Amit Kumar Verma, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 11, Issue 1, (Series-I) January 2021, pp. 52-58

RESEARCH ARTICLE OPEN ACCESS

Experimental Analysis of Dual Fuel Engine Run on Gaseous Fuel

Amit Kumar Verma[1], Ravindra Mohan[2] and Neeraj Agarwal[3]
[1]Research Scholar, [2]Assistant Professor, [3]Associate Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]IES College of Technology, Bhopal, M.P., India

ABSTRACT:
As the world ends up amidst general energy deficiency, compounded by an equal need to lessen toxins, all things considered; we should take genuine look at novel wellsprings of bountiful energy and approach of its utilization. C_2H_2 gas with its noteworthy ignition properties give off an impression of being substantiating itself as the best fuel for future inside motors on the off chance that it is used appropriately. In light of innate challenges in dealing with C_2H_2, innovation has accentuated the usage of C_2H_2 by infusion procedures to battle back fire in inward burning motors. A trial examination was done on a solitary chamber, air cooled, DI diesel engine intended to create 4.4 kW at 1500 rpm. C_2H_2 was infused into the admission port as an auxiliary fuel and biodiesel was infused straightforwardly into the chamber. The gas stream rate was fixed at 1 lpm, 2 lpm,3 lpm etc. and biodiesel was injected as usual way of diesel. The burning, execution and emanation boundaries were read for the above stream rates by fluctuating the heap from low burden to full load. Results show that NO_x, HC and CO outflows diminished when contrasted with biodiesel activity because of more slender activity. A minor expansion in smoke discharge was noticed and BTE was closer to diesel activity. All in all, it is presumed that without misfortune in BTE, safe activity of C_2H_2 is conceivable in planned port infusion strategy. Decreased NO_x, HC and CO emanation levels, with negligible expansion in smoke outflow level were accomplished.

Keyword: Performance; Gaseous fuel; Dual Fuel; Diesel Engine; Biodiesel

Date of Submission: 26-12-2020 Date of Acceptance: 06-01-2021

I. INTRODUCTION

Acetylene (C_2H_2) based double fuel CI motors offer astounding advantages including high warm productivity, high burning productivity, serious level of steady volume ignition, less ignition irreversibility, and almost zero carbon-based emanations HC, CO and smoke etc. In any case, these double fuel motors endure a significant obstruction of restricted C_2H_2 energy replacement for their compelling usage in future energy frameworks. The most extreme C_2H_2 energy share in a double fuel motor is ordinarily confined by beginning of thumping [1-2]. Thumping could be characterized as anomalous burning marvel which requirements the improvement in motor execution. Thumping burning could be identified in a few different ways, for example, in-cylinder pressure based discovery, chamber block vibration estimation, acoustic wave estimation investigation, heat move based examination, and so forth Both pace of weight rise and warmth discharge rate together can be utilized for an examination of the thump inclination in a CI engine. In a test it was upheld the way that the thumping burning in a CI engine is straightforwardly relative to its most extreme pace of weight rise [3]. A thermodynamic model was created for thump location in a SI (sparkle start) motor worked with diverse vaporous fills [4]. In the event that a CI motor works with thumping, the motor gets extreme harm including breakage of cylinder rings, cylinder softening, and disintegration of chamber head. In this way, CI motors normally work with less C_2H_2 energy share for thump anticipation in the motor. A reasonable innovation should be recognized and evaluated for replacement of high C_2H_2 energy share in CI motors under double fuel mode for thump free activity. The subtleties of writing survey on the greatest measure of C_2H_2 used in diesel motors at various loads under dual fuel mode are given in Table 1. It very well may be seen from the table that the greatest C_2H_2 energy share accomplished with a planned complex infusion method is in the scope of 6%, 16.4%. Nonetheless, this energy offer could additionally be expanded to 30% at lower load (lower brake mean compelling weight of 2.2 bar) with a port infusion technique. It was set up that the C_2H_2 energy share in CI motors diminishes with increment in motor burden. For model, the C_2H_2 energy share expanded from 18.8% at 100% burden to 48.4% at half burden in a 7.4 kW appraised power CI motor [5]. The different issues related to motor activity with high C_2H_2 energy share are high pace of weight rise, high in-cylinder top weight, too progressed burning, high in-cylinder top temperature, autoignition of premixed C_2H_2air charge, and loss of accessible work. Miyamoto et al. announced the event of auto-start wonder in a double fuel CI motor when the C2H2 part is higher than 8% volume [6]. This comparable pattern with diesel-propane fuel was accounted for all load operation. They uncovered explanations behind auto-start of C_2H_2-air charge are because of high polytropic list of C_2H_2, higher in-chamber temperature, and expanding preignition synthetic responses. Some of the potential energy sources are given below.

