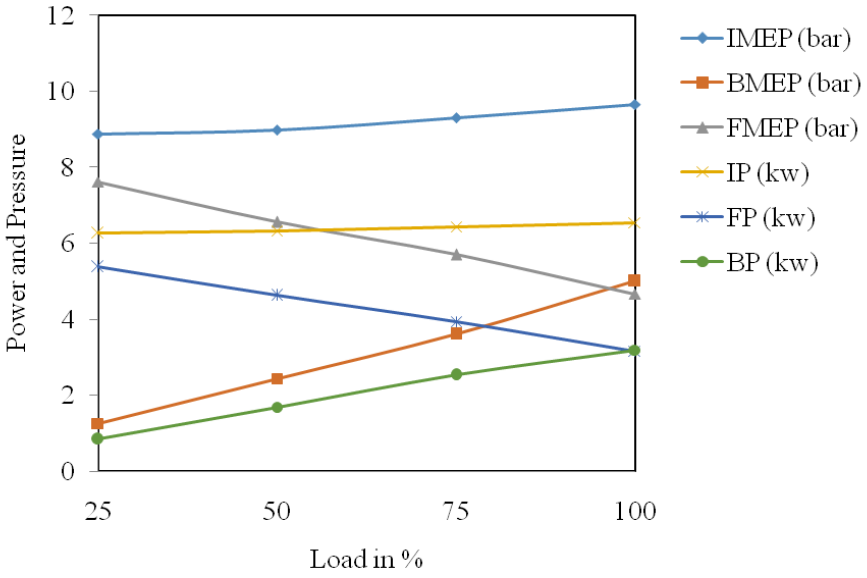
Injection Pressure (bar)	Engine Loads (%)	Air flow rate (Kg/hr)	Cooling Water (ºC)		Vol. eff. (%)	IMEP (bar)	FMEP (bar)	Mechanical Efficiency (%)	Indicated Power (kW)	Friction Power (kW)	BMEP (bar)
			Inlet	Outlet							
190	25	14.422	29	41.536	54.828	8.880	7.624	14.150	6.260	5.374	1.257
	50	14.456	29	43.751	55.812	8.985	6.556	27.035	6.334	4.622	2.429
	75	14.375	29	45.663	55.540	9.303	5.697	38.760	6.430	3.938	3.606
	100	14.249	30	47.924	57.269	9.662	4.665	51.720	6.545	3.160	4.997
200	25	14.424	30	40.765	55.744	9.664	8.377	13.319	6.946	6.021	1.287
	50	14.333	30	43.049	55.365	11.055	8.626	21.975	7.793	6.081	2.429
	75	14.289	30	45.198	56.304	9.934	6.305	36.533	7.004	4.445	3.629
	100	14.216	30	47.466	57.256	11.001	6.125	44.319	7.603	4.233	4.875
210	25	14.676	29	38.037	56.685	8.345	7.085	15.093	5.998	5.093	1.259
	50	14.646	29	41.520	56.612	9.146	6.604	27.799	6.448	4.655	2.543
	75	14.568	29	44.080	58.521	9.740	6.031	38.079	6.732	4.169	3.709
	100	14.590	29	46.905	58.638	10.495	5.385	48.691	7.108	3.647	5.110
220	25	14.895	30	38.079	57.537	9.477	8.249	12.956	6.812	5.929	1.228
	50	15.019	30	41.473	59.136	9.713	7.237	25.492	6.713	5.002	2.476
	75	14.806	30	44.240	59.489	9.715	6.013	38.106	6.714	4.156	3.702
	100	14.592	30	47.008	59.841	9.873	4.930	50.668	6.649	3.255	4.943
230	25	13.568	29	39.303	52.444	9.137	7.899	13.543	6.567	5.678	1.237

	50	15.287	29	41.428	60.202	9.861	7.363	25.331	6.952	5.191	2.498
	75	15.083	29	43.389	58.190	8.650	4.884	43.539	5.979	3.376	3.766
	100	15.003	29	45.955	60.521	9.878	4.890	50.495	6.554	3.245	4.988

