EFFECT OF PREHEATING OF INLET AIR TO STUDY THE PERFORMANCE & EXHAUST EMISSION OF IC ENGINE: A REVIEW

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ABSTRACT

Intake air temperature plays a predominant role in achieving better efficiency. Manifold heaters are used in diesel aapplications needing quick, reliable, and environmentally friendly starts. Many researchers have already worked on different methods for improving engine performance and reduction of exhaust emissions. To get the maximum output with the least input intake air heaters are used on a diesel engine. In present work we have reviewed some research papers and concluded that Air intake heaters reduce white smoke, engine wear, battery consumption, and fuel consumption during start up.

KEYWORDS: *Preheating inlet air, performance of engine, exhaust Emissions*

I. INTRODUCTION

1.1 General Aspects of I.C Engines

The internal combustion engine is a heat engine that converts chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use. For engines this will often be the propulsion of a vehicle (i.e., automobile, truck, locomotive, marine vessel, or airplane). Other applications include stationary engines to drive generators or pumps, and portable engines for things like chain saws and lawn mowers.

Most internal combustion engines are reciprocating engines having pistons that reciprocate back and forth in cylinders internally within the engine. There are other types too like rotary engines, external combustion engines etc. The reciprocating engines are mainly of two type viz. Petrol Engine and Diesel Engine. Reciprocating engines can have one cylinder or many, up to 20 or more. The cylinders can be arranged in many different geometric configurations. Sizes range from small model airplane engines with power output on the order of 100 watts to large multicylinder stationary engines that produce thousands of kilowatts per cylinder.

1.2 Combustion in I.C. Engine[11,12]

In I.C. engine combustion is a chemical reaction in which certain elements of the fuel like hydrogen and carbon combine with oxygen liberating heat energy and causing an increase in temperature of the gases. The conditions necessary for combustion are the presence of combustible mixture and some means of initiating the process. The process of combustion in engines generally takes place either in a homogeneous or a heterogeneous fuel vapor-air mixture depending on the type of engine.

In spark-ignition engines a nearly homogeneous mixture of air and fuel is formed in the carburettor. Homogeneous mixture is thus formed outside the engine cylinder and the combustion is initiated inside the cylinder at a particular instant towards the end of the compression stroke. In a homogeneous gas mixture the fuel and oxygen molecules are more or less, uniformly distributed.

In a homogeneous mixture with an equivalence ratio, Ø, (the ratio of the actual fuel-air ratio to the stoichiometric fuel-air ratio) close to 1.0, the flame speed is normally of the order of 40 cm/s. In a spark-ignition engine the maximum flame speed is obtained when Ø is between 1.1 and 1.2, i.e., when the mixture is slightly richer than stoichiometric.

In compression-ignition engines heterogeneous mixture is used. The air is already inside the chamber and the fuel enters the chamber near the end of compression stroke. The rate of combustion is determined by the velocity of mutual diffusion of fuel vapors and air and the rate of chemical reaction is of minor importance. Self-ignition of fuel-air mixture, at the high temperature developed due to higher compression ratios, is of primary importance in determining the combustion characteristics.

1.3 Air Intake Heaters[1]

IC engine efficiency depends on multiple complex parameters like heat losses during cooling of engine, heat losses in exhaust gases, friction loss, transmission efficiency losses etc. Intake air temperature plays a predominant role in achieving better efficiency. Air Intake pre Heaters are used in diesel applications needing quick, reliable, and environmentally friendly starts. Air Intake Heaters are installed in the intake manifold and pre-heat the combustion air to the required temperature for ignition of fuel. Powered by the vehicle battery, air intake heaters provide an on-board, unplugged, cold weather starting aid. This type of engine preheating is cost-effective and good for the environment. In addition to producing fast starts, Air Intake Heaters reduce white smoke, engine wear, battery consumption, and fuel consumption during start up.

II. LITERATURE SURVEY

Chirtravelan. M, Duraimurugan. K, Venkatesh. M[1], have experimentally proove that the effect of preheated air on standard diesel fuel engine indicated a good result on emission control. NOx and CO emissions at intake air temperature of 55°C were less when compared at intake air temperature of 32°C. Result are prooved from this experiments like that Higher inlet air temperature will be affect some factors (a) lower ignition delay (b) lower NOx formation. (c) Uniform or better combustion (d) lower engine noise (e) Easy vaporization (f) better mixing of air and fuel occur due to warm up of inlet air (g) lower CO emission.

