OVER-EXPANSION RATIO VARIATION IN ELLIPTICAL ROTARY ENGINE

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Over the last two decades, the Atkinson-cycle engines have been successfully used in hybrid electric vehicles and range extended electric vehicles and have exhibited great fuel economy and emission performance [1]. In this study the novel elliptical rotary engine was studied. This engine has valuable advantages such as: low weight and dimensions, large specific power and excellent engine balance [2]. The Atkinson thermodynamic cycle, which is realized in elliptical rotary engine, is of special interest in the field of improving the thermal conversion efficiency. The whole essence of the Atkinson cycle is the disparity between engine's cycles: the expansion is longer than the compression. The disparity allows to extract more energy from the gases during the expansion cycle and, therefore, to increase the thermal efficiency of the engine. In the present study, the effect of the over-expansion variation by means of adjustment of intake port closure timing relative to bottom dead center is numerically investigated [3].

The exhaust port open (EO) and intake port closure (IC) timings are adjusted by asymmetrical ports arrangement on the engine's rotor. The variation of EO and IC with following over-expansion ratio (OER) can be seen on the over-expansion diagram (Fig. 1). It can be seen that over-expansion ratio exceed unity either early or late IC as regard to the bottom dead center at 180 crank angles. In both cases the compression stroke becomes shorter than expansion. As a result, fewer air-fuel mixture trapped at the combustion chamber and power density is decreased. On the other hand, the expansion stroke is extended and more energy from combustion can be obtained.

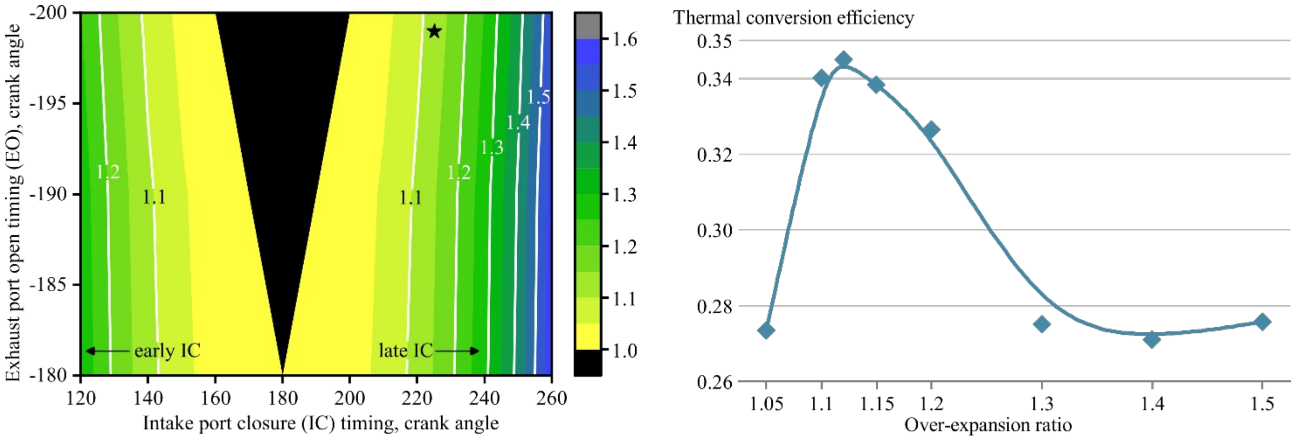

Fig. 1. Over-expansion ratio diagram (left) and thermal efficiency evolution (right).

The OER variation affects the thermal conversion efficiency (Fig. 1). Increasing the OER from 1.05 to 1.15 can improve engine efficiency, due to more complete expansion of gases allows more work to be obtained from each cycle. This results in increased engine power and lower specific fuel consumption. However, increasing the OER from 1.2 to 1.5 can lead to decreased engine efficiency. This can be explained by lower volumetric efficiency. Thus, the optimum range of the OER in elliptical rotary engine is 1.1–1.15. In this range the optimal performance, efficiency and emission parameters is achieved.

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