JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# EXPERIMENTAL INVESTIGATIONS OF HYDROGEN-DIESELDUEL FUELED ENGINE USING TIMED MANIFOLD INDUCTION TECHNIQUE

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***Abstract:***Depletion of oil based good resources and the need to crush the outflow of greenhouse gas to investigate for elective quality. Hydrogen is desirable to be introduced as a secondary possible alternative fuel in the world. Hydrogen has more extensive combustibility limits contrasted with diesel by volume in air and Hydrogen self start temperature is high contrasted with diesel. Elective sources transporters other than hydrocarbon, gas and diesel energizes, which are the established ones. It has been tentatively surveyed that the Timed Manifold Induction (TMI) strategy assumes an exceptionally predominant role in the smooth action of the engine. An electronically controlled Timed Manifold Induction Technique (TMI) structure is to be made. It involves the mixing of hydrogen and air into a diesel engine and the application of a pilot spray of diesel fuel to light the blend. Hydrogen has been applied at different mass flow rates of 10%, 20%, 30%, 40% and 50% liters per minute. Specific fuel consumption, indicated thermal efficiency, and cylinder pressures (IMEP, BMEP) are examined at different load conditions.

***Keywords*: IC Engine, Hydrogen, Timed Manifold Induction technique, Speed, Emissions.**

## I.INTRODUCTION

Present world energy usage levels and concerns about global warming have given rise to strong research interest in non-oil, carbon-free compounds and non-polluting fuels, especially in the transport, power generation and agricultural sectors,which has led to an interest in research and the production of suitable elective fuel as a replacement for oil based fuels, responding to rising energy request with minimal economic and ecological effects, thus decreasing the dependence on non-renewable energy sources.According to Gopal. G. et al. [1], the usage of a duel fuel engine is the appropriate and most bendy manner to use hydrogen in a diesel engine. Throughout this look at, a dual-fuel engine substituted with hydrogen because the recounted gasoline used in place of diesel for a elegant four-stroke, single-cylinder diesel engine. The essential thoughts of the observer were to set up the top-quality balance of hydrogen and diesel oil in various engine situations. The findings show that Hydrogen should deliver the engine with energy up to a enormous volume, and the thermal efficiency tests carried out have been nearly same to those of pure diesel activity. The primary issue seen is that knocking starts to happen a whole lot earlier than the stochiometric hydrogen-air ratio. Naber. J. D. et al. [2**]** contemplated the hydrogen combustion in diesel engine instances, wherein situations for direct-injection (DI) diesel engines and car ignition hydrogen combustion have been investigated. The consequences revealed that begin postponement of much less than 1.0 ms changed into received at gasoline temperatures more than 1120 K with $O_2$ fixes as low as 5%. (viaquantity). These findings suggest that, below the right TDC situations, hydrogen compression ignition in a diesel engine is feasible. Additionally, the findings showed that DI hydrogen ignition charges are insensitive to low oxygen fixations. Because they provide the capability for a significant reduction within the emission of nitric oxides from a pressure touched off the DI hydrogen engine by using use of fumes gasoline-distribution, disregard for, delay of starting, and burning price to reduced oxygen attention are crucial. Tomita, E. et al. [3]