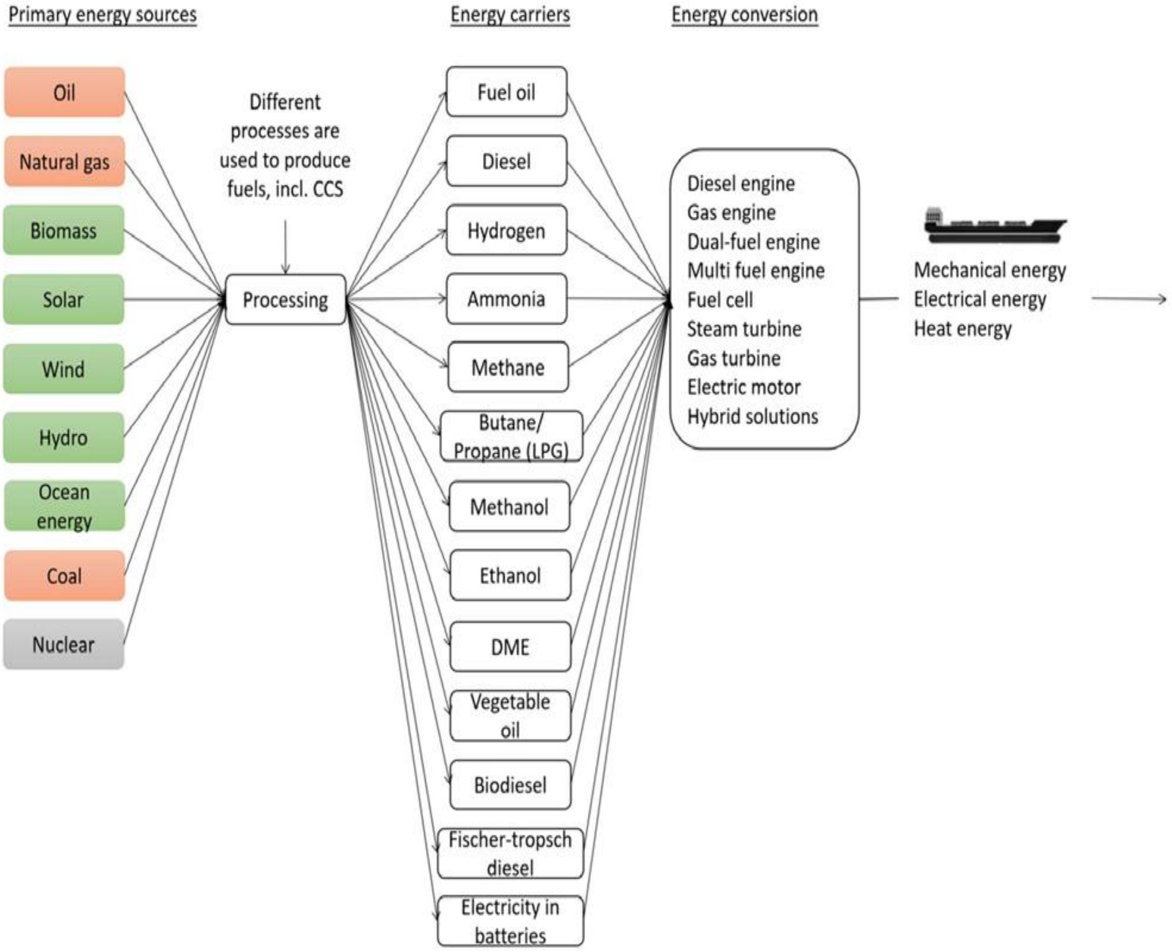


Fig.1 Potential energy resources

In another trial it was discovered an increment in mass of vaporous fuel (Liquefied Petroleum Gas/ Methane/Natural gas) would prompt huge expansion in the most extreme pace of weight ascend in a solitary chamber variable pressure aberrant infusion diesel motor (Ricardo E6: 9 kW appraised power) [9]. He likewise reasoned that the vaporous fuel existing in the burning chamber could be greater for auto-start Various explicit techniques including hindered infusion timing of fluid fuel (pilot fuel), utilization of high cetane number pilot fuel, EGR (fumes gas distribution), water infusion, and pressure proportion decrease could give a few answers for the upgrade of the C_2H_2 energy share in a double fuel motor. A not many examinations are accessible in writing on the improvement of the C_2H_2 energy share utilizing water infusion and pressure proportion decrease procedures. For instance, the C_2H_2 energy share was expanded from 14.8% with ordinary double fuel mode to 66% with double fuel mode utilizing water expansion [10]. Also, the other study shows the improvement of the C_2H_2 energy share from 19% with traditional dual fuel mode to 36% with water added double fuel mode. Adnan et al. recommended an ideal water infusion timing of 20 CA (wrench point) after TDC (top dead community) for better execution of a C_2H_2 double fuel CI motor. Masood et al. announced an addition in the measure of C_2H_2 replacement from 0.096 kg/h with 24.5:1 pressure proportion to 0.138 kg/h with 16.35:1 pressure proportion in a C_2H_2 powered double fuel motor. With this inspiration, the present study is focused on an improvement of the utilization of C_2H_2 energy share in diesel engine when biodiesel is used as secondary fuel.

