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Radivoje Pešić[1]
Snežana Petković[2]
Golec Kazimierz[3]
Emil Hnatko[4]
Stevan Veinović[5]

ADVANCE IN INTERNAL COMBUSTION ENGINES, BIOFUELS AND DELUSIONS OF THE "KYOTO PROTOCOL"

ABSTRACT: The controversy over global warming gets even more complicated when you include politics, economics, greed, and the self interests of the various governments, NGOs and companies. In the dec.1997's, a number of western nations crafted a CO_2-reduction treated named Kyoto for the city in which the key conference was held. China, India, Brazil and most of the third world are exempt from its limits. The United States refused to sign, even when Al Gore was vice-president.

Energy, once used, is not regenerative. This means that, during any energy activation, we are filling up the space of this Planet with parasite forms of energy (Anergy) or Global warming. Researchers are hard at work exploring new fuels, engines and vehicle technologies- but there are not "clean" cars, "clean" energy or "full renewable" fuels. The next stage of power train and fuel strategy involves using new high economy combustion engines that can be run with partially renewable fuels and used worldwide.

This paper analyses delusions of the "Kyoto protocol" and presents the results of our own research of cetane characteristics, bio-diesel fuel and technological solutions for maximal energy efficiency engines with minimal adverse effects on environment.

KEYWORDS: alternative fuel; cetane number of biodiesel; new technologies of engine; Kyoto protocol

[1] *Radivoje Pešić, Ph.D., full professor, Faculty of Mechanical Engineering in Kragujevac, Sestre Janjić 6, Kragujevac, Serbia, pesicr@kg.ac.yu*
[2] *Snežana Petković, Ph.D., Assist. professor, Faculty of Mechanical Engineering, Banja Luka, Bulevar Vojvode Stepe Stepanovića 71.A, Republic of Srpska, petkovic@urc.bl.ac.yu*
[3] *Golec Kazimierz, Ph.D., full professor, Politechnika Krakowska, Poland, kgolec@usk.pk.edu.pl*
[4] *Emil Hnatko, Ph.D., full professor, Faculty of Mechanical Engineering in Slavonski Brod, Trg I. B. Mažuranić 18, Croatia, ehnatko@sfsb.hr*
[5] *Stevan Veinović, Ph.D., full professor, Faculty of Mechanical Engineering from Kragujevac, Sestre Janjić 6, Kragujevac, Serbia, vpst@kg.ac.yu*

INTRODUCTION

Global warming and “Kyoto protocol”

Rational and controlled vehicle use in transport and traffic is an obligation for the future. Any activation of energy bears a burden to the environment in full amount. A warm-up lifts light gases like oxygen and nitrogen, while steam and carbon-dioxide choke the environment. Such are the signs of nature: there are no pure energy forms, no "clean fuels", no "clean engines", neither "clean vehicles". Actual reserves and natural gifts – coal, petroleum and gas – should be used less as power sources and more as raw materials. The greatest contribution to ecological prolongation of life on our planet is given by rational, economical technologies and products that carefully engage the gifts of nature.

Our greatest duty is to control both heating and pollution of environment. It's all the same if we overheat or poison the atmosphere, because, by doing so, we change genetic basis of life and endanger our survival on the planet. We are under obligation to consider the aims of sustainability: as rational as possible engagement of energy, as low as possible heating and as less as possible chocking of environment, as optimisation.

Heavy critics claim that a group of Western scientists has put together the prepositions for Kyoto protocol. In the protocol, they limit the production of the following six components with human activities: carbon dioxide, methane, nitrous oxide, per fluorocarbons, sulphur hexafluoride and hydro fluorocarbons. The most dangerous role is assigned to carbon dioxide, so, on that basis, the elimination of carbon dioxide production is proclaimed as ecological success. The escalation is continued in such a pace, that "clean technologies (?)", "clean fuels (?)" and "clean vehicles (?)" and similar are defined. Especially catching is the program with which the US president popularizes so called hydrogen technologies. If, for a moment, we forget the problems of acquiring hydrogen, then all hydrogen technologies are clean: vehicles, rockets, military technique and similar. It's just like with the earlier story on "clean" bombs that kill soldiers, and leave the environment unaffected [11].

Let's not forget that this is written in the years of physics and frequent mentioning of A. Einstein and N. Tesla. Their opposition to military use of nuclear energy is easily forgotten. None of us knows how powerful a trigger may be (activated by humans or from out of space) which will, similar to uncontrolled fire, burn the whole atmosphere around the Globe! We ignore laws of nature on mass and energy over and over again. Humans can transform the matter and forms of energy to definite degree, but they can not neither create nor destroy energy. The biggest delusion is to bid on unlimited energy sources that should be brought to our planet. In such way, we can only burn or choke the Green Planet, as it had happened on Mercury and Venus. In general, everyday life and all human activities always have the same end – global warming.

