The investigations of emission of a variable compress ratio internal combustion engine driving the power generator

M. Wozniak[1], K. Siczek[1], M. Glogowski[1], P. Kubiak[2], G. Ozuna[3]

[1]Lodz University of Technology, Poland, [2]Warsaw University of Technology, Poland, [3]University of Sonora, Mexico, [4]Lodz University of Technology

Introduction & Background

The purpose of the investigations is to obtain characteristics of the variable compress ratio engine as a function of rotational speed and load. Currently, the improvement in the efficiency and emission level of the engine can be obtained using a variable compression ratio enabling combustion under almost constant pressure. This approach is used in the tested engine cooperating with a power generator.

The control of such an engine requires the use of a control unit and the selection of the appropriate strategy. The control in the present engine is based on the knocking beginnings. The appearance of such a phenomenon causes the need to reduce the throttle opening angle. The displacement of the additional piston automatically adjusts to the pressure constituting the cylinder. The principle of the ACC motor is shown in figure 1.

The principle of its operation is as follows: when the pressure in the engine cylinder overcomes the initial load on the pneumatic spring (3), an additional piston (2), constituting a barrier in the active combustion chamber, rises while storing energy in the spring (3). When the piston (2) reaches its maximum position, the energy accumulated on the spring (3) reaches its highest value. At this time, all forces acting on the piston (3), including inertia forces, remain in balance. From that moment - the piston falls, the energy accumulated in the spring is recovered (3). This energy can then be used to keep the pressure and volume in the combustion chamber relatively constant. The control of the lower docking position of the piston (2) is provided by a unidirectional pneumatic spring (5) and a unidirectional shock absorber (6). The adaptability of the ACC system results from a change in the pneumatic stiffness of the spring (3): a change in the volume of the spring caused by a movable partition (4) or a change in pressure supplied by the spring.

Adjusting the compression ratio is an immanent feature of the ACC engine. This is advantageous because the higher initial velocity of the additional piston in this system in the initial combustion phase reduces the reaction time during combustion. A direct consequence of the more vigorous reaction is the possibility of further increasing the compression ratio to values that are not achievable in most engines with the VCR system.

Methodology:

A converted DG6700RC-S aggregate engine with 12 HP and 3000 rpm is used, in which the cylinder head is converted to allow the installation of gasoline injectors and a special patented piston design is used, which includes an additional movable auxiliary piston, which movement allows changing of the combustion chamber volume and, as a result, of the compression ratio. The knocking combustion is monitored by knock sensor during operation. The engine characteristics are obtained by measuring the speed of the crankshaft and the torque is estimated by measuring the electrical power lost on the resistors loading the aggregate. Fuel consumption is measured and exhaust gas analysis is performed using by analyzer.

Results & Conclusions:

The obtained results of the engine characteristics are presented: power and torque of the analyzed engine as a function of speed as well as its fuel consumption and emissions. The obtained characteristics are compared with these of the original diesel engine.