Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 5, May-2016

Effect of cow urine fumigation on performance and emission parameters of single cylinder CI engine.

Prof. Rushi. B. Rawal [1], Vijay H Patel [2], Prof. Hardik. N. Vora[3]

[1] *Assistant Prof., Dept. of Mechanical Engineering, Government Engineering College, Bhuj*
[2] *ME Scholar, Dept. of Mechanical Engineering, Government Engineering College, Bhuj*
[3] *Lecturer, Dept. of Mechanical Engineering (Diploma), L.E.College of Engineering, Morbi*

Abstract* — *Experiment has conducted to estimate the effect of cow urine fumigation on performance and emission characteristics of single cylinder, air cooled and constant speed CI engine. Fumigation mechanism so connected that fumigated PCU enters in to combustion chamber along with atmospheric air during suction stroke for 4 ml/min, 6 ml/min, 8 ml/min, 10 ml/min and 12 ml/min flow rate of PCU. It's observed that performance parameter like Brake Thermal Efficiency (BTE), BSFC improves up to 8 ml/min flow rate of PCU; further increase reduces the same parameter. For 8ml/min flow rate of PCU 5.02 % BTE increases compare to without fumigation of PCU, also for same condition 0.253 Kg/hr reduction of Fuel Consumption has observed as well as significant reduction in value of Exhaust Gas Temperature (EGT) observed, hence drastic reduction of NOx formation founded for every load condition throughout entire test. Also observed that CO and HC emission reduces or remain very close to the emission by only diesel fuel till 8 ml/min flow rate of PCU. CO_2 emission increases up to 10 ml/min flow rate of PCU and then decreases for further increase of PCU flow rate.

Keywords- Fumigation, Processed Cow Urine (PCU), Flow rate, emission, Brake Thermal Efficiency (BTE)

I. INTRODUCTION

Diesel engines have better fuel to power conversion efficiency and due to this advantage, diesel engines are mostly used engines in mass passengers & goods transportation, heavy industries, and agricultural sectors. In spite of their preferable advantages, it has big problem concern with environment of high pollution. Primary pollutants emitted by diesel engines are particulate matters (PM), black smoke, nitrogen oxides (NOx), sulphur oxides (SOx), unburned hydrocarbon (HC), carbon monoxide (CO), and carbon dioxide (CO2)[14]. As Non-renewable sources like petroleum products have certain quantity left on earth also it is reducing day by day, hence the price hike. Demand for fuel is increasing because of increasing number of automobiles. Because of these reasons, alternative fuel technology will become more common in the coming decades in country like India. The engines used for alternative fuels need some modification in present diesel and petrol engine. Extensive search and development will be needed to maximize the performance of engine running on alternative fuels. Also cost of the alternative fuel is high at present due to limited use of it. If use of alternative fuels will increase, cost of alternative fuel can decrease compare to present day price. Traditionally Indian economy revolves around the cow. Life of rural people of India heavily depends on the Indian cow. A healthy cow gives average 10 kg of dung and 5 kg of urine/day. Experimental studies show the potential of energy generation from the cow's dung and urine. Bio-gas production from cow dung and urine is cost effective and very simple way of energy production. Also hydrogen can be produce from urine by 35% less energy to compare to water electrolysis [15]. This experiment is humble try to explore new technique of extracting energy from cow urine with negligible cost and modification in existing CI engine.

II. EXPERIMENTAL SETUP & FUMIGATION MECHANISM

2.1 Experimental Set Up

As shown in fig.1 single cylinder, air cooled, constant speed CI engine connected with 3 phase AC alternator of 6 KVA, 440 Voltage and 6.9 amp. capacity. Resistant load bank is connected with output of AC alternator to vary the load condition. Digital Voltmeter and ammeter connected in parallel and series respectively to measure output of alternator. Fumigation mechanism attached so that fumigated PCU reach in to combustion chamber along with intake air with variable flow rate. Manometer attached with intake air manifold to measure the vacuum pressure in intake air manifold. Fuel tank placed at some height for gravitation fuel supply to fuel pump of the engine. K type thermocouple attached in to exhaust manifold to measure the Exhaust Gas Temperature. Also exhaust gas analyzer placed at exhaust of the engine to measure the emission of engine at various load and different flow rate of PCU in to intake manifold.

