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# THEORETICAL ENGINE DESIGN SOLUTION TO MINIMIZE CONSUMPTION AND POLLUTION

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***Abstract:*** *In this paper, we attempt to describe a possible design solution of the engine with turning arm in order to bring some information with respect to engine working efficiency. The modifying of the functional parameters such as: piston stroke, displacement or ratios of compression will lead to obtain some different energy engine parameters (power, torque) as well as different ecology engine parameters (consumption, emission).*
*The analyses were made using specific module of the PTC software (Pro/E Mechanism.*
***Keywords:*** *engine, optimization, piston stroke and ratio of compression*

## 1. INTRODUCTION

The evolution of the automotive which became one of the most important vehicles, as well as the enhancement of the car park from the last time were imposed a continuous development process for different parameters or characteristics (increase power, lower consumption, increase the durability or reliability) of the sub-assembly that power propelled the automotive.

The power unit with the highest development level in the actual context that directly contributes to automotive propulsion is the engine with internal combustion. The grand manufacturers of the automotives are focused the activity on the different functional parameters or constructive parameters of the engine in order to obtained more power with lower consumption or lower emission of the exhaust gas (CH, NOx, CO, e.g.).

The efficiency of the engine with internal combustion depends on cycle characteristic processes. The assessments with regards to engine efficiency can made based on constructive parameters, such as: engine displacement, stroke – bore ratio, ratio of compression or based on operational parameters (engine management, forming and controlling mixture air/combustible, ignition timing, e.g.).

The increasing pressure that acts on the engine manufacturers regarding to minimize combustible consumption or gas exhaust emissions, it make them to pass in production flux the news constructive solutions for actual engines that are being in the market – gasoline and diesel engines.

One of the actual constructive solutions with satisfied results of the consumption or emissions is the engine with turning arm and variable compression ratio – VCR. His concept is emerged from 2001 and the promoter is Dr. Joe Erlich. This engine has appeared on the automotives being in marketplace from this millennium (more exactly, SAAB has developed this concept) and the VCR technology could be one of the keys that would lead on to obtain some better performance both partial charges and full charges.

Beside the increase engines performance goal focused, the research-development process has to search the solutions in order to minimize the expensive for development and optimization of the product. It can be achievable by means of computers that replace classical tools and making achievable efficiency and useful methods.

In the analysis and simulation mechanical systems domain there are a lot of programs used, such as: classical programming languages (FORTRAN, PASCAL, C), design programs (CATIA, PRO/E, EUCLID, SOLID WORKS), MBS software (ADAMS, FLEXUS, DYMES) and FEA software (ANSYS, PATRAN, NASTRAN)
The analysis, modeling and simulation were made by means of Pro/Mechanism module of the PRO/E software.

## 2. FUNCTIONAL DESCRIPTION OF ENGINE MECHANISM

## 2.1. ENGINE MECHANISM WITH TURNING ARM

The kinematics schema for engine mechanism with turning arm is shown in figure 1. Also, in figure 2, it is shown the virtual model.

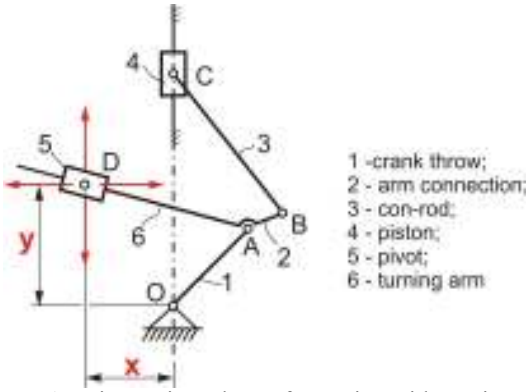


**Figure 1 -** Kinematics schema for engine with turning arm

This new concept is an operating principle of the conventional engine carrying on that converts translational motion of piston in rotating motion of crankshaft by con-rod.

The difference between a conventional engine and this engine analyzed consists in how con-rod is assembled in mechanism: for conventional engine the con-rod is directly connected to crankshaft and for engine with turning arm, the con-rod is connected to crankshaft through arm 2. This arm (2) is jointly with turning arm 6. This turning arm slides in the bearing (5), and it can made possible OB length varying and piston stroke, also. When the engine mechanism running, the point of turning (D) that is position by means of x and y variables can be moved on the vertical and vertical direction thus position of the turning arm is changed. In this way, it can be obtained different values of the compression ratio and piston stroke and also can be obtained an optimization of the engine working regimes depending on charge.

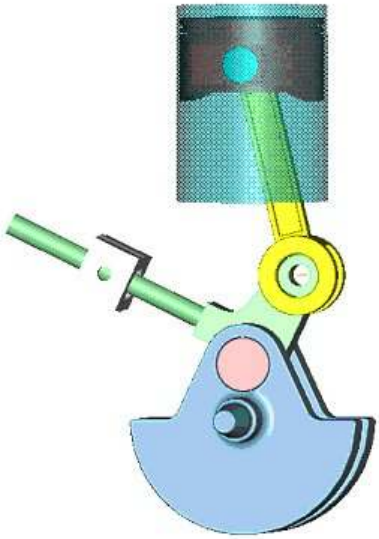

**Figure 2 -** Virtual model of engine with turning arm

Based on figure 3b, for the engine with turning arm, the trajectory of the con-rod big end obtained on a complete crankshaft rotation is ellipse unlike circular trajectory obtained on a conventional engine. This elliptical trajectory will determine an increased of piston motion time between top dead center and bottom dead center comparison by conventional engine.