There is much confusion about a liquid called "water". According to the International Union of Pure and Applied Chemistry (UIPAC), the compound of two atoms of hydrogen and one atom of oxygen (hydrogen-oxide or bi-hydroxide) is "easy water" or simply water. The major property of "ordinary water" is that the ice is less heavy than liquid and thus it protects the living things on Earth. Only surface layers of water mass freeze in winter. Furthermore, water drops have high surface tension which detains water in plants and makes the transport of water from roots to leaves easier. Drinkable and healthy water is present in all living organisms. We only do not know how it emerges.

Atmospheric water covers 71% of the Globe; it is in 80% of the human body; in atmosphere, it gives 0.3% mass mainly (about 80%) in gaseous phase, and up to 90% in so called "greenhouse" (choky) gases. Theory implies that the heat of evaporation and the heat of condensation are equal, but only in theory. Solar radiation directly causes the creation of cloudy cover (global dimming) which darkens the sky. Once lifted, the clouds are further heated and then chemical processes, along with dust, particles and sulphates, bring to decomposition of these evaporations. Large cloud masses are overheated and agglomerated. Once lifted, mass is physically and chemically such altered that changes the climate on Earth. All this is ignored by Kyoto protocol.

The delusions on vehicles are like this. In engines, there is no term "ideal", but "complete" combustion. It means that there is a little (less then 1%) of unburned or partially burned fuel, C_xH_y. Each, even the smallest, quantity of not completely burned or thermally decomposed fuel is toxic. Quick oxidation of hydrocarbon fuels that lasts several milliseconds is considered under as normal combustion. Abnormal combustion is performed even more quickly with high temperatures and pressures, so that large percent of different combinations between four elements C-H-N-O. It is very hard to find any data on chemistry of different H_xO_y under extreme conditions that exist in engines, fuel cells and their connection to "ordinary water", especially when connections with nitrogen of cyan-hydrogen type (dangerous nerve gases) are formed [2, 11].

When products of combustion are divided on choky and poisonous, then quantities according to Table 1 are obtained. Secrets of heavy poisons creation are in temperatures and pressures at which toxic compounds are formed. Conditions in engines remind of such technologies, Table 2.

Table 1 *Combustion products of standard petrol fuels with air in heat engines*

Combustion products	N_xO_y		C_xO_y		H_xO_y		Rest
Standard petrol fuel	% Volume	% Weight	% Volume	% Weight	% Volume	% Weight	%
Complete combustion	73-76	70-73	12-15	20-22	12-13	7-8	Difference
The most frequent components	N_2-nitrogen NO-nitrogen monoxide N_2O-dinitrogen oxide N_2O_3-nitrogen trioxide		C- particles and PM CO- carbon monoxide CO_2-carbon dioxide...		H_2O –hydrogen monoxide H_2O_2- hydrogen peroxide H_2O_3- hydrogen trioxide		The rest of compounds (less than 1%!?)

Table 2 *Conditions of combustion in IC engines*

Conditions in chamber	Pressure during combustion bar			Temperature during combustion °C		
Course of combustion	Normal	Abnormal	Turbo engines	Normal	Abnormal	Turbo engines
Otto engines	60	100	80	2200	3000	2500
Diesel engines	100	120	160	2000	2200	2200

Hydrocarbon technologies are uncontrollably replaced with hydrogen "clean (?)" technologies, with large consumption of oxygen without which, there is no survival for living beings, figure 1. Full engagement of energy, weather we call it "useful" or "obsolete", leads to global warming. It is repeated several times, because all engaged energy finishes first locally, then globally as warming of environment and blanking of sky. An illustration of a vehicle fulfilling Euro 5 regulations is given in figure 2 and it, once more, suggests the obligations of changing to highly economic versions of engines and vehicles.

