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Turbulence kinetic energy analysis of a single cylinder engine

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ABSTRACT – In the paper show the study of time dependent and turbulence flow inside a cylinder of an alternative engine through the simulation investigation of the distribution of the turbulence kinetic energy in whole chamber. This investigation is carried out during at intake valve. CFD is used to predict the flow behavior in the single cylinder engine. Turbulence model of the inlet air in cylinder has bigger effect into the performance of the engine. Therefore, contours of Turbulence Kinetic Energy are presented to support results. From the results, it is found that the lower valve lifts had better turbulence kinetic energy value.

1. INTRODUCTION

Natural gas is delivered from gas or tied in with unrefined petroleum generation. Natural gas can be compressed and can be stored and use as compressed natural gas (CNG). Furthermore, natural gas is secured than fuel in numerous territory viewpoints. The ignition temperature for natural gas is higher than fuel and diesel. Also, natural gas is lighter than air and will disseminate upward quickly if break happens [1].

This can be accomplished by improving the tumble movement inside the engine cylinder, which upgrades the mean flow and turbulence of the mixture. Producing a huge vortex flows inside the IC engine cylinder amid the intake process generates high turbulence intensity during the later phase of compression stroke prompting quick smoldering rates [2]. In past work clearly delineates that the in-cylinder flows have predominant impact on the engine performance and emission characteristic. Along these lines, a superior comprehension of the in-cylinder flows in an IC engine is all that much crucial for the advancement of the engine parameters [3].

The cylinder speed, the cylinder chamber geometry, fuel utilization, in-cylinder liquid dynamics and ignition devices utilized, speak to distinctive variables that influence the internal combustion [4]. For the most part, the principal air movements were filled into categories such as the rotary movement induced tangentially in the cylinder (swirl) and the rotary movement in the axial plane (tumble) [2]. It is clear that the flow generation with intense vorticity (swirl and/or tumble) in the cylinder during the intake stroke is an efficient tool to obtain a great intensity of turbulence which can be kept up during the compression stroke.

2. METHODOLOGY

The purpose of this study is focused on the flow of the turbulence as well as the method used to analyze the air and fuel flow in the single cylinder engine. The main result obtained were the contours of Turbulence Kinetic Energy.

2.1 CFD simulation analysis

Simulation analysis consists of three elements which are pre-processing, solver and post processing.

2.2 Creation of 3D engine geometry

The geometry was created based on the actual single cylinder engine which is Robin Ey-20D. The process of creating 3D geometry begins with measurements of all parts involved like the intake and exhaust valve, cylinder head, piston, connecting rod and pin and lastly combustion chamber.

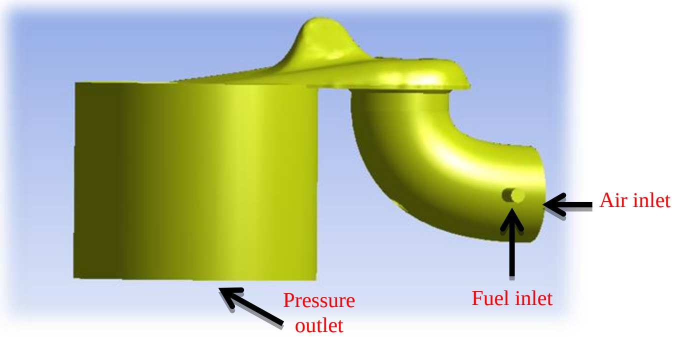


Figure 1 Boundary condition.

2.3 Mole fraction substance of methane, oxygen and nitrogen

The outlet pressure is set to zero in this simulation. The mass fraction at the outlet is calculated. Mass in each mole of the substances and mass fraction are as follows:

$CH_4 + 2O_2 + 2(3.76)\ N2 – CO_2 + 2H_20 + 2(3.76)\ N_2$

Table 1 Mass and Mole Fraction.

	Mass in one mole	Mass fraction
Methane	16.01	0.05508
Oxygen	64	0.220196
Nitrogen	210.64	0.72472
Total	290.65	

3. RESULTS AND DICUSSION

Results were analyzed and calculated for valve lifts 1.302 mm, 2.604 mm, 3.906 mm, 5.208 mm and 6.51 mm. The results of this simulation were presented in graphical views. Besides, the contour of turbulence kinetic energy, mass fraction and pressure distribution is going to be evaluated.

