Experimental Investigation of EGR at Various Fuel Substitutions on Dual Fuel CI Engine

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***Abstract* - Many of the fuels that are been iterated by many researchers across the world as future fuel or alternate fuel as substitute for conventional diesel and petrol has their respective effect on the emissions. Gaseous fuels such as Hydrogen and CNG emits numerous amounts of oxides of nitrogen when combined with diesel. Recirculation of the part of exhaust gas has evident effect on the emissions of CI engine with less compensation of performance, when optimum amount of exhaust gas is inducted into the inlet manifold. In present research article, the effect of amount of exhaust gas recirculation is discussed for pure diesel and diesel with Hydrogen and CNG substitution.**

***Key Words* - EGR, Diesel, Hydrogen, LPG, NO_x**

I. INTRODUCTION

EGR is commonly used to reduce NOx in S.I. engines as well as C.I. engines The theory of EGR is to re-circulate about 10% to 25% of the exhaust gases back into the inlet manifold where it mixes with the fresh incoming air and this will reduce the quantity of Oxygen available for combustion [11]-[1]. This reduces the O2 concentration and dilutes the intake charge, and reduces the peak combustion temperature inside the combustion chamber which will simultaneously reduce the NOx formation. About 15% recycle of exhaust gas will reduce NOa emission by about 80%. It should be noted that most of the NOx emission occurs during lean mixture limits when exhaust gas recirculation is least effective. The exhaust gas which is sent into the combustion chamber has to be cooled so that the volumetric efficiency of the engine can be increased. The exhaust gas for recirculation is taken through an orifice and passed through control valves for regulation of the quantity of recirculation [4]. Normally exhaust gas recirculation is shut off during idle to prevent rough engine operation. EGR is a very useful technique for reducing the NOx emission. EGR displaces oxygen in the intake air and dilute the intake charge by exhaust gas re-circulated to the combustion chamber. Re-circulated exhaust gas lower the oxygen concentration in combustion chamber and increase the specific heat of the intake air mixture, which results in lower flame temperatures. It was observed that 15% EGR rate is found to be effective to reduce NOx emission substantially without deteriorating engine performance in terms of thermal efficiency break specific fuel consumption (BSFC) and emissions. Thus, it higher rate of EGR can be applied at lower loads and lower rate of EGR can be applied at higher load. EGR can be applied to diesel engine fuelled with diesel oil, biodiesel, LPG, hydrogen, etc without sacrificing its efficiency and fuel economy and NOx reduction can thus be achieved.[4] EGR is a useful technique for reducing NOx formation in the combustion chamber. Exhaust gas consists of CO2; N2 and water vapours mainly. When a part of this exhaust gas is re-circulated to the cylinder, it acts as diluents to the combusting mixture. This also reduces the O2 concentration in the combustion chamber. The specific heat of the EGR is much higher than fresh air; hence EGR increases the heat capacity (specific heat) of the intake charge, thus decreasing the temperature rise for the same heat release in the combustion chamber. Experimental investigation of EGR at various fuel substitutions on dual fuel CI engine as follows.

II. EGR ON DIESEL FUEL

Exhaust gas recirculation with various percentages on diesel fuel compression ignition engine and its NOx emissions at various break powers and are plotted which are shown in the figure 1:, with graphical representation and also without EGR and with different percentages of EGR un used oxygen with break power of diesel are plotted which are also shown in figure 2:, thermal efficiency versus break power of diesel engine are shown in figure 3:,

EGR on Diesel Fuel

EGR on diesel fuel engine with different substitutions of EGR and its related graphs shown in following figures