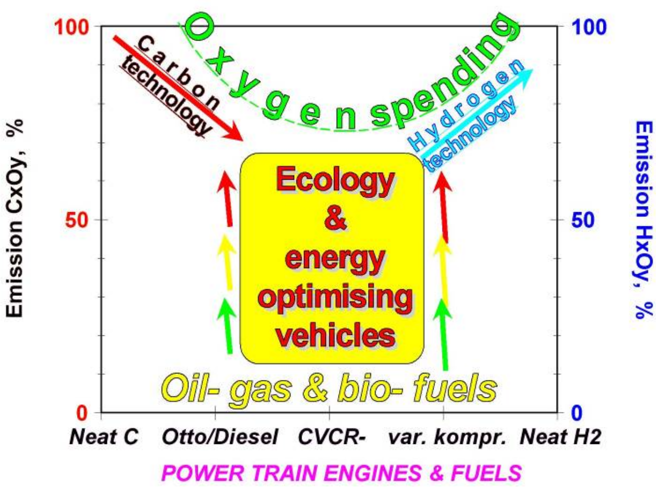


Figure 1 *Future of power-train engines and fuels in transport*

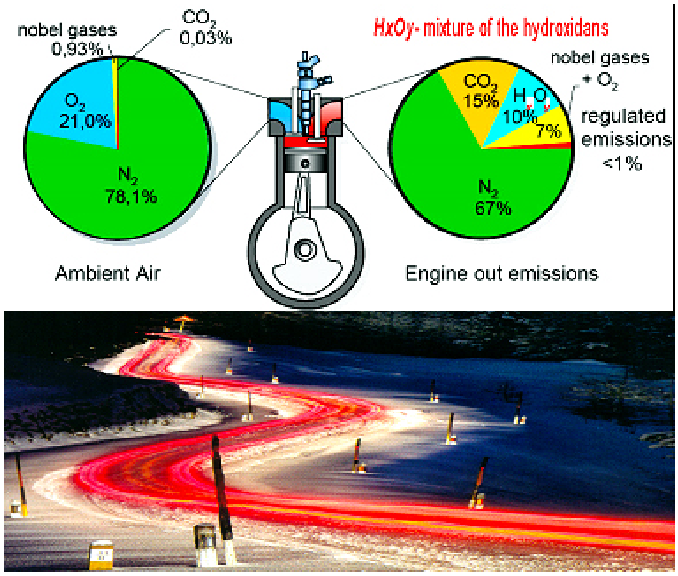


Figure 2 *Vehicles left behind themselves a cloud hot, like sauna, of gases without oxygen*

NO_x formation cannot be avoided during combustion, because Nitrogen is the dominant part of fresh air.

Global warming and biofuels

The 2003 biofuels directive [3] aims to substantially increase the use of these fuels for transport, and in particular for road transport. National measures are to be taken by countries across the EU aiming at replacing 5.75% of all transport fossil fuels (petrol and diesel) with biofuels by 2010. To give an indication of the size of the task, biofuels accounted for only about 0.45% of EU road transport energy consumption in 2002. However, though absolute levels are low, the production of biofuels is growing rapidly. The share was only 0.25% in 1999, but estimates based on production capacity indicate that it could reach 1% by 2004. If such growth rates are maintained, then the indicative target for 2010 could be achievable for the EU as a whole.

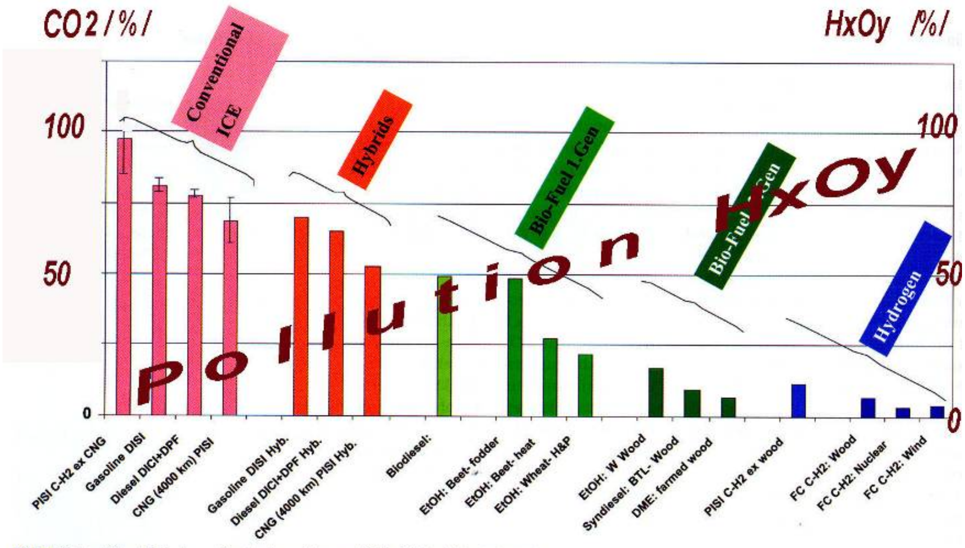


Bild 2: Well-to-Wheel-Emissionen (Quelle: Eucar/Concave/JRC – Well-to-Wheels Report)

Note: The bars represent best estimates and the lines represent ranges from literature. Dark green bars represent future fuels and light green bars represent fuels currently available.