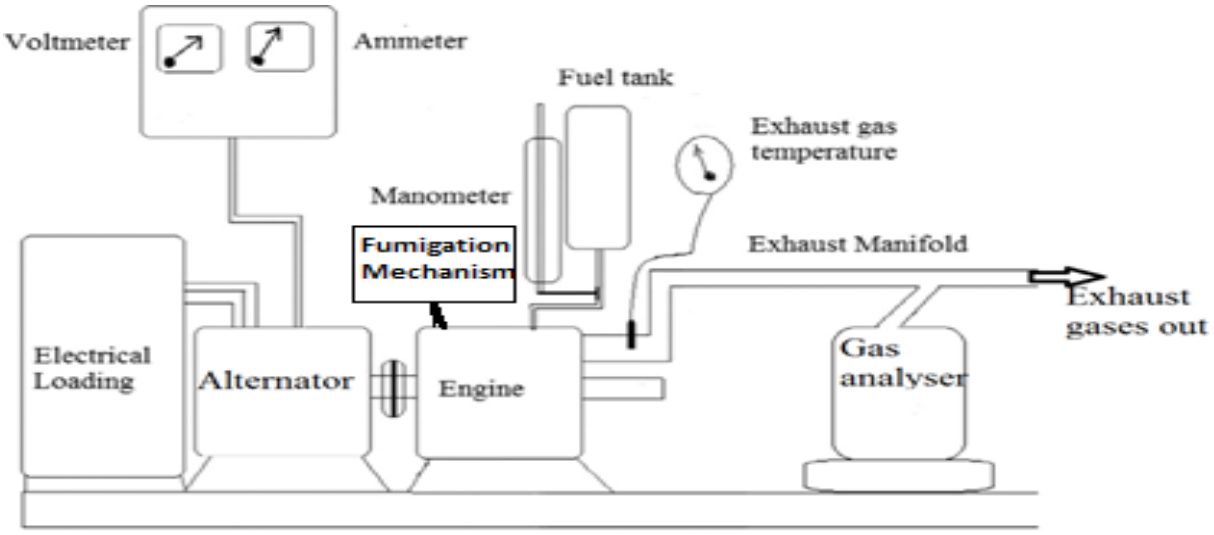

Figure 1- Schematic Diagram of Test Rig.

Table 1 - Specification of Single cylinder diesel engine

Parameter	Specification
Make	Powerlite
Rated brake power	5.65 kW
Speed	1500 rpm
No of Cylinder	1
Method of cooling	Air cooled
Compression Ratio	18:1

Table 2- Specifications of A.C. Alternator

Parameter	Specification
Manufacturer	Alfa Electricals
Output	6 KVA
Volts	440 V
Amperes	6.9 A
Frequency	50 Hz

2.2 Fumigation Mechanism

(A) **(B)**

Figure 2 - Fumigation mechanism

As shown in fig. 2 fumigation mechanism consist of pressure pump, atomizer, By pass valve, Pipe Lines. Pump is operated by D.C electric supply. Specification of the pump given below, which is use to operate atomizer. Atomizer

shown in fig. B has hole of 0.5 mm diameter. For operating range of pump, atomizer can give output from 3.5 ml/ min to 12 ml/min of liquid.

Table 3 - Specification Of Pump

Parameter	Specification
Operting Voltage	24 V D.C
Max.Inlet Pressure	60 PSI
Max. O/P Pressure	110 PSI
Flow	1 Ltr/Min

III. FORMATION OF PCU AND TEST PROCEDURE

3.1 Formation of PCU

In order to remove salt and other solid particles from cow urine distillation process is carried out. Figure 3 shows glass type distillation unit use for cow urine distillation.