conducted a test on a four-stroke single cylinder diesel engine with a dual fuel methodology for hydrogen-diesel blends. In their research made an undertaking by drafting hydrogen from the intake port into a diesel engine's cylinder and light and light oil was mixed in the cylinder. The heat release rate had been settled from the cylinder's pressure background. The association between the exhaust emissions and the heat release rate are inspected. The light oil, particularly mixed with air or hydrogen-air mixture and the underlying burning, gets smooth exactly when the injection timing of light oil into the cylinder was moved. Owing to lean premixed with inlet air, HC, CO and $CO_2$ outflows decrease without smoke, NOx emissions decrease. At any way brake thermal efficiency is fairly not as much as that in the basic diesel ignition. In particular, both smoke and NOx are simply around zero and HC is low when the injection timing it fundamentally progressed.Masood, M., et al [4] studied the outcomes of mixing diesel and hydrogen to various stages on ignition and discharges. An evaluation of the outcomes of accepting twin fuelling through the inlet manifold and direct hydrogen injection into the combustion chamber was accomplished in a paper that changed into equal to this one. In addition to decreasing diesel costs, hydrogen alternative degrees multiplied from 20percent to 80percent. Using the CFD programming FLUENT and GAMBIT, the CFD investigation of simultaneous fuel burning and discharges changed into performed. The CFD duel gasoline intake evaluation and outflows had been completed the use of GAMBIT for the two techniques using the CFD software FLUENT, in concurring with the combustion chamber.S. Murillo et al [5] the motivation behind this investigation is to determine the execution engine and the outflow after effects of biodiesel provided by the vegetable oil (cooking oil) that was applied in Diesel engines at various levels. The Result has shown the utilization of biodiesel has brought about lower carbon monoxide discharges by up to 12%, while raising nitrogen oxide levels to 20%, although in one instance a small decrease has been added.C. Sayin et al [6] concentrated on the execution engine because of injection timing. The examination likewise debilitates outflows of a single-cylinder CI engine by utilizing ethanol blended Diesel fuel from 0% to 15% with an expansion of 5%. The load of the engine was gotten as 15 and 30 Nm and the experiments were conducted by changing the thickness of the forward shim at five particular injection timings (21°, 24°, 27°, 30° and 33°CA BTDC). To the extent BSFC and BTE, were concerned, the delayed and propelled injection timings contrasted with the first IT in all fuel combinations, providing unhelpful outcomes for both engine speeds and loads. In its evaluation of advanced hydrogen, diesel combustion, Samuel,Stephen.et.al [7] attempted to investigate the appearance and discharge characteristics of a diesel engine using a hydrogen-oxygen mix of diesel fuel derived from water for use. During the time of induction, limited amounts of hydrogen and oxygen were added into the air stream without any changes to the current engine. The research found the consumption of fuel, emissions of $CO_2$ and CO could be substantially decreased by injecting limited quantities of oxygen and hydrogen into the air stream of a regular diesel engine. The in-cylinder estimation demonstrated no significant change in cylinder constrain qualities to require configuration changes. The examination additionally recognized optimum level of hydrogen for decreasing NOx level.Kose. H. et al [8] examined the impacts of CI engine when the hydrogen is used as an extra fuel. The efficiency and exhaust parameters at various speeds of engine at maximum load were analyzed. A four-cylinder, four-stroke CI engine with turbocharger seas worked with a 17:1 compression ratio. Although Diesel fuel was legitimately injected into the combustion chamber, Hydrogen was applied as a volume to the inlet manifold at 2.5%, 5% and 7.5% levels. Thus, at each additional hydrogen level, an expansion in engine torque, power, thermal efficiency, nitrogen oxides (NOx) and exhaust gas temperatures was needed, although the decreases in hydrocarbon (HC), carbon monoxide (CO) and oxygen ($O_2$) were accomplished. Hariram et al [9] considered the direct injection CI engine with a single cylinder changed into tested at various CRs (compression ratios) of 16, 17, and 18 under various loads. They certainly targeted on the performance and combustion variance for the unique CR (compression ratios). There become a decrease in brake thermal efficiencies (BTHE) and a growth in exhaust fuel temperatures whilst the compression ratios (CR) were reduced from 18 to 16. As the CR reduced, the BSFC (brake specific fuel consumption) was enhanced. Datta. A,Mandal. B. K. et al [10] considered the impacts of alcohol to diesel in a CI engine. There was seen a peripheral increment in thermal efficiency with increment in ethanol expansion to diesel. Be that as it may, generally speaking, diesel created higher brake thermal efficiency because of higher density. A Higher heat release rate and increased delays in the ignition were observed for combustible fuels. The ascent for peak pressure was seen to be lower for liquor mixed fuels. A noteworthy decline in PM (Particulate Matter), NOx and smoke outflows were watched. The reduction in NOx emissions had occurred after substantial increase. The plunge was seen to proceed till the 8000 rpm. The fall in $NO_X$ outflow had begun at 5000 rpm. It was caused because of absence of living arrangement time. Because of which development of NOx was steadily eased back.