II. EXPERIMENTATION

A solitary chamber, four-stroke, air-cooled, and normally suctioned, DI diesel motor intended to build up an intensity of 4.4 kW at 1500 rpm was used for C_2H_2 double fuel activity. The specialized details of the motor are given in Table 2. A schematic of the trial plan is appeared in Fig. 1. C_2H_2 was brought into admission complex at a guide nearer toward the admission valve by a non-return valve game plan through a fire trap. The progression of C_2H_2 was constrained by a valve and was estimated by an aligned gas stream meter. Wind current was controlled by precisely estimating the pressure drop over a sharp edge hole of the air flood chamber with the assistance of a U-tube manometer. The diesel stream was estimated by a burette plan, by noticing the hour of fixed volume of diesel devoured by the motor.

A water-cooled piezoelectric weight transducer was fixed on the chamber head to record the weight minor departure from the screen of a cathode-beam oscilloscope alongside wrench point encoder. Fumes gas temperature was estimated by a chrome– aluminum K-type thermocouple. The fumes gas constituent's CO and analyzer, NO_x outflow was estimated by electrochemical technique and smoke outflow was estimated by a Bosch smoke meter. The motor was turned over utilizing diesel fuel and permitted to heat up. C_2H_2 fuel was then provided into consumption complex at fixed recommendation of the complete charge through a stream meter.

