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ANALYSIS OF SCAVENGING PARAMETERS IN TWO STROKE ENGINE

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ABSTRACT

The SI engines are of extreme importance to the automobile industry. The efficiency of the SI engine depends on several complicated processes, including induction, mixture, preparation, combustion, and exhaust flow. Externally scavenged engine is developed in I.C. Engine laboratory to eliminate short-circuiting losses and reduce the pollutant emitted by engine cylinder. This work deals with comparative experimental investigations carried out on a single cylinder two stroke S.I. Engine in carburetor mode with normal and modified scavenging system. The focus of the research presented in this paper is to estimate the scavenging parameters of a two-stroke externally scavenged engine by measuring various factors such as delivered charge, scavenging efficiency, retained mass, swept volume, delivery ratio, etc. Effects of external scavenged system on performance and emissions of two stroke engine are investigated at different loads and speeds by scavenging parameter calculations. Performance of externally scavenged engine is compared with crank-cased scavenged engine. Result show that scavenging efficiency and delivery ratio of modified engine is improved due to supply of leaner air-fuel mixture to the engine. The most outstanding result of using the external scavenged system is the significant reduction in the retained mass from engine.

KEYWORDS: *SI Engines, Scavenging Efficiency, Scavenging Parameters, Exhaust Emission*

Article History

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INTRODUCTION

The function of scavenging is the removal of the products of combustion from the engine cylinder by fresh air charge in preparation for the next working cycle. This process is common in all internal combustion engines. If the scavenging process is not proper, then there may be loss of power [3]. It also tends to increase in fuel consumption. So it becomes necessary to study the scavenging process to avoid the loss.

A detailed study of scavenging process is required to analyze the performance and scavenging parameters. This paper presents an experimental analysis of various scavenging parameters for various speed and load conditions. Experimentation is carried out on the modified engine in which a passage is made in the block for air aspiration to avoid the short-circuiting in the engine cylinder. So the process of scavenging is effective.

SCAVENGING PARAMETERS

To facilitate open discourse of two-stroke engine-related research and design, a large body of standard terminology has been created. This section will give a summary of the standard definition of terms that will be used to describe experimental configurations and the results later in this text.

The delivery ratio is defined as the ratio of the mass delivered to the mass the displaced volume of air has at ambient conditions,

$$R_{del} = \frac{m_{del}}{V_{swep} \cdot \rho_{amb}}$$

Where m_{del} is the mass of air delivered, V_{swep} is the volume swept by the piston each crankshaft revolution, and ρ_{amb} is the density of air at ambient conditions.

Scavenging efficiency, η is defined as the ratio of mass of retained charge to the mass the total mass trapped in cylinder:-

It can be calculated as

$$\eta_{sc} = 1 - e^{(-R_{del})}$$

Where, R_{del} is the delivery ratio.

The trapping efficiency is defined as the mass fraction of the delivered charge that is retained. It can also be expressed as the ratio of the charging efficiency to the deliver ratio.

It can be measured by the general equation

$$\eta_{trap} = \frac{\eta_{sc}}{R_{del}}$$

Charging efficiency, η_c, relates the retained portion of the delivered charge to the swept mass. It is measured by

$$\eta_c = \eta_{sc} \cdot R_{del}$$

ENGINE SPECIFICATION

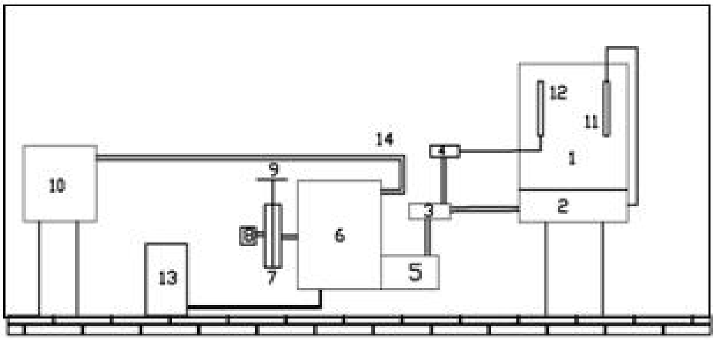
Table 1

Technical Specifications of the Engine Under Consideration		
Peak power	8.0 hp at 5500 rmp	Highest power amongst 2-stroke scooters
Peak torque	1.35 Kgm at 3500 rpm	Instantaneous pick-up
Engine		
Type	5-port single cylinder, 2-stroke with reed valve induction	Advanced engine for superior performance
Transmission	4-speed gear box	Smooth easy shifting
Clutch	Wet multi-disc type	
Operating cycle	Two-stroke spark ignition, 150 cc engine	
Compression ratio	6-10	
Bore	0.05-0.085 m	
Stroke/bore ratio	1.2-0.9	
Max rated BMEP	4-10 Atm	
Wt/power ratio	5.5-2.5	
Appr. Best Bsfc	350 (gm/kw hr)	

EXPERIMENTAL SETUP

The Experimental setup consist of a 150cc two stroke, one cylinder S.I. Engine, an engine test bed and an exhaust analyzer. 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 the test bed is shown in figure 2. The 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. an exhaust gas analyzer is used in this experiment. The DELTA 1600S analyzer is used to measure exhaust gases. It is small and light weight analyser. Its response time is 15s and flow rate approximately 1.2l/min.

