Flexible valve timing strategies for boosting a small four-stroke spark ignition engine performance

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ABSTRACT

Variable valve timing (VVT) technology has been successful in enhancing internal combustion (IC) engine performance. VVT offers an additional control on engine breathing so that the engine operating conditions may be tailored more precisely hence, output and performance are amplified. In this paper, an approach of boosting IC engine performance through flexible valve timing (FVT) is presented. A numerical baseline model was developed using one-dimensional numerical simulation tool based on a 65cc four-stroke gasoline engine. The flow coefficient values of intake and exhaust ports were obtained from flow bench experiments. The baseline model was validated against specification from manufacturer and results from previous research. This model undergone performance tuning to obtain the power and torque curves for the whole engine speed range. Next, performance optimization was conducted through design of experiments (DoE) with the target of boosting the torque and power of the baseline model between 5 to 10% for the engine speed from 1,500 until 6,000rpm. This was obtained through the variation of intake and exhaust valves timing as well as maximum lift using a full factorial experiment with three levels. The DoE experiments have identified several optimum FVT profiles. The result has shown an increase of up to 13% in brake power than the baseline. Volumetric efficiency is improved resulting in corresponding BMEP amplification. Finally, the potential of FVT system implementation is illustrated through laboratory prototype linear motor direct actuation system. The linear motor motion control preliminary testing has shown 4 to 11% difference between the demand and actual positions of the valve closing position. In conclusion, this study has shown high potential of FVT strategies which can improve engine performance over the whole range of engine speeds.

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