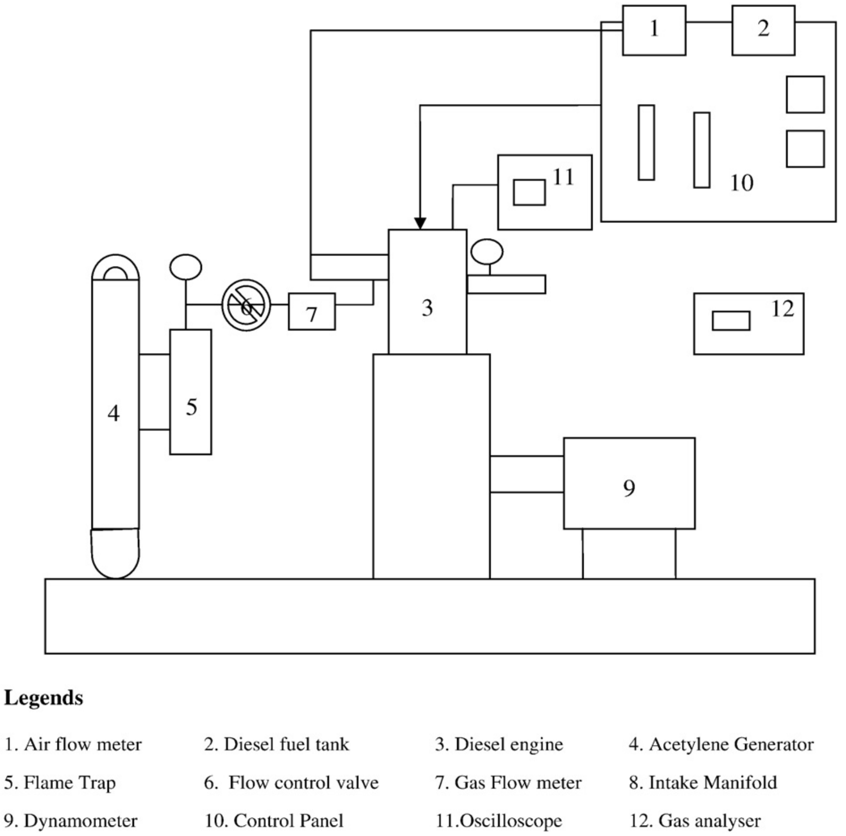
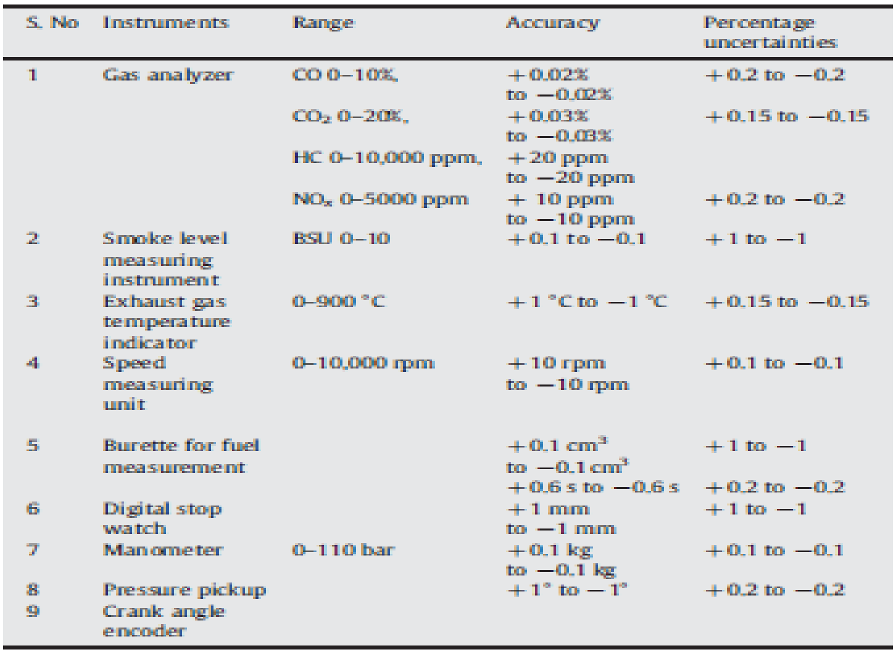


Fig.1 Schematic representation of test setup

The amount of infused biodiesel fuel was consequently differed by the lead representative appended to it, which kept up the motor speed at 1500 rpm all through the try. At that point the investigation was rehashed for different gas stream rates by differing the heap. The identicalness ratio was changed from no load to full load by gas acceptance. It was shifted from 1 lpm, 2 lpm, and 3 lpm flow rate of acetylene gas and usual way of biodiesel injection. The energy share proportion for C_2H_2 and diesel fuel for various burden conditions at most extreme stream pace of 3 lpm. CO_2 were estimated by utilizing a nondispersive infrared gas (NDIR) principle.