Figure 1: Experimental Setup



1. Control Unit 2. Air Box 3. Carburattor 4. Fuel Meter 5. Crankcase 6. Engine 7. Dynamometer 8. Tachometer 9. Spring Balance 10. Air Box for Scavenged Air 11. Manometer 12 Burrete 13. Exhaust Gasanlyser 14. Direct Air Aspiration

Figure 2: Schematic Diagram of Experimental Setup

PLANNING OF EXPERIMENTS

- The first phases of investigation consist of evaluation of performance of engine to form base for further comparisons. This included the measurement of Brake Power, BSFC, exhaust gas temperature, HC and. CO at different load and speed.

- The second phase of the investigation consisted of modification of the base engine. Crank cased scavenged engine is converted into external scavenge engine. Scavenging port was designed so as to aspirate external air inside engine cylinder. The scavenging port diameter was calculated based upon volumetric efficiency and other operating parameters. This optimum diameter of scavenging port allows air to pass to combustion chamber so as to evacuate it with exhaust gases for better scavenging.

- In the third phase of investigation performance parameter of the external scavenged engine is evaluated. This included the measurement of BP, BSFC, exhaust gas temperature, HC and CO at different load and speed.
- In the fourth phase of investigation performance characteristic and exhaust emission of base engine was compared. Improvement in the performance characteristic and exhaust emissions were noted. All the tests were performed at constant speed and variable load and vice – versa.

RESULTS AND DISCUSSIONS

The variation of brake thermal efficiency with Brake power for the normal and modified engine is shown in Figure 3. 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 the higher oxygen content in the combustion chamber due to the extra air aspired by the engine. This air aspiration improves the combustion process which leads to higher brake thermal efficiency. This is due to reduction in short-circuiting losses and an 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.

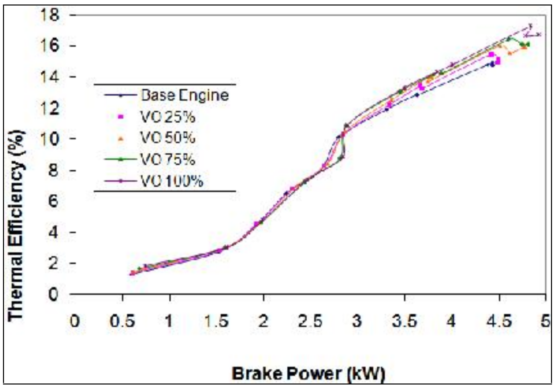


Figure 3: Variation of Thermal Effeciency with Brake Power

The folowing graphs were also drawn for the performance evaluation of an engine for evaluating scavenging parameters.

- Speed Vs Delivery Ratio
- Speed Vs Scavenging Efficiency
- SpeedVs Trappingl Efficiency
- SpeedVs Charging Efficiency

