Časopis Naučnog društva za pogonske mašine, traktore i održavanje
Journal of Scientific Society of Power Machines, Tractors and Maintenance

TRAKTORI I POGONSKE MAŠINE

TRACTORS AND POWER MACHINES

1/2
UDK 631.372
ISSN 0354-9496
Godina 26
Dec. 2021.

Novi Sad, Srbija

Trakt. i pog. maš., Trac. and pow. mach., Vol. 26, No. 1/2, p.1-73, Novi Sad, Dec. 2021.

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Časopis
TRAKTORI I POGONSKE MAŠINE

Jurnal
TRACTORS AND POWER MACHINES

Izdavač – Publisher

Naučno društvo za pogonske mašine, traktore i održavanje
Scientific Society of Power Machines, Tractors and Maintenance

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Časopis izlazi svaka tri meseca
Godišnja pretplata za radne organizacije je 1500 din, za Inostranstvo 5000 din a za individualne predplatnike 1000 din
Žiro račun: 340-4148-96 kod Erste banke

Jurnal is published four times a year
Subscription price for organization is 40 EURO, for foreign organization 80 EURO and individual subscribes 15 EURO

Rešenjem Ministarstva za informacije Republike Srbije, Br.651-115/97-03 od 10.02.1997.god., časopis je upisan u registar pod brojem 2310
Prema Mišljenju Ministarstva za nauku, Republike Srbije ovaj časopis je "PUBLIKACIJA OD POSEBNOG INTERESA ZA NAUKU"

Štampa – Printed by
Štamparija "BIROGRAF COMP" doo, 11080 Zemun, Atanasija Pulje 22
Tiraž 100 primeraka

JUMTO

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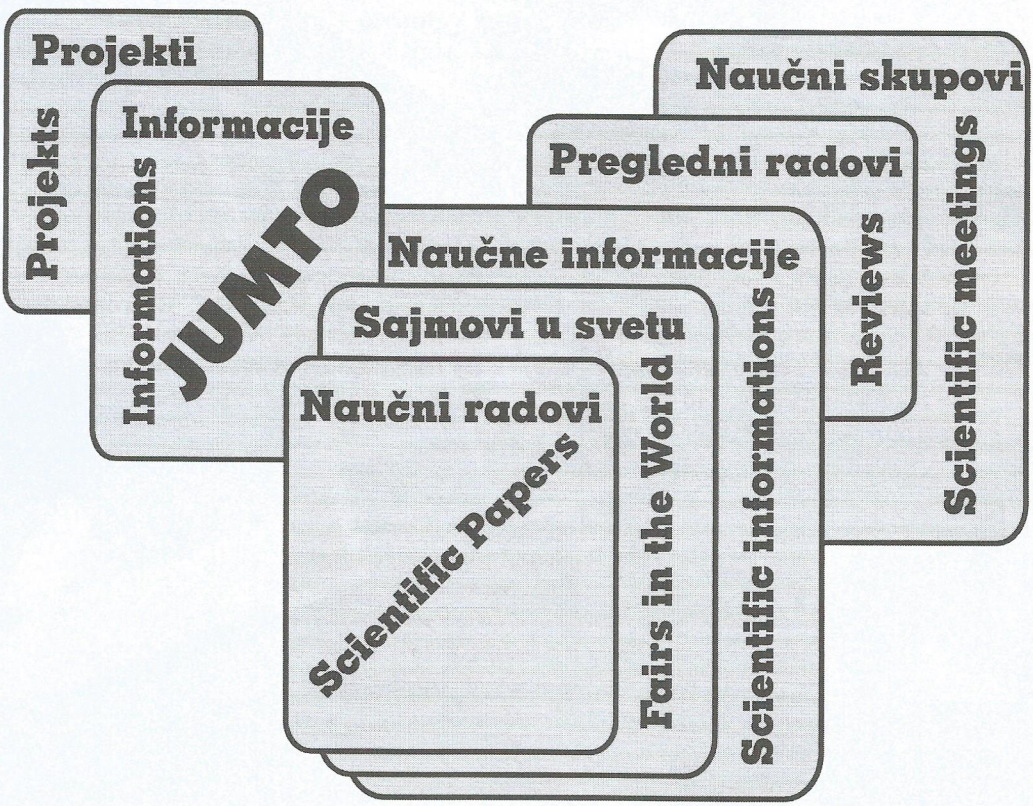

Novi Sad, Srbija

Trakt. i pog. maš., Trac. and pow. mach., Vol.26, No.1/2, p.1-73, Novi Sad, Dec. 2021.