A. Malaisamy, P. Balashanmugam [2], have experimentally investigated that by two types of designing heat exchanger matrix using for air pre heater in two stroke single cylinder air cooled SI engine. Selecting suitable materials to serve the design purpose. Aluminum is selected for the research work because of highly resistant to corrosion attack, light weight & bright appearance, cost is less compare to copper and steel. Using the matrix two is more applicable because of flow of turbulent occur when air is passed through spiral path. Matrix one is complicated and difficult to weld for the design point of view. Percentage of CO of two stroke single cylinder engine is 5.20,5.51,5.45,7.19 at different load condition(25%,50%,75%,100%).With the use of heating chamber, percentage of CO is 4.84, 5.02, 5.14, 6.80. Similar percentage of HC is reducing with the use of heating chamber.The result of the experiment is to improve the volumetric efficiency because of the reducing the %CO, HC using the air pre heater as compared to normal condition of the engine.

Mhia Md. Zaglul Shahadat, Md. Nurun Nabi and Md. Shamim Akhter [3] , have experimentally investigated reducing the % NOx by preheating inlet air in single cylinder, four stroke water evaporative type diesel engine with new set up**.** The maximum length of exhaust pipe was surrounded by inlet air passage so as to extract maximum quantity of heat from exhaust gases. To reduce heat transfer to atmosphere from inlet air, inlet passage was insulated by plaster of paris whose heat resistivity is comparatively higher. Without preheating, the temperature was recorded as 32°C and with preheating; the inlet air temperature was set at 55°C by controlling the exhaust gas valve. The data was taken at medium load condition. Result of the experiment reducing the percentage of NOx is reduced with the new air preheating set up. Higher inlet air temperature is caused the lower ignition delay, Uniform or better combustion, Easy vaporization and better mixing of air and fuel, improving engine thermal efficiency.

Jaffar Hussain, K. Palaniradja, N. Alagumurthi, R. Manimaran[4], have performed on effect of EGR on performance & emission characteristics of a 3 cylinder direct injection CI engine. Exhaust Gas Recirculation is an effective method for NOx control. EGR displaces oxygen in the intake air by exhaust gas re-circulated to the combustion chamber. Exhaust gases lower the oxygen concentration in combustion chamber and increase the specific heat of the intake air mixture, which results in lower flame temperatures. Reduced oxygen and lower flame temperatures will be affect the performance & emissions of diesel engine in different ways. Thermal efficiency is slightly increased and BSFC is decreased at lower loads with EGR compared to without EGR. But at higher loads, thermal efficiency and BSFC are almost similar with EGR than without EGR. Exhaust gas temperature is decreased with EGR, but NOx emission decreases significantly. The result from this experiment is that higher rate of EGR can be applied a small loads. EGR can be applied to diesel engine without sacrificing its efficiency & fuel economy and reducing the percentage of NOx can thus be achieved. The increase in CO, HC, and PM emissions can be reduced by using the techniques of exhaust after-treatment like that diesel oxidation catalysts (DOCs) and soot traps.

J. S. Jadhao, D. G. Thombare[5] , have explained the Review on Exhaust Gas Heat Recovery for I.C Engine. in this paper will be represented that the Large amount of hot flue gases is generated from ic engine. If same of this waste heat could be recovered, a considerable amount of primary fuel could be saved. So heat recovery system will be beneficial to the large engines comparatively to smaller engines. The heat recovery from exhaust gas and conversion in to mechanical power is possible with the help of different cycle like that rankine, stirling and brayton thermodynamic cycles, vapour absorption cycle. These cycles are proved for low temperature heat conversion in to the useful power. Waste heat can be utilized for the heating purpose like space heating, Preheating intake air and fuel, dryer etc. Review from this paper that It is helpful for increases in thermal efficiency and reduction in emission level.

D. Tamilvendhan[6] , have performed that the Performance and Emission and Combustion Investigation on Hot Air by using the pre –heater in single cylinder, air cooled, vertical and direct injection diesel engine. The inlet side of the engine consists of anti pulsating drum, air heater and air temperature measuring device. The amount of preheat required for the intake air is depends upon the load condition of the engine. Basically the engine requires more preheat when the starting condition and the idling condition and at lower loads but it requires less preheat when higher loads and peak loads are requires. The result from this paper is below when increasing temperature .