## II .EXPERIMENTAL METHODOLOGY

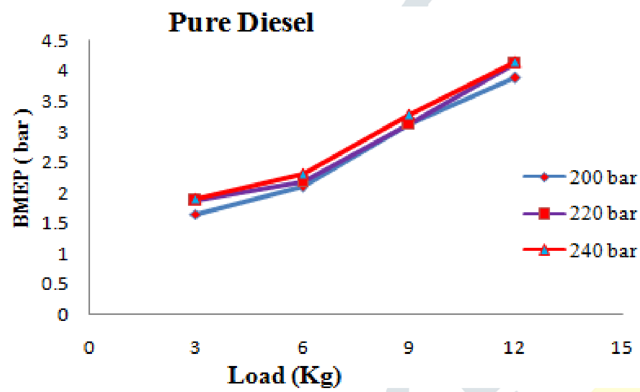
The existing engine is to be fuelled by hydrogen, problems of backfire, pre-ignition, high rate of pressure rise and even knock can become apparent. Hence, considering the temperamental nature of hydrogen fuel, sufficient care was taken to integrate outmoded safety measures in the hydrogen induction circuit. The system is designed as shown in below, so that the intake manifold does not contain any combustible mixtures and to ensure that air being inducted prior to fuel delivery thereby providing a pre- cooling effect and thus avoiding situations leading to undesirable, combustion phenomena like pre-ignition etc. Electronic fuel injection control is attainable and can easily provide the flexibility of control needed for optimum overall engine performance.The engine was run at a constant speed of 1500 rpm at variable loads. Hydrogen was introduced at the mass flow rate of 10%, 20%, 30%, 40% and 50%

liter/minute. Specific fuel consumption, indicated thermal efficiency, and cylinder pressures (IMEP, BMEP) are investigated at different load conditions. Experimental setup was shown in Fig.1.

Figure1.Photographic View of Experimental Setup

## III .RESULTS AND DISCUSSIONS

Figure2(a-f) shows the variation of BMEP with respect to load at different mass flow rates of diesel and hydrogen in dual fuel mode. It was observed that with increasing hydrogen injection strategy there is an enhancement of BMEP.

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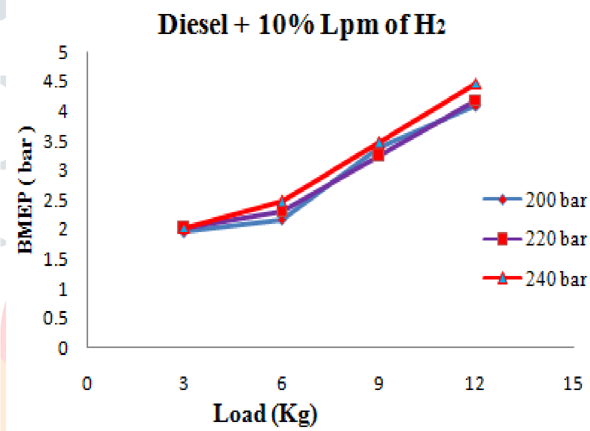


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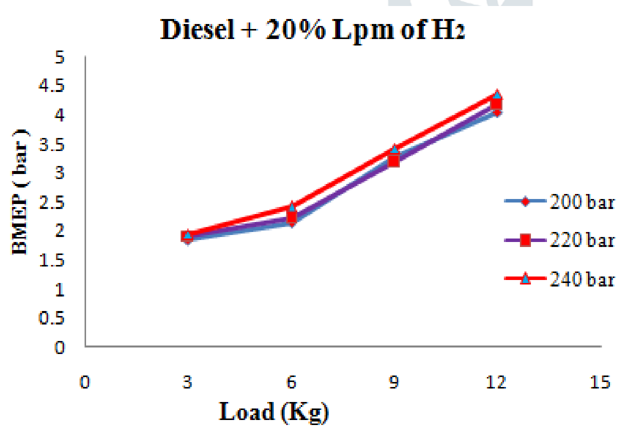


