Proceedings of the
International Conference on Mechanical Engineering 2005
(ICME2005) 28- 30 December 2005, Dhaka, Bangladesh

ICME05-TH-29

EXPERIMENTAL INVESTIGATION ON EMISSION CHARACTERISTICS OF KEROSENE-ETHANOL BLENDS TYPE FUEL IN SMALL GAS TURBINE ENGINE GILKES GT 85/2

Hitesh K. Solanki[1] and S. A. Channiwala[2]

[1]Mechanical Engineering Department, S V National Institute of Technology, Surat – 395007,India
Email: solankihitesh4u@yahoo.com
[2]S V National Institute of Technology, Surat – 395007, India
Email: sac_svr@hotmail.com

ABSTRACT
Gas turbine operator has had to comply with increasingly strict exhaust emission regulations. The exhaust constituents of greatest concern are oxides of nitrogen and carbon monoxide. The increasing awareness towards environment protection and peak load response is accredited in the development of gas turbine system. Many such system preliminary utilizes liquid fuels like kerosene. This paper discusses about the experimental investigation on emission levels with kerosene-ethanol blended fuel using emission analyzer installed at the exhaust of the turbine. The experimental investigations have been carried out on this unit with ethanol blended kerosene fuel to a concentration level of 25% ethanol in the step of 5% increment. The investigations of the emission levels were carried out for CO and HC with respect to equilibrium temperature at four different overall equivalence ratios. The equivalence ratios were 0.1811, 0.1845, 0.1878 and 0.1908. It is worth to mention that the experimental measurements of emission indicate that usually the HC emission increases with increase in ethanol addition while CO emission does not show any unique trend However in operating equivalence ratio 0.1878 the minimum CO level is observed to be with 10% of ethanol addition.

Keywords: Emission, Kerosene-ethanol, CO

1. INTRODUCTION
The majority of land based gas turbine system utilizes axial flow machines in open cycle in the capacity range up to few megawatts. The small capacity systems invariably employ radial flow machines in open cycle.

The increasing awareness towards environmental protection and quick load response has accelerated the development of gas turbine systems, as it utilizes primarily the liquid fuels like kerosene. The emission levels with liquid fuel like kerosene may be reduced by addition of oxygenated fuels like alcohol. Unfortunately not much literature is available on use of oxygenated fuel like ethanol in kerosene fired gas turbine.

Hence the basic objective of this paper is to investigate experimentally the influence of ethanol addition on emission levels of the kerosene fired small laboratory gas turbine unit.

2. THE INVESTIGATIONS

2.1 Emission Characteristics Using Mixture of Ethanol and Kerosene as a Fuel
In this experiment the mixture of ethanol and kerosene is used as a fuel. The mixture strength is varied from 5% ethanol to 25% ethanol in a step of 5%. For each mixture strength the emission levels are accessed at four different equivalence ratios. Experimental investigation on emission levels with kerosene-ethanol blended fuel using emission analyzer installed at the exhaust of the turbine.

2.2 Results and Discussion
Fig. 1 to 10 gives the CO and HC emission levels for pure kerosene and mixture of kerosene and ethanol varying from 5% to 25% in a step of 5% respectively. It is observed that addition of ethanol result in increase in HC emissions. This is because of presence of organics in the fuel. Usually such compound has long molecular chain which may not break during combustion in available residence time and hence may offer higher HC levels [1].

The CO trends however is not unique, its variations are influenced with respect to operating conditions because the presence of soot and turbulence may alter the CO emission significantly [1, 2].

However the minimum CO emissions are observed to be at about 10% ethanol kerosene mixture in the optimal operating range of equivalence ratio of 0.1 to 0.2. This is quite in tune with theoretical findings. Thus it may be stated that with respect to emission minimization the ethanol addition up to 10% to 15% may be beneficial.

