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Reduction in Fuel Consumption Through Eco-Driving: A Review

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Abstract – *Eco-systems currently being implemented all around the world. The Euro emission control is introduced on the same basis, to decrease pollution of the environment and make the vehicles more eco-friendly. Idea is on the same basis of developing an eco-bike engine model which will use its exhaust emissions to pre-heat its air-fuel mixture with the help of a heat exchanger, that will increase the inlet mixture temperature and vaporize any water content so that better and full combustion occurs which will emit less no. of harmful emissions than a standard running motorbike.*

Keywords: Eco-systems, Motorbike, Pollution, Euro systems, Combustion

1.0 INTRODUCTION

The global warming and the greenhouse effect are a serious problem all around the world [1,2]. Restrictions are being implemented all over the world to reduce the harmful emissions and make this world a better place [3]. In the recent years significant research is being done on this side by introducing the euro emission control standards and new technological advancements [4]. Over the past few years CO_2 emissions have gone along way up due to increased traffic. They produce the greenhouse effect which increases the earth temperature which causes climate changes and sea level changes. Following figures show the CO_2 emissions all around the world. While the need for change is increasingly difficult to challenge [5], and in many cases the technology and vision for a future automotive industry and auto mobility exist [6,7], many of those within the existing system remain incredibly obdurate. There have been many socio-technical experiments, but no fundamental change [8].

Worldwide Greenhouse effect produced by the CO_2 emissions is shown in the Fig. 2. To mitigate these effects, the euro emission control system was introduced which keeps a check on the emissions and limit them so that minimum amount of harmful gases are being exhausted out. Road traffic is the main source of anthropogenic nitrogen oxide emissions. The sum of

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nitric oxide (NO) and nitrogen dioxide (NO_2) is referred to as nitrogen oxide (NOx) and is limited for vehicle certification.

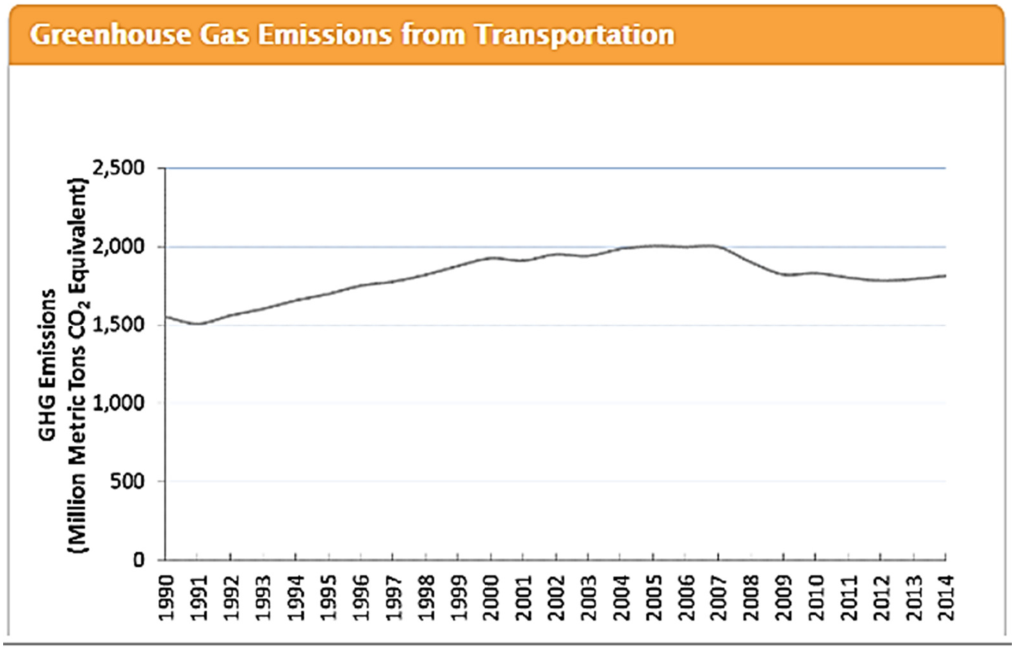

Figure 1: CO_2 emissions over the past years from road transport.

