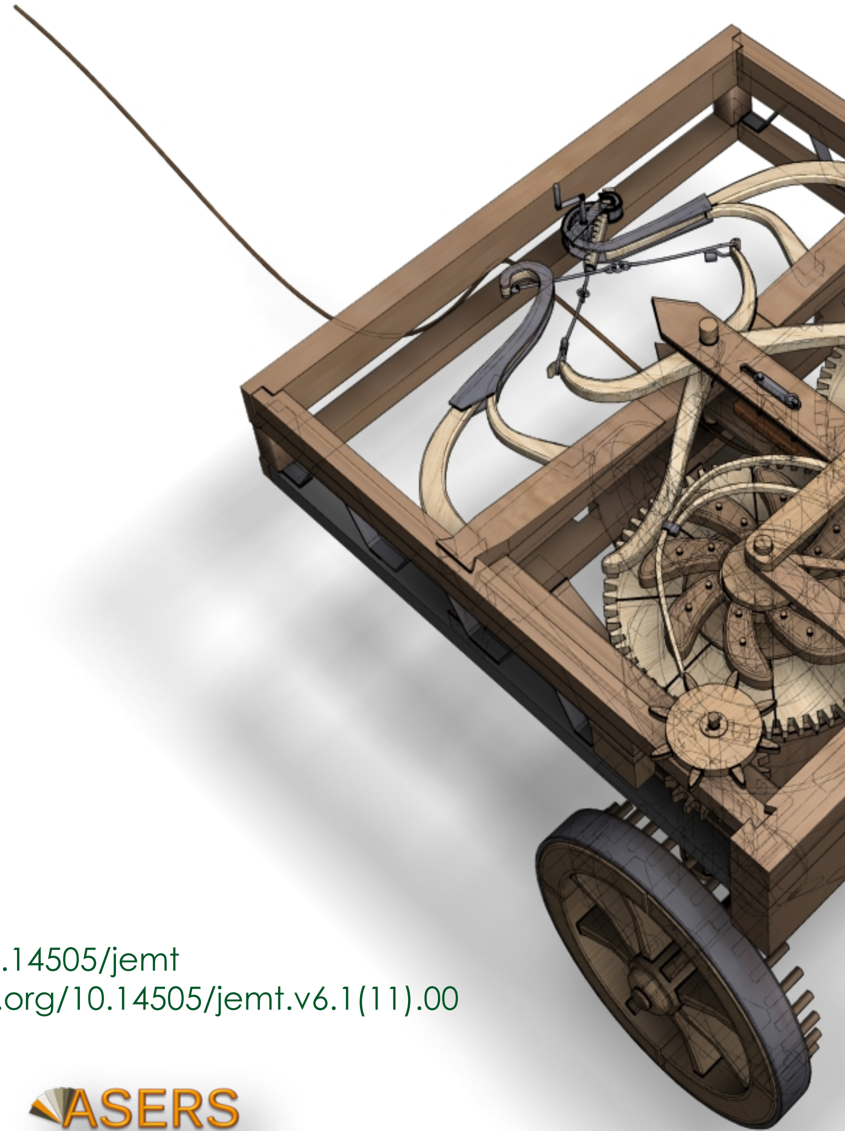
ASERS

Journal of Environmental Management and Tourism



Biannually
Volume VI
Issue 1(11)
Summer 2015

ISSN 2068 – 7729
Journal **DOI:** http://dx.doi.org/10.14505/jemt
Journal's Issue **DOI:** http://dx.doi.org/10.14505/jemt.v6.1(11).00

ASERS Publishing

Published by:

ASERS Publishing, 2015

http://www.asers.eu/asers-publishing

Summer 2015
Volume VI,Issue 1(11)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: http://dx.doi.org/10.14505/jemt

Contents:

Summer 2015
Volume VI,Issue 1(11)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: http://dx.doi.org/10.14505/jemt

