

The Electro-Hydraulic Valve Actuation (EHVA) for Medium Speed Diesel Engines – Development Steps with Simulations and Measurements

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ABSTRACT

Electro-Hydraulic Valve Actuation (EHVA) is one of the most promising ways to improve the performance and reduce the emissions of the diesel engines. The EHVA gives fully variable lift and event duration of the gas exchange valves and thus the combustion process can be better controlled in different operation points such as idle and partial load situation. Also totally new kind of gas exchange processes are possible to achieve.

This paper consists of alternative solutions of EHVA systems, the comparison of them by means of simulation and measurements, the empirical tests of EHVA system in a laboratory and finally conclusion and future research activities.

The developed EHVA system fulfills the requirements very well. The lift of the gas exchange valve is fast enough, and the seating velocity is under control. The system is able to run with open and closed loop control.

INTRODUCTION

The development project of the EHVA system is part of the larger project I.P. HERCULES (Integrated Project: High Efficiency Engine R&D on Combustion with Ultra Low Emissions for Ships) coordinated by Wärtsilä Corporation and MAN B/W Diesel AG [1].

The proposed EHVA system is designed for medium speed diesel engines. The presented system is further development step of system IHAFlex made in TUT/IHA 2001 [2]. The goal of the 2nd stage is to solve the problems found in the 1st prototype and to meet the requirements of the experimental engine. The new system is simulated in order to estimate roughly the power consumptions of the different hydraulic systems, and find out the most suitable EHVA system to this

application. The dimensions of the hydraulic parts are also defined by the simulation. The simulation model is verified by measurements, and the performance of the whole system is measured in the test bench. The EHVA system is installed in the experimental diesel engine EVE (Extreme Value Engine, cylinder bore 200 mm, stroke 280 mm) which is located in Internal Combustion Engine Laboratory (ICEL) of Helsinki University of Technology (HUT). The test engine is one of the first this type and size diesel engine in the world, which is running with EHVA system.

The purpose of the study is to find out more suitable hydraulic system to fulfil the updated requirements of the test engine EVE, and get the controllability of the system better than in case of the 1st prototype. The 1st prototype has also problems which had to be fixed: the heavy pressure oscillation, the zero-point floating of the controlling servo valve and the reliable measurement of the actuator and the gas exchange valve displacements. The system should also be able to run by closed loop control.

DEVELOPMENT STEPS

The first step is to find out the new control valve which flow rate is big enough with low pressure drop. The dynamics of the valve has to be fast enough. Thus the hydraulic system could be built as a directly operated system where the control valve is steering the actuator directly. The required opening or closing time of the gas exchange valve is 15 ms (80 crank degrees at 900 engine RPM) with the maximum opening displacement. The conventional work cycle of the valves are illustrated in Figure 1. The other requirement is that the exhaust valve is able to open against pressure difference of 28 bar (cylinder pressure of 30 bar).