Towards Engine Downsizing: Examining the Effect of Injection Strategies and Novel AC Ion Sensor on Preignition Tendency of Spark-Ignited Engines

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Preignition (PI) is an abnormal form of combustion that has recently emerged as a bottleneck towards engine downsizing and improved efficiency in spark-ignited engines. Several speculative theories in regards to the cause of preignition have been proposed, however none have been verified. Fuel-lubricant oil interaction on the cylinder liner is thought to be a major stimulus of the phenomenon. In this regard, this research tests varying injection strategies, leading to different levels of homogeneity and fuel impingement on the cylinder liner, to establish potential causes of the preignition phenomenon. The injection strategies include going from central direct injection to side direct injection to port injection of gaseous fuel and various combinations. Thereof, it was found that preignition tendency is heavily dependent on fuel impingement on the cylinder liner. Mixture homogeneity was found to be a major factor in establishing the preignition tendency of a spark-ignited engine. After 56x6000 cycles of each optimized injection strategy, central direct injection was found to be the worst offender, whereas port injection of gaseous fuel registered zero PI events. The next step was the proposal of an AC ion sensor apparatus. This novel apparatus will provide (1.4ms) to take evasive measures, such as the restriction of fuel injection, reduction of throttle opening, or adjustment of camshaft. The results of this research may lead to the complete obliteration of preignition in SI engines, paving the way towards further engine downsizing.

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