EFFECT OF PRODUCER GAS AND H_2 COMBINATION ON DUAL FUEL ENGINE EMISSION

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ABSTRACT-Experiments were performed on a dual fuel engine with variable supply of producer gas and hydrogen as secondary fuels. The engine was operated under 5%, 20%, 40%, 60% and 80% of rated loads. The brake thermal efficiency and CO, CO_2 and unburned HC emissions were studied. It was found out that under compromised condition, the engine operated at 40% of the rated load and supplied with 75% of produce gas and 20% of H_2, performs satisfactorily to emit favorable emissions.

***KEYWORDS*-Dual fuel engine; Thermal efficiency; CO, CO_2 and unburned HC emissions**

INTRODUCTION

In engines, alternative fuelshave been the focus since a decade due to crude shortage and worriedness concerning environmental protection. Producer gas and hydrogen are known to be the potential alternative fuels. However, hydrogen engines have inherent trouble of premature ignition particular when operated at high loads due to lower ignition energy, extensive flammability range and smaller quenching distance. Nevertheless, producer gas now a day is considered as promising alternative fuel for diesel engines however, it can only be used with the injection of diesel. In the present investigation husk was used to produce producer gas while the hydrogen was taken from the procured storage cylinder. A dual fuel engine was used in which hydrogen and producer gas was used as secondary fuel at various operating loads, while emission investigation of CO, CO_2 and unburned hydrocarbons was carried out.

From the literature review some observation related to the use of alternative fuel in engines were obtained. Luijten and Kerkhof [1] used jatropha oil and biogas(CH_4& CO_2) in their experiments & found the addition of different quality(CH_4 volume fraction ranging from 0.4 to 1) to the intake using aventuri results the maximum heat release fraction of methane of about 80% for pure methane & 25-55% for biogas(depending on load & biogas quality). Efficiency also suffered at the low loads and at high loads. Prabir and Bose[2] used hydrogen as inducted fuel and diesel as injected fuel & found supply of 0.15 kg/h of hydrogen increases brake thermal efficiency by 12.9% but at high rate the combustion becomes uncontrolled and hence thermal efficiency decreases. They found that the hydrogen –diesel blend has proved to be a viable approach to minimize pollution and improved performance. Roy & Tomita [3] uses two producer gas having different hydrogen content, found smooth and smoke free engine operation for different fuel-air equivalence ratios and pilot injection timing. Uma and Khandpal [4] used diesel alone and dual fuel modes with producer gas and found that the diesel engine is capable of running with dual fuelling with 67-86% diesel replacement rate. Krishna &Ajitkumar [5]used coffee husk as biomass for gasification and analyzed the performance of diesel engine on dual fuel mode. They could achieve the maximum diesel replacement of 31% only. It is because of clinkers' formation and a low density of biomass. It has been seen in previous literatures that the maximum work has been done on biomass gasification of wood chips only. Ramadhas et.al.[6] carried out on coir-pith, but the other biomass & agricultural residues are also available.

In the present investigation, the experiments were conducted in a 4-cylinder turbocharged diesel engine, which was coupled with 62.5 kW Genset, by using secondary fuel as hydrogen and producer gas. The producer gas is principally a mixture of carbon monoxide, hydrogen, nitrogen and carbon dioxide and here it was produced by partial combustion of solid agricultural waste like rice husk and coke in gasifier. The contents of Producer gas produced were 20.2%CO ; 20.5%H_2 ; 1.2%CH_4 ; 48% N_2 and 10.1% CO_2. Flow chart of the working arrangement is shown in Fig.1. Engine specification is shownin Table1.