Figure 3 *Well-to-wheel greenhouse gas emissions for different fuels*

The graph, figure 3 shows the estimated greenhouse gas emissions associated with fuel production, transport, distribution and use, represented on an emission per kilometer scale. In the longer term, biofuels produced from lignocelluloses biomass have the potential for greatest reductions of CO_2 (*at the same time pollution of H_xO_y increasing*) if the laboratory concepts of today can be converted to full scale production. In general, emissions under 50 g CO_2/km can be reached. Technological development and economy of scale effects may reduce the current high costs and improve the environmental benefits.

Biodiesel is a part-renewable fuel produced from vegetable oils such as those from rape seed and sunflower seed. In the transport sector, it may be effectively used both when **blended** with fossil diesel fuel and in **pure** form. Tests undertaken by motor manufacturers in the European Union on blends with diesel oil between 2% and 30% and 100% pure have resulted in guarantees for each type of use. Minor modifications (seals, piping) are required for use at 100% pure, unless specifically guaranteed by car manufacturers.

Biodiesel and cetane number

Research and optimization of diesel engine's operating process assume knowledge of the engine characteristics of used fuel, especially its auto-ignition described by cetane number (CN). The cetane number is one of the most commonly cited indicators of diesel fuel quality. It measures the readiness of the fuel to auto ignite when injected into the engine. It is generally dependent on the composition of the fuel and can impact the engine's start ability, noise level, and exhaust emissions.

The cetane number of biodiesel is generally observed to be quite high. Data presented below will show values varying between 45 and 67 [4].

In the case of application of the fuels originating from bio-mass and also of classical fuels with additives for auto-ignition improvement (so called cetane improvers), engine method is the only option for determination of CN. Standard tests like ISO 5165 (ASTM D613), DIN 51773 and similar tests demand the application of specific, very expensive laboratory installations, so a relatively small number of institution is accredited for these tests. *Laboratory for IC engines and fuels and lubricants* at the Faculty of Mechanical Engineering from Kragujevac is engaged in research of application of ecologically acceptable fuels from part renewable sources, so a real need for finding the possibilities for determination of the cetane number of biodiesel fuel emerged. Analysis of standard ISO 5165 and capabilities of our laboratory equipment have given encouraging results, which led to development of specific engine method for determination of auto-ignition characteristics of different fuels [1].

Our first investigation a cetane number of biodiesel was conducted on the Sample Methyl Esters (SME) from soybean oil. The sample produced by »PRVA ISKRA« AD from Barič, Beograd with next characteristic:

- Density, 15˚C   0.892 [g/cm^3]
- Water   0.16%
- Iodine value   112.69 [J2/100 g]
- Acid number   1.80 [mg KOH/100 g]

- Date of production 07. September 2006.

Measurement was conducted according to the method described in [1], and result is CN_{SME}=66.5. The value of cetane number of sample methyl esters from soybean oil, attained by the suggested method, occurs within literature data. The value is near by high limit value, which can explain by oxidation and the old age the sample.

Second investigation was conducted with the sample of soybean methyl esters made by VICTORIAOIL from Šid. The sample was produced at 05.07.2007. Measurement was conducted according to the method described in [1], and result is CN_{SME}=51.5.

Fuel which has been distilled oxidizes much more quickly than un-distilled fuel. While the distillation process does not affect the cetane number, the oxidation results in a cetane number increase. When the fuel was oxidized to a peroxide value of 82, the cetane number increased between 7 and 8 points. Further increases in the peroxide value did not increase the cetane number [4].

ADVANCE IN INTERNAL COMBUSTION ENGINES

Ways of symbiosis of Otto and Diesel processes in the same engine cylinder

Compression ratio belongs to design parameters which directly affect the fuel economy. Compression ratio in current conventional engines is constant geometrical value. Because of that the Otto engines have an absolute minimum of fuel consumption at very small are on the whole operating regimes, and the fuel consumption increasing when the load of the classical Otto engine decreasing, figure 4 and figure 5a.