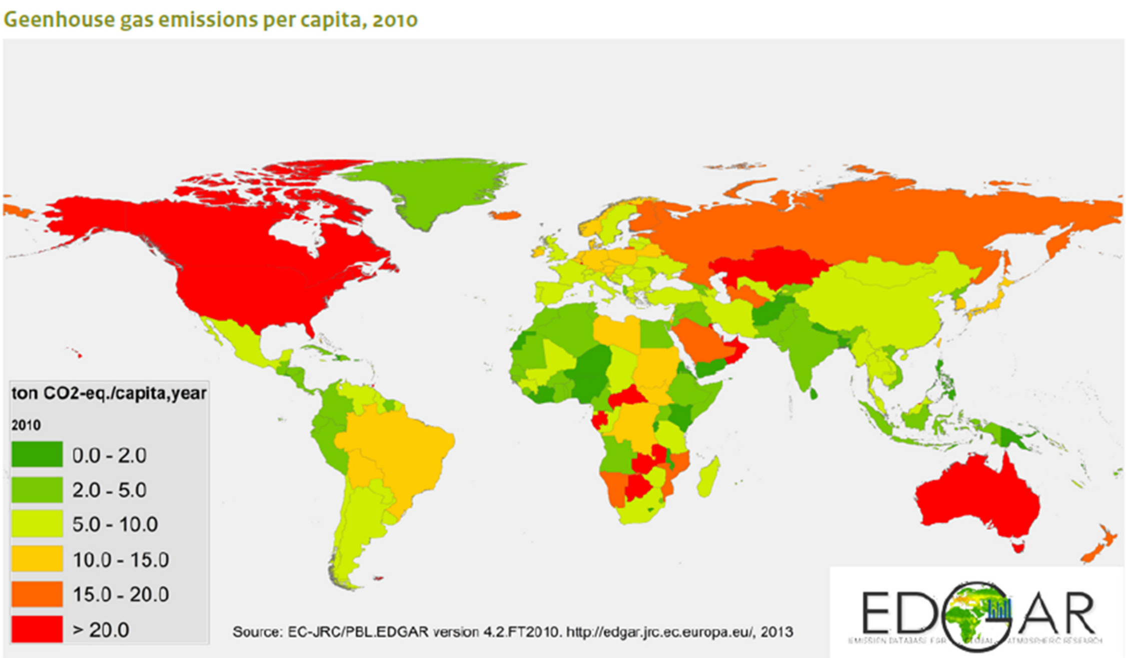

Figure 2: Greenhouse gas emissions per capita, 2010.

NOx, in conjunction with volatile organic compounds (VOCs), plays a major role in the formation of ground-level ozone [9]. In America a survey was conducted to show the casualties of car crashes against car emissions it was found that 43,510 people died in car crashes in a

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year and 52,800 people died a premature death from car emissions. So this is a serious matter which should be taken in account. Euro standards are being now implemented on cars all around the world. The gaseous emissions of the EURO5 engine exhibited very good results. The concentrations of NH_3 and N_2O remained close to the detection limit. However, the EURO4 engine emitted rather high concentrations of NO_2 at about half-load range. Emissions of Vanadium with EURO5 and Platinum with EURO4 were low in both cases, even below detection limit [10]. Following are the euro standards.

Emission limits for new vehicles with petrol engine						
	valid from	CO (g/km)	HC (g/km)	NOx (g/km)	HC+NOx (g/km)	PM
Euro I	12/92	2,72	-	-	0,97	-
Euro II	01/97	2,20	-	-	0,5	-
Euro III	01/00	2,30	0,20	0,15	-	-
Euro IV	01/05	1,00	0,10	0,08	-	-
Euro V	09/09	1,00	0,10	0,06	-	0,005*
Euro VI	08/14	1,00	0,10	0,06	-	0,005*

* with direct injection

Emission limits for vehicles with petrol engine

Figure 3: Euro emission standards for Light petrol vehicles.