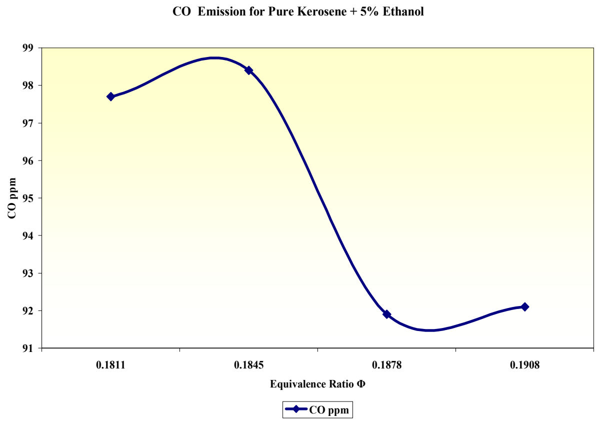

Fig 1. Measured CO Emission for Kerosene + 5% Ethanol

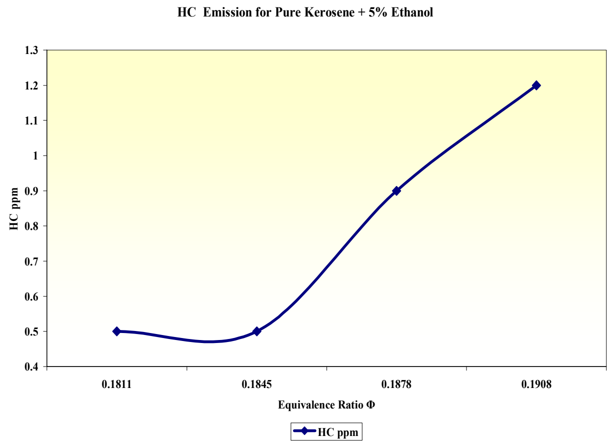

Fig 2. Measured HC Emission for Kerosene + 5% Ethanol

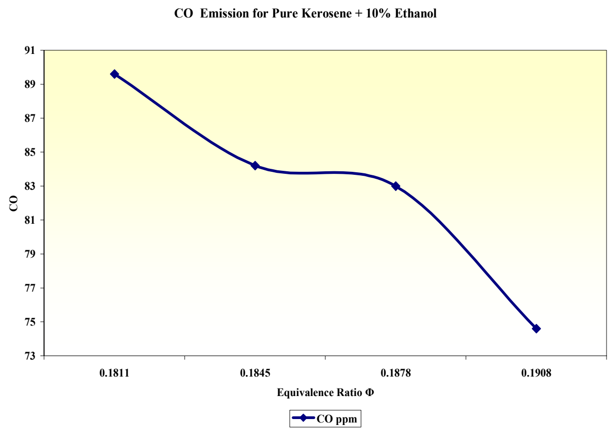

Fig 3. Measured CO Emission for Kerosene + 10% Ethanol

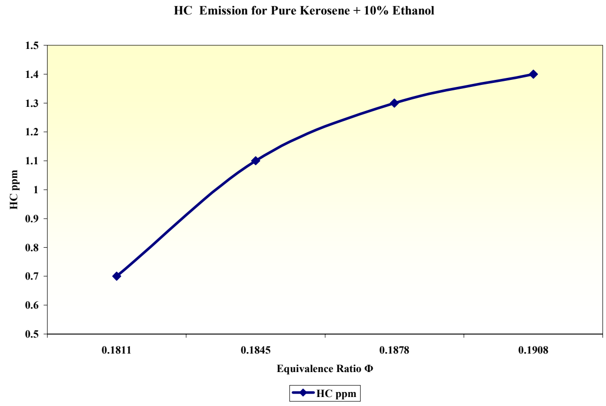

Fig 4. Measured HC Emission for Kerosene + 10% Ethanol

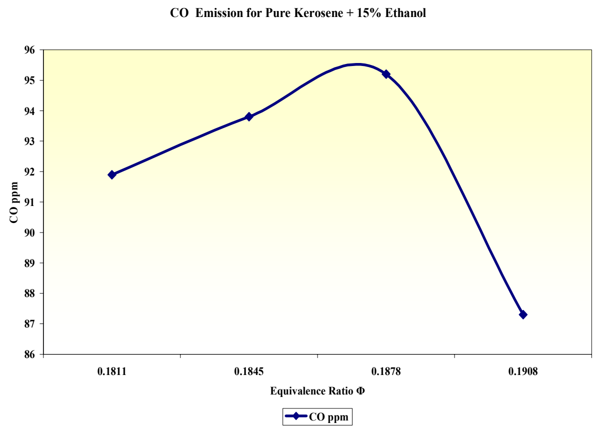

Fig 5. Measured CO Emission for Kerosene + 15% Ethanol

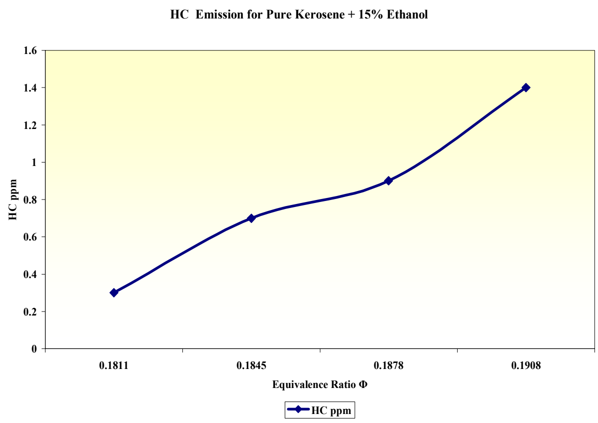