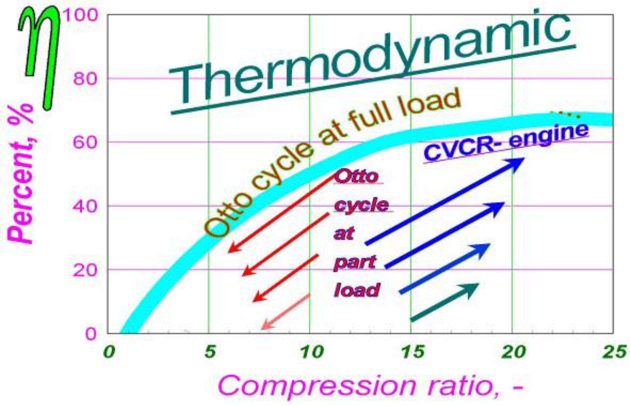
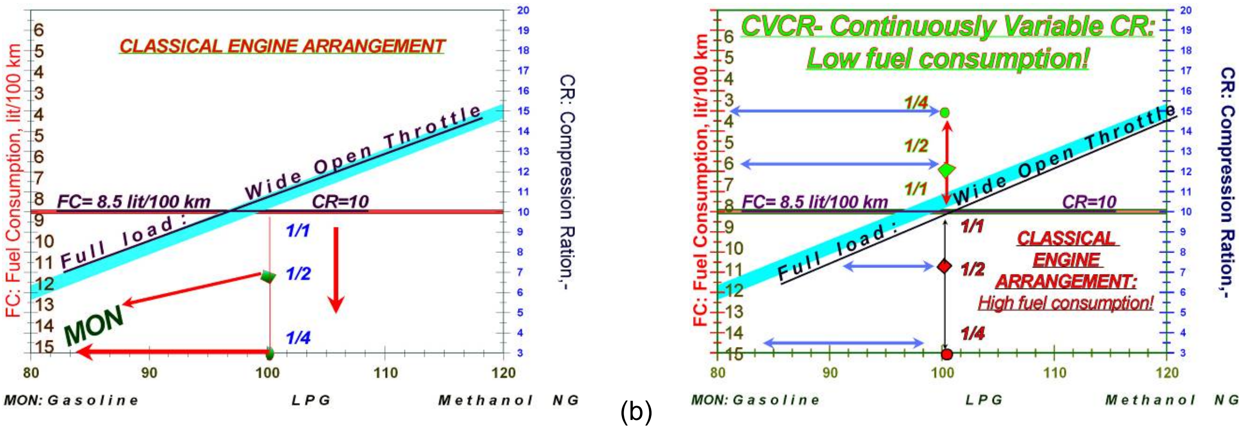


Figure 4 *Efficiency during a constant-volume cycles function of the compression ratio*



(a) (b)

Figure 5 *Distribution of fuel consumption as a function of drive conditions*

Compression ratio at Otto engines is limited by knock at full load. At partial loads, compression ratio values at knocking limit are greater, and compression ratio can increasing when load engine decreasing. It's the main cause for the efficiency increasing, figure 5b. A Continuously Variable Compression Ratio (CVCR) Otto engine is indifferent to operation on full or part load with the high efficiency and same octane ratings; thus an engine's thermal efficiency can be increased by Continuously Variable Compression Ratio.

The significant increase of the engine efficiency ratio is possible only by its optimization over the whole range of operating regimes, not only at the nominal regime. Therefore, the engine must have ever more variable systems (variable compression ratio, variable distribution, etc.) These variable systems are widening the field with the optimal consumption, toxic emission, noise, etc. over the whole range of operating regimes of an automotive engine.

With today's diesel engines in cars, a fuel economy improvement of at least 30% over comparable cars with spark ignition engines is achieved. For this reason, the direct injection diesel engine is, at least in Europe, seen as the best solution for reducing fuel consumption and thus reducing CO_2 emissions. Due to higher compression ratio, it is possible to achieve good fuel economy at full load. At diesel engines, compression ratio is limited by successful cold start. The Variable compression ratio diesel engines are more advantageous in terms of fuel efficiency and reduced emissions over conventional diesel engines. Compared to conventional diesel engines, the NOx and particle emissions were significantly reduced. The amount of the fuel burned at the first stage (premixed combustion) significantly increases with the decrease of the compression ratio at constant amount of the injected fuel and constant engine speed. Optimal compression ratio value is a compromise between fuel consumption and particle emission, at optimal injection advance angle. Summarily, we suggest the diesel engines with variable compression ratio that could improve cold start ability, low load operation, enable multi-fuel capability, increase fuel economy and reduce emission [6].

