Experimental and Neural Network Based Investigation on Externally Scavenged S.I.Engine

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Abstract- **The present research describes experimental investigation and ANN simulation of two-stroke externally scavenged engine. The two stroke engine is relatively small and has higher Power to weight ratio, simplicity of operation and less cost. However these engines have high exhaust emission and low brake thermal efficiency due to short circuiting losses and incomplete combustion. To eliminate short circuiting losses, externally scavenged engine is developed in I.C.Engine laboratory. In this study, effects of externally scavenged system on performance and emissions of two stroke engine is investigated at different loads and speeds with ANN simulation. Performance of externally scavenged engine is compared with crank-cased scavenged engine. Result show that brake power and brake thermal efficiency of externally scavenged engine is improved due to supply of leaner air-fuel mixture to the engine. Simulation of engine shows the authenticity of the investigation carried out experimentally.**

Index Terms- Artificial Neural Network, Brake power, externally scavenged engine, Emission Analysis.

1. INTRODUCTION

The method of removing the exhaust gases with the help of fresh charge in petrol engine or by the inlet air in diesel engine is known as scavenging. This is carried out during the overlapping of inlet and exhaust ports[1,2]. The basic requirement of an ideal scavenging system is to remove exhaust gases without any loss of fresh charge or air. Such ideal system in practice is impossible but utmost care should be taken to reduce the loss to minimum. The best air path is achieved through scavenging in which mixture or air is admitted at one end of the cylinder and exhaust gases are discharged from the other end.
Simulation consists of three layers. First layer is known as input layer. Number of neurons in input layers equal to the number of independent variables. Second layer is known as hidden layer. Number of neurons in hidden layer is equal to the number of independent variables. The third layer is the output layer. It contains one neuron as one of the dependent variable. Multilayer feed forward topology is decided for the network.
In this present work, externally scavenged engine is developed with piston of aluminium. Performance and exhaust analysis of modified engine is evaluated at 25%, 50%, 75% and 100% scavenging port opening. Performance of the modified engine is compared with the base engine.

2. WORKING OF EXTERNALLY SCAVENGED SYSTEM

Atmospheric air enters the crankcase through the carburetor along with the fuel in the conventional way, as well as through the two reed valves fitted at the transfer ports. When the piston moves from BDC to TDC the pressure inside the crankcase is below atmospheric pressure and air from the atmosphere gets into the crankcase through the above-mentioned three paths as shown in Figure 1. When the air flows through the reed valves, the fuel-air mixture present in the transfer ducts as a result of the previous cycle is forced into the crankcase and air takes its place. This process results in either a partial or a complete filling up of the transfer crankcase and air takes its place. This process results in either a partial or a complete filling up of the transfer ducts by pure air. During the downward stroke of the piston, pressure builds up in the crankcase and in the transfer ducts as soon as the inlet ports and the intake to the crankcase are closed. Hence, the reed valves are also closed.

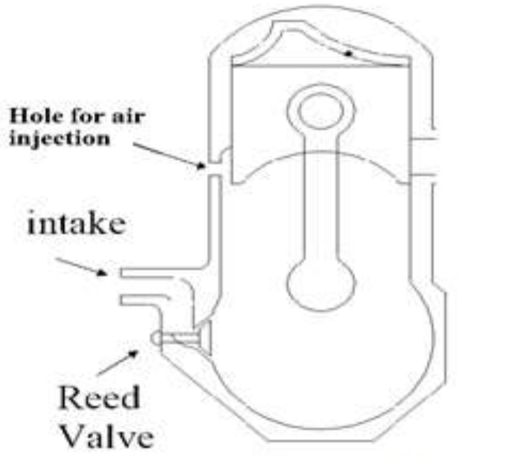

Fig. 1 Externally Scavenged Engine

3. EXPERIMENTAL APPARATUS

3.1 Experimental setup

The Experimental setup consists of a 150cc two stroke, one cylinder S.I.Engine, an engine test bed and an exhaust analyser. The schematic of the Experimental setup is shown in the figure 1.Specification of the base engine are given in Table 1.A view of test bed is shown in figure 2.Eddy current dynamometer is used to measure the torque developed by the engine. The engine speed is noted and useful or brake horsepower may be calculated.

3.2. Exhaust gas analyser

As described above, an exhaust gas analyser is used in this experiment. The DELTA 1600S analyser is used to measure exhaust gases. It is small and light weight analyser .Its responce time is 15s and flow rate approximately 1.2l/min.This analyser can measure carbon mono oxide(CO),Carbon dioxide(CO_2),Hydrocarbon(HCs),Oxygen(O_2) etc

Table 1 Test Engine specification

Type	2-stroke, S.I.
No. of cylinder	1
Displacement	149.56 cc
Bore	57 mm
Stroke	57 mm
Compression Ratio	8.7:1
Transmission	4-speed gear box
Peak power	1.3 Kgm at 3000 rpm

Fig.2 Experimental Set up

4. RESULTS AND DISCUSSION

4.1 Variation of Brake Thermal Efficiency with BP

The variation of brake thermal efficiency with Brake power for normal and modified engine is shown in Fig 5. It is seen that Brake Thermal Efficiency of modified engine is more than normal engine in all cases. This increase in Brake Thermal Efficiency for modified engine is attributed to higher oxygen content in the combustion chamber due to extra air aspired by engine. This air aspiration improves combustion process which leads to higher brake thermal efficiency. This is due to reduction in short-circuiting losses and increase in air-fuel ratio. Air-fuel ratio can be made slightly leaner by supplying extra air through the extra port.

