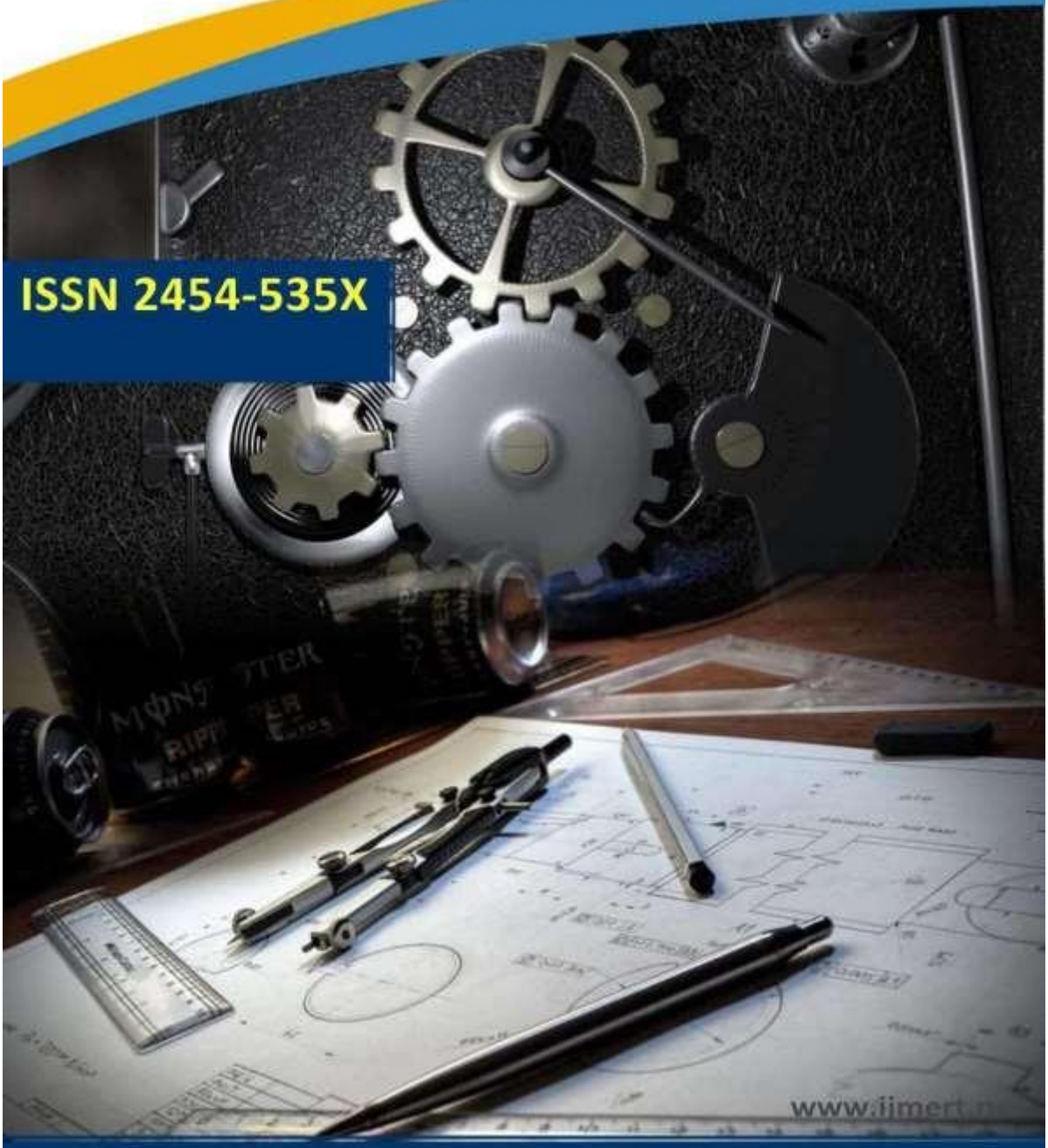
International Journal of Mechanical Engineering Research and Technology

ISSN 2454-535X



Email ID: info.ijmert@gmail.com or editor@ijmert.net

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

The Effects of Combustion Duration on Engine Emission Characteristics

K Dhananjay, S Vinay & B Venkatesh

†Faculty of Automobile technology, Hanoi University of Industry

*Corresponding Author Email: SVK@haui.edu.vn

ABSTRACT:

The purpose of this research is to study how the combustion durations get effect on engine emission characteristics. To achieve this goal, an experimental system is installed with dynamo testing system and a simulation model is established using AVL-Boost software. The simulation model is used to determine the residual gas ratio and engine emission characteristics. Inthis research, the combustion duration will be increased from 40 deg to 110 deg of crank angle and engine testing speeds are6000 rpm, 7000 rpm and 8000 rpm. The results show that: the combustion durations get big effect on residual gas ratio, effective real energy and engine performance. When combustion duration is changed, the residual gas ratio and effective real energy are changed in various trends of engine speeds. At the engine speed is 6000 rpm, the minimum residual gas ratio is 0.22% at 80 deg combustion duration and maximum effective real energy is 0.826 KJ at 60 deg combustion duration. With the engine speed is7000 rpm and 8000 rpm the minimum residual gas ratio is 0.14% and 0.15%. The residual gas affected the release energy and CO emission. The trend of residual gas was opposite those of effective release energy and CO emission. If the residual ratio was increased, then the effective release energy decreased and CO emission increased, and vice versa. The NO_x and HC emission has decreased when the combustion duration increased.

.KEYWORDS: combustion duration; residual gas; engine torque; engine power; effective real, energy,

INTRODUCTION

Combustion time is a crucial metric in the combustion cycle that shows the ideal burning process. Fuel cannot burn fully in a very brief combustion period, which means that some of the fuel's chemical energy will not be transferred to heat energy. Furthermore, longer combustion times result in higher thermal energy loss since it takes longer for heat to get from the fuel to the cylinder, piston, and flowing exhaust gas outside. A recent publication of study on the subject of combustion duration revealed the impact of combustion duration on engine performance. In addition, scientists are looking at the variables that fuels, engine speeds, engine load conditions, and ignition timing all have an impact on combustion duration. (Source:) This study illustrates the combustion duration trend.

EXPERIMENTAL SETUP AND MATERIAL

Experiment setup

Figure 1 shows the block diagram of the experimental setup and experimental system. The experiment is performed at enginespeed testing band from 3000 rpm ÷ 10000 rpm, compression ratio at 11.8:1, air/fuel ratio is 13,6 and air intake temperature is at 29,5÷30 deg C. Before doing the experiments, all the testing equipment is calibrated. The resistant moment of system is controlled by dynamometer. The engine oil temperatures is kept at 800C and engine coolant by air, the thermocouple, encoder sensors are used to measure oil temperature, intake air temperature, exhaust temperature and engine moment. Air and fuel go into the cylinder by intake manifold and injector, respectively. Air-fuel ratio is controlled by injector controller. The experiments are performed at steady state while the throttle angle is kept for 100% of opening. Because of the researching engine could able to provide maximum engine torque in the band of engine speed from 6000 rpm to 8000 rpm. Besides studying effect of combustion durationon residual gas, effective release energy and engine performance. This research also would like to point out the optimal combustion duration at that value engine has best torque. For those reason, this research will concentrate to present the result atengine

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

speed are 6000 rpm, 700 rpm and 8000 rpm.

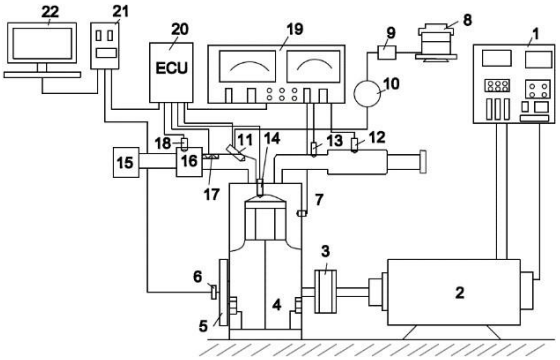


Figure 1. The block diagram of experimental system

This paper uses the small SI-engine as a research engine equipped for the motorbike. The applied engine specifications are shown in Table 1.