Table 2 Turbulence kinetic energy.

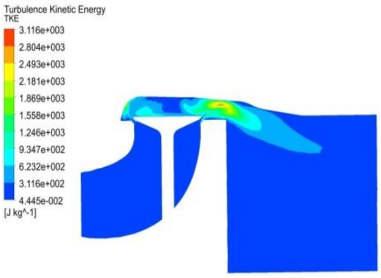
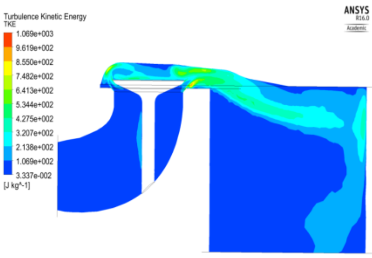
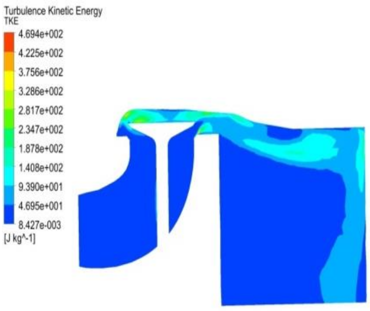
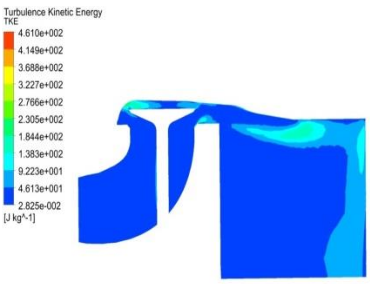
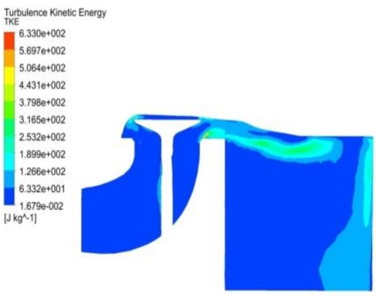
Valve lift	Result	Max. value
1.302 mm		3.116 kJ/kg
2.604 mm		1.069 kJ/kg
3.906 mm		0.4694 kJ/kg
5.208 mm		0.4610 kJ/kg
6.51 mm		0.6300 kJ/kg

Table 2 illustrates the Turbulence Kinetic Energy at the y-z axis at all value lifts. Referring to the table above, the brightest color indicates higher value of Turbulence Kinetic Energy. The brightest colors are more visible at the valve opening. Turbulence represents the irregularity of flows and it is beneficial in gaining the best air-fuel mixing propagation before combustion thus it may increase the combustion rates. Turbulence Kinetic Energy decreases as the value opening is larger due to the decreasing shear rate. For the graph below, it is proven that Turbulence Kinetic Energy is decreasingly as the valve opening increase in value.

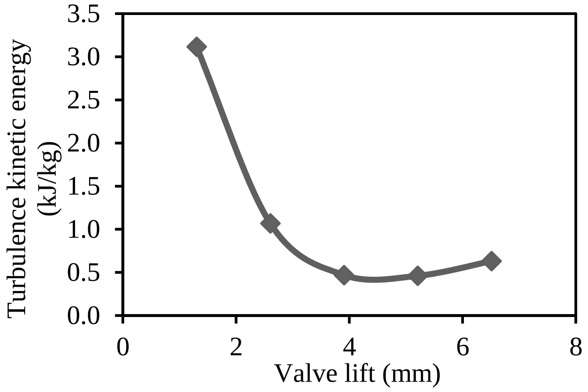


Figure 3 Turbulence kinetic energy for various valve lift.

3. CONCLUSION

At the lower valve lift which is 1.302 mm, the highest turbulence kinetic energy which is 3.116 kJ/kg compared to larger valve lift which is only 0.6300 kJ/kg. Thus, lower valve lift height gives better performance to the engine.

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