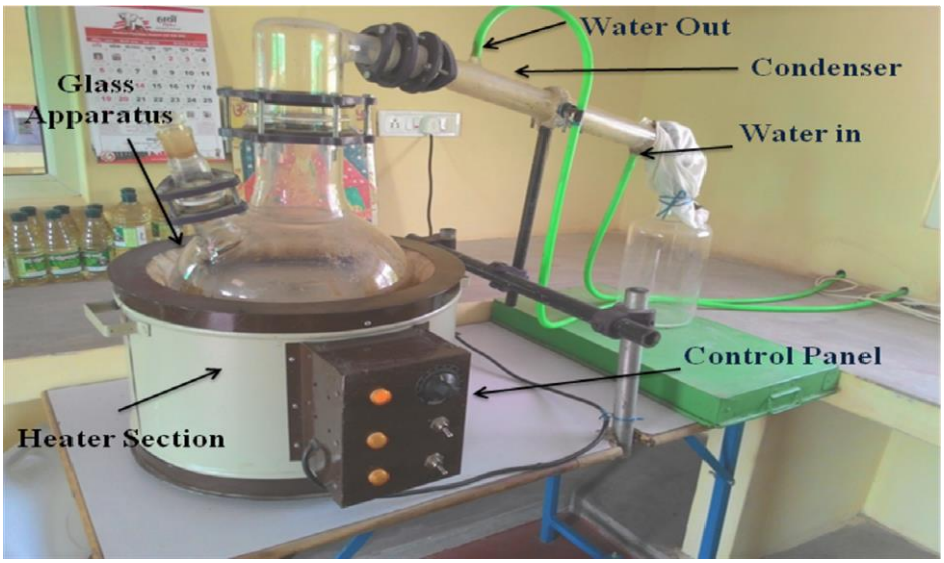

Figure 3 - Distillation plant

It has capacity of 12ltr and yield of 8ltr of distilled fluid. It has water cooled condenser and temperature controller by on/off heater and voltage regulator. 50-60 ^{0}C temperature maintain in distillation process. Distillation unit required 220V A.C supply. Distilled cow urine filtered by 400 number filter paper which filter particles larger than 8µ m size. As most of engine fuel filters are nominal of 15 or 10 micron and the most damaging particle size in fuel by volume is 5-10 microns. Vacuum filtration unit is utilizing instead of normal filtration process to accelerate the filtration process and minimize oxidation chance of distilled liquid.

3.2 Test Procedure

- The engine started by the mechanical lever.
- Before taking reading, engine allowed to run for 30 minutes to achieve steady state condition for every test run.
- At first, the tests conducted using diesel as fuel.
- Observations are taken for each test at different loads 25%, 50%, 75%, 100%.
- Observations are taken at time when exhaust gas temperature remains steady.
- Various performance parameters are measured at each load and different fumigation rate of processed cow urine. Using measured data, brake power, brake thermal efficiency, brake specific fuel consumption are calculated for each fumigation rate including without fumigation of PCU.

- At each operating condition; load on control panel, engine speed, time for 15 gm fuel consumption, exhaust gas outlet temperature and readings of exhaust emissions CO, CO2, HC, O2 and NOx are recorded.
- Repeated test for each fumigation flow rate of processed cow urine. Results of the engine performance and emission recorded.
- Graphs plotted to compare various performance parameter of engine for each fumigation flow rate of processed cow urine with neat diesel fuel.

IV. RESULT AND DISCUSSION

4.1 Engine Performance Parameter

Engine performance parameter like fuel consumption, brake specific fuel consumption, brake thermal efficiency, and exhaust gas temperature discussed with only diesel fuel and different rate of cow urine fumigation with diesel respectively.

4.1.1 Fuel Consumption

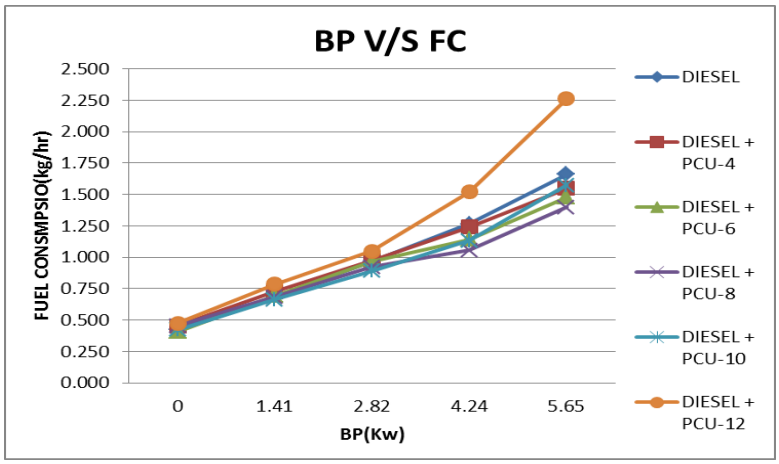

Figure 4 - BP v/s Fuel Consumption

Fig. 4 shows that fuel consumption is increases for every test run with increase of load from no load to full load condition. From the graph it is clear that as load increases fuel consumption of diesel fuel decreases for 4 ml, 6ml, 8 ml/min flow rate of PCU and again starts to increase for 10 ml, 12 ml/min fumigation rate of cow urine. Maximum FC throughout test run is 2.264 kg/hr for 12ml/min flow rate of PCU and 1.662 kg/hr without fumigation of PCU at full condition.

4.1.2 Brake Specific Fuel Consumption

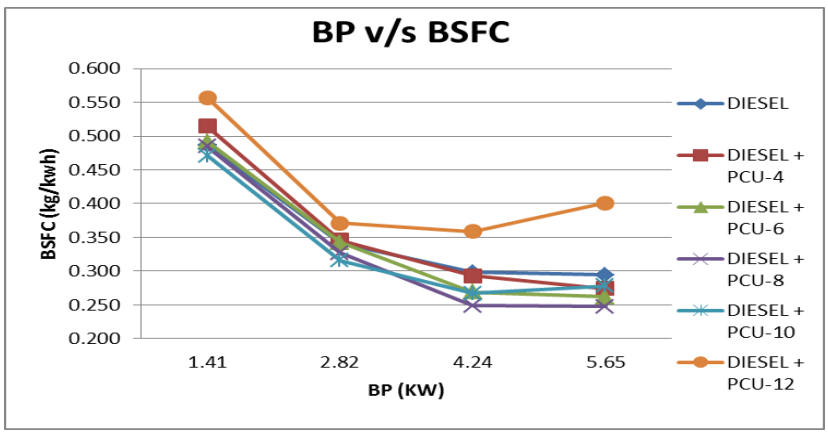

Figure 5 - BP v/s BSFC

Fig.5 shows that brake specific fuel consumption decreases as load increases for all tests run. Almost up to 50 % loading condition, BSFC of engine slightly higher for all fumigation rate of PCU than without fumigation of PCU except

10 ml/min. For more than 50 % load BSFC starts to decrease up to full load for all fumigation rate of PCU than without fumigation of PCU except 12 ml/min. Minimum BSFC obtains over entire test run is 0.248 kg/kwh at full load condition with 8 ml/min fumigation rate of PCU into the intake manifold.

4.1.3 Brake Thermal Efficiency (BTE)

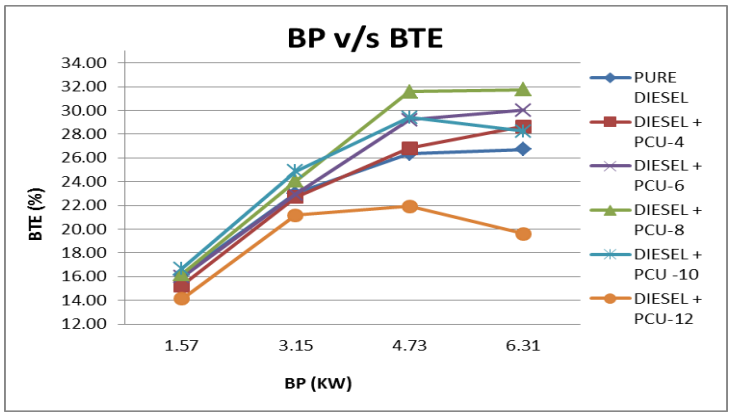

Figure 6 - BP v/s BTE

Fig.6 shows that efficiency of engine increases as load increases up to full load condition for every test except Diesel + 12 ml/min flow rate of PCU. Also it is clear that brake thermal efficiency of the engine is higher for all fumigation rate of PCU than only diesel fuel at every load condition except 12 ml/min flow rate of cow urine. Maximum BTE throughout entire test run is 31.74 % for 8 ml/min fumigation rate of PCU in intake air manifold at full load condition. While, Maximum BTE of engine running only on diesel fuel is 26.76 % at full load condition.

4.1.4 Exhaust Gas Temperature (EGT)

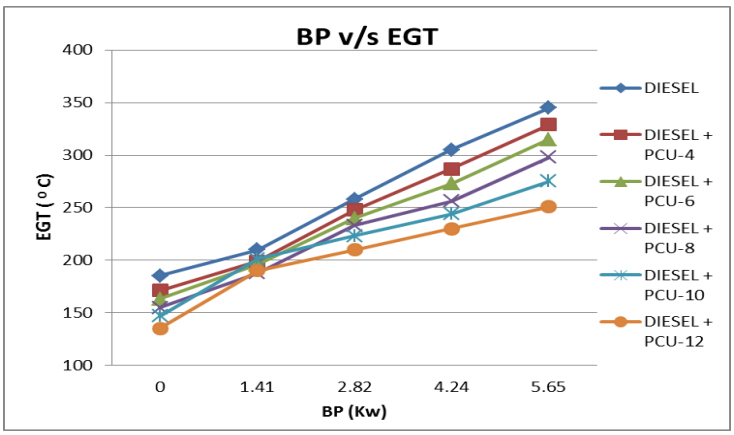

Figure 7 - BP v/s EGT

Fig.7 shows that Exhaust Gas Temperature increases as load increase from no load to full load condition for entire test run. Also it can be see that value of EGT decreases with increasing flow rate of PCU along with intake air at same load condition. Maximum EGT is 345 ^{0}C at full load condition when engine runs on only diesel fuel without fumigation of cow urine and lowest EGT is 251 ^{0}C at full load condition with 12 ml/min PCU fumigation rate and highest EGT at no load condition is 185 ^{0}C when engine run on only diesel fuel without fumigation of cow urine and lowest EGT at no load condition is 135 ^{0}C with 12 ml/min PCU fumigation rate.

4.2 Emission Characteristics

Variation of emission parameter like unburned hydro carbon (HC), Carbon dioxide (CO_2), Carbon Monoxide (CO), Nitrogen oxide (NO_X) at 4 ml/min, 6 ml/min, 8 ml/min, 10 ml/min, 12ml/min flow rate of PCU and without fumigation of PCU recorded & discussed below.

4.2.1 Carbon dioxide (CO_2)

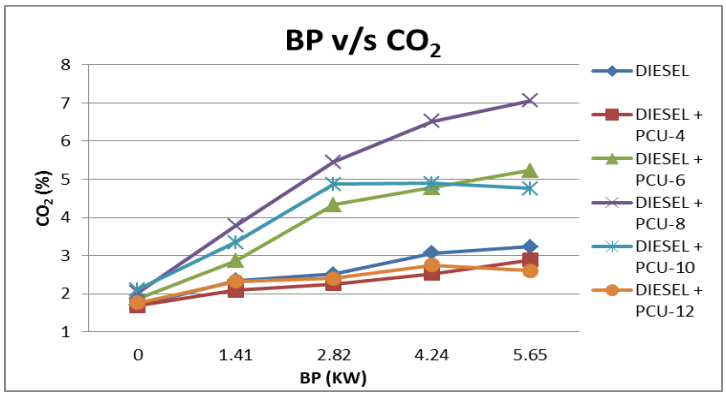

Figure 8 - BP v/s CO_2

From the fig.8 it can be see that CO_2 is increases as load increases for all tests. Range of CO_2 remains in between 1.69 to 3.29 % from no load to full load condition. For 8 ml/min flow rate of PCU fumigation CO_2 formation is Maximum for all load condition than any other flow rate of PCU. Also it is clear that value of CO_2 increases for 6 ml/min, 8 ml/min, and 10 ml/min comparatively than only diesel fuel, whereas its decreases for 4 ml/min and 12 ml/min than engine run on only diesel fuel.

4.2.2 Hydro Carbon (HC)

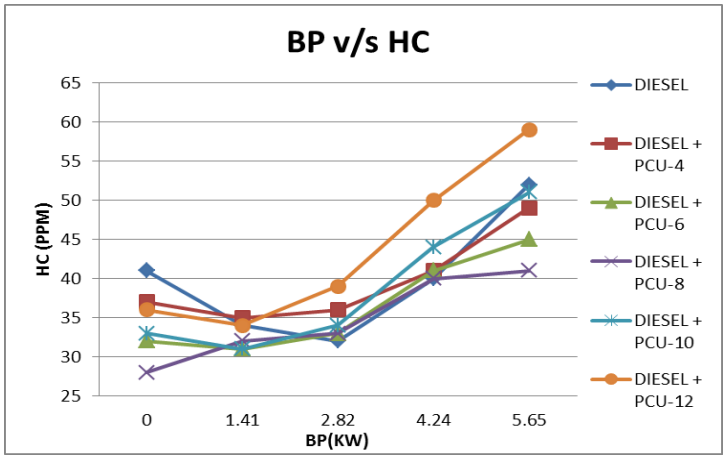

Figure 9 - BP v/s HC

Trend of the HC emission for the entire test run up to 50 % load HC emission decreases and again up to full load HC emission increases. HC emission of only diesel fuel ranges between 41 ppm to 52 ppm from no load condition to full load condition. Out of all fumigation rate HC emitted on 12 ml/min rate of PCU is maximum, which is 59 ppm at full load.

4.2.3 Carbon Monoxide (CO)

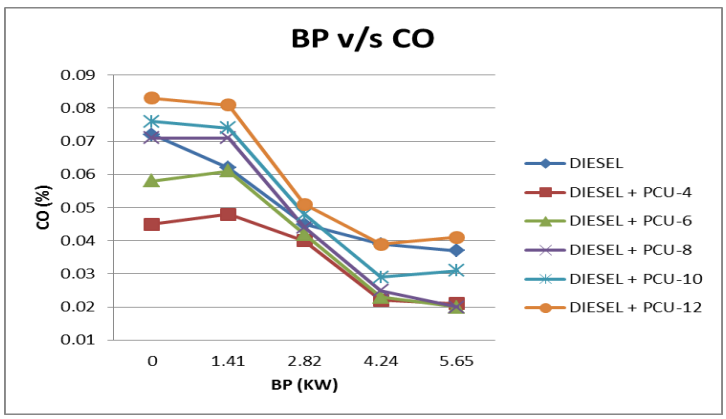

Figure10. BP v/s CO

Fig.10 shows that CO emission decreases as load increases from no load to full load condition for entire test run. Range of CO emission for only diesel fuel is 0.072 % to 0.037 %. Minimum CO emission is 0.02 % for 8 ml/min and Maximum CO emission 0.041 % for 12 ml/min. fumigation rate of PCU at full load condition. As flow rate of PCU increases CO emission increases at light load condition and decreases at high load condition, compared to only diesel fuel.

4.2.4 Nitrogen Oxides

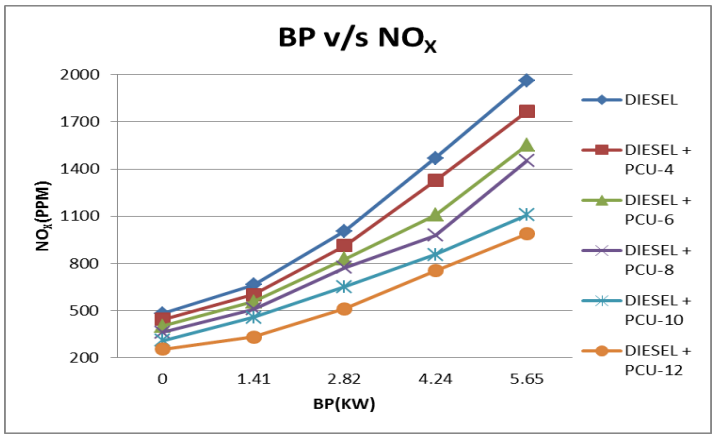

Figure11. BP v/s NOx

The comparison of NOx formation from no load to full load condition and different flow rate of PCU in intake manifold along with atmospheric air illustrated in fig.11 trend of NOx formation is such that as load increases NOx emission increases for entire test run. It is observed that NOx formation is highest without fumigation of PCU,and it is decreases as flow rate of PCU in to intake manifold increases. This happens because when PCU along with diesel enters in to the combustion chamber PCU containing water vaporises quickly due to presence of high temperature and pressure inside the cylinder, PCU takes some heat from the combustion chamber and brings down the cylinder temperature. Combine effect of absorbing heat and rise the partial pressure of oxygen, helps to decrease formation of NOx. Highest NOx formation at full load condition is 1960 ppm without fumigation and 987 ppm for 12 ml/min flow rate of PCU at full load condition. NOx formation trend is similar to EGT because NOx formations mainly depend on peak temperature rise in combustion chamber. Reduction of NOx for 12 ml/min flow rate is almost half than only diesel fuel used without fumigation of PCU.

V. CONCLUSION

Engine performance improves up to 8 ml/min flow rate of fumigated PCU in intake manifold along with intake air further increase of PCU fumigation reduces the performance. Highest BTE obtain is 31.74 % for 8ml/min flow rate of PCU at full load condition, while at same load condition without fumigation of PCU with only diesel fuel BTE is 26.72 %, hence 5.02 % BTE increased. BSFC For 8 ml/min flow rate of PCU fumigation is 0.248 kg/Kwh at full load condition compare to without fumigation of PCU is 0.294 kg/kwh. That is why, 0.253 kg/hr fuel can be save possible by 8 ml/min flow rate of PCU along with intake air at full load condition. CO and HC emission varies with different flow rate of PCU. But it remains close to emission of diesel fuel. CO_2 emission increases up to 10 ml/min flow rate of PCU along with intake air, except light load condition and more than 10 ml/min flow rate of PCU. Significant reduction of NOx observed. NOx reduces to half for 12 ml/min flow rate of PCU and 35 % for 8 ml/min flow rate of PCU compare to without fumigation of PCU.

REFERENCES

1. Street, J.C. , Bulchin, J.E. and Harris, L.E. , " Estimating urine energy from urine nitrogen" , Journal of Animal Science, 1964 , 23,836-842
2. Andrew W Bristow , David C Whitehead and John E Cockburns , " Nitrogenous Constituents in the Urine of Cattle, Sheep and Goats. ", J Sci Food Agric , 1992, 59, 387-394
3. R. Lanzafame "Water injection effects in a single-cylinder CFR engine." SAE 191999-01-0568
4. F. Bedford , C. Rutland, P. Dittrich, A. Raab and F. Wirbeleit , " Effects of Direct Water Injection on DI engine Combustion." , SAE 2000-01-2938
5. S. Nemser, D. Stookey and J. Nelson, "Diesel engine NOX reduction via nitrogen enriched air." , Fluid/Particle Separation Journal , 2003, 69–80.

6. M.I. Cutrignelli , G. Piccolo, S. D'Urso, S. Calabrò,F. Bovera, R. Tudisco and F. Infascelli , " Urinary excretion of purine derivatives in dry buffalo and Fresian cows. " , Ital. J. Anim. Sci. , 2007, 6 , 63-566
7. K. Kannan and M. Udayakumar , " NOx and HC emission control using water emulsified diesel in single cylinder diesel engine." ARPN Journal of Engineering and Applied Sciences, 2009, 1819-6608:8
8. Xavier Tauzia, Alain Maiboom, Samiur Rahman Shah, "Experimental study of inlet manifold water injection on combustion and emissions of an automotive direct injection Diesel engine", Energy 35 (2010) 3628-3639.
9. K.A. Subramanian, "A comparison of water–diesel emulsion and timed injection of water into the intake manifold of a diesel engine for simultaneous control of NO and smoke emissions." , Energy conversion and Management, 2011 , 52 , 849-857
10. S.S. Gill, G. S. Chatha , A Tsolakis , S.E.Golunski and A.P.E.York, "Assessing the effects of partially decarbonising a diesel engine by co-fuelling with dissociated ammonia." International journal of hydrogen energy , 2012 , 37 , 6074-6083
11. Angela Chiosa , Dan Scarpete, Raluca and Cristina Buturca , " An overview on combustion in performance characteristics of diesel engine using diesel-water emulsion.", 5th International Conference on Thermal Engines and Environmental Engineering Galati,Romania , 2013
12. Sagar Patel, Gaurav Rathod and Tushar Patel , " Water injection effects on performance characteristics of a CI Engine." , IOSR-JMCE , 2014 , 11, 66-70
13. Sagar Patel, Gaurav Rathod and Tushar Patel, "Experimental investigation of diesel engine with water injection system on emission." , IOSR-JMCE , 2014 , 11, 47-51
14. Mohammed Yahaya Khan , Z. A. Abdul Karim, Ftwi Yohaness Hagos, A. Rashid A. Aziz, and Isa M. Tan, " Current Trends in Water-in-Diesel Emulsion as a Fuel." , The Scientific world journal , 2014 , 527472
15. Yogendra Nandgaoli and Rasika R. Kakade , "The Urine Engine." , IOSR-JESTFT, 2014 , 8 ,37-42
16. http://samvadsetu-gaumata.blogspot.in/2010/12/cow-urine-content.html
17. http://www.brighthub.com/environment/renewable-energy/articles/88584.aspx
18. W. Addy Majewski , "Water in diesel combustion ." , 2002 https://www.dieselnet.com/tech/engine_water.php
19. V. Ganeshan - Internal Combustion Engines, McGraw Hill Education (India) Pvt. Ltd, ISBN 1259006190