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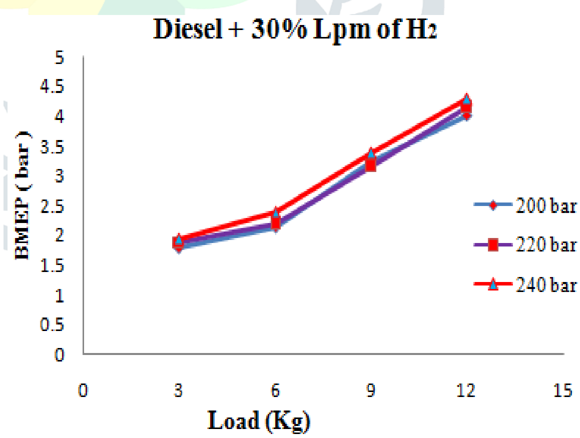


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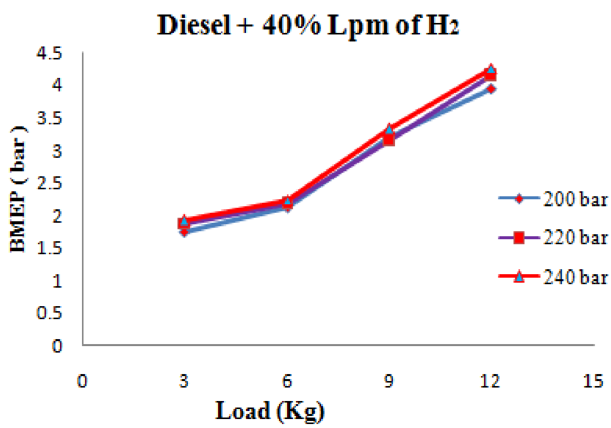
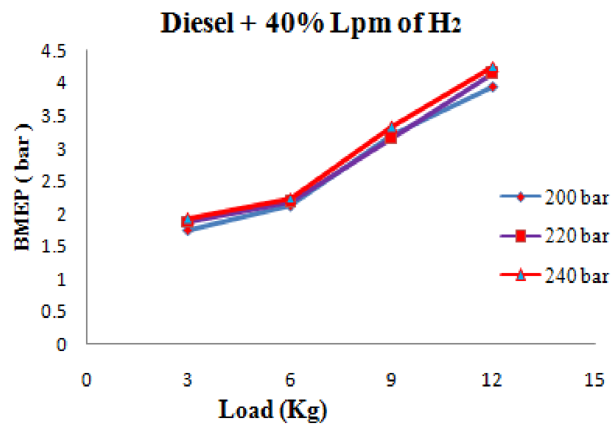
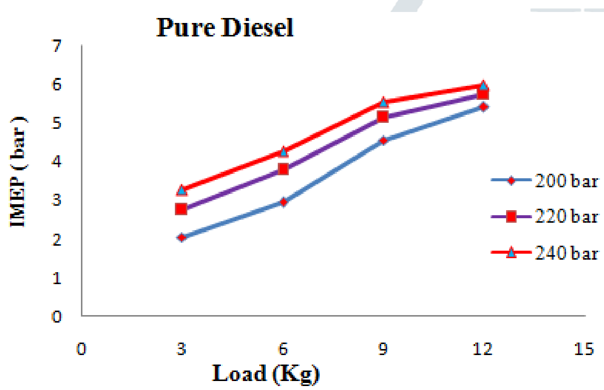


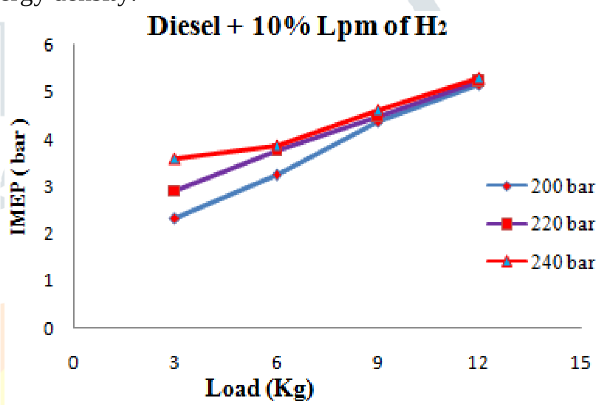




( e ) ( f )

Figure 2. Load Vs BMEP

Figure3 (a-f) shows the variation of IMEP with respect to load at different mass flow rates of diesel and hydrogen in dual fuel mode. It was observed that with increasing hydrogen injection strategy there is an enhancement of IMEP which gives an indication of hydrogen participation inside the cylinder with higher energy density.