Table 1 Uncertainty Analysis of the instruments



S. No	Instruments	Range	Accuracy	Percentage uncertainties
1	Gas analyzer	CO 0–10%,	+0.02% to −0.02%	+0.2 to −0.2
		CO_2 0–20%,	+0.03% to −0.03%	+0.15 to −0.15
		HC 0–10,000 ppm,	+20 ppm to −20 ppm	
		NO_x 0–5000 ppm	+ 10 ppm to −10 ppm	+0.2 to −0.2
2	Smoke level measuring instrument	BSU 0–10	+0.1 to −0.1	+1 to −1
3	Exhaust gas temperature indicator	0–900 °C	+1 °C to −1 °C	+0.15 to −0.15
4	Speed measuring unit	0–10,000 rpm	+10 rpm to −10 rpm	+0.1 to −0.1
5	Burette for fuel measurement		+0.1 cm^3 to −0.1 cm^3	+1 to −1
			+0.6 s to −0.6 s	+0.2 to −0.2
6	Digital stop watch		+1 mm to −1 mm	+1 to −1
7	Manometer	0–110 bar	+0.1 kg to −0.1 kg	+0.1 to −0.1
8	Pressure pickup		+1° to −1°	+0.2 to −0.2
9	Crank angle encoder			

III. ANALYSIS OF THE RESULTS

The variety of BTE productivity with brake power for different stream rates is appeared in Fig. 2. From the chart, higher BTE is accomplished in 3 LPM acetylene in RCCI ignition. As the amount of acetylene increments in the RCCI mode, the BTE additionally increments for all heaps up to 3 lpm of C_2H_2 infusion. This is expected to the higher calorific estimation of C_2H_2 which improves consuming climate before the infusion of Karanja biodiesel and that will lead the expanding pattern in BTE [11]. The BTE for infusion of 3 lpm acetylene alongside biodiesel in different mode ignition is lower than diesel mode in CDE activity. The explanation is that the dissolving pace of acetylene in the admission complex is low contrasted with any remaining combinations of air and C_2H_2. It was also noticed that lower SFC was recorded for dual fuel operation. By and large, biodiesel-energized motors require more fuel than regular diesel fuel ignition. The explanation behind this is the low warming substance (calorific estimation) of biodiesel. It very well might be noticed that in double fuel motors the warm effectiveness diminishes at low