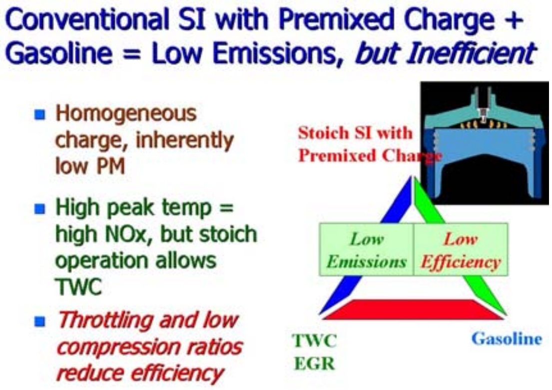


Figure 6 Conventional Otto (SI) engine

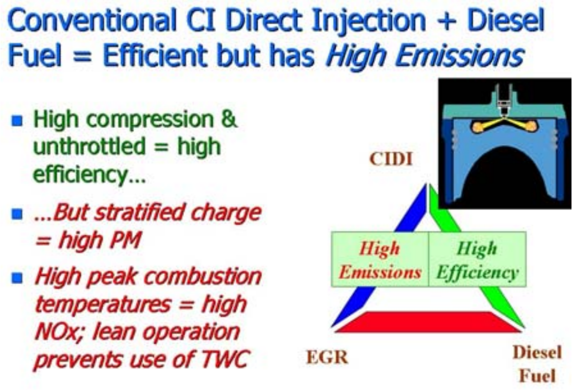


Figure 7 Conventional Diesel (CI) engine

The new concept of the IC engine based on CVCR (Continuously Variable Compression Ratio) -unit which has the possibility and versatility to work as an Otto as a Diesel engine, and above all, as an environmental friendly engine. A flexible cycle engine combines the best characteristics of both Otto and Diesel engines. At higher loads, at which Diesel engines have problems with smoke and particle emission, the engines automatically proceeds on operation by Otto cycle. At lower loads engine achieves the greatest efficiency operating with Diesel cycle.

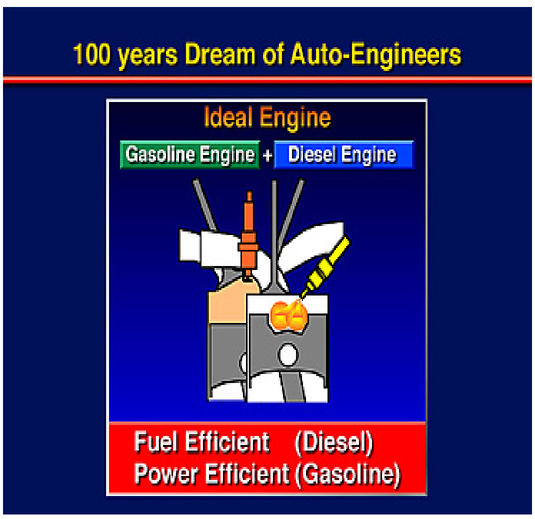


Figure 8 Ideal engine

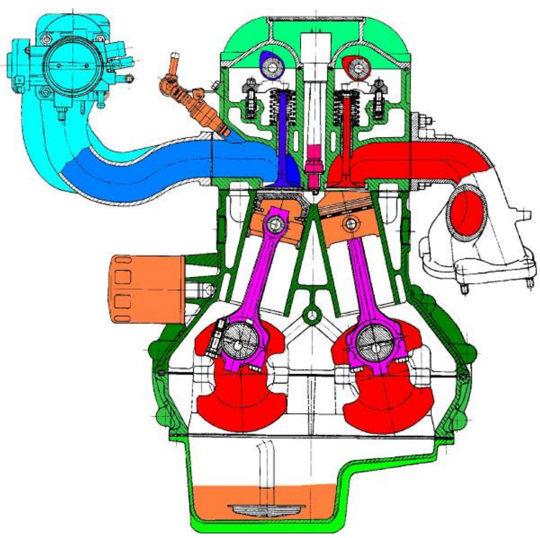


Figure 9 Engine with self adjusting Compression ratio

The real side of these subjects has its own history. With Diesel engines there are versions “M” and “D” of the combustion systems. The Otto engines, in the early stage of aviation, have had the injection of fuel and then stratified combustion at the start of the ecological era of the vehicles. Most of these pre-phases in the engine history have strived to the multi-fuel characteristics of the working process.

Conventional Otto engine with premixed charge has low efficiency on the partial load and low emission (homogenous charge and three-way catalytic converter TWC + EGR –Exhaust gas recirculation) on the high load, figure 6. Conventional Diesel engine, with stratified charge, has high efficiency and high emission PM on the full load and low emission PM on the partial load, figure 7. An ideal engine, which represents the best characteristics of both Otto and Diesel engines, is 100 years dream of auto-engineers, figure 8.

The biggest differences in the construction of SI (Otto) and CI (Diesel) engines were mentioned the most at the time of their appearance. If we want to optimise on the whole working field then the criteria for optimising are the level of compression, number of rpm, full- and part-throttle acceleration and workload. The conditions can be the ecological and economic aspect in fuel consumption, noise and all sorts of compromises. The problem again comes to the choice of fuel. Our engine with self adjusting Compression ratio represents the best characteristics of both Otto and Diesel engines, figure 9 and figure 10 [7-10].