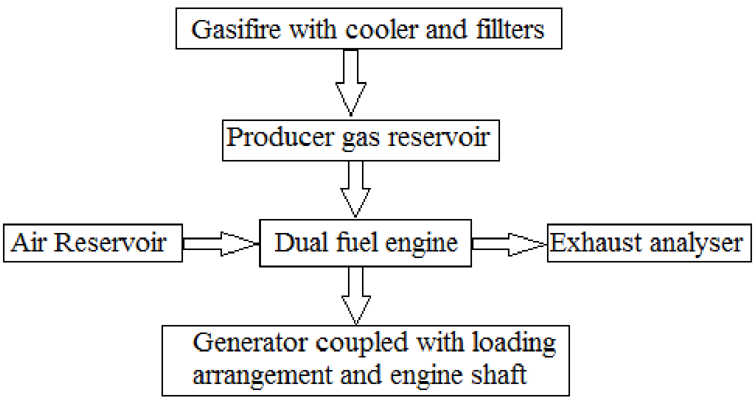


Fig.1 Flow chart of working arrangement

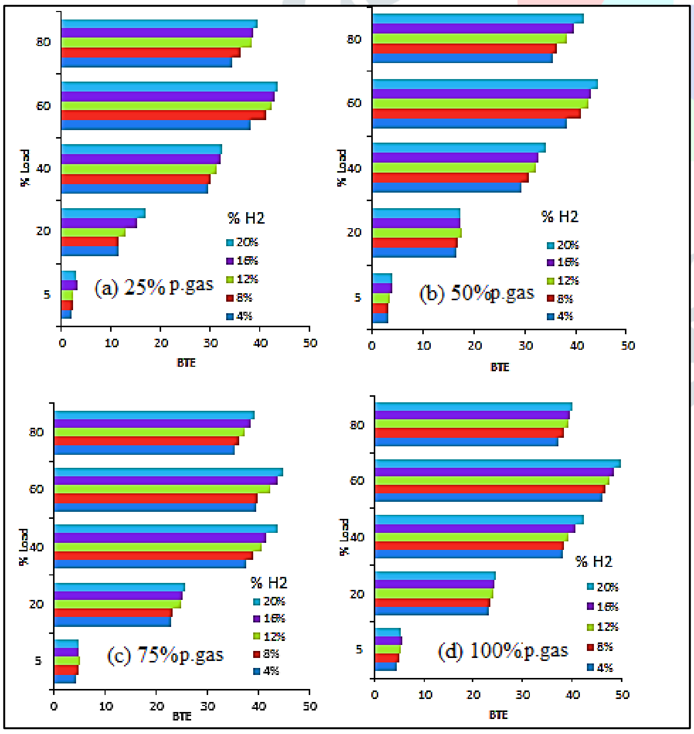
Table 1: Engine specification and general details

Make, model and other details	Ashok Leyland /ALU WO4CT / 4S / CI / vertical / constant speed / water-cooled / DI / turbo charger with intercooler coupled with electricity Generator				
No. of cylinder	4	Clearance volume	84.90 cc	Compression ratio	17.5:1
Bore	104 mm	Rated power	62.5 kW at 1500 rpm	Injection pressure	260 bar
Stroke	113 mm	Inlet pressure	1.06 bar	Injection timing BTDC(°)	16°
Rated speed	1500 rpm	Inlet temperature (K)	313 K	Nozzle diameter	0.285 mm
Swept volume	3839.67 cc				

RESULTS AND DISCUSSION

From Fig.2 it can be observed that the brake thermal efficiency is higher for the 60% of the rated engine load and it is very low for low load. It can also be understood that when the H_2 was 20% in the mixture, the brake thermal efficiency was maximum for 40% or higher rated loads. In addition, the brake thermal efficiency also increases with increase in quantity of produces gas and attains highest values at 100% supply. Fig.3 shows that the brake thermal efficiency drastically increases after 60% supply of producer gas and at 100% supply it approached 50% brake thermal efficiency.

Fig. 4, 5 and 6 illustrates that the exhaust emissions are highest at 80% of the rated engine load. Also, it can be observed that all types of exhaust emissions are highest when 100% producer gas was used. Fig.4 shows that CO emissions are nearly same for 25%, 50% and 100% of producer gas supply and it is quantatively very low. Nevertheless, the lowest CO emissions are at 5% of rated load, which was obvious and Co emissions increases with increase in percentage of H_2. Fig.5 shows that CO_2 emissions are nearly same for all supplies of producer gas and it is highest for 80% engine loading. The figure also shows that the effect of $\%H_2$ is in the CO_2 emissions is that it increases with increase engine load but unaffected by the % of producer gas. Fig. illustrates that unburned HC emissions are highest for 80% engine loading and least for 60% engine loading. Here also the $\%H_2$ effects in a similar manner to that of CO_2 emissions.



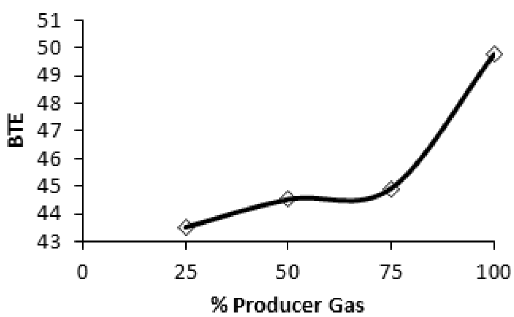


Fig.2 Brake Thermal Efficiency v/s Load at different H_2 for 25%, 50%, 75% and 100% producer gas supplies.