It indicates that the engine can operate in leaner air fuel ratio without loss of power. This is achieved because of precise timing and design of externally scavenged port in modified engine.

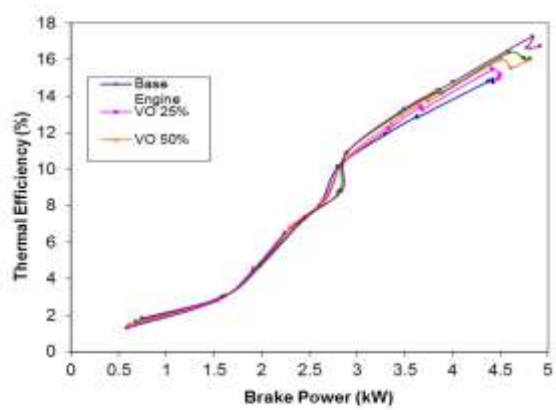

Fig. 3 Variation of Brake Thermal Efficiency with BP

4.2Variation of Exhaust gas temperature with Brake power

The variation of brake power on exhaust gas temperature is shown in Fig 6. Exhaust gas temperature increases with the increase in brake power in all cases.

Exhaust gas temperature is an indicative of the quality of combustion in the combustion chamber. The increase in exhaust gas temperature with engine load is clear from the simple fact that more amount of fuel is required by engine to produce extra power which is also needed to take up additional load. At the same time with increase in value opening exhaust gas temperature increases in all the cases. It is due to supply of leaner air fuel mixture to the engine cylinder.

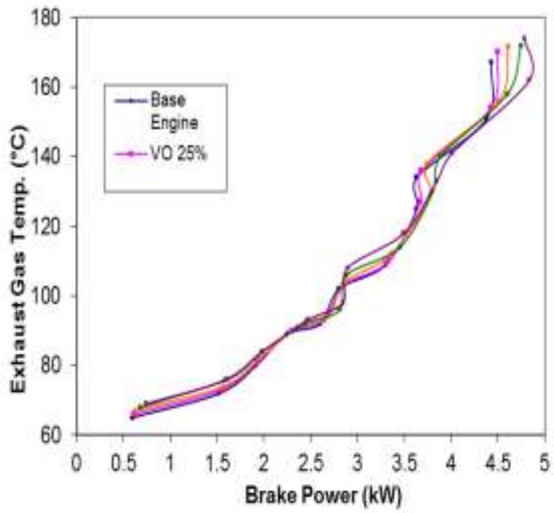

Fig 4 Variation of Exhaust gas temperature with BP

4.3 ANN for Brake power

MATLAB software is used for ANN simulation for the Brake Power. Feed Forwards Back Propagation neural network is used. The computer code is generated for this simulation of BP in MATLAB. Three layer simulation is used which is trained using Levenberg Marquardt algorithm.. Fig.5 shows the comparison of Experimental and ANN model of Brake Power. The values of the brake power are plotted for number of experiments obtained using ANN and experimental values. The results obtained by the ANN Simulations are in close agreement with the experimental values.

Regression analysis for the Brake Power is performed using regression analysis tool. Regression analysis represents training, testing, validation and overall data used for simulation. Since the overall regression coefficient is unity, there exists very strong correlation between the experimental and ANN data based model.

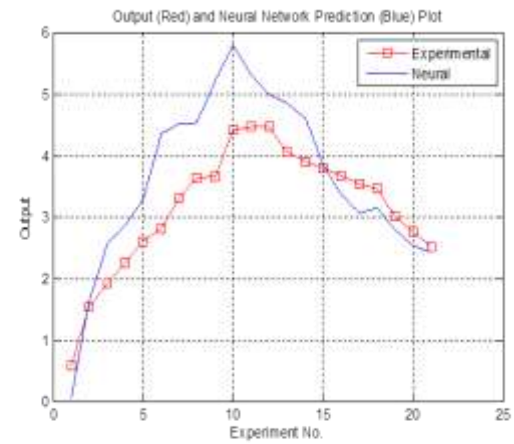

Fig. 5 Comparison of Experimental and ANN Simulation for BP

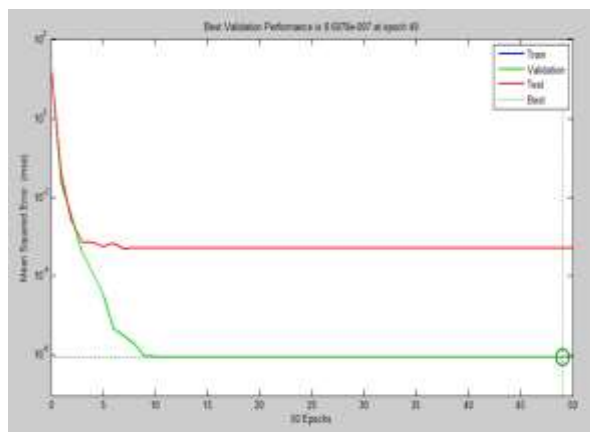

Fig.6 Validation Data for ANN Simulation for Brake Power

5. CONCLUSION

Externally scavenged engine gives superior performance as compared with base engine (Crank Cased Engine) Performance parameters like BP, BSFC are improved. ANN is an effective simulation tool to validate experimental values. ANN gives authenticity to the developed relationship between various engine parameters

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