Direct Injection and Spark Controlled Jet Ignition to Convert A Diesel Truck Engine to LPG

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Jet ignition and direct fuel injection are potential enablers of higher efficiency, cleaner Internal Combustion Engines (ICE). Very lean mixtures of gaseous fuels could be burned with pollutants formation below Euro 6 levels (in the ultra-lean mode), efficiencies approaching 50% full load and small efficiency penalties when operating part load. The lean burn Direct Injection Jet Ignition (DI-JI) ICE uses a fuel injection and mixture ignition system comprising one main chamber direct fuel injector and one small size jet ignition pre-chamber per engine cylinder. The jet ignition pre-chamber is connected to the main chamber through calibrated orifices and accommodates a second direct fuel injector. In the spark plug version, the jet ignition pre-chamber includes a spark plug that ignites the slightly rich pre-chamber mixture that then bulk ignites the ultra lean, stratified main chamber mixture through multiple jets of hot reacting gases entering the in-cylinder. This paper uses coupled CAE and CFD simulations to provide better details of the operation of the jet ignition pre-chamber. They have been analysed so far with downstream experiments or standalone CFD simulations, enabling a better understanding of the complex interactions between chemistry and turbulence that governs the pre-chamber flow and combustion. CAE simulations are performed for a production 11 litre, in-line six, 24 valve Diesel Truck engine. It is turbo charged, with inter cooler and cooled Exhaust Gas Recirculation (EGR). It is modified to fit the jet ignition pre-chamber and run propane fuel by replacing the Diesel fuel injector with a direct injector for the LPG fuel plus reducing the compression ratio and changing the piston shape. Operation full load with same air-to-fuel equivalence ratio ?=1.55 is considered first. The load of the DI-JI LPG engine is then reduced by reducing the quantity of fuel injected Diesel like. The DI-JI LPG engine shows better than Diesel full and part load performances.

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