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EFFICIENCY AND ECOLOGICAL CHARACTERISTICS OF A VCR DIESEL ENGINE

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ABSTRACT–Compression ratio (CR) is a design parameter with highest influence on efficiency, emission and engine characteristics. In conventional internal combustion (IC) engines, the compression ratio is fixed and their performance is, therefore, a compromise between conflicting requirements. One fundamental problem is that drive units in the vehicles must successfully operate at variable speed and loads and in different ambient conditions. If a diesel engine has a fixed CR, a minimal value must be chosen that can achieve a reliable self-ignition when starting the engine in cold start conditions. In diesel engines, variable compression ratio (VCR) provides control of peak cylinder pressure, improves cold start ability and low load operation, enabling the multi-fuel capability, increase of fuel economy and reduction of emissions. By application of VCR and other mechanisms, the optimal regime fields are extended to the prime requirements: consumption, power, emission, noise, etc., and/or the possibility of the engine to operate with different fuels is extended. An experimental Diesel engine has been developed at the Faculty of Engineering, University of Kragujevac . The changes of CR are realized by changing the piston chamber diameter. Detailed engine tests were performed at the Laboratory for IC engines. Special attention has been given to decrease of fuel consumption and exhaust emissions. An optimal field of CR variation has been determined depending on the given objectives: minimal fuel consumption, minimal nitric oxides, and particulate matter emissions, etc.

KEY WORDS : Diesel engine, Efficiency, Exhaust emission, Variable compression ratio

1. INTRODUCTION

Public discussions often give the impression that the Carbon Dioxide (CO_2) emission problem in the European Union can be solved by just reducing the CO_2 emissions from road traffic. In the EU and in Germany, road traffic contributes about 20% to the overall CO_2 emissions. Although other human activities generate far more CO_2 than road traffic, the automotive industry has been working intensively for years on reducing CO_2 emissions by improving the fuel economy of their vehicles (Gruden, 2005).

It is well known that Diesel engines are one of the best candidates to face the future CO_2 limitations thanks to their high thermal efficiency. In modern diesel engines, the relation between nitric oxides (NOx) and particulate matter (PM) emissions has to be deeply improved, maintaining low CO_2 emission (Pesic, 1994; Milojevic, 2005).

The automobile owes its worldwide spreading mainly to the lucky symbiosis between the existence of crude oil - which still can be considered as the least expensive and the most uncomplicated energy resource in the world - and the invention of the reciprocating piston engine with its Otto and Diesel variants (Gruden, 2005).

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Almost from the beginning, engineers had been looking for alternative concepts to replace the Otto and Diesel power units and more than once, the era of the combustion engine had been said to come to an early end. Nevertheless, both drive concepts have prevailed and are sure to do so also in the near future (Gruden, 2005).

Cars will be powered by Otto and Diesel engines far into this century (Lang *et al*., 2004). Development of Otto and Diesel engines leads to symbiosis of their operating processes into a multi-process Otto-Diesel engine that integrates only their good features. The application of engines with automatic variable compression ratio (VCR) makes this possible (Pesic *et al*., 2003).

Use of retarding the intake valve closing is the other way to reduce pollutant emissions in a diesel engine. Experimental results showed that the retarded intake valve closing could enhance the premixed combustion phase, and thus simultaneously reduce soot and NOx emissions (Benajes *et al*., 2008).

Premixed charge compression ignition (PCCI) is expected to make automobile engines more efficient and cleaner, which will help mitigate environmental problems. As a wishful combination of the conventional spark ignition (Otto) and compression ignition (Diesel) engines, PCCI engines are believed to have higher efficiencies than Otto engines due to their high CR and absence of throttle