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# Cfd Modeling of the In Cylinder Flow In Direct-Injection Diesel Engines

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## ABSTARCT:

Internal combustion engines today is the best available source of reliable power for all industrial applications, local transport a large scale. It is called a key issue in the efficiency of these engines. All attempts to improve these engines tend to achieve maximum efficiency. Is improving the performance of diesel engines by appropriate design of the multi-slot, exhaust manifold, combustion chamber, piston, etc., the study on the impact of the configurations of the cylinder piston on the development of infrastructure. Here it is used for direct injection diesel cylinder and a study. For entry into multiple spiral density used a combination helicalspiral. An increase in the intensity of the vortex results in better mixing of fuel and air. Swirling speeds in the load can be significantly increased by proper design pressure piston. In this paper, it is a study on the impact of different air traffic piston configuration and turbulence within the cylinder direct injection (di) diesel out using the code computational fluid dynamics (cfd) fluent 13 . The three-dimensional models of pistons and cylinders openings are created in catia v5 and using 10.0 preprocessorhypermesh mix.

## INTRODUCTION:

Internal combustion engine and was a big part of the community for over 150 years. It has dramatically increased human prosperity and vital for our society that works day. However, the combustion process has a not inconsiderable negative european electronic system, such as local and global emission of pollutants side. Vehicle emissions have shown pose a health hazard in many large cities, among other things, of los angeles that because of its location is particularly prone to contamination. Smog is a serious threat to health, the agency for environmental protection (1998), and in order to reduce smog emissions legislation has been introduced. Europe began the so-called european legislation in 1992 with euro i standards governing oxides nitrogen, nitrogen oxides and particulate blocks per kilowatt hour of work. Since the organization has become more stringent, and

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in january 2014, all new trucks that meet european standards sixth.

Several strategies can be used to achieve these objectives emissions. Examples of such is the time of injection, selective catalytic reduction (scr), and exhaust gas recirculation (egr) to reduce emissions of nitrogen oxide, as well as filters and high injection pressure to reduce the mass of the particle. In general, these strategies lead to increased fuel consumption and / or cost. Therefore, q trade between local emissions (nitrogen oxides and particulates) and global emissions (second self-bonn dioxide, co2) are present. For the transport sector, and low fuel consumption is equivalent to less expensive. Therefore, the search engine manufactures to reduce fuel consumption for a given level of emissions. This is the main motivation of this-sis. Furthermore, fuel consumption is closely linked to emissions of carbon dioxide. Therefore, reducing fuel consumption and increasing the products and reduce emissions of carbon dioxide by the goods transported. Moreover, as the production of conventional crude oil reached in 2006, the international energy agency (2010), further increases in oil production is based on nonconventional more expensive sources, and perhaps that oil prices maintained. High and volatile. Due to high oil prices and a growing interest in climate change effort to minimize fuel consumption is likely to increase the economic and political reasons. In order to reduce fuel consumption without increasing emissions, and improve knowledge of all physical processes occurring in the essential engine. The work presented in this thesis aims to increase the understanding of the flow of pre-combustion, any amount of pressure and strokes. To make the united nations and understanding flow precombustion help drive manufactures to design amount of engineering that provide a flow field (rotation and analysis pages turbulence web) and formation of liquid (mixture of exhaust and inlet air) at the start of ignition (soi) in order to improve the combustion process. In this paper, the amount of flow and is considering the use of engineering platform called static test with fixed and changing the boundary conditions and raises the valve to better understand the dynamic effects during the drag spiral. He studied engineering and a detailed description of the constant flows. However, with the new boundary conditions, it has been found previously unknown effects of acceleration engineering and movement of the valve. The effect of pressure with engine geometry samples with initial conditions innovative. The initial conditions are used to study the effect of rotational motion it tends pressure experienced and the effects of agitation cycle. It was found to amplify fluctuations rotary pressure while stirring damped by rotation about the axis of the cylinder. In order to validate the methodology that has been turmoil it has several sessions and whose engine simulation engine. These simulations were also used to provide an improved and validate to calculate the number of the same spiral methodology.

**LITERATURE REVIEW:**

The main principle of the internal combustion engine is to convert chemical energy into mechanical work. There are several ways this can be done, but the most commonly used engine cycle is the four-stroke engine. The four-stroke engine works in four distinct, although sometimes overlapping, phases:

**Intake stroke**:(or induction stroke) the piston starts at top dead center (TDC), moving downward while the intake valves are opening. This process draws air through the intake ports pass the valves into the cylinder. The geometry of the intake ports directs the air, creating large-scale in-cylinder motions. Around the end of the intake phase, close to bottom dead center (BDC), the valves close.