These standards are being used in vehicles. The motorcycles in Pakistan are now designed on Euro 2 standards. This work is to review and suggest a system that will further degrade the emissions by providing complete burning and have greater miles per gallon (MPG). The following sections will cover the design and changes introduced.

2.0 DESIGN FOR HEATING OF THE FUEL

Fuel is coming from the tank directly into the carburettor of the bike. Where it mixes with the atmospheric air sucked in and then goes into the engine where it is compressed by the piston and then ignited. Now the fuel coming into the carburettor is nearly at atmospheric temperature and is in liquid form when mixed with the air. At low RPMs the combustion of mixture is satisfactory and almost complete. But when the engine reaches higher RPMs the tables turn, now the fuel is pumped in with a lot more velocity then before which makes the fuel not to burn completely and is pumped out unburnt. This causes a loss in millage efficiency.

To encounter this a system is required that will take the fuel from the fuel supply system and heated to a sufficient temperature it will go into the carburettor by applying a spiral heat exchanger, that will roll over the exhaust manifold. After being heated up, it will get mixed with the air. The heated up fuel, as gasoline having a low boiling point, will vaporize forming fumes of high temperature than the fuel going in through a standard system. The higher temperature fuel on compressing will have a higher temperature than standard fuel and will combust better giving a better millage efficiency [11-14]. Researchers conducted a sequence of important researches in order to identify all EGR (Exhaust gas recirculation) system actions in the combustion process. Their studies concluded that there are four factors which contribute

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to EGR effects, namely, dilution, thermal, chemical effects and one increase of the air intake. Positive effects of the EGR are also described by different researchers [10,15-18].

The changes needed for this system are a copper tube and a pump to make the liquid flow against the gravity after being heated up. The copper tube will carry out the liquid fuel over the heat exchanger and then will drop it into the carburettor. The fluid will flow via the push of the pump. The copper tube surface area and geometrical parameters rely upon the amount of heat transfer required. Change in diameter can be employed to make the flow rate and heat transfer better. The power of the pump is also required a small pump can be used to make the liquid flow and the power will be calculated via calculations and the frictional losses. The Darcy-weisbach equation can calculate head losses [19], finding the height to alternate the power of the pump.

3.0 ROLE OF CONDUCTION AND CONVECTION IN PRE-HEATING

Both conduction and convection play an important role in heat transfer.

Conduction happens via direct contact between stationary fluids. Heat transfer in case of a pipe varies upon the inner and outer diameters of the pipe being used. The formula used is the Newton's law of cooling [20].

$$\dot{Q} = -kA\frac{dT}{dr} \tag{1}$$

$$\dot{Q} = 2\pi kl\frac{\Delta T}{\ln(\frac{r2}{r1})} \tag{2}$$

Convection is the transfer of heat between moving fluids. It is dependent on the surface area that comes in contact of the two fluids and the velocity at which they are travelling [20].

$$\dot{Q} = h\ As\ \Delta T \tag{3}$$

Comparison of convection and conduction showed in figure 4 at different diameters.