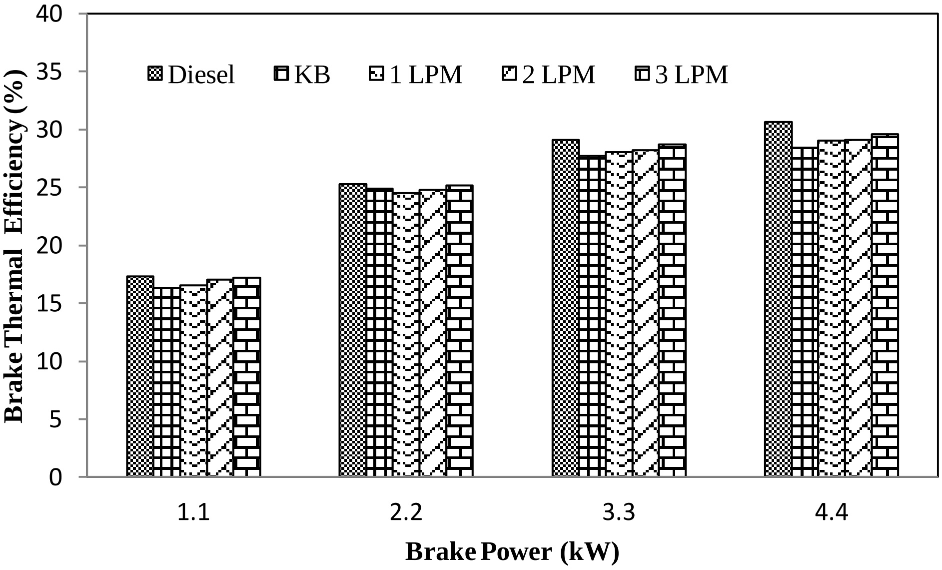


Fig.2 BTE Variations

The EGT at full burden is portrayed in Fig. 3. It is 370 °C at 1 lpm, 330 °C at 2 lpm and 302 °C at 3 lpm of C_2H_2 stream rate in acceptance procedure and 439 °C on account of standard diesel activity. C_2H_2 acceptance diminished the fumes gas temperature at all heaps demonstrating the headway of energy discharge in the cycle and higher fire speed [12].

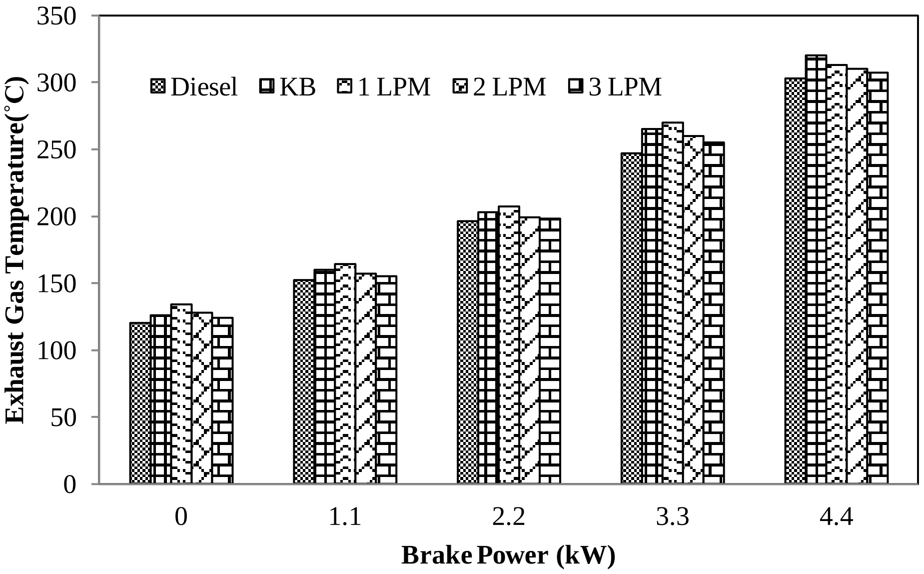


Fig.3 EGT Variations

Chamber pressure graph affirmed this, in which the most extreme weight happens prior in the cycle when C_2H2 was presented alongside the consumption air. Warmth misfortune from the gas to the divider expanded because of higher warm conductivity of gases, prompting higher misfortunes that may likewise be the purpose behind lower fumes gas temperature [13]. It very well may be seen from Fig. 4 that NOx emanation is 564 ppm at greatest yield with slick diesel fuel activity. In double fuel activity with C_2H_2 enlistment at full burden, NOx emanation is 496 ppm with a proportionality proportion of 369, 458 and 579 ppm. When contrasted with standard diesel activity, NO_x discharge expanded steadily when gas stream rate was increased. In double fuel activity with C_2H_2 acceptance, NOx outflow expanded by 31% at 3 lpm, 26% at 2 lpm and 21% at 1 lpm of gas stream rates when contrasted with diesel fuel activity. As per Zeldovich instrument model, the development of NOx is expected to the response temperature, response span and the accessibility of oxygen [14].