**Compression stroke**: During the compression stroke, the piston moves up-ward, compressing the air. The ratio between the volumes at BDC and TDC is called the compression ratio. The compression stroke ends with the piston reaches ring TDC (TDC) and Combustion is initiated. During combustion, the chemical energy of the fuel is converted into potential energy in the form of pressure.

**Power stroke:** As the piston moves downward, the potential energy is converted into mechanical work. The power stroke is the only phase that performs work, while the other phases require work supplied by the other cylinders.

**Exhaust stroke**When the exhaust valves open around BDC, exhaust gases are rst evacuated by the pressure difference between the cylinder and exhaust manifold, i.e. the blowdown phase. Once the pressure difference has been reduced, the remainder of the exhaust gas is forced out from the cylinder by the piston. This is called scavenging.

**Combustion processes** For internal combustion engines, two different types of four-stroke combustion processes are traditionally used; spark ignited (SI) and compression ignited (CI) combustion. The former is used in gasoline engines, where the fuel is mixed with the air prior to TDC when a spark ignites the mixture. In the latter, the compression ignition engine, the fuel is injected close to TDC and the heatcaused by the compression ignites the fuel. This type of engine, use primarily diesel fuel and is often called diesel engines. In a spark ignited engines the fuel is mixed with the air at start of combustion (SOC). The combustion process is thus entirely premixed. In the direct injected diesel engine, several processes occur before and after the main discussion combustion

**METHODOLOGY:**

## Flow structures of internal combustion engines

The flow structures found in the cylinder of an internal combustion engine are characterized by swirl, tumble, squish and small-scale turbulence. During the intake phase, the fluid enters the cylinder through the valves, forming jets. The jets induce angular momentum forming coherent structures such as swirl and tumble, see Sec. 3.1. Some of the jet energy will be converted into turbulence and in the early to mid-intake stroke turbulence levels will be very high, Lumley (1999). In the second half of the intake stroke, turbulent production is significantly reduced as the intake jet vanishes. This in turn leads to a rapid decay of small-scale turbulence and by the end of the intake stroke only low levels of turbulence are found, Celik et al. (2005).

During compression, the increase in density and the changes in length scales (due to geometrical change) have an amplifying effect of the remainder of the turbulence, Lumley (1999). Moreover, the reduction of geometrical length scales affects both tumble and turbulence level, Sec. 3.1. For pistons with a piston bowl an inward fluid motion will be introduced at the end of the compression stroke known as squish,

**3.1. Swirl and tumble**

Engine swirl number, SN, is defined as the gas angular velocity around the cylinder vertical center axis, $_{Swirl}$, normalized by the angular velocity of the crank shaft, $_{E}$, Eqn. (3.1) see Heywood (1988). Tumble number (TN) is defined as the gas angular velocity around an axis perpendicular to swirl, Tumble, passing the cylinder center of gravity, Eqn. (3.2). A more thorough description of how swirl and tumble numbers are calculated can be found in below

$$SN = \frac{\Omega_{Swirl}}{\Omega_E} \quad (3.1)$$

$$TN = \frac{\Omega_{Tumble}}{\Omega_E} \quad (3.2)$$

The strength of the different motions can be chosen by careful intake port design. If a swirling motion is wanted, the flow from the intake ports should be directed in the tangential direction of the cylinder. Tumble can be created in a similar manner by adjusting the angle to the cylinder axis at which the flow enters the cylinder.

Both swirl and tumble are large-scale structures that dissipate slowly. Sub-jected to compression, swirl and tumble will be affected differently. As the angular momentum around the cylinder axis is conserved during compression (if viscosity losses are small), the evolution of swirl depends solely on moment of inertia around this axis. For a piston with a bowl, the moment of inertia around the cylinder axis is decreased (mass is directed inward) and swirl is increased during the late part of compression. The tumble motion is affected by both a change in angular momentum (will be discussed in the next section) and a decrease in moment of inertia. The decrease of moment of inertia will act in order to increase the tumble angular velocity.