Fig 6. Measured HC Emission for Kerosene + 15% Ethanol

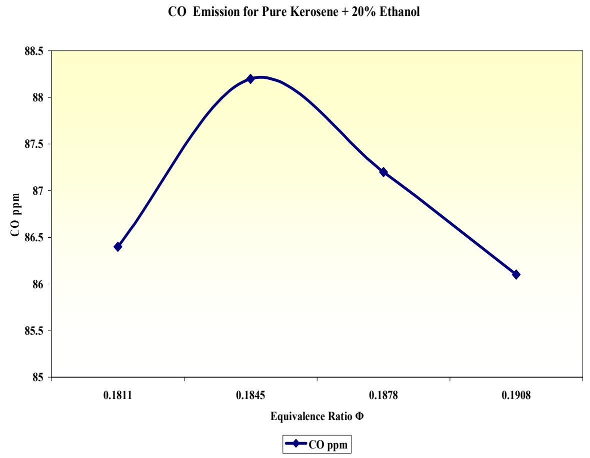

Fig 7. Measured CO Emission for Kerosene + 20% Ethanol

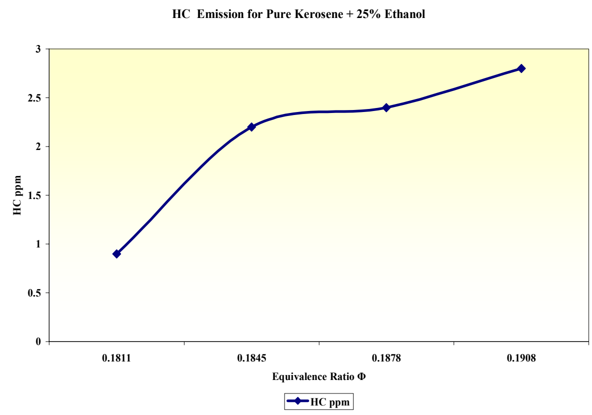

Fig 10. Measured HC Emission for Kerosene + 25% Ethanol

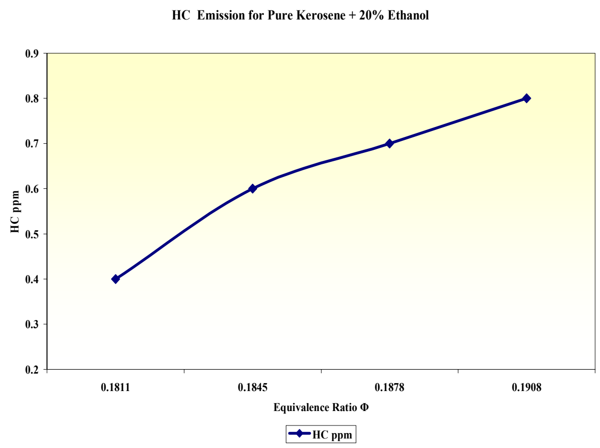

Fig 8. Measured HC Emission for Kerosene + 20% Ethanol

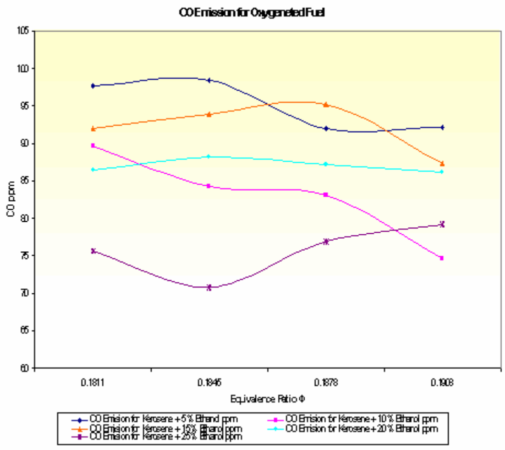

Fig 11. Measured CO Emission for different concentration of ethanol blended kerosene type fuel for different equivalence ratios