Časopis Traktori i pogonske mašine broj 1/2 posvećen je XXVIII-om naučnom skupu "Pravci razvoja traktora i obnovljivih izvora energije"

The journal Tractors and power machines number 1/2 is devoted to XXVIII scientific meeting "Development of tractors and renewable energy resources"

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Štampanje ove publikacije pomoglo je:
Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije
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Biblid: 0354-9496(2021) 26: 1/2, p. 5-8
UDK: 631.372

Naučni rad
Scientific paper

NUMERICAL INVESTIGATION OF IC ENGINE MULTIPROCESS WORK

Grujic I.[1], Stojanovic N.[2], Davinic A.[3], Doric J.[4]

SUMMARY

In order for the experimental work to be successful, it is necessary a serious preparation, as well as time for experimental work execution. Also, experimental work is usually demands high costs for equipment, materials and engaged people. However, one is for sure, the experimental work cannot be replaced, but the numerical approach can be a good tool, at least for the first stages of the product development, in order to reduce the experimental work costs. In the paper was performed numerical investigation, of the IC engine muliprocess work. The obtained results, were compared with the experimental ones. How the numerical investigation was used to simulate the IC engine working cycle, as the control parameters were taken the indicating parameters. By comparing with the experimental data, it was found that the maximal error is less than 3.5%. This means that the numerical approach gives a satisfying results, and as such can be used for further investigations.

Key words: numerical approach, IC engine, multiprocess work, indicating parameters.

INTRODUCTION

Transportation is very important activity of everyday life. Currently, the IC engines are main power trains used for almost all vehicles. This means that, the IC engine is one the most important parts of the motor vehicle, which further leads to the conclusion that the IC engines are requiring constant improvement.

Two basic conceptions of IC engines which have sustained from the beginning of IC engines usage until today, are so called spark ignition engines and diesel engines. Both conceptions have advantages and disadvantages. Because of this, good idea for the IC engines improvement is the combination of advantages of both conceptions. In this way, can be obtained so called multiprocess work of IC engines [1].

The best way to investigate the IC engine working cycle is the experiment. However, the experiment usually demands, people engagement, resources and time. Because of this, as well

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as because of software's progression, many researchers are avoiding the experimental work in the past few years. The best tool which can be widely used instead the experiments are numerical analyses.

Numerical analyses are a very good tool, which are widely used for many engineering problems. The main reason of this is the good matching between the experimentally obtained results and the numerical ones [2, 3]. However, before the entire trust is given to the numerical analysis, the experimental work should be performed, in order to make validation of the numerical analysis.

Numerical analyses which are performing for the IC engine work investigation are so called CFD (Computional Fluid Dynamics) analyses. This type of the analysis, gives the insight in the complex phenomena's within cylinder [4]. So the CFD analyses can be considered as a very useful tools. When is necessary to improve an existing design of the IC engine [5], or to construct a new one.

The main of this aim of his paper is the numerical simulation of the working cycle of multiprocess IC engine, as well as the validation with the experimental data. In order to achieve this, the experimental work is performed on the test engine, and some of the results are used to define the boundary conditions for the numerical analysis.

EXPERIMENTAL WORK AND NUMERICAL SETUP

In order to simulate the working cycle and to validate the results obtained by the numerical analysis, the experimental work is conducted on the test engine. The test scheme of experimental installation is given on the Figure 1.

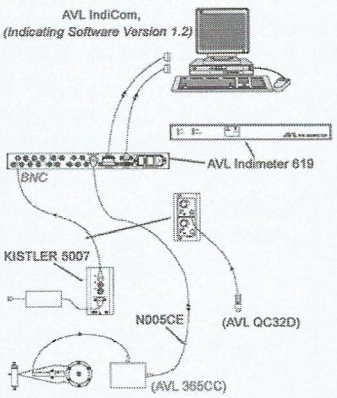
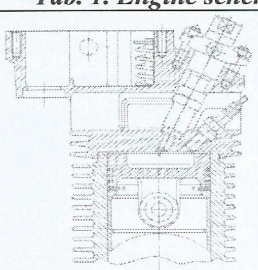


Fig. 1. The scheme of the experimental installation [6]

The installation from the Figure 1, represents the measurement chain, for the cylinder pressure measurement. The cylinder pressure actually represents the IC engine working cycle, and by this, and main data for the numerical simulation validation.

The experimental work was conducted on the multiprocess, mono-cylinder, air cooled engine. The engine is called multiprocess, because it work in spark ignition engine mode, as well as in diesel engine mode. The scheme of multiprocess engine and it characteristics are given in Table 1.

