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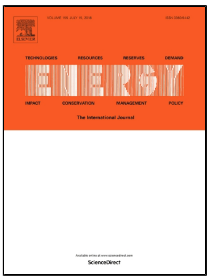

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Efficiency enhancement of spark-ignition engines using a Continuous Variable Valve Timing system for load control

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Abstract

In this work, a Continuous Variable Valve Timing (CVVT) system for load control in spark-ignition engines is proposed, analyzed, and compared with a conventional Throttle-controlled Engine. An analytical model for ideal processes is initially developed to study the performance of both cycles during part-load operation. Then, irreversibilites comprising charging dilution effects and heat losses during compression and expansion strokes are considered to approach a more realistic engine operation. At full-load, both cycles reach a maximum efficiency corresponding to that of an Otto cycle. However, a reduction in the efficiency occurs at part-load operation, with the CVVT Engine having a higher efficiency with respect to the Throttled Engine due to its unthrottled load control mechanism, which avoids power consumption caused by friction during air intake. It is found that charge dilution exerts a strong impact in the net power output and efficiency of both cycles. Additional reductions in power output and efficiency are caused by heat losses. At part-load operation, lower temperatures and pressures are reached in the CVVT Engine, which imply lower mechanical stresses that favor engine lifetime. It also represents a potential for additional efficiency enhancement via increasing combustion temperature. Finally, a fuel economy estimation analysis is carried out to provide quantitative assessment about the economic advantage of the proposed CVVT Engine. From this analysis, a fuel economy increment of up to 4.1% is obtained for a CVVT Engine with respect to a Throttled Engine at a 20% to 30% load, which is typical of a real vehicle engine operation.

Keywords: Continuous Variable Valve Timing Engine (CVVT Engine), Throttled Engine, Efficiency Enhancement, Irreversible Engine Operation, Fuel Economy.