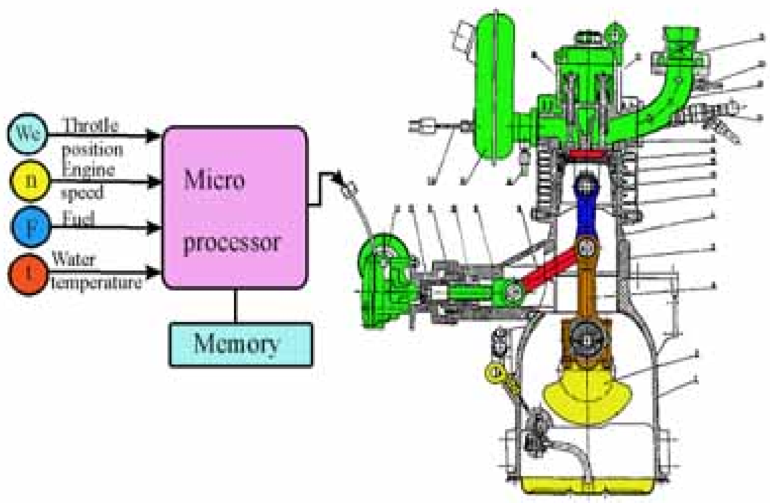


Figure 10 *The experimental CVCR (Continuously Variable Compression Ratio) engine*

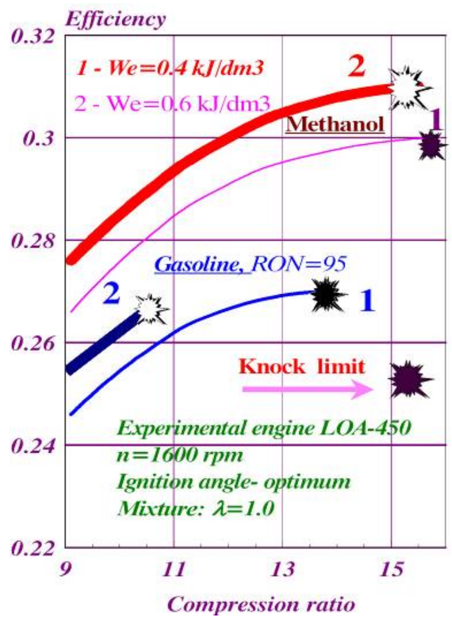


Figure 11 *Fuel consumption of the experimental engine with gasoline and methanol*

Figure 10 shows the experimental CVCR *(Continuously Variable Compression Ratio)* engine that was developed at the Technical University in Kragujevac. The engine has automatic and continual change of the compression ratio. And it can be used to determine the quality of fuel, when working as an Otto engine, and to determine the quality of diesel fuel, when performing as a diesel engine.

Methanol-burning engines are more efficient than those that run on gasoline. On figure 11 are the results of the methanol research comparing with the fuel RON-95 (Research Octane Number). When the engine is incorporated with the highest qualities of fuel we can obtain higher level of efficiency (In the races “Indianapolis 500 miles” from 1964 the basic fuel was methanol). Methanol has a high latent heat which reduces the temperature in the cylinder and also NOx. The engine can have the optimal compression ratio for pure methanol (12-14), lean mixture**,** supercharger boosts and peak power but the all present hardships with cold driveability and start.

We investigated operation of the experimental engine with flexible Otto-Diesel process in double burn variant. Investigations were performed on an experimental engine at the Laboratory for IC engines of the Faculty of Mechanical engineering from Kragujevac. Diesel fuel was directly dosed into the cylinder by a standard system, while a gaseous fuel (*in this case - natural gas NG*) was introduced into intake system by a nozzle. Some of the results are shown at figure 12. It can be noticed, that at lower loads (*under 0.5* kJ/dm^3), the experimental engine achieves the greatest efficiency operating with pure Diesel fuel that is operating under Diesel cycle with non-homogenous combustion.

At higher loads, the greatest efficiency is achieved in operation with pure natural gas, that is, during combustion of homogenous mixture, which corresponds to Otto cycle.