Fig.3 Brake Thermal Efficiency v/s %producer gas

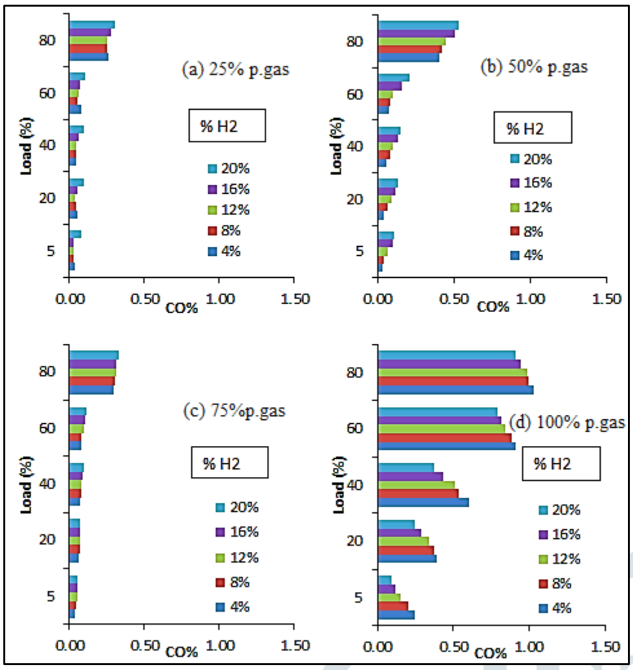


Fig.4 Load *v/s* CO emission at different $\%H_2$& % producer gas

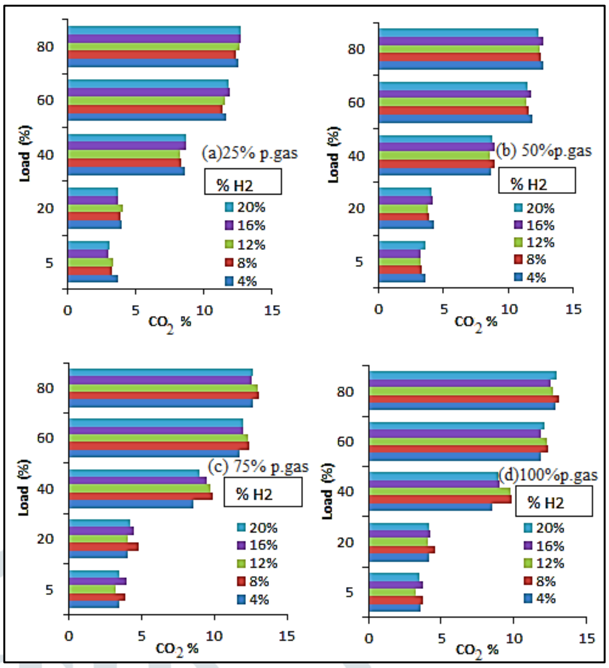


Fig.5 Load *v/s* CO_2 emission at different $\%H_2$& % producer gas

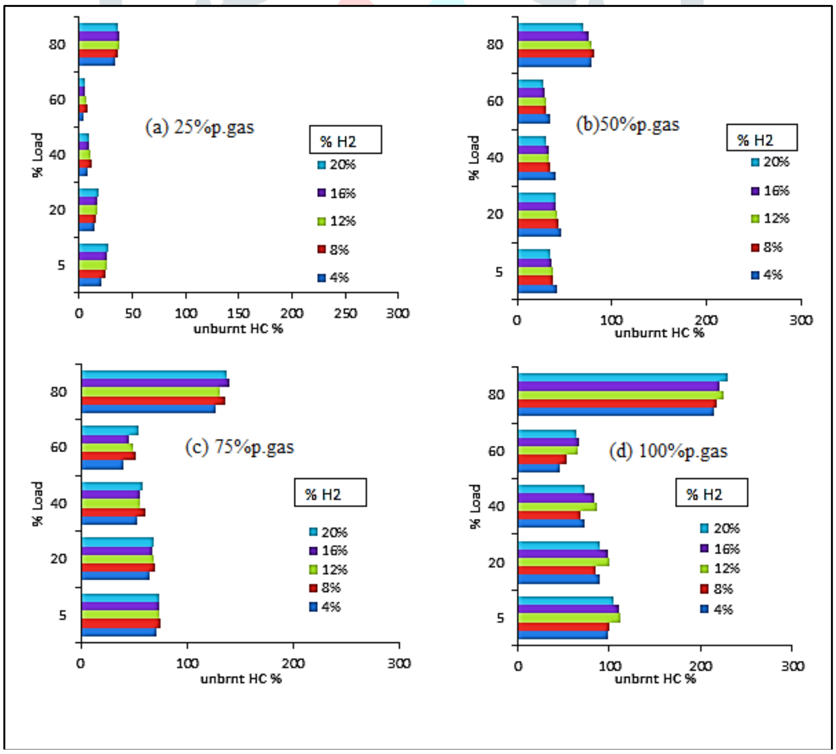


Fig.6 Emission of unburned hydrocarbons *v/s* engine load

CONCLUSIONS

Following are the conclusions made from the experimental investigation:

1. As a compromise, the engine must be operated at 40% of the rated load and must be supplied with 75% of produce gas and 20% of H_2 because under this condition the favorable emissions would be obtained.
2. For high performance when engine operates at 100% rated load, 50% producer gas and 4% hydrogen must be supplied

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