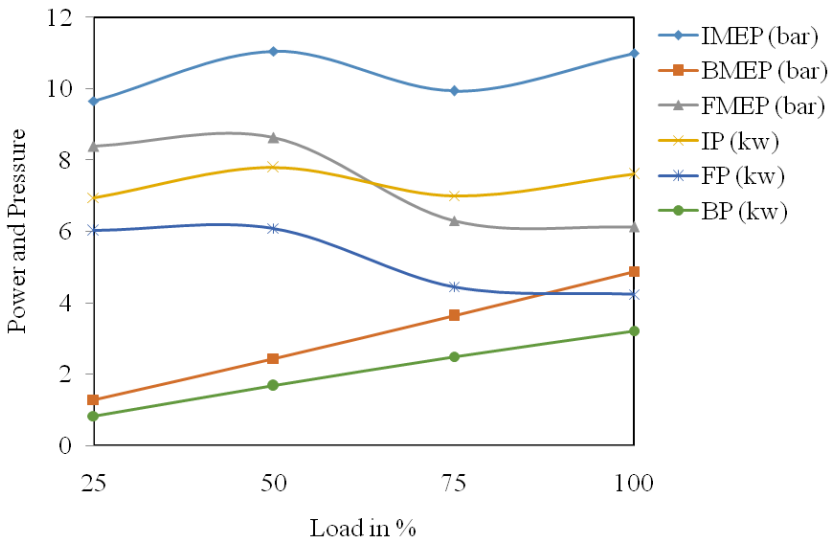
RESULTS AND DISCUSSIONS

The experimental investigation of the engine operated at various injection pressures at different load conditions is studied in DI Diesel Engine as an EGR 25% Condition are plotted in Table 3.3

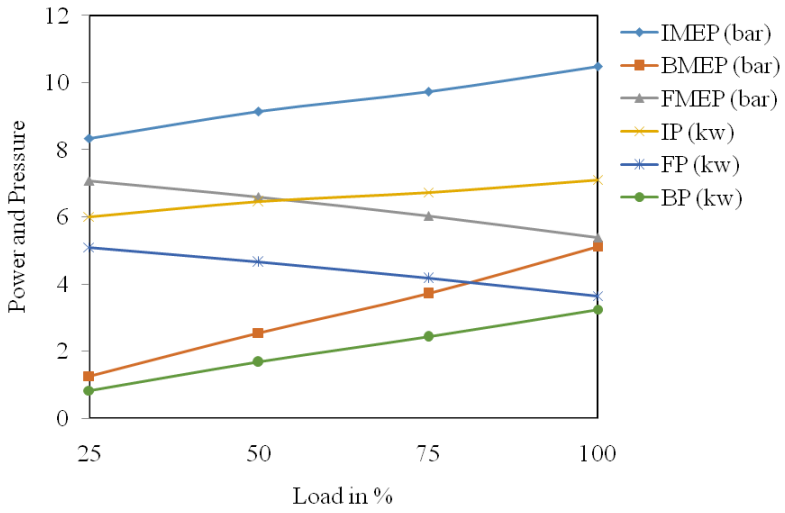
The Performance characteristic curves of the various pressures and power are plotted is shown in Fig. 3.73. It shows that the variation of Indicated mean effective pressure, Friction mean effective pressure, Brake mean effective pressure, Indicated power, Friction power and Brake power with the effect of engine loads is discussed in details. The performance values for various injection pressures of 190 bar, 200 bar, 210 bar, 220 bar and 230 bar were conducted and plotted the effect of pressure and power with respect to engine loads. As the engine load increases the performance values of Indicated mean effective pressure (IMEP), Brake mean effective pressure (BMEP), Indicated power (IP), Brake power (BP) progressively increases at the same time Friction mean effective pressure (FMEP), Friction power (FP) is decreasing. It is also observed from the Graph shows that the pressure ranges from 1 bar to 10 bar and power ranges from 0.8 kW to 7 kW is acceptable ranges occurs in EGR 25% condition.



