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INJECTION TIMING STRATEGY FOR EXHAUST HEAT RECOVERY OPTIMIZATION ON A TURBOCHARGED DIESEL ENGINE

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Abstract: *The paper presents a numerical analysis of injection timing effect on engine output power and heat rejected by exhaust gas in a turbocharged direct injection diesel engine implemented for a tractor application. The engine performance and exhaust gas enthalpy were studied by means of an engine computational model built in advanced simulation code AVL Boost. A Rankine-Hirn cycle model was developed due to estimate recovery potential of the exhaust gas. Injection timing optimization was carried out at the most commonly used engine operating points (n=1650rpm and variable load). The maximum engine output power was chosen as a target parameter to determine the optimal injection timing. A combination of Rankine-Hirn cycle using water as working fluid and injection timing optimization increased the maximum engine output power by 7.4%. The results revealed that in order to optimize overall engine efficiency in case of waste heat recovery system is applied it is necessary to reduce injection advance by 2deg to 5deg.*

Keywords: *diesel engine, injection timing, waste heat recovery, Rankine-Hirn cycle, simulation*

1. INTRODUCTION

Although the number of modern techniques such as: turbocharging, high pressure direct injection, variable valve timing, variable compression ratio etc., the overall engine efficiency is lower than 40%. Only in special engines such as high boosted diesel marine and stationary engines the efficiency could meet 50%. It means that at most commonly used operating points more than 60% of the fuel energy is lost [1,2]. Some part of this energy is rejected by exhaust gas, other part is lost in the cooling system and the rest is lost in the auxiliaries [3].

To meet the future restriction of CO_2 emissions it will be necessary to improve overall engine efficiency by means of more sophisticated techniques. Recovery of that energy, rejected by exhaust gas seems to be a good prospective for further improvement of overall engine efficiency [3-5].A number of research [6-11] revealed that the Rankine-Hirn cycle is the most promising techniques of waste heat recovery from exhaust gas. According [11-13] the Rankine-Hirn cycle provides higher efficiency than other techniques under development such as: turbo-compounding and thermoelectric generators.

It is well known from reciprocating engines theory that injection timing as well as injection rate and injection duration are the key point in engine optimization [14]. Injection timing is an important parameter in engine performance optimization. However at the last decades at wide operating range of diesel engine map the injection timing strategy was used to decrease engine noise and toxic components in exhaust gas. Usually, earlier injection timing than that provides maximum power increases maximum pressure and temperature in the combustion chamber. In results of that the energy lost in cooling system increases as the exhaust energy decreases. Due to