Journal of Environmental Management and Tourism

DOI: http://dx.doi.org/10.14505/jemt.v6.1(11).09

Provision of Gas Engine Bus Performance with Air-Fuel Mixture

Alexandr KULAKOV
Federal University, Branch in Naberezhnye Chelny[6], Russia
alttrak09@mail.ru

Ilmir GATTAROV
Kazan Federal University Branch in Naberezhnye Chelny, Russia
gilm86@mail.ru

Alexey FROLOV
Kazan Federal University Branch in Naberezhnye Chelny, Russia
froloff_alex@mail.ru

Suggested Citation:

Kulakov, A., GattarovI, I., Frolov, A. (2015). Provision of gas engine bus performance with air-fuel mixture, *Journal of Environmental Management and Tourism*, (Volume VI, Summer), 1(11): 90-99, DOI: 10.14505/jemt.v6.1(11).09. Available from: http://www.asers.eu/journals/jemt/curent-issue.

Article's History:

Received March, 2015; *Revised* June, 2015; *Accepted* July, 2015.

Abstract:

To evaluate air ratio impact on the engine temperature condition, environmental and economic performance, in-operation and bench test of gas engines with an exhaust gas catalyst have been performed. Air-fuel mixture was adjusted with adjustment of a fuel supply ECU. Data given shows us air-fuel impact on environmental and economic performance as well as reliability of a gas engine.

Keywords: Pollutant emissions, gas engine, catalyst, concentration, exhaust gases, air-fuel mixture, compressed natural gas (CNG).

JEL Classification: Q59

1. Introduction

At the present moment due to reduction of oil reserves use of alternative fuels is becoming a topical one. Estimation of the proven natural gas reserves of different countries shows that in the short and long term prospective it is most preferable for Russia to use natural gas. More than 55% of energy sources consumption accounts for it. In the expert's opinion, Russia has almost one third of the global natural gas reserves, whereas Russian oil reserves are estimated to be only 5% of the global proven reserves.

Unique physical and chemical characteristics of natural gas, its essential natural reserves and some environmental advantages as compared to conventional fuels enables to consider natural gas as the most prospective motor fuel of the 21st century.

Scientists have researched the entire chain: production, processing, transportation, fueling vehicle tanks, and found out that liquefied natural gas (LNG) is the most environmentally-friendly motor fuel, then goes compressed natural gas (CNG) and liquefied petroleum gas (LPG). Use of gas fuels characterized by high

[6] Prospect Mira, 68/19 Naberezhniye Chelny, 423823, Russia

combustion value in internal combustion engines (ICE) provide for high homogeneity of an air-fuel mixture, completeness and evenness of combustion process, high service life of an engine due to less contamination of motor oil with combustion materials, high oil lifetime, no carbon deposit on pistons, valves and ignition plugs.

Global trends in use of gas fuels are to create and establish commercial production of vehicles with a new generation gas motor with better environmental and energy characteristics in order to satisfy the demand in Russian and global markets.

Foreign countries pay a great attention to convert their vehicles into gas fuel vehicles. December 12, 2001 UN Economic Commission for Europe (UN EEC) approved the Resolution which stipulates that 10 % of all vehicles in European countries shall use natural gas by 2020.

Every year, more than 1 mln 600 ths tons of contaminants, are spilled into the atmosphere by vehicles. As it was mentioned earlier, using of gas fuel in ICE reduces the pollutant emissions with exhaust gases. This is provided with high homogeneity of the gas mixture, identical content of the mixture in terms of time and volume, and possibility to ensure stable engine operation using leaner mixtures.

The price of CNG shall not exceed 50% of A-80 petroleum sold in a region according to the applicable Directive of the RF Government # 31 dd. 15.01.93. On immediate actions to facilitate replacement of motor fuels with natural gas (Internet …).

Considering low price and environmental advantages of natural gas, municipal public transport is the most profitable option to use CNG as a motor fuel.

