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THEORETICAL FLOW ANALYSIS AND EXPERIMENTAL STUDY ON TIME RESOLVED THC FORMATION WITH RESIDUAL GAS IN A DUAL CVVT ENGINE

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ABSTRACT−Recently, a variable valve timing system has been widely adopted in internal combustion engine in order to improve the fuel economy and torque at low engine speed. In addition, it is known that varying valve timing according to the various engine operations could reduce exhaust gas, especially NOx, because of residual gas by valve overlap. In this study, to improve the low exhaust gas and fuel economy at part load condition, the residual gas and back flow of exhaust gas due to valve overlap were calculated computationally. Moreover, the characteristics of engine performances and NOx formations were investigated with the experiment of combination of intake and exhaust valve timing condition. Under these various valve operating conditions, the effects of both the positive valve overlap and negative valve overlap (valve underlap) were examined simultaneously. Finally, the characteristics of cyclic THC emission were analyzed by using Fast Response FID (FR-FID) in the cylinder, intake port and exhaust port positions. Besides, the effect of the different gradients of the valve timing change on engine performance was investigated and an optimum control strategy was suggested.

KEY WORDS: VVT, Valve overlap, Internal EGR, Residual gas, Fast response FID, Cyclic THC emission

1. INTRODUCTION

In recent years, engine development has been focused on the two issues: reduction of CO_2 and air pollution. To address these technologies, CVVT (Continuously Variable Valve Timing) system is widely adopted since it can enhance the performance, while simultaneously reducing exhaust emissions and fuel consumption. With the CVVT system of intake cam phaser, maximum torque and power are improved through the optimization of valve timing according to the overall engine operating condition (Parvate-Patil *et al*., 2003; Lee *et al*., 2005). Exhaust valve timing has influenced on the providing of internal EGR (Exhaust Gas Recirculation) to reduce the NOx and fuel consumption with a longer valve overlap period at part load. Dual CVVT allows very flexible control of valve overlap (Jang *et al*., 2002; Sutela *et al*., 2001), which can be used to aggressively reduce throttling losses, increase EGR, lower NOx emissions and fuel consumption (Ohm and Lee, 2003; Kim and Cho, 2006; Fiorenza *et al.*, 2003). Therefore, an optimal combination of intake and exhaust valve timing is essential for improvement of engine performance. However, quantitative analysis on the residual gas fraction at in-cylinder and intake ports is difficult to apply to the CVVT engine.

In this study, the residual gas fraction was investigated for mainly at part load condition using a specially designed 1-D engine simulation model. Based on the computational results, the performance of the CVVT engine such as flow characteristics at the intake manifold and combustion phenomena was examined and analyzed accord-

Table 1. Specification of test engine.

Item	Specification
Engine type	In-line, DOHC 16
Bore (mm)	75.5
Stroke (mm)	83.5
Displacement (cc)	1495
Valve timing (°CA)	IVO: BTDC 30~ATDC 5
	EVC: BTDC 10~ATDC 25
Valve duration (°CA)	Intake: 228
	Exhaust: 236

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