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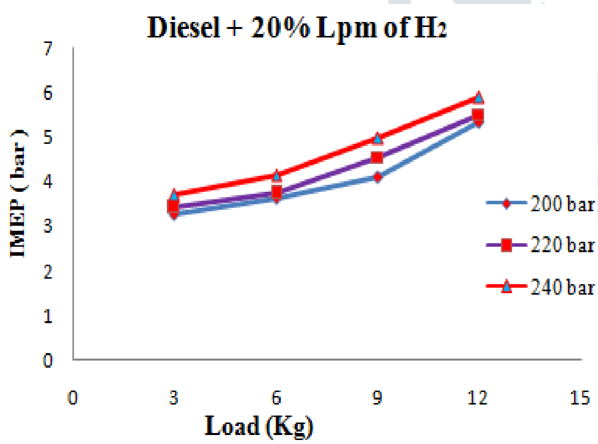


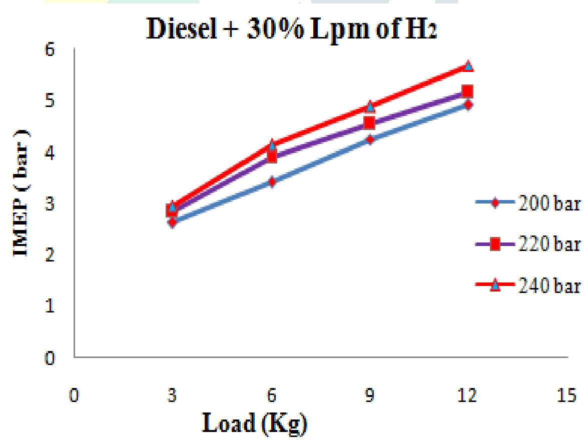


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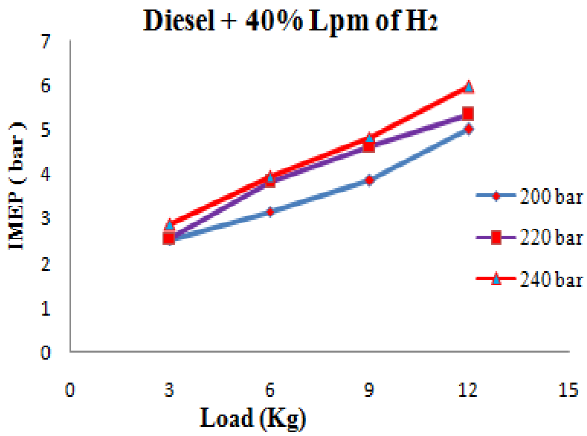


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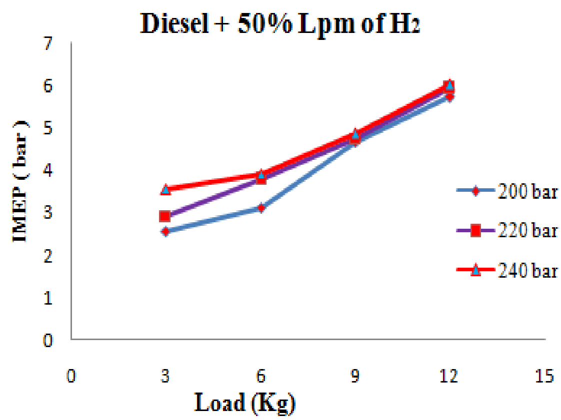
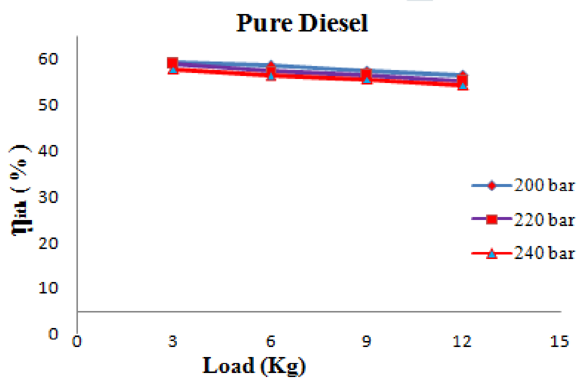