- The brake thermal efficiency increases with increase in intake temperature, reaches a maximum condition and thereafter decreases considerably at all loads.
- Reduces ignition delay and advances the occurrence of peak pressure
- Volumetric efficiency decreasing
- Decreases air density

Quangang Wang, Chunde Yao , Zhancheng Dou, Bin Wang, Taoyang Wu[7] **,** In this paper will be study that , the influence of intake pre-heating and injection timing on the engine performance, combustion characteristics and emissions of a methanol fumigated diesel engine has been experimentally investigated and proove that following points.

- The low efficiency at light loads of a DMDF engine can be improved significantly by raising the intake temperature.
- An increase in the intake temperature significantly decreased the combustion delay.
- Heat release rate of premixed combustion decreased and combustion rate of methanol by flame propagation increased as the intake temperature increased
- The rate of premixed combustion decreases while the rate of flame propagation increases as the methanol substitution percent increases. Soot-NOx trade-off dilemma on DMDF operation is completely broken at lower intake temperature and higher methanol substitute percent.

Veneţia SANDU[8] , have worked on the increase of performance of a heavy duty turbocharged diesel engine when the intake air is cooled in an heat exchanger (air-to-air type), being turned into a turbocharged and intercooled (Aluminum will be used in inter coller)engine. Following test will be done like that dynamometric tests, rated power, torque, specific consumptions and smoke level on the speed characteristic at total load condition. By mild intercooling the newly developed engine - turbocharged and intercooled (798-05R) demonstrated 15 kW higher rated power (15%), 100 N·m higher maximum torque (30%) and 9 g/kWh (5.7%) specific fuel consumption lower than the turbocharged version (798-05), at lower smoke emissions.Also, the charge air cooling reduces the temperature in cylinders and exhaust system, improving engine durability.

R.G. Papagiannakis[9] have worked on study of air inlet preheating and EGR impacts for improving the operation of CI engine running under dual fuel mode. In the present work, an existing two-zone phenomenological model was used to examine the effect of the EGR and the inlet air temperature, on performance characteristics and emissions of pollutant of a natural gas/diesel CI engine. Following result obtained from this experiments that (a) inlet air preheating without using exhaust gas recirculation could lead to a sensible improvement (about 20% at high load) of engine efficiency.(b) In general, the increase of exhaust gas recirculation percentage accompanied with increased air inlet temperature could be a promising solution for improving engine efficiency and reducing percentage CO of emissions.(c) maximum cylinder pressure could be restrained by a simultaneous slight increase of exhaust gas recirculation percentage, without a considerable deterioration of engine efficiency. Thus, at high air inlet temperatures, the use of exhaust gas recirculation could be a potential methodology for improvement of dual fuel engine brake thermal efficiency without problems associated with the engine structure.(d) The negative impacts of dual fuel operation on percentage CO of emissions could be curtailed by air inlet preheating. Via this specific methodology, a reduction of both percentage CO and soot emissions may be achieved.

Andrew Roberts, Richard Brooks, Philip Shipway[10] have performe that One area of the cold-start; the thermal efficiency of the internal combustion engine is lower at cold start condition than when the vehicle reaches steady state temperatures condition owing to other -optimal lubricant and component temperatures. The common theme of attempting to reduce the energy losses so that systems and components reach their intended operating temperature range as soon as possible after engine start. It can be seen that there are noticeable improvements to be had in both fuel consumption and emissions as a direct result of improving the cold start performance of the IC engine. To improveing the engine cold-start performance and improve the fuel efficiency of the engine whilst also targeting quality of emission . During cold-starting condition, three key are important (1) To increase the cylinder temperature of liner warm-up rates to improve combustion conditions (2) improve quality of emission. So that an issue also reduces the piston/liner friction levels and improves the fuel consumption. (3) an increase in the rate of lubricant warm-up .

III. CONCLUSIONS

- The heat input required for the engine reduces with increase in intake air temperature.
- Fuel consumption reduces and brake thermal efficiency increases.
- CO content in the exhaust gas slightly reduces with increase in intake air temperature.
- CO2 & O2 content in the exhaust gas remains unaltered in the exhaust with increase in intake air temperature.
- NOx content in the exhaust gas slightly increases with increase in intake air temperature.

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