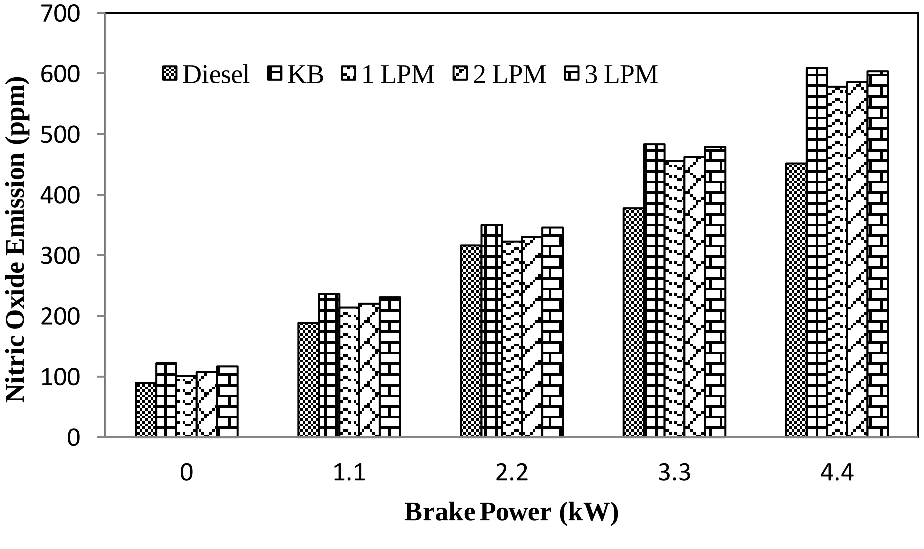


Fig.4 NO_x variations

For this situation, when C_2H_2 is drafted, increment in NOx might be credited to the expanded pinnacle cycle temperature level due to quicker energy discharge, which is affirmed by the expanded pinnacle cycle pressure. The variety of smoke level with brake power is appeared in Fig. 5. The incomplete combustion is described by the behavior of smoke. Sometimes EGR is done to enhance the combustion quality. The EGR for optimal flow rate of 3 lpm can be better option to reduce the smoke of C_2H_2 in dual operation for 50% load.

Figure depicts the conduct of smoke and fumes gas re-dissemination for ideal stream pace of C_2H_2 in double activity for half burden. In ordinary CI motors, the stockpile of EGR builds the smoke rate and the purpose behind that is the smoke level relies on the amount of air present in the burning chamber. In double fuel mode, the acetylene gas dislodges a certain amount of air. This may cause to improve the smoke level in any case, very little since the acetylene presence in the burning chamber improves the burning quality.

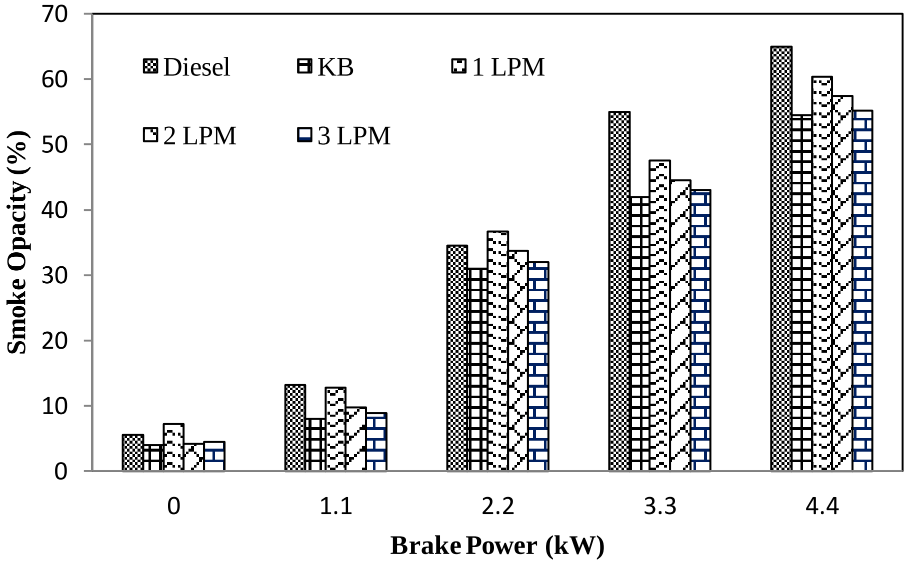


Fig.5 Smoke variations

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