

Ekkawut Pattarajaree 2011: A Numerical Study of Intake Flow Phenomena in Diesel Dual Fuel Engines. Master of Engineering (Mechanical Engineering), Major Field: Mechanical Engineering, Department of Mechanical Engineering. Thesis Advisor: Mr. Tanet Aroonsrisopon, Ph.D. 119 pages.

Diesel dual fuel is an alternative operating mode for internal combustion engines. Diesel dual fuel engines have been defined in several approached. The dual fuel system of interest in this research work was one with natural gas port fuel injection and diesel being directly injected into the combustion chamber. The computational fluid dynamics (CFD) simulation model was established to investigate flow phenomena in a four-cylinder four-stroke engine under steady-state engine operations.

In this study, the engine conditions were part-load operations at 1400 and 2600 rpm. This research work consisted of 3 parts. The first part was to study effects of port-injection timings on flow behavior and mixture distribution in an intake manifold. The second part was to investigate in-cylinder flow phenomena prior to the diesel injection timing. The investigation was performed for two case studies: 1) locations of natural gas injectors connected by rubber hoses to either a circular port or a rectangular port, and 2) use of a swirl control valve installed at intake ports. The swirl control valve was set at fully closed position, 30°, and 60° opening angles. The comparisons were also made for the condition without a swirl control valve installed. The final part was to examine the situation if this engine was converted to a dedicated natural gas engine. The investigation was on the effects of piston-bowl shape on mixture distribution in the combustion chamber prior to the spark timing. For all simulation runs, pure methane (CH₄) was used as a surrogate fuel natural gas.

In the first part, results indicated that the most end of injection timing was at 270° before TDC of compression. If the port injection was at other timings, it could cause greater amounts of methane remained in ports and intake manifold. Moreover, some of these methane amounts entered other cylinders causing larger variations in methane trapped in each cylinder after IVC. In the second part, it was found that switching the CH₄ injection from a circular port to a rectangular port affected the CH₄ distribution in the cylinder under engine operation at 1400 rpm. However, at 2600 rpm, the effect on CH₄ distribution became less pronounced. Furthermore, use of the swirl control valve showed significant effects on the turbulence kinetic energy (TKE) and mixture gradient in the combustion chamber. By comparing the opening position of the swirl control valve, the fully closed position demonstrated the highest TKE in the piston bowl region. With the fully closed position, the mixing between CH₄ and the air could be improved as it produced high vorticity in the region with high mixture gradient. Finally, in the last part, engine operation using $\lambda = 1.6$ with the original piston shape provided local λ around the spark plug closest to 1. Results from this research will be further used as a guideline for improvements and developments of engine modifications.

Student's signature

Thesis Advisor's signature