



## PAPER NO.: 163

# The design and operation of the fully controllable medium-speed research engine EVE

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**Abstract:** The Extreme Value Engine (EVE) is a unique medium speed test engine with 200 mm cylinder bore designed exclusively for research purposes. The basic structure is designed for high loads and for easy access to the combustion chamber. Electrically controlled systems are extending the possibilities to modify several parameters in real time, enabling fast changes in valve timing, charge air parameters, back pressure, and fuel injection.

The single-cylinder test engine project was introduced for the first time during the CIMAC congress 2001, and the first operating experiences were presented at the CIMAC congresses 2004. Since then, several different engine tests have been completed at the Internal Combustion Engine Laboratory (ICEL) of Helsinki University of Technology (HUT). As a result of these tests, some changes in the engine and auxiliary systems were executed to improve the usability, operational reliability, and safety of the installation.

A totally new, second generation valve system was introduced on the basis of the tests and experiences with the first prototype. The system was created in cooperation with the Institute of Hydraulics and Automation (IHA) of Tampere University of Technology (TUT). The new valve block has two actuators instead

of the four in the previous system, and engine oil is used as hydraulic fluid. The high speed control system was re-programmed to take full advantage of the valve system controllability. The cylinder head and injection system were replaced with the target of producing similar combustion chamber conditions with production engines. The current operational state of the engine is described in the paper.

The focus of the paper is in presenting the test results and operating range of the research engine. Special areas of interest are the electro-hydraulic valve system, engine control system and auxiliary systems. The gas exchange valve operation data, such as opening/closing points and speed, valve lift, adjustable valve overlap and different operating modes, are presented. Charge air pressure and temperature limits, fuel injection system performance and cooling system parameters are also covered. A description of the measurement system and instrumentation is included.

The structure of the one dimensional simulation model of the engine is presented. The model was used in many ways; here are explained the advantages it offers in supporting laboratory tests or when planning and evaluating future engine research.