(f)

Figure 3. Load Vs IMEP

Figure4 (a-f) shows the variation of $\eta_{ith}$ with load for mass flow rates of diesel and hydrogen in dual fuel mode. It was observed that with increasing hydrogen injection strategy at various IOP there is a reduction of $\eta_{ith}$.

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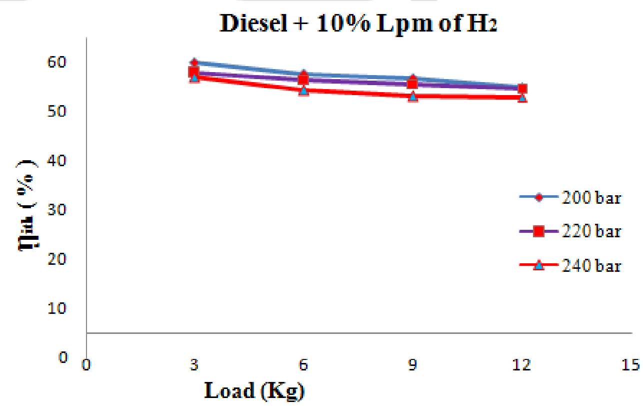


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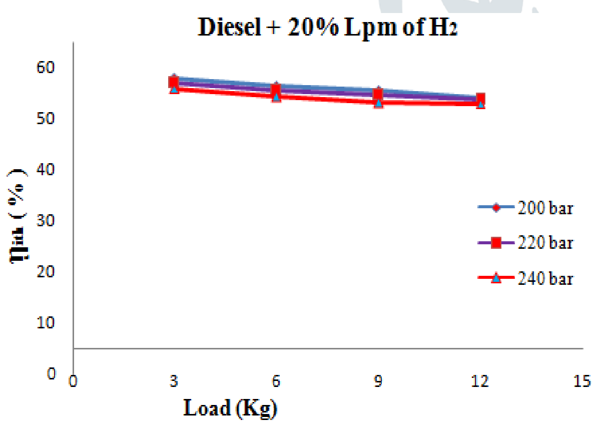


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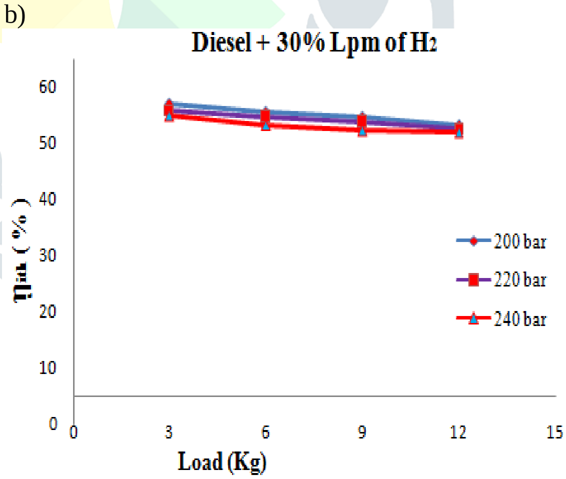