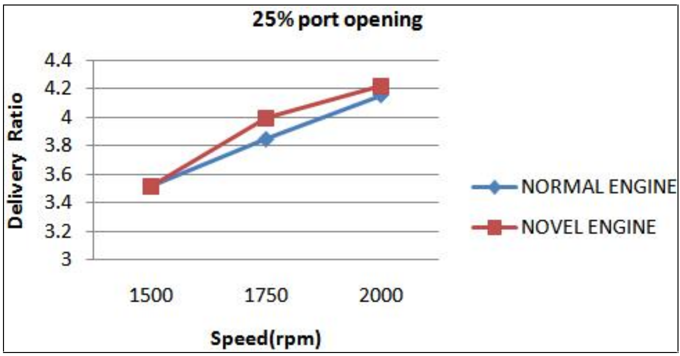


Figure 4: Delivery Ratio Vs Speed for 25% Port Opening

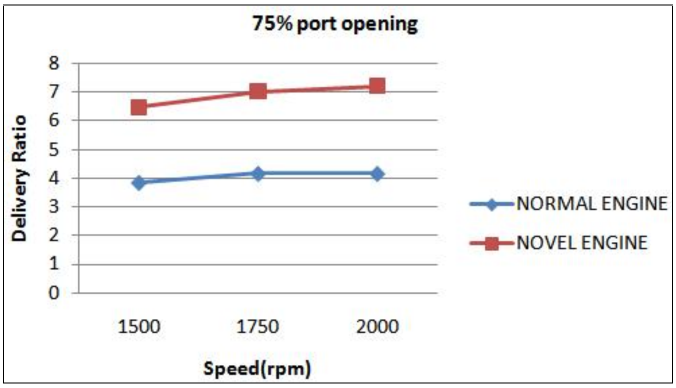


Figure 5: Delivery Ratio Vs Speed for 75% Port Opening

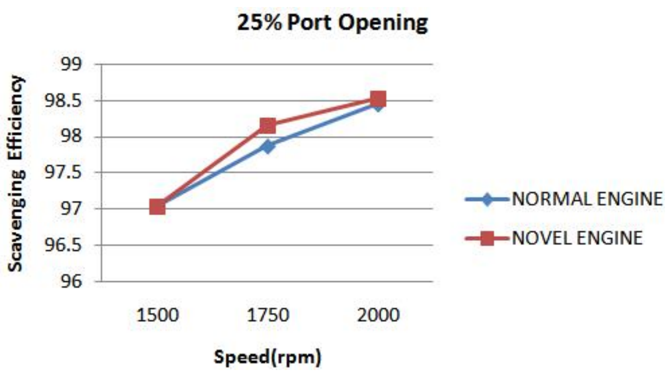


Figure 6: Scavenging Efficiency Vs Speed at 25% Opening

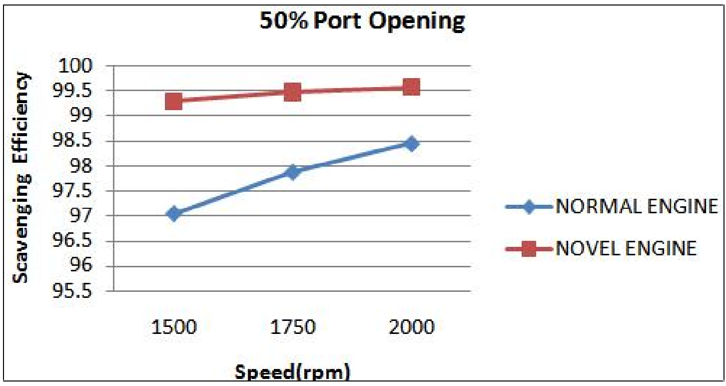


Figure 7: Scavenging Efficiency Vs Speed at 50% Opening

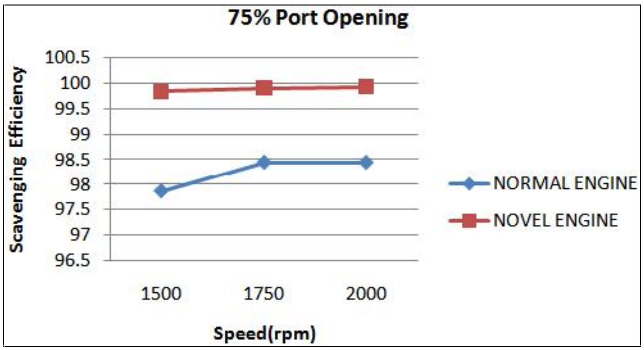


Figure 8:Scavenging Efficiency Vs Speed at 75% Opening

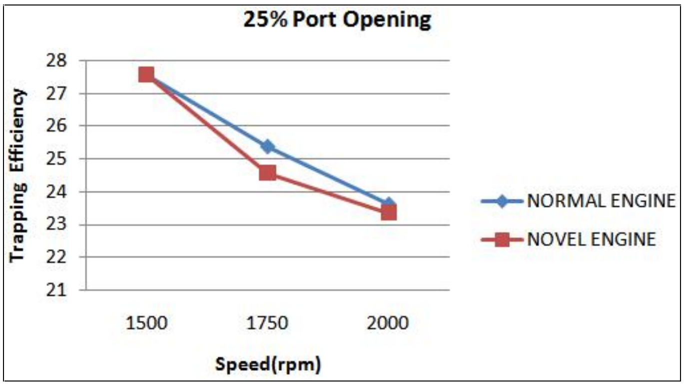


Figure 9: Trapping Efficiency Vs Speed at 25% Port Opening

CONCLUSIONS

Externally Scavenged engine developed in this investigation allows aspiration of air inside the engine cylinder without external devices. Reciprocating motion of the piston is sufficient for aspiration of external air, through the scavenging port. Externally scavenged engine gives superior performance as compared with a base engine (Crank Cased Engine) There is an increase in the delivery ratio, scavenging efficiency, charging efficiency and decrease in the trapping efficiency for different speeds and loads for novel engine. Increment in delivery ratio on an average is is 48.68% and decrease in trapping efficiency on an average is 48.1%

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