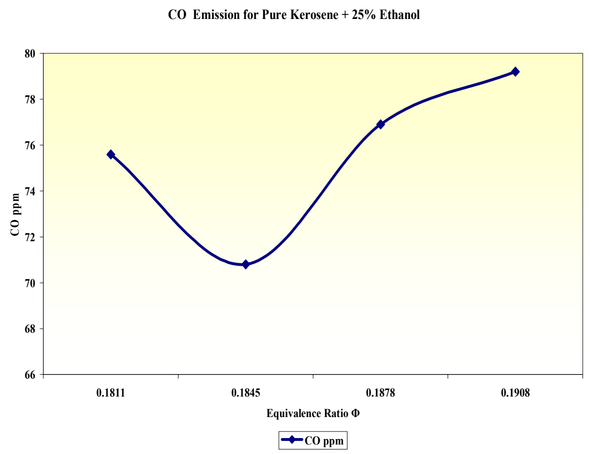

Fig 9. Measured CO Emission for Kerosene + 25% Ethanol

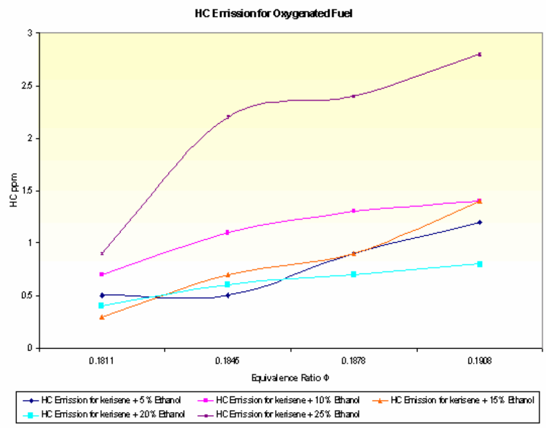

Fig 12. Measured HC Emission for different concentration of ethanol blended kerosene type fuel for different equivalence ratios

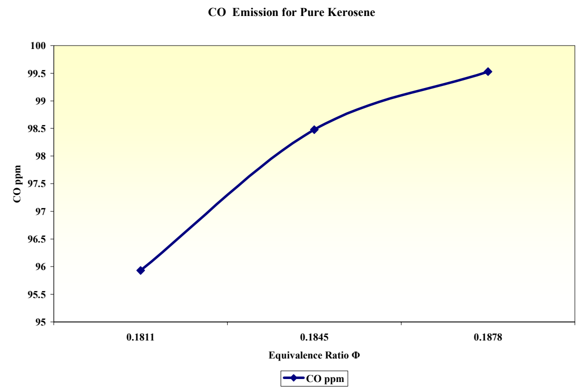

Fig 13. Measured CO Emission for Pure Kerosene

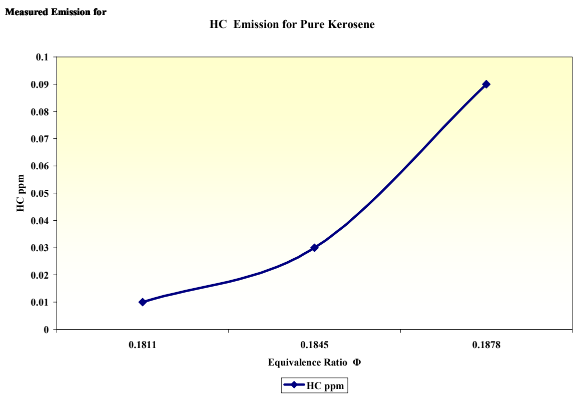

Fig 14. Measured HC Emissions for Pure Kerosene

3. CONCLUSIONS

The experimental measurements of emission indicated that usually the hydrocarbon emission increases with increasing ethanol addition while the CO emission does not show any unique trend. However in the operating equivalence ratio range of 0.1 to 0.2 the minimum CO levels are observed to be with 10% of ethanol addition.

Thus it may be concluded in nutshell that the ethanol addition in the range of 10% to 15% in kerosene fired gas turbine unit will certainly offer reduced emission levels.

4. REFERENCES

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5. NOMENCLATURE

Symbol	Meaning	Unit
CO	Carbon Monoxide	
$C_{10}H_{22}$	Kerosene	
HC	Hydrocarbon	
T	Total Temperature	°C
Φ	Equivalence Ratio	

6. ACKNOWLEDGEMENT

We thank the staff of Internal Combustion & Automobile Engineering Laboratory of S. V. National Institute of Technology, Surat for their help with the experimental setup. I have received constant support, guidance and encouragement from Mr. D. B. Kulshreshtha & Mr. Zoeb K Lakdawala. I sincerely acknowledge their valuable contribution for their endless inspiration for writing this paper.