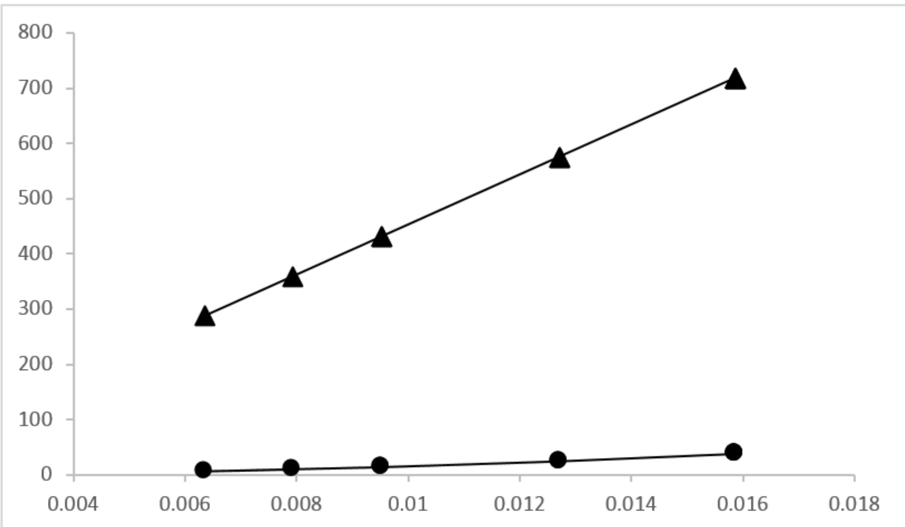

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Figure 4: Heat Transfer at different diameter (conduction curve-●, convection curve ▲)

This graph shows the conduction and convection curve for a circular pipe at different radius. From graph this can be concluded heat transfer through convection mode is efficient.

4.0 PRE-HEATING THE AIR-FUEL MIXTURE

The idea of pre-heating the air-fuel mixture was initially the main clause through a unique design [21]. The design uses the hot exhaust gases. The exhaust gases transfer their heat content to the air-fuel mixture through "convection". This was a difficult task as the increase in the temperature of the air-fuel mixture effects the thermal efficiency negatively. Due to increase temperature of the inlet, the available temperature difference will decrease taking the efficiency down [22].

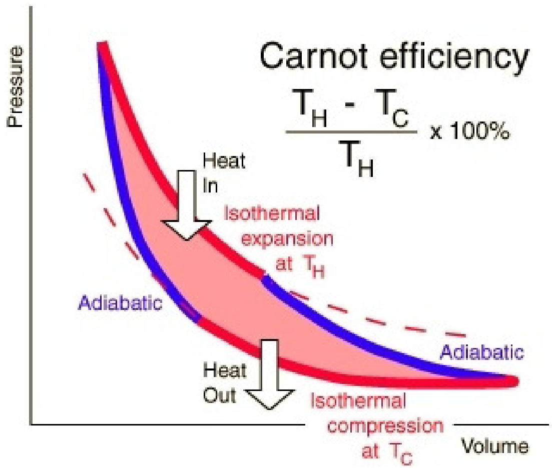

Figure 5: Basic Thermal Cycle for Gasoline Engine: Carnot Cycle.

4.1 Pre-Heating the Fuel

Instead of pre-heating the air fuel mixture, to heat the fuel alone is relatively easier and efficient in utility. Now, the fuel (gasoline) is taken from the reservoir and allowed to flow downward through a coil. This coil is wound over the area of silencer nearest to the exhaust manifold. The out coming exhaust gases from the exhaust manifold transfer their heat through the phenomenon of "convection" to the cold fuel. A small pump run from the battery of the vehicle to push the hot fuel back to the inlet manifold where it mixes with the air and goes to the engine for combustion. This technique is very effective in making the air-fuel mixture to completely burn even at high engine rpms.

5.0 BSFC OF MODIFIED SYSTEM

The efficiency increase for the aforementioned process can easily be stated by break specific fuel consumption. Brake specific fuel consumption is a type of comparison which looks at engine's fuel efficiency in terms of how much fuel a vehicle uses versus how much power it

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produces at the flywheel. Lower BSFC means higher efficiency because the engine is creating a high level of power while using a low amount of fuel [22].

$$BSFC = \frac{mass\ flow\ rate\left(\frac{kg}{s}\right)}{BHP\ (kW)} \tag{4}$$

6.0 CONCLUSION

Literature reveals that fuel pre-heating shows significant improvement in the performance as compare to pre-heating of air-fuel mixture. The pre-heating of fuel involves heat transfer gives minimized value of BSFC compared to pre-heating of air-fuel mixture and the unmodified version of engine. So, pre-heating of fuel through conduction and convection is a more favourable process.

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