Table 1. Engine specifications

Parameter	Unit	Value
Engine model	-	Four stroke, Spark ignition
Number of cylinder	-	2(V-Twin)
Compression ratio	-	11.8:1
Bore	mm	57
Stroke	mm	53.8
Connecting rod	mm	107.9
Intake valve	-	2
Exhaust valve	-	2
Cooling system	-	Air cooled
Fuel		Gasoline

Simulation model

AVL-Boost is strong and effective software for simulation internal combustion engine. This software is able to simulate the engine 4 strokes or 2 strokes, spark ignition or combustion ignition engine. The applied range of engine's capacity is very wide; it is from small capacity of motorcycle engine to industrial engine. Figure 2 shows small SI-engine simulation engine model by AVL-Boost software. The elements in the simulation model describe for engine parts of researching engine. Those simulation elements are used to define researching engine's parts characteristics.

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

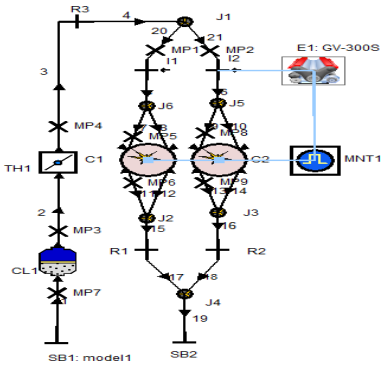


Figure 2. Simulation model.

The simulation condition of steady state or transient state is permitted to select in the engine element E1. The monitor element MNT1 is an extra element because this part is not in researching engine. This monitor element helps researcher is able to select observing output data as well as engine torque, residual gas ratio, effective release energy, etc. And the selected observing output data is able to shows in transient results. The element SB1and SB2 is system boundary of intake and exhaust pipe. Element CL1 is the air cleaner of the system. The opening of the throttle angle is set in element TH1, in this research the throttle is kept for opening 100%. The pressure loss in the intake and exhaust pipe (1, 2, 3…21) is described by element restriction R1, R2, R3. The element junction J1, J2, J3, J5, and J6 help to collect or to distribute the flow in the pipe. By using measuring element MP1, MP2 on the intake and exhaust pipe to determine the flow characteristic as well as: air mass flow, flowing velocity, air flow temperature. Injector I1 and I2 provides fuel in to cylinder C1 and C2 of the engine.

RESULTS AND DISCUSSION

After simulation model was validated, the effect of combustion duration on engine emission characteristic can be studied. The simulation results were discussed below.

Figure 3 shows when combustion duration is increased from 40 deg to 110 deg: at engine speed are 7000 rpm and 8000 rpm,the residual gas ratio has down trend from 0.25% to 0.13%. But At 6000 rpm, the residual gas ratio is decreased from 0.36%to 0.22 % after that increase to 0.3%. The minimum of residual gas ratio is 0.22% at 80 deg of combustion duration. It can beexplain by that at a low and medium engine speed, excessively long combustion duration can extend the burning process until the pistons are at BDC or even in the exhaust stroke. This process will affect the next intake stroke to reduce fresh air-fuel into the cylinder, thereby sweeping the exhausted gas outside.

Figure 4 shows the effect of combustion duration on BMEP. At 6000 rpm the maximum BMEP is 10.55 bar at 60 deg of combustion duration. At 7000 rpm, the maximum BMEP is 10 bar at 80 deg of combustion duration. At 8000 rpm, the maximum BMEP is 9.24 bar. Figure 5 shows the effect of combustion duration on brake specific fuel consumption. In each engine speed, we can find out a value of combustion duration at that the specific fuel consumption is optimal. At 6000 rpm the minimum BSCF is 319.8 g/KWh of 60 deg combustion duration. At 7000 rpm, the minimum BSFC is 373.5 g/KWh of 80deg combustion duration. At 8000 rpm, the minimum BSFC is 385.7 g/KWh of 80 deg combustion duration.

Figure 6 shows the effect of combustion duration on engine brake torque. At 6000 rpm, the maximum brake torque is 22.7 Nm of 60 deg combustion duration. At 7000 rpm, the maximum brake torque is 21.55 Nm of 80 deg combustion duration. At8000 rpm, the maximum brake torque is 20.25 Nm of 80 deg combustion duration.

Figure 7 shows the results of the NOx emission that decreased when the engine combustion increased because increased engine combustion decreased peak firing temperature. The peak firing temperature showed the greatest effect on NOx emission. When the peak firing temperature increased, the NOx emission increased; when peak-firing temperature decreased,NOx emission decreased.

