# NEW FUELLING STRATEGIES FOR PORT INJECTION SPARK IGNITION ENGINES TOWARDS IMPROVEMENT IN FUEL CONSUMPTION AND EXHAUST EMISSION

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# CONTENTS

# ABSTRACT

Multi-point fuel injection (port injection) become popular with most passenger cars as it eliminates most fuel transportation problems through the induction system. It provides an excellent fuel distribution, fuel consumption and less exhaust emission. However, fuel deposition on the inlet port wall and on the valve stem and shoulder, in particular, during transient and low speed running forced many car manufacturers to investigate the direct fuel injection as an alternative fuelling strategy. In this method, the fuel is injected directly inside the cylinder. Therefore, problems related to fuel deposition and cyclic combustion variation will be eliminated completely. Mixture preparation of the air and fuel injection at the inlet port has considerable effect on the engine performance, fuel economy and emission characteristics. Therefore, enhancement of mixture formation before induction into the cylinder was the major concern of many investigators.

In this study investigation is carried for the direct fuel injection through a three-dimensional, two-phase computer model. Fluent software is used to model the air flow and the fuel spray behaviour. The engine geometry is based on a WIRA 1.6 engine. The study was conducted with different engine speeds, spray location, and fuel injection angles.Maximum air velocity is found to be at the exit of the inlet valve. There are two highly turbulent domains observed on both sides of the inlet valve and a stagnant domain below the valve face. The fuel injection angle has to be offset by a $30^\circ$ relative to the valve stem axis, gives a significant spray distribution in the cylinder.

A Laser Imaging System is used to invetigate the fuel spray developments in terms of the spray angle, spray penetration and the radial axis. The fuel spray characteristics in terms of the fuel droplet velocities in two dimensional and the fuel droplets diameter, was studied by the Particle Dynamic Analyzer (PDA) system.

Fuel spray generated from a fuel injector was used in the experimental investigation. The fuel injector is extended from the modification of the fuel system of the Wira 1.6L engine. It was found that the spray angle stays at $36.8^0$ at all engine speed. This is because the fuel pressure at the nozzle inlet (at the main trail) is constant. Results reveals that te diameter is in a range of 65 um to 80 um. The droplet diameter show a tendency to increase with high engine speed.

A further study was carried out to explore the behavior of the flow inside the cylinder. Three different configurations concerning the shape and design of the piston head and combustion chamber were investigated. The direct injection inside the cylinder during the compression stroke (as the case in CI engines) is conducted at an engine speed of 2000 rpm. The piston is located at three different positions from the top dead. Results show that with a flat piston head, about 70 % of the fuel spray move towards the right side of the inlet valve leads to poor improper mixing of the air and the fuel. However the modified piston head controls effectively the distribution of the fuel within the cylinder, providing a swirl effect enhancing a better mixing of the fuel and air. As the piston moves up towards the top dead center the air velocity increase as noticed in all the cases studied. The modified combustion chamber with a normal piston show a slight better air fuel distribution. It was noticed that piston shape has more significant effect on the velocity distribution compared to the other cases. Moreover the velocity of the air fuel mixture is increasing towards the core of the cylinder providing optimum mixing of the charge around the spark plug.