Improvement on Cylinder-to-Cylinder Variation in PCCI Engines Using Variable Start of Injection and Exhaust Valve Closing Timings

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Premixed charge compression ignition (PCCI) is widely considered to be a possible method of meeting increasingly strict emissions regulations in internal combustion engines. PCCI can reduce harmful emissions substantially and at the same time increase efficiency relative to conventional combustion modes. Because of the nature of PCCI, changes in in-cylinder conditions have a greater impact than in conventional diesel engines. Therefore cylinder to cylinder variations are amplified which leads to problems such as misfire and decreased efficiency in cylinders with increased ignition delay and lower apparent heat release rate (AHRR) amplitudes. Two possible methods to counteract this effect in diesel engines were studied. First a GT-POWER simulation showed that by altering the start of injection (SOI) for each cylinder individually it is possible to move the start of combustion (SOC) for individual cylinders back. Second a method of advancing SOC and increasing AHRR amplitudes by using early exhaust valve closing (EVC) to trap hot exhaust gases in cylinders was simulated in GT-POWER and analyzed. GT-POWER simulations showed that moving SOI forward successfully resulted in earlier SOCs. Through analysis of the same simulation data it was determined that SOI should be advance by 0 to 3.44 crank angle degrees (CAD) from the nominal SOI timing. The simulations indicated that the EVC altering method would not have the desired effect on SOC and this result was analyzed. This work provides a method of decreasing cylinder to cylinder variations thus increasing the stability and efficiency of PCCI combustion.