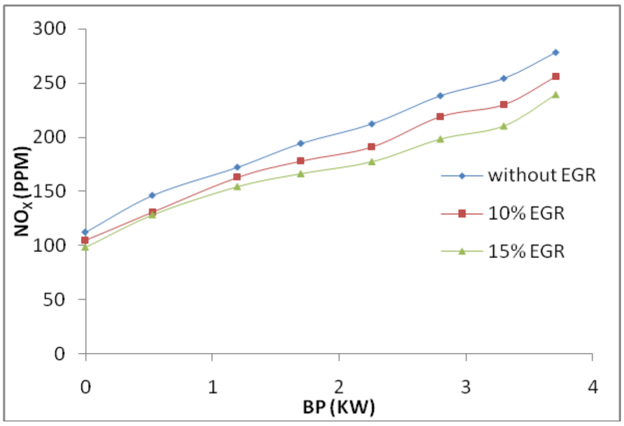

Figure1: NOx Vs break power for pure diesel

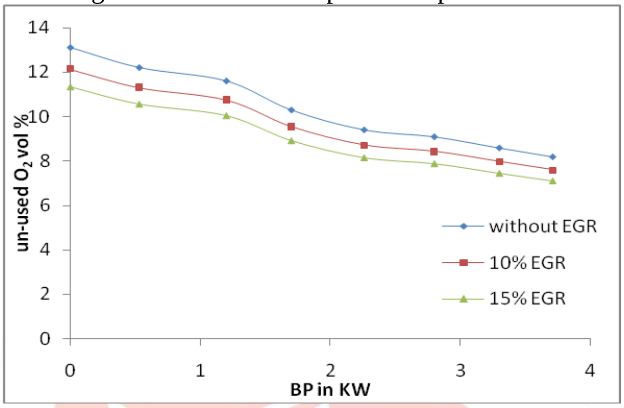

Figure2: Un-used Oxygen Vs brake power for pure diesel

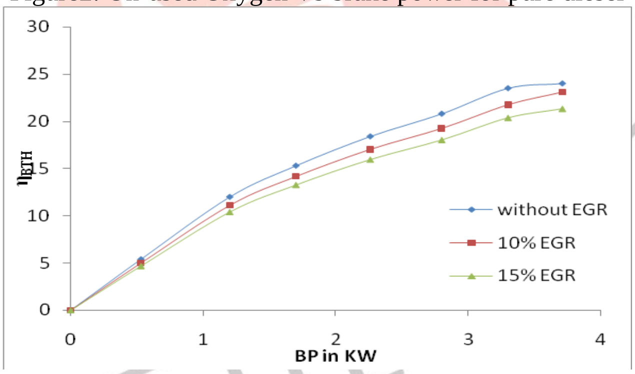

Figure 3: Thermal Efficiency Vs Brake Power for pure diesel

III. EGR ON HYDROGEN FUEL

Hydrogen has attained a position of prominent gaseous fuel in IC engine for the future generation because of its renewability. As it is a well known fact that many researches are in search of a renewable IC engine fuel that can be immediately substituted partially or completely without much modifications in the existing design of the engine. Hydrogen used in the CI engine by inducing in the inlet manifold along with air replacing diesel partially, this needs little modifications of the engine. Looking at the other side, the hydrogen usage comes with disadvantage of increased emissions of oxides of Nitrogen; this can be overcome recirculation of exhaust gas in selective and appropriate quantities. In present experimental investigation, emissions of oxides of nitrogen (NOx)are compared at 10%, 20%, 30%, 40% and 50% v/v of hydrogen substitution at various percentages of exhaust gas recirculation.

EGR on Hydrogen Fuel

EGR on duel fuel engine with hydrogen as fuel and its experimental observations at different substitutions of EGR and its related graphs shown in the following figures