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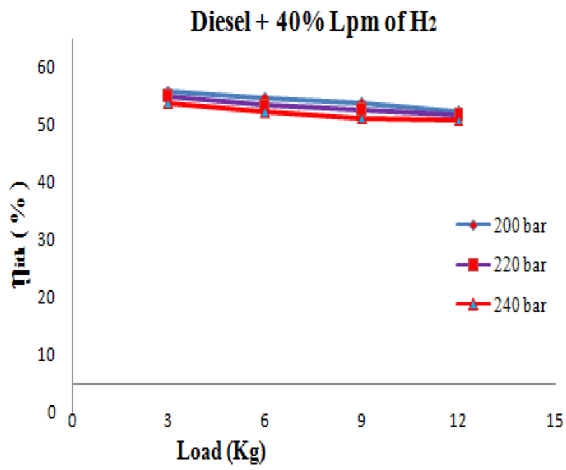


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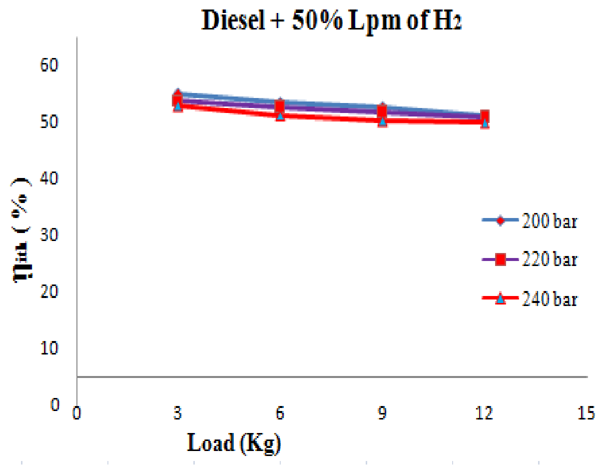
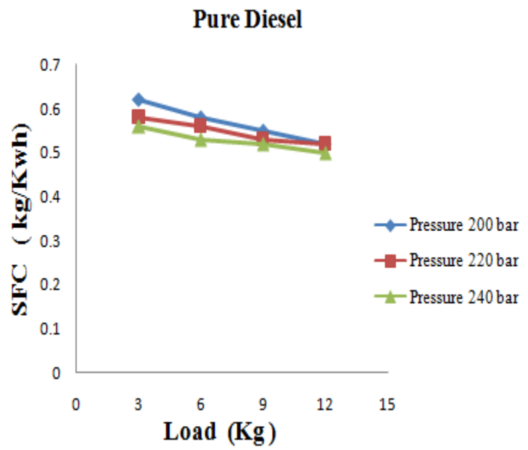


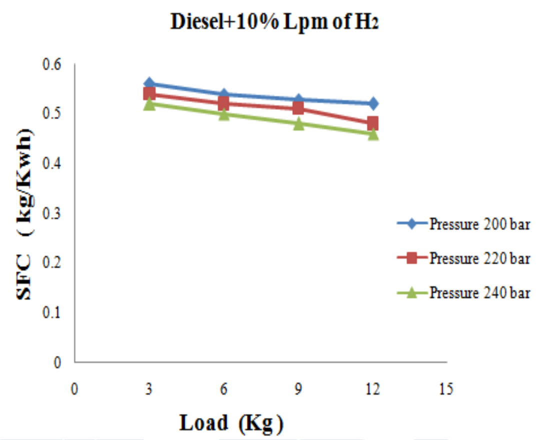

( f)

Figure4.Load Vs Indicated Thermal Efficiency ( $\eta_{ith}$)

Figure5(a-f) illustrates the variation of SFCwith load for pure diesel and with hydrogenenrichment in dual fuel mode. This is an indicative of the enhanced combustion of conventional diesel combustion on account of high flame velocities and high calorific content of the participating hydrogen with air resulting in complete combustion of fuel and a little more engine power due to the increase in the amount of hydrogen fuel.