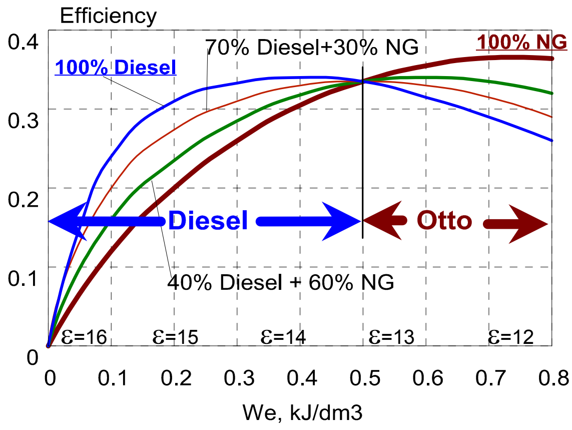


Figure 12 *Efficiency of the experimental engine [5, 7]*

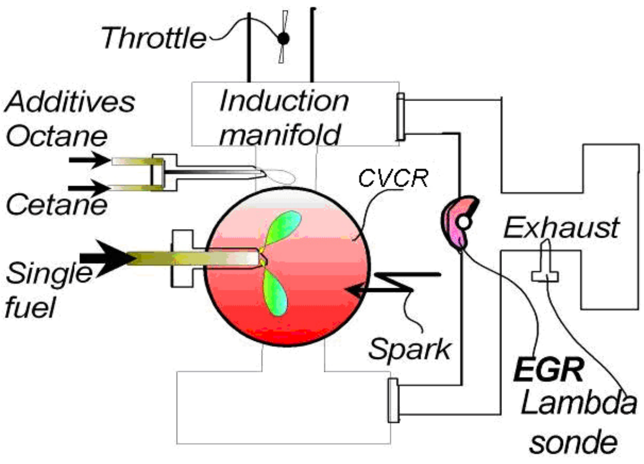


Figure 13 *Ways of symbiosis Otto and Diesel processes in the same engine cylinder [8]*

The engine, with flexible Otto/Diesel cycle (Diesel-Otto engine), can operate with two fuels – gasoline (or LPG or NG or ethanol) and diesel (or biodiesel) and with single fuel and additives. We give the advantage to the solution with single fuel (biofuel), which would be technologically and ecologically optimised and different additives, figure 13. The normal conduction of combustion process is regulated with additives. Such a Diesel-Otto engine also solves the problem of smoke emission of Diesel engines in such a way, that, at high load regimes, when smoke emission is dominant, it will work by Otto cycle, which, due to combustion of homogenous mixture, eliminates the problem of smoke appearance [6-10].

We are suggesting the basic fuel should be the barrier of the environmental and energetic attributes and at the same time, the additives should correct the items of the engine fuel, cetane and octane numbers. In accordance with the desired “engines fuel items” we have the environment for the rational consumption of the additives. Under such condition we have the opportunities for the better global environment in which we are in position to use the more efficient transport vehicles on the whole.

β=0
CR =15

β=max
CR =10

Figure 14 *The “CVCR” engine with self - adjusting compression ratio*

An engine with continuously variable compression ratio according to operating regimes and with electronic control of the accelerator is the basic assumption for the Diesel-Otto engine. Corresponding ignition system, fuel supply system (or *fuels* supply systems) or additive supply system with proper electronic control system are superposed on this engine. Such an engine design, with the aluminum block cylinder, is being developed at the Faculty of Mechanical Engineering from Kragujevac *(“CVCR” engine*) and is shown in figure 14 and 9 [7-10].

CONCLUSIONS

Motor vehicles are mass-produced industry products that are comparable with its number to the number of people, and are influencing the global relations ***R+3E = raw materials + energy + ecology + economy*** on the Planet.

Up-to-day principles of design, production and utilization of vehicles had not underlined the ecological and economical domination, which unconditionally requires from new vehicle to be mans' friends, but not enemies in conservation of genetic and ecological basics of life.

Vehicles with minimal fuel consumption have to understand the basic laws of the nature in all details: low consumptions at low speeds, and the lowest emission, recycling, restorable sources of energy and utilization materials in whole.

The existing gasoline and diesel infrastructure represents hundreds of billions of dollars of investment over many years. To be widely used, alternative fuels may require similar investments in fuel infrastructure. Thus far, most attention has been focused on the development of biofuel infrastructures.

Develop technologies to enable mass production of affordable new vehicles and ensure maintains infrastructure to support them. New engine designs must have *the variable mechanisms* that guaranteed the minimal fuel consumption in most of working regimes, but not as today, in a narrow range that is rarely used.

The next stage of power train and fuel strategy involves using new combustion engines that can be run with part-renewable fuels and used worldwide. By applying the principles of optimization, CVCR engine is important for the advanced development of the combustion process leading to the combined Otto (SI) and Diesel (CI) cycle in the same cylinder. The Diesel-Otto engine will combine the fuel efficiency of an IC-CI (Diesel engine) with the exhaust gas quality of an IC-SI (Otto engine).

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