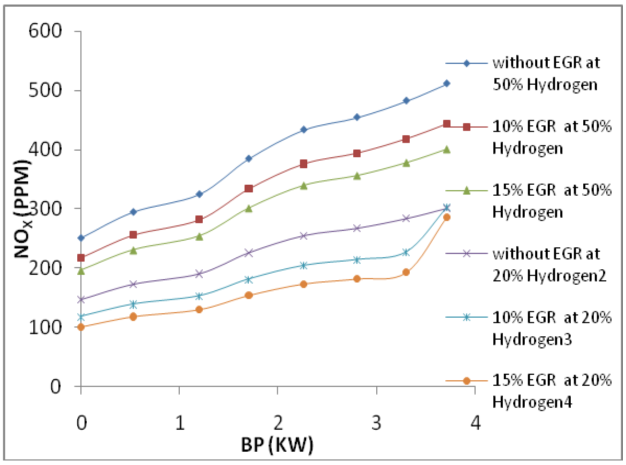

Figure 4: NOx Vs Brake power at various Hydrogen substitutions

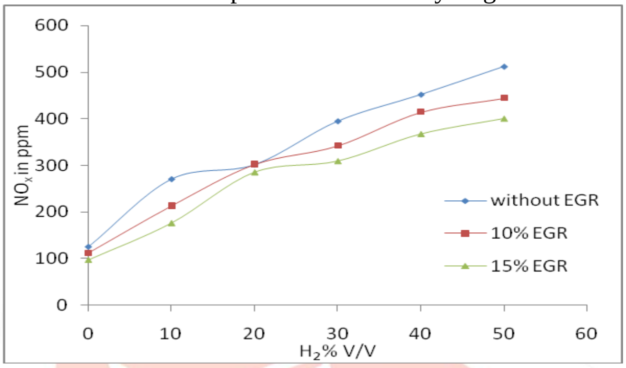

Figure 5: NOx Vs Brake power at various Hydrogen substitutions

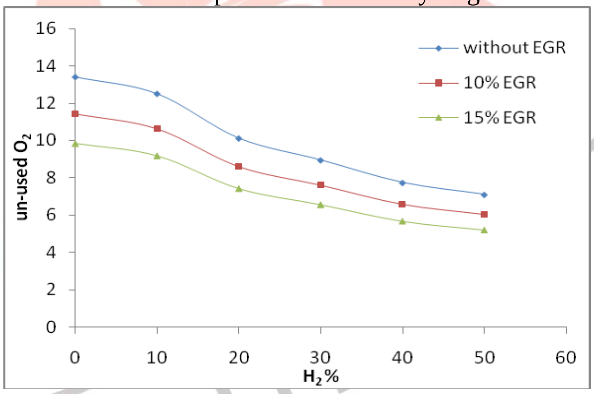

Figure 6 : Un-used oxygen Vs Brake power at various Hydrogen substitutions

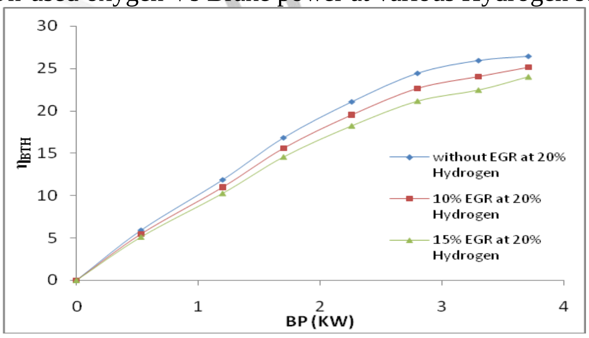

Figure7: Thermal Efficiency Vs Brake Power at Various Substitutions of Hydrogen

IV. EGR ON COMPRESSED NATURAL GAS

EGR at various substitutions of CNG Compressed Natural Gas (CNG) has become a better option as a clean burning fuel of an IC engine. In order to comply with the ever-stringent emission norms throughout the world and crunch in petroleum reserves, the modern day automobile industry is compelled to hunt for new and alternative means of fuel sources to keep the wheels spinning globally [4]. Paradoxical objectives of attaining simultaneous reduction in emission along with high performance has provided with a few alternative. Natural gas produces practically no particulates since it contains few dissolved impurities (e.g. sulphur compounds). Moreover, natural gas can be used in compression ignition engines (dual fuel diesel– natural gas engines) since the auto-ignition temperature of the gaseous fuel is higher compared to the one of conventional liquid diesel fuel [7]. Dual fuel diesel–natural gas engines feature essentially a homogeneous natural gas–air mixture compressed rapidly below its auto-ignition conditions and ignited by the injection of an amount of liquid diesel fuel around top dead centre position. Natural gas is fumigated into the intake air and premixed with it during the induction stroke. At constant engine speed, the fumigated gaseous fuel replaces an equal amount of the inducted combustion air (on a volume basis) since the total amount of the inducted mixture has to be kept constant. Furthermore, under fumigated dual fuel operating mode, the desired engine power output (i.e. brake mean effective pressure) is controlled by changing the amounts of the fuels used. Thus, at a given combination of engine speed and load, the change of the liquid fuel ‘‘supplementary ratio” leads to a change of the inhaled combustion air, thus resulting to the alteration of the total relative air–fuel ratio [8].