(a)

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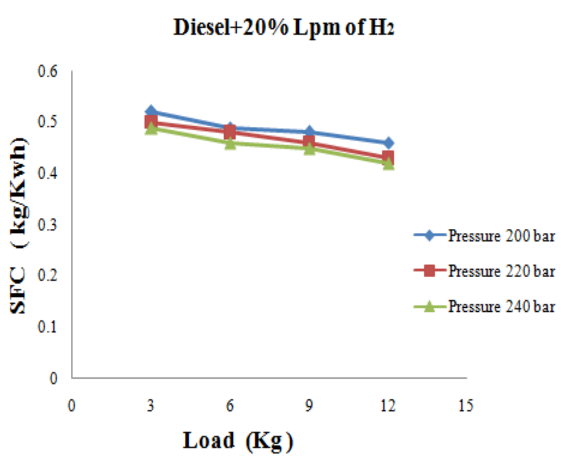


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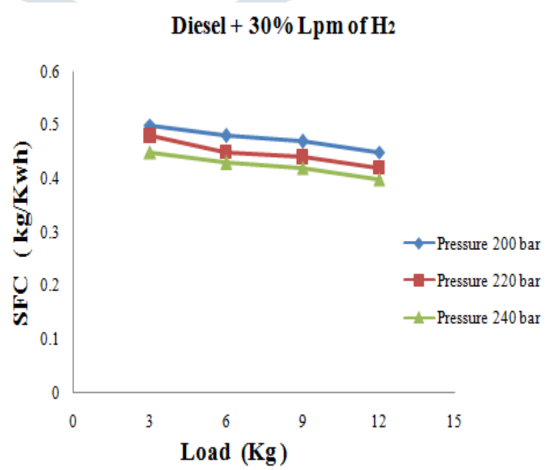


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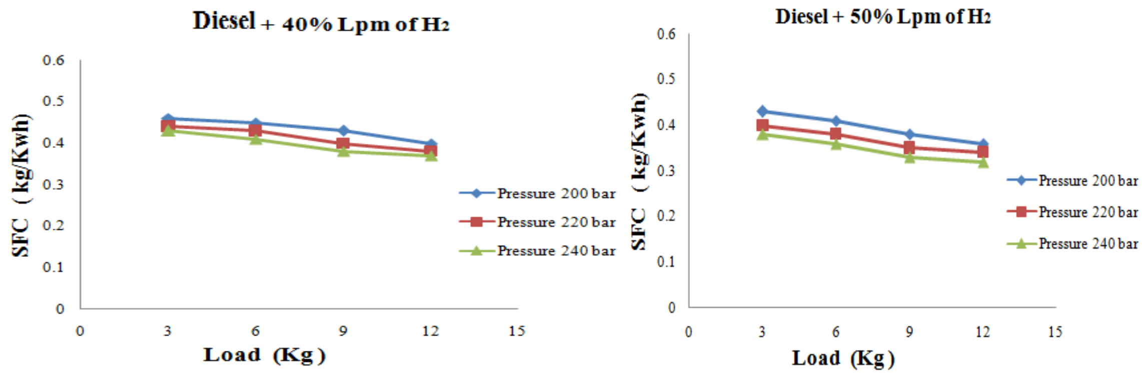


(e) (f )

Figure 5.Load Vs Specific Fuel Consumption (SFC)

## IV.CONCLUSIONS

Delayed fuel delivery, either at the intake port or directly into the cylinder using atimed fuel injection technique, is beneficial in circu mventing backfire problem in the intake manifold.The dual fuel engine's brake thermal efficiency is approximately the same as that of the diesel engine through the operating range. For lower diesel flow rates, the thermal output usually increases as the induction of hydrogen commences. The Brake Mean Effective Pressure [BMEP]at higher hydrogen blend, yet it was equivalently high with pure diesel fuel.

There was a reduction in particulate matters at fixed injection diesel and engine load belowIndicated Mean Effective Pressure [IMEP] of 5.5 bar to 6.02 bar. When increased the mass flow rate of hydrogen and engine load Indicated Mean Effective Pressure [IMEP] will be increased and particulate matters also increased. Indicated thermal efficiency (ITE) will be maximum with low hydrogen mass flowrates, and the value will be lowered to high hydrogen mass flow rates.

From the graphs, the Specific Fuel Consumption (SFC) showed varying hydrogen concentrations in diesel, and found a reduction in SFC with an increase in hydrogen addition. The value of SFC shows an increase in both the diesel and the dual fuel mode at lower engine load.

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