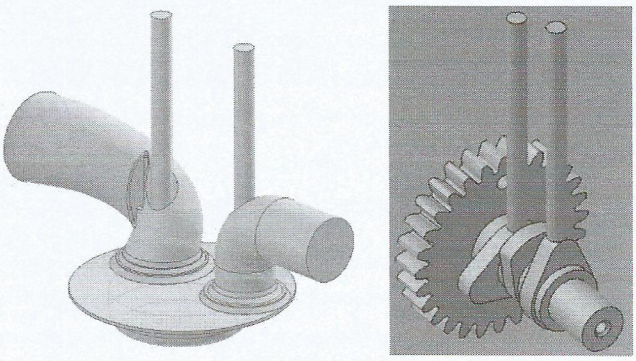
Tab. 1. Engine scheme and characteristics



Name and unit	Value
Displacement, cm^3	454
Compression ratio, -	12.5
Bore, mm	85
Stroke, mm	80
Inlet valve open, °CS BTDC	16
Inlet valve close, °CS ABDC	40
Exhaust valve open, °CS BBDC	40
Exhaust valve close, °CS ATDC	16

In order to make adequate simulation of IC engine, working cycle, it was created the geometry

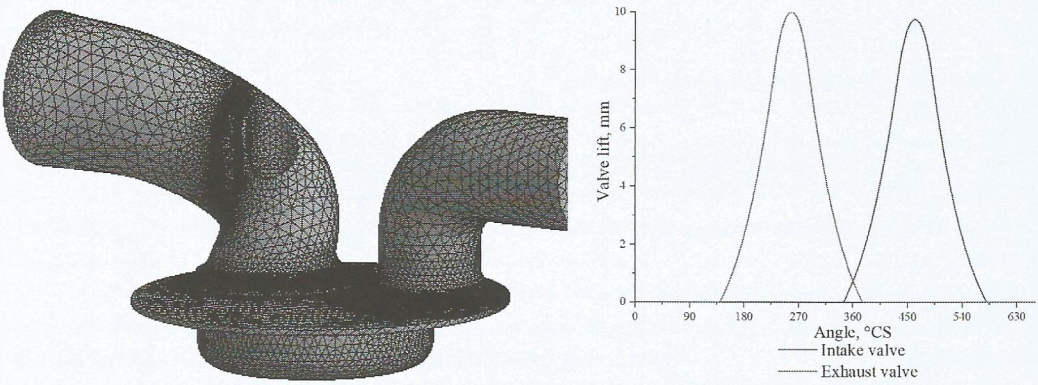
(Figure 2 (a)) which by dimensions corresponds to the real engine. Also it was created the model of IC engine camshaft (Figure 2 (b)), in order to obtain correct data about valves lift profile.



(a) *(b)*

Fig. 2. Engine and camshaft models

The adequate geometry shape and dimensions are very important, in order to obtain correct and accurate results. After geometry creation, the finite elements mesh (type of the elements is tetrahedral) was created (Figure 3 (a)), while the valve lift profile from Figure 3 (b), was imported as the one of boundary conditions in the analysis.



(a) *(b)*

Fig. 3. Finite elements mesh and valve lift profile

The mesh refinement was performed in the area of the valves seat. The number of elements of created mesh is 474993, while the number of nodes is 96270.

RESULTS AND DISSCUSION

The analysis was performed for the entire working cycle, that is for all four strokes. The comparison between the results obtained experimentally and numerically can be seen on the Figure 4.

By results analysis, it can be seen that exist a good matching between experimental and numerical results. This confirm the claim, that numerical analyses can be used instead the experiment in some stages of product development. In order to perform beater analysis, a

several parameters were taken as control factors of numerical analysis accuracy, and that:

- Indicating power and
- Indicating efficiency.

The value of the indicating power obtained experimentally is 7.436 kW, while the numerically obtained value is 7.177 kW, which means that the difference between these two values is 3.48%. In the case of the indicating efficiency, the experimentally obtained value is 0.369, while the experimental one is 0.358. This means that the difference between the experimental and numerical value is 2.98%.

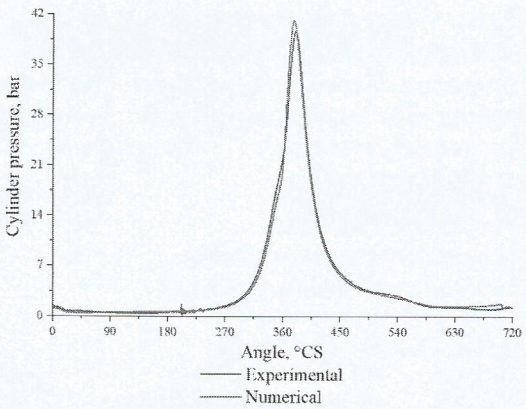


Fig. 4. Cylinder pressure obtained experimentally and numericaly

CONCLUSSION

The IC engines are dominant type of powertrain. Constant demands of the market are requiring development of IC engines and their improvement. The best way to test the performances of IC engine was and will be the experiment. However, in early stages of the development, should consider to use numerical analyses. The main reason for this is reduction of unnecessary costs, and insight did the development is on good path. The results of the numerical analysis conducted in this paper, have shown a good matching with the experimental results. The maximal error between the control parameters was 3.48%, which is satisfying. In future researches, more control parameters should be taken into the consideration, in order to see, where the greatest error is obtaining.

ACKNOWLEDGEMNT

This paper was realized within the framework of the project "The research of vehicle safety as part of a cybernetic system: Driver-Vehicle-Environment", ref. no. TR35041, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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Rad primljen: 22.10.2021.
Rad prihvaćen: 17.11.2021.