Hall &Bracco (1987) noticed that the swirl number was approximately constant with engine speed. However, Liou&Santavicca (1983) observed a decrease in swirl number with engine speed. This discrepancy is likely caused by engine breathing capacity, Hill & Zhang (1994). Although there are excep-tions, Daimler (2011), most CI engines exhibit a swirling gas motion, as swirl has been found to reduce soot emissions in CI engines, Jayakumar et al. (2012);

Benajes et al. (2004); Dembinski&Angstr•om (2013). The reduction of soot is caused by two e ects; rstly, by de ecting the fuel spray and thus hindering it from reaching the wall; secondly, by increasing the post-oxidation of the soot. However, an

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increase of swirl increases heat transfer to the cylinder walls, Hill & Zhang (1994); Woschni (1967). An increase of swirl has also been linked to an increase of premixed combustion leading to higher peak combustion tem-peratures and consequently higher thermal thermal$NO_x$, Benajes et al. (2004); Dembinski (2013). Jayakumar et al. (2012) also found that increasing the swirl number from a modest 1.44 to a very high 7.12 increased the particle number in the exhaust. According to Vermorel et al. (2009) low tumble numbers in-creases cycle-to-cycle variations for SI engines, which is consistent to what was reported by Fogleman et al. (2004).

Tilt angle

The ratio between swirl and tumble has been defined using the angle between the axis of rotation and the cylinder axis, in this thesis referred to as the tilt angle, see Fig. 3.1. Zero and ninety degree tilt angle is equivalent to pure swirl and tumble, respectively.

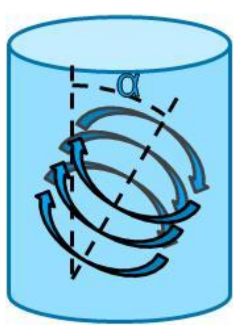


Figure 3.1. Definition of tilt angle,

**RESULTS:**

The moving mesh is generated by DYNAMIC MESH ROUTINE, a moving mesh module in FLUENT. In engine operation, valves and the piston move, so the mesh should move according to the real engine in order to simulate the charge of valve and piston position with crank angle. Piston and piston bowl movement are decided by the stroke, connecting rod and crank angle. Calculation starts at 360o CA and ends at 1080o CA.

A cold flow analysis is performed for this purpose. Cold flow simulations for IC engines can provide valuable design information to engineers. These simulations allow for the effect on volume efficiency, swirl and tumble characteristics to be predicted based on changes in port and combustion chamber design, valve lift timing, or other parameters.

**6.1 Pressure and temperature**

The graphs Fig 5 and 6 shows pressure distribution, temperature distribution are plotted against the time step for various cases. Note that each increment of a time step is equals to an increment of 0.25° of crank angle. Piston starts from TDC about 0

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degrees and the maximum pressure reaches at 360 degree. At the start of combustion after the ignition delay there is a sudden change of slope of the p-θ curve. The pressure rises rapidly for a few crank angle degrees, and then moves slowly towards a peak value. The Maximum pressure and end of compression stroke is 60 bars and temperature is 980 K.