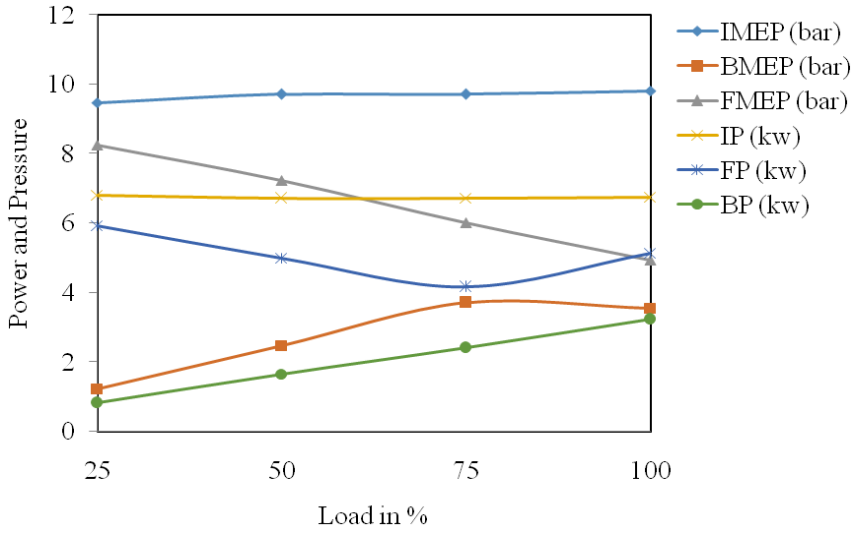
(a) 190 bar Injection Pressure



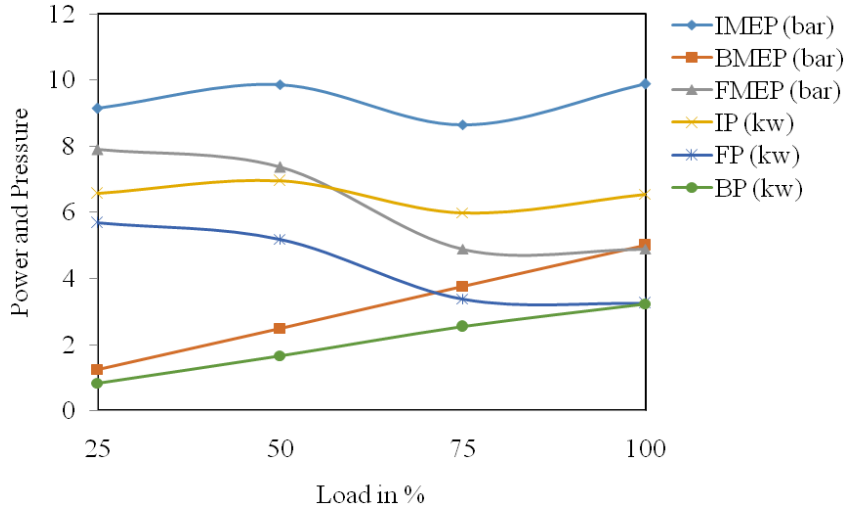
(b) 200 bar Injection Pressure



(c) 210 bar Injection Pressure



(d) 220 bar Injection Pressure



(e) 230 bar Injection Pressure

Fig. 1.1: Effect of pressure and Power of Various Injection Pressure with EGR 25%.

Conclusion:

Experimental exhaust cooling in a DI diesel engine with the aim of energy recovery was investigated. The results reveal that the amount of the recovered energy from the exhaust is affected by engine load and injection pressure. It is shown that energy recovery from heat exchanger can properly be assumed as a part of engine power. The exhaust gas of a diesel engine carries a lot of heat and this energy can be recovered efficiently using baffled shell and tube type heat recovery heat exchanger. The heat transfer between exhaust gas and thermic fluid (oil) was reported for different injection pressure. It reveals that at 230 bar injection pressure both the temperature of the exhaust gas outlet of the heat exchanger and thermic fluid (oil) almost equal. Brake thermal efficiency of diesel engine was 8.16 % improved at 230 bar injection pressure. However, brake specific fuel consumption was reduced for increased in injection pressure.

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