More holding piston close to the T.D.C. (top dead center) create more friendly conditions in order to carry on the ignition process at constant volume with more efficiency.

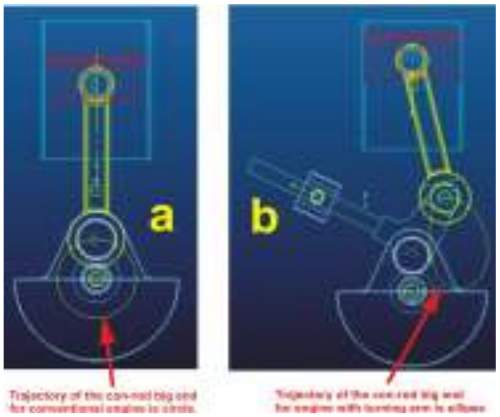


**Figure 3 -** Comparison trajectories of the both engine analyzed

Also, on the T.D.C. the force that acts on piston generated a torque motor because the connecting rod small end has an eccentric position with respect to crankshaft axis what it means there is torque motor on the all-downward stroke time detent process [2].

Also, at the engine with turning arm, the admission stroke and exhaust stroke are longer than conventional engine, in this way the gas exchange process is favored. [2]

The elliptical trajectory of the con-rod big end at engine with turning arm will generate an increasingly of piston stroke, displacement engine and ratio of compression comparison by conventional engine. This aspect, it can be observed in figure 4. The conventional engine piston stroke obtained (curve 1) is shorter than engine with turning arm piston stroke (curve 2). A modifying of piston stroke will have implication about displacement engine and ratio of compression.

The compression ratio parameter (ε) has a directly influenced on some important parameters of engine, such as: filling grade, pressure of the end compression, temperature of the end compression and residual gas coefficient (ratio between gas quantity remaining in cylinder from the previous cycle and live gas quantity aspirate, the both expressed in kilo mol).

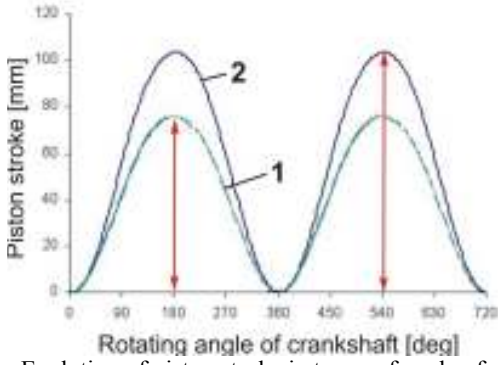


**Figure 4 -** Evolution of piston stroke in terms of angle of crankshaft

The advantages of this engine type consist in addition to high-density power and lower emission to silent and uniform working. The companies are interested of this engine type (General Motors, Ford, Daimler Chrysler and MG Rover) and makes plans in order to industrialize it in the next two years [2].

## 3. CONCLUSIONS

As it was specified, the using of the modeling and virtual simulation software offers a quickly and efficiency control of geometric and functional system parameters.

By means of simulation software used (Pro/Mechanism), it was analyzed the output kinematics parameter (piston stroke) and implicitly of the others that are depending on it (displacement engine, ratio of compression), starting from input kinematics parameter (crank throw position).

It can be conclusion that from constructive and functional viewpoint, based on parameters determined from virtual simulation, the engine with turning arm presents advantages with respect to a conventional engine.

Beside mentioned, the solution of the engine mechanism with turning arm can be adopted on the any type of engine with gasoline or diesel with two or four cycles engine, for any type of engine dimensions.

VCR technology offers the largest potential improvement in part-throttle fuel efficiency and CO2 emissions when compared to other competing technologies.

Also, VCR technology can offer torque enhancement at low rpm when boost systems are least effective.

The main obstacles to adoption of VCR are incompatibility with major components in current production and difficulties of combining VCR and non-VCR manufacturing within existing plant. As environmental pressure on the automobile increases and investment plans for new products are put in place, the justification for VCR will become more evident.

A UK-based international engineering is claiming that its new design for a combustion engine has the potential to revolutionize the global market for all internal combustion engine applications, with 40% improvement in fuel efficiency and 50% fewer emissions compared to conventional engines.

It is very interesting, what Dr. Joe Erlich (the promoter of engine mechanism with turning arm) said about conventional engine: “I have always felt that the conventional crank and con-rod was flawed. It wasted too much energy and does not optimize combustion.”

Taking into account to over 160 million combustion engines are made every year, this revolutionary engine can be represented a very good solution for the actuality.

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