And greater attention of vehicle manufactures to designing and producing buses with gas engines and increase of their number on the city streets proves the above stated. In addition to that there is some experience in converting means of transport from conventional motor fuels to CNG. Though, it is worth mentioning that the most effective way to ensure vehicle pool conversion to the use of gas fuel is to manufacture vehicles with gas engines. (Bakhnutov 2014)

Main means of transport to be converted to CNG use are municipal busses and street-cleaning vehicles. In major European cities (Italy, France, Germany, Spain, Sweden, Greece, Portugal, Netherlands) 9,000 (13%) of 70,000 municipal buses use CNG; 3,000 (15%) of 20,000 dump trucks in Europe (France, Spain, Italy, Greece, Portugal) use CNG as well.

2. Main part

2.1. Feasibility evaluation and concept of gas engine use

Today only a few companies in Russia have launched commercial production of cars and busses with gas engines, JSC KAMAZ and LLC LiAZ are among them.

Improvement of a vehicle operating efficiency, namely performance and environmental characteristics of gas engines may be ensured both during designing and by development of methods of monitoring and control over a vehicle technical condition.

Table 1 shows comparative data on operation of LiAZ-529271 buses using diesel fuel and CNG.

Table 1.Operating costs of State Unitary Enterprise Mosgortrans for buses using diesel fuel and CNG

Key performance indicators	Bus using diesel fuel	Bus using gas fuel
	LiAZ-529271	LiAZ-529222
Bus price, RUB	7,672,550	7,161,350
Fuel consumption rate per 100 km	69 m^3	48 l
Fuel price, RUB	12.57	26.99
AC (operating) per 800 ths km, RUB	10,778,640	13,500,160
Fuel costs, RUB	6,938,640	10,364,160
Maintenance and repair costs, RUB	3,840,000	3,136,000
Emission standard	EURO-5 (EEV)	EURO-5
Engine power, kW	206	184
Exterior noise, dB	76	80
Cost advantage per vehicle when using CNG for the lifetime, RUB	2,210,320	

Main requirements to gas engines:

- Power characteristics of a gas engine are not lower than of a basic diesel engine.
- Fuel consumption at the power factor within the range of 10…30% of the full power shall be 10…20% lower as compared to the conventional gas engines.
- Pollutant emissions into the atmosphere shall not exceed Euro 5 requirements.
- Minimal costs to start production.
- Maximum harmonization between gas engines and basic diesel engines.
- Complete interchangeability regarding connections with a basic engine.
- Engine value appreciation shall be not more than 100 ths RUB.
- Compliance with EURO-5 environmental requirements.

Lack of experience in designing and operating a vehicle using natural gas, namely municipal public transport determines a necessity to study the problems in this sphere. Such characteristics as fuel efficiency, engine-to-transmission system consistency, load conditions for a bus engine, toxicity of exhaust gases require deeper studies and development of recommendations to design buses with gas engines.

As it was mentioned above, environmental protection issues and reduction of global oil resources lead to an increased interest in alternative fuels. The higher public interests in improvement of the air quality, the tougher, and the law requirements on pollutant emissions related to the engine exhaust gases, vehicle noise in cities. Natural gas is the most prospective fuel among other alternative fuels, as global resources of natural gas are essential, and with natural gas there is a potential to get less emissions of toxic matters and provide high engine performance indicators.

One of the most important lines in this sphere is designing and production of engines using the alternative fuel- natural gas. JSC KAMAZ is an active participant of the fight to improve the environment, which they do manufacturing their products. Research and development activities to design engines, cars, buses, power units which will operate on CNG have been performed by this auto major since 1999. At the present moment the plant has commercial production of buses with gas engines complying with the emission standard EURO-4.

The concept of diesel-to-gas engine conversion: minimal changes in the engine design, cylinder-piston assembly remains unchanged, high performance-per-liter at the level of 27-30 kW/l is achieved and the environment safety requirements at the level of EURO-5 emission standard are met. (Bakhmutov 2014)

KAMAZ gas engine is designed on the basis of a diesel engine, