International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 12 | Dec -2016 www.irjet.net p-ISSN: 2395-0072

A Review on Exhaust Gas Recirculation on CI Engine fuelled with Biodiesel Blends

Ashish Singh[1], Akash Tiwari[2], Ankit Sawant[3], Deepak Singh[4], C.Srinidhi[5]

[1234]U.G. Student, Suman Ramesh Tulsiani Technical Campus-Faculty of Engineering
[5]Asst. Prof, Department of Mechanical Engineering, SRTTC-FOE, Kamshet, Pune

---

Abstract - It is deeply anticipated to find an alternate fuel for CI engine which can be of good replacement for the current performance to current engine. In due course biodiesel tops up the line and diminishing fact of NOx limits its usage. One of the primitive ways is in-cylinder treatment by using Exhaust Gas. The paper debriefs various efforts taken by many investigators which explain the performance and emission characteristics of Compression Ignition Engine using Exhaust Gas Recirculation methods. The overall survey points in reduction of Nitrous oxides emission in compensation of brake thermal efficiency. Also it's desirous the amount of Carbon monoxide emission also to diminish using this method

Key Words: EGR, Emission, Biodiesel, Performance and emission, CI Engine

1. INTRODUCTION

We all know the CI engines are widely used because of it high thermal efficiency and low maintenance [2]. It runs on diesel fuel which is a conventional fossil fuel and is on the verge of extinction. Also exhaust gas (HC, CO, CO2, NOx etc) of diesel engine are very harmful and major source of air pollution hence contributing to global warming. Studies have found that over 60% of the total air pollution is caused by engine exhaust. Engineers and scientists have done lots of research and experiments to finding alternative for diesel engine and effective means to control emission which is contributing to air pollution. They found that biodiesel as a fuel can replace diesel and also it can reduce the harmful exhaust gases to significant amount. However, people are still working in this field to find the best alternative for diesel fuel. Biofuel (biodiesel) have potential to meet the growing energy demand for this world in sustainable manner. But it was found that biodiesel fuel has higher NOx emission than pure diesel operated engine. Also many researches in total ambiguity to concentrate on blend concentration and finalization of engine parameters [11] and to fight food to fuel crises [10] NOx emission cannot be eliminated completely but it can be reduce to considerable amount with the help of exhaust gas recirculation (EGR).

1.1 WHAT IS EGR?

In EGR technique we recirculate the part of exhaust gases which aids in reducing the NOx emission. Exhaust gas normally contains of CO2, NOx etc and mixture has higher specific heat compare to atmospheric air, thus recalculated exhaust gas displace fresh air in combustion chamber and hence, it helps to reduce oxygen available for combustion and also it increase the specific heat of mixture entering the combustion chamber thus lower flame temperature.

EGR(%) is define as mass of percentage of recalculated exhaust in total intake mixture.

$$\text{EGR}(\%) = \frac{\textit{mass percentage on recirculated air}}{\textit{Total intake mixture}} \times 100$$

[1] have used CO2 % to measure the percentage of EGR

$$\text{EGR}(\%) = \frac{\textit{Percentage of CO2 (inlet)}}{\textit{Percentage of CO2 (outlet)}} \times 100$$

EGR is one of the most effective and economical method to reduce NOx emission. EGR helps in increasing the heat capacity, dilution of intake charge and ignition delay. Dilution theory says that, effect of EGR on NOx is caused by increasing amount of inert gas in the mixture reduces the adiabatic flame temperature.

2. LITERATURE SURVEY

S V Channapattanaa et al. performed performance and emission testing of DI VCR-CI engine runned with Calophyllum Inophyllum oil. They performed tests using biodiesel mixtures B20, B40, B60, B80, B100 and mineral diesel as a fuel varying compression ratios ranging from 15, 16, 17 and 18. They stated that as the CR value increases correspondingly Brake Thermal Efficiency increases for all HnOME bio-diesel mixtures. At peak CR value, BTHE reduced by 8.9%. At peak CR Value of 18 the CO, HC emissions fell due of the better combustion of the fuel. NOx emission grew for all mixtures of biodiesel and later decreased for fossil Diesel. At CR=18, NOx emission was observed high. [9]

C. Srinidhi et al. Worked on CI engine fuelled with Honne oil methyl ester for performance and emission determination. They stated that as the load increases Specific Fuel Consumption reduced for all blends. The Brake thermal efficiency is linear proportional load. BTHE for B20 is similar to diesel for all loads. NOx emission of B100 was observed to be highest for all loads.[10]