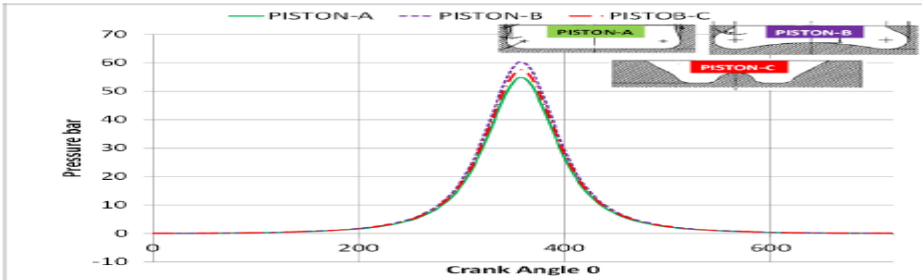


**Figure Pressure Vs. crank angle**

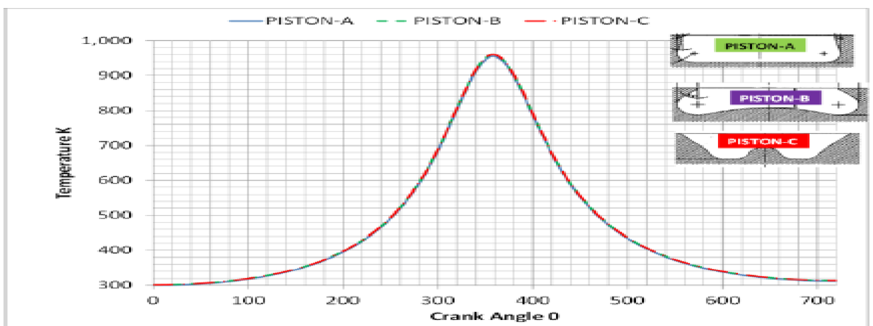


**Figure Pressure Vs. crank angle**

**Swirl and Tumble ratio inside the cylinder**

Swirl and tumble ratios are generally defined as the ratio of the angular momentum of the in cylinder flow about each of the three orthogonal axes. It is normalized against the same gas rotating as solid body the same axes at crank speed. The usual method for determining these ratio is, first the centre of the combustion chamber is determined. Then the X, Y and Z are dined with the origin of the centre of the mass. The Z axis is defined as being parallel to the line of piston motion. The Y axis is defined as perpendicular to Z and parallel to central axis of the inlet manifold. Finally, the X axis is defined as perpendicular to Z and Y.

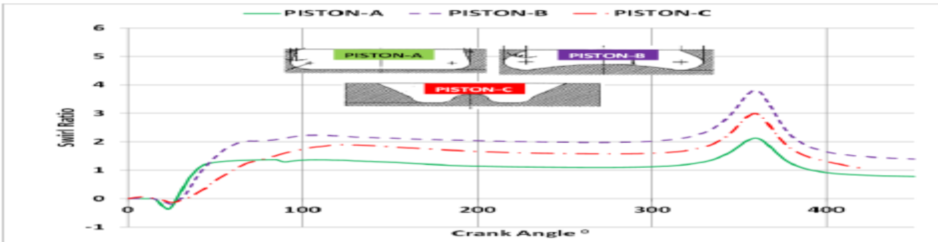


**Figure Swirl ratios for different piston configurations**

**CONCLUSION:**

It is the motivation behind the development of any internal combustion engine in the first place fuel efficiency and emissions requirements. This requires adjustment operations in the cylinder flow, the mixture formation and combustion. optimal design for a container dose / exhaust port, valves and pistons is essential to meeting the above requirements. The use of computational fluid dynamics (CFD), along with optimization tools can help shorten the cycle time optimal design. The traditional approach of experiments using flow bench testing is very expensive and a waste of time. Moreover CFD allows penetration into the small details that would not capture flow through flow bench tests. Air movement inside the intake manifold is one of the most important factors engine and emission control performance of multi-cylinder diesel engines. And therefore the study of literature is a spiral vortex eat multiple combination. amplifying piston geometry air movement at the end of the compression stroke. In this project work, research and internal flow in the combustion chamber of the diesel calculation for different property settings piston engines. The solution to the equations governing the unsteady flow, three-dimensional, compressible, and turbulent two RNG model equation ε k to watch the complexity of the geometry and movement of fluids.general flow field was examined within the combustor and different quantities, such as pressure, speed distribution, swirl and tumble dry proportions for the three types of pistons.

Swirl and rotate proportions can be obtained very accurately, for both production and search engines by using computational fluid dynamics. Comparative summary is as follows:

1. piston by creating a spiral of increasing piston within the cylinder C.

2. piston provides a higher volumetric efficiency. This is achieved by improving the volumetric efficiency facing the piston C.

3. kinetic energy of the piston C provides the highest with problems and find the x and the ratio of y.

4. Piston and provide relatively low proportion turbulence, the lower the turbulent kinetic energy and a lower volumetric efficiency

**REFERENCES**

[1] Aita S, Tabbal A, Munck G, Montmayeur N, Takenaka Y, Aoyagi Y, *et al.* . Numerical simulation of swirling portvalve- cylinder flow in Diesel engine. SAE 910263, 1991

[2] Benny Paul1, V. Ganesan, Flow field development in a direct injection diesel engine with different manifolds, International Journal of Engineering, Science and Technology Vol. 2, No. 1, 2010.

[3] Celik I, Yavuz I, Smirnov A. Large eddy simulations of in-cylinder turbulence for internal combustion engines: A Review. Int J Engine Res 2001;2(2):119–48.

[4] Chen A, Veshagh A, Wallace S. Intake flow predictions of a transparent DI Diesel engine. SAE 981020, 1998.

[5] Dillies B, Ducamin A, Lebrere L, Neveu F. Direct injection Diesel engine simulation: a combined numerical and experimental approach from aerodynamics to combustion. SAE 970880, 1997

[6] F. Payri , J. Benajes, X. Margot , A. Gil, CFD modeling of the in-cylinder flow in direct-injection Diesel engines, CMT-MotoresT_ermicos, Universidad Polit_ecnica de Valencia, Camino de Vera s/n, 46022 Valencia, Spain.