Figure 8 shows that the CO emission trend was not maintained; this trend was similar to that of the residual gas ratio. At 6000rpm, the CO emission decreased and the combustion duration increased from 40 degrees to 80 degrees. After that, CO emission increased. At 7000 rpm and 8000 rpm, the CO emission trend decreased when engine combustion duration increased from 40degrees to 80 degrees. These results show that residual gas had a

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

large effect on the CO emission characteristics because the residual gas increased, this also in-creased the amount of fresh air in the next intake cycle, and the amount of oxygen in the cylinder decreased. This shows why increased residual gas increased CO emission.

when

Figure 9 shows that HC emission decreased when the combustion duration increased because of the increase in time neededfor complete fuel burning.

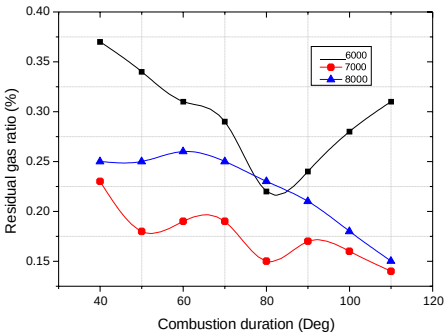


Figure 3. Residual gas ratio versus combustion ratio.

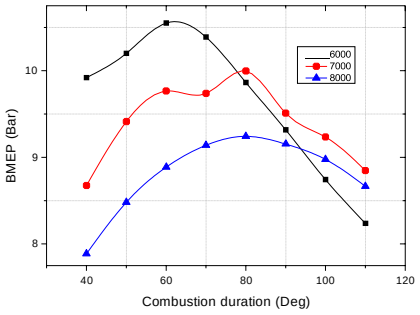


Figure 4. BMEP versus combustion ratio.

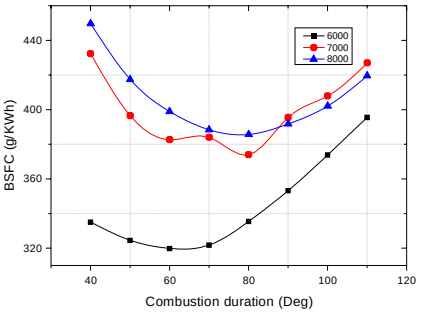
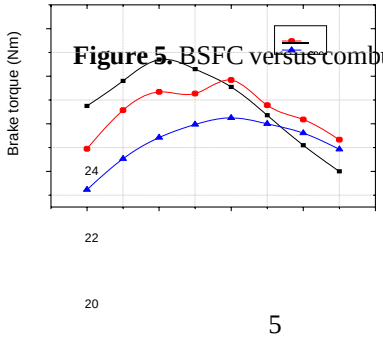


Figure 5. BSFC versus combustion ratio.



International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

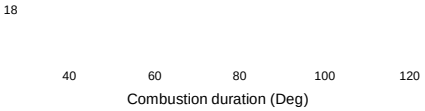


Figure 6. Engine torque versus combustion ratio.

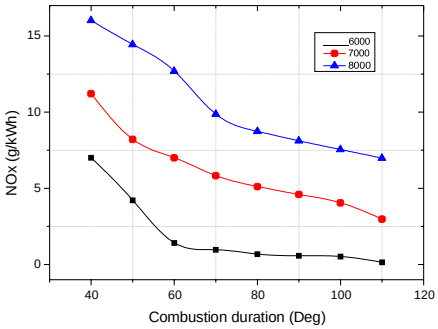
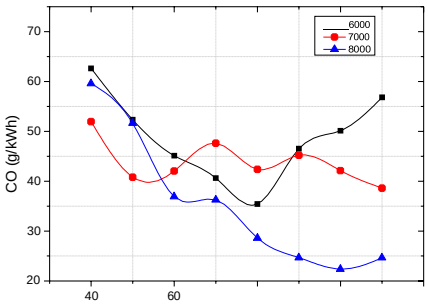


Figure 7. NO_x versus combustion ratio.



80 100120

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

Combustion duration (Deg)

Figure 8. CO versus combustion ratio.