A. Paykaniet et al. investigated performance and emission characteristics of diesel engine fueled with biodiesel and diesel fuel using EGR. They have performed experiments on single cylinder, four stroke, water cooled, indirect injection (Lister8-1) diesel engine at full load and constant engine speed of 730rpm. The fuel used was canola oil ethyl ester as biofuel with blends of B20, B50 &B100. They observed that CO,UHC emission for biodiesel were lower than that of diesel fuel, but NOx emission for biodiesel were higher. Measurement of EGR was observed using Venturi type differential manometer system. It was found that the CO, HC and CO_2exhaust gas did not change but NOx emission were considerably reduced to lower EGR values. They also observed that brake thermal efficiency increased at low EGR ratio for four fuels. They stated that at higher EGR rate resulted in decrease in brake thermal efficiency. NOx emission is a direct factorial biodiesel percentage and decreases proportionally with increase in EGR percentage for both net diesel and COEE blends. Emission like CO, UHC were found to be lower with increase in biodiesel percentage. However, increasing EGR flow rates to high level resulted in considerable rise in CO and HC emission for both net diesel and COEE blends [1].

R.Senthilkumar et al. have performed experiment to study the effect of hot and cold exhaust gas recirculation (EGR) methods on emission and efficiency of diesel engine. They have conducted experiment on single cylinder, 4-stroke, water cooled, direct injection diesel engine. The tests are conducted at rated speed of 1500rpm and at various loads. They used heat exchanger for obtaining different EGR methods. They have carried out experiment with and without EGR having 10%, 15% and 20% of EGR. They observed that specific fuel consumption was noted high at all loads with and without EGR, brake thermal efficiency with 10% EGR was comparable without EGR at all loads. They also investigated that indicated thermal efficiency for cold EGR (water cooled) was found to be better in comparison with hot EGR and intermediate EGR, but it relatively low without EGR. Oxides of Nitogen (NOx) emittent coming out from the test rig using hot EGR is comparatively higher than without EGR and Cold EGR of higher rates shows much effective in reducing NOx emission. And CO emissions with EGR were increased in part loads and decrease with higher loads as compare without EGR [2].

Pratik G. Sapre et al. have investigated various exhaust gas recirculation rates on engine emission characteristics like NOx, HC, CO, CO2, exhaust gas temperature. They evaluated experimentally on a single cylinder, naturally aspirated 4-stroke, vertical air cooled CI engine. Readings were recorded on the following torque ratios 5, 10, 15, 20, 25, 30, 35, 40, 45N-m and varying EGR.

They found that NOx emission got reduced to 64.75% and HC emission increased with EGR mode but HC emission was observed less with non EGR. They concluded that 20% of EGR was optimum for NOx reduction without significant penalty on brake specific fuel consumption and HC emission [3].

Aparna v. Kulkarni et al. studied that exhaust from biodiesel fuel has more NOx emission than exhaust from diesel fuel. They aimed to reduce the NOx emission from exhaust gas using effective exhaust gas recirculation (EGR) technique. They conducted experimental analysis on 7HP single cylinder four stroke DI, with EGR system (water cooled type) fuelled with biodiesel blend of BD20 (20%v%cotton seed oil methyl esters (CSOME)) blend as fuel for the engine. They found a 27% reduction in the NOx

emission without demoralizing engine performance-emission penalties after recirculating the 12% of exhaust gas. [4].

Shaik Khader Basha et al. had conducted the experiments on single cylinder, four stroke diesel engine with hot and cold EGR. The temperature variation of EGR was performed using heat exchanger (Tube in Tube type. They experimental observed the performance and emission parameters on 0, 10%, 15% and 20% EGR rates. Emission take place due to the higher quantity of the oxygen in combustion chamber, and by recirculating exhaust gas in the chamber reduces the quantity of oxygen that increases the temperature of intake charges which reduces the flame temperature and results into the lower NOx emission [5].

K Srinivasa Rao et al. performed experiments on single cylinder, direct injection, CI engine using waste cooking oil methyl ester blends with varying EGR rates of 0% , 5% , 10% , 15% and 20%. They stated that the brake thermal efficiency of engine shooted up till 15% of EGR, and reduces with further increase in EGR percentage. The unburned hydrocarbon emission was observed low at lower EGR rates. Lowest BSFC was obtained at 15% EGR. It is observed that the NOX emissions were reduced for all blends using Exhaust Gas Recirculation technique. For all blends at 15% EGR rate, the engine characteristics were phenomenal [6].

Mr. Ravindra Deshpande et. al. performed experimental studies on variable speed diesel engine. Performance test were conducted constant compression ratio of 18. Recordings were made on varying EGR rates of 0%, 5%, 10% and 20% and varying loads engine (25%, 50%, 75% and 100%). Based on experimental results they concluded that BSFC and BTHE are functions of the EGR rates on varying loads of the engine. At 15% EGR rate NOx emission from the engine was least [7].

Meshack Hawi et al. aimed to study a dual fuelled direct injection CI engine which uses the biogas as a primary fuel and diesel as the secondary fuel with varying EGR. They compared the results of single fuel operation with duel fuel operation, At single fuel operation they observed that they were 14.5% reduction in BTE at full load and 10.3% reduction in BTE at quarter load while 11.2% reduction in BTE at full load and 9.5% reduction in BTE at quarter load when operating with duel fuel. Also increasing EGR reduces the Specific fuel consumption and NOx emissions but escalates the hydrocarbons (HC) and carbon mono-oxides (CO) emissions [8].

3. CONCLUSIONS

As the EGR rate and load are gradually increased, the BSFC is found to be reduced. It is also observed that for a non EGR system as the load increases form CI engine the SFC decreases [9, 10]. On the contrary, as the load and the EGR rate are increased together the BTE is found to be increased. The BTE is directly proportional to load applied on the engine, as the load increases the EGT also increases with increases in the EGR rate [9, 10]. To the above the statement, however the heat releases rate decreases form increasing the EGR rate. The Nox emission also decreases with increase in EGR in variant to increase in the load. Other emission like CO, HC are found to increase.

It is also found that cold EGR is much more effective than Hot EGR in reduction of NOX. Also in hot EGR is is found that with increasing in Hot EGR the BTE decreases which is unsatisfying factor.

REFERENCES

1. A. Paykaniet, A. Akbarzadeh and M. T. Shervani Tabar “Experimental investigation of effect of exhaust gas recirculation on performance and emission characteristic of a diesel engine fueled with biofuel.” International Journal of Engineering and technology, vol-3, no-3, june2011.
2. R.Senthilkumar, K. Ramadoss and R. Manimaran “Experimental investigation of performance and emission characteristics by different exhaust gas recirculation methods used in diesel engine”. Global journal of research in engineering mechanical and mechanics engineering, volume 13 issue 1 version 1.0 2013.
3. Pratik G. sapre, Kunal A.bahgat. “Emission characteristics for single cylinder DI diesel engine with EGR system”. International journal of engineering sciences &research technology sapre,3(09): September, 2014.
4. Aparna v. Kulkarni, Sachin l. Borse & Mahesh Joshi “an experimental investigation of effect of cooled exhaust gas Re-circulation (EGR) for NOx reduction in single cylinder CI Engine using

biodiesel blends", International Journal of Automobile Engineering Research & Development (IJAERD) ISSN 2277-4785 Vol. 3, Issue 1, Mar 2013.

5. Shaik Khader Basha , Srinivasa Rao. P, K. Venkata Sheshaiah Naidu and Rajagopal K "Use of EGR in Diesel Engine for Investigating the Performance and Emission Characteristics in Diesel Engine", International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161 February 2014.
6. K Srinivasa Rao, K Bhaskara Mutyalu and A Ramakrishna "Effect of exhaust gas recirculation on performance and Emission characteristics of diesel engine fueled with Waste cooking oil methyl ester", ARPN Journal of Engineering and Applied Sciences, VOL. 10, NO. 11, JUNE 2015.
7. Mr. Ravindra Deshpande, Prof. Sohail Bux "Effect of exhaust gas recirculation (EGR) on the performance and emission characteristics of diesel engine" International Journal of Advances in Engineering Research, (IJAER) august 2015.
8. Meshack Hawi, Robert Kiplimo, Hiram Ndiritu "Effect of Exhaust Gas Recirculation on Performance and Emission Characteristics of a Diesel-Piloted Biogas Engine", Smart Grid and Renewable Energy, 2015.
9. S V Channapattanaa*,Kantharaj Cb,V S Shindec Abhay A Pawar, Prashant G Kamble,2015, Emissions and Performance Evaluation of DI CI - VCR Engine Fuelled with Honne oil Methyl Ester / Diesel Blends Science Direct Energy Procedia 74,pp 281 – 288
10. C. Srinidhi ,S.V.Channapattana J.A. Hole, A.A.Pawar P.G.Kamble ,2014,Investigation On Performance and Emission Characteristics Of C.I. Engine Fuelled With Honne Oil Methyl Ester : International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734,Volume 3 Issue 5 pp.59-66
11. S.V. Channapattana , Abhay A. Pawar & Prashant G. Kamble, " Investigation of DI-CI four-stroke VCR engine at different static injection timings using biofuel derived from non-edible oil source as a fuel", Biofuels 2016, DOI: 10.1080/17597269.2016.1187540