EGR on Compressed Natural Gas

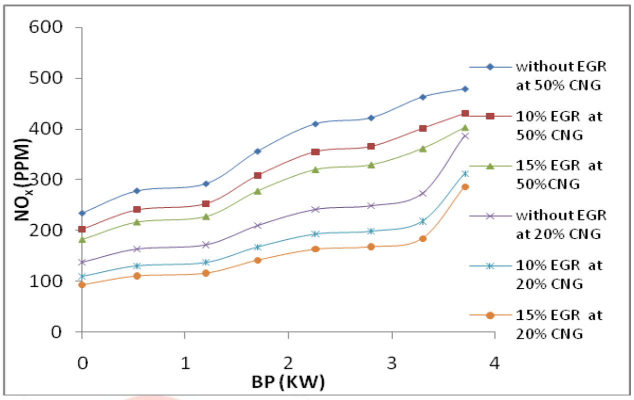

Figure 8: NO_x Vs Brake power at various CNG substitutions

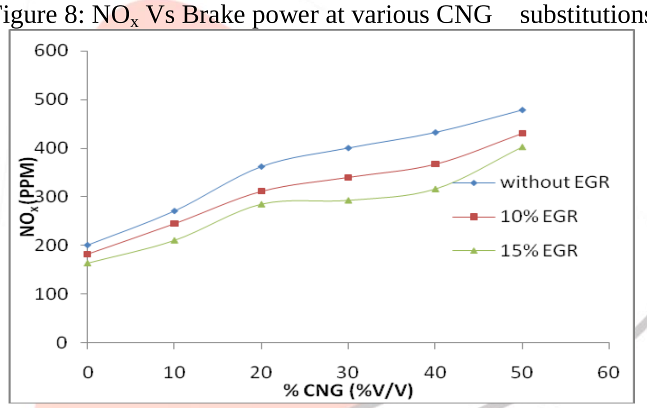

Figure 8: NO_x Oxygen Vs Brake power at various CNG substitutions

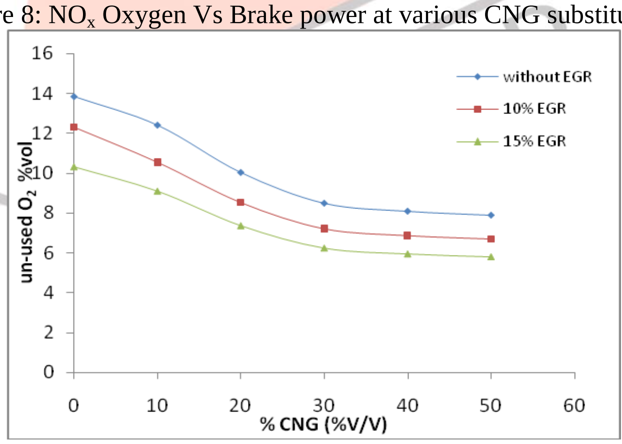

Figure 9: Un-used Oxygen Vs Brake power at various CNG substitutions

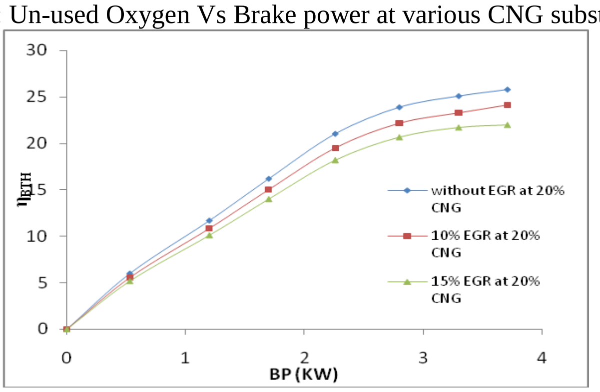

Figure 10: Brake Thermal Efficiency Vs Brake Power at Various Substitution of CNG

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