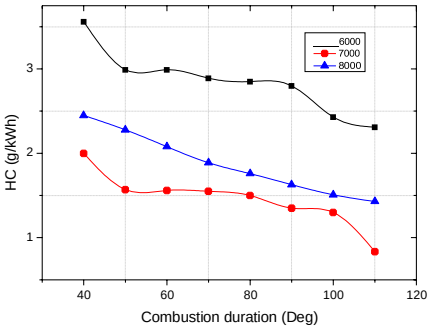


Figure 9. HC versus combustion ratio.

The above results reveal the importance of combustion duration in a small SI-engine and how this parameter influences the combustion stroke and other parameters such as residual gas ratio and engine emission characteristics.

CONCLUSIONS

The effect combustion durations on residual gas,

and engine emission characteristic of a motorcycle

engine has studied.The results show that:

1) The combustion duration has a large effect on residual gas, effective release energy, engine performance, and engine emission characteristics. The combustion duration has gotten different effects on residual gas, and effective release energy in different engine speeds.

2) BMEP, BSFC and engine brake torque is achieved at the same combustion duration value of each engine speed.

3) The results point out that: at engine speed is 6000 rpm and combustion duration is 60 deg then engine will give the optimalperformance. In this case, the engine is able to achieve the maximum brake torque is 22.7 Nm increases 4.13% bigger than when engine working at 7000 rpm and 80 deg combustion duration.

4) The residual gas affected the release energy and CO emission. The trend of residual gas was opposite those of effective release energy and CO emission. If the residual ratio was increased, then the effective release energy decreased and CO emission increased, and vice versa.

5) The NOx and

HC emission has

decreased when

the combustion

duration

increased.

REFERENCES

[1] B.G. Sun, H.Y. Tian, F.S. Liu, “The distinctive characteristics of combustion duration in hydrogen internal cobustion engine”. *International Journal of Hyrogen Energy*, vol. 39, I4472-I3378, 2014.

[2] M. Elmnifi, M. Amhamed, N. Abdelwanis, O. Imrayed. “Solar Supported Steam Production For Power Generation In Libya”, *Acta Mechanica Malaysia*, vol. 1, no. 1, pp. 5-9, 2018.

[3] B. Hakan, D. Orhan, “Development of an empirical correlation for combustion duration in spark ignition engies”. *EnergyConversion and Management*, vol. 45, pp. 1419–1431, 2004.

[4] M. Kumar. “A Novel Integer Programming Approach with Separable Structure for Scheduling Job Shops”, *Advances InIndustrial Engineering And*

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
www.ijmert.com
Vol. 7 Issue. 1, Feb 2015

Management, vol. 7, no. 2, pp. 30-45, 2018.

[5] A.E Dhole, R.B Yarasu, D.B Lata, "Investigations on the combustion duration and ignition delay period of a dual fuel diesel engine with hydrogen and producer gas as sec-ondary fuels." *Applied Thermal Engineering,* vol. 107, pp. 524– 532, 2016.

[6] A. Zada, S. Ali. "Stability Analysis Of Periodic And Almost-Periodic Discrete Switched Linear System, *Matrix ScienceMathematic,* vol. 3, no. 1, pp. 1-6, 2019.

[7] Z. Chunhua, Z. Ao, Y. Shen, Y. Li, Q. Shi, "Effects of combustion duration characteristic on the brake thermal efficiency and NOx emission of a turbocharged diesel engine fueled with diesel-LNG dual – fuel". *Applied Thermal Engineering,* vol. 127, pp. 312–318.

[8] E.O. Omini, O.M. Akpang. "Cavity Detection Under Re-Enforced Concrete Floor Using Ground Penetration Radar, *Engineering Heritage Journal,* vol. 2, no. 2, pp. 11-18, 2018.

[9] D.B Lata, A Misra, S. Medhekar, "Investigations on the combustion parameters of a dual fuel diesel engine with hydrogenand LPG as secondary fuels". *Int. J. Hydrogen Energy,* vol. 36, pp. 13808–13819, 2011.

[10] A Jehad, A Yamin., H. Gupta, Nm and B.B. Bansal. "The effect of combustion the performance and emission characteristics of propane-fueled 4-Strocke S.I. Engines". *Emirates Journal for Engineering Research,* vol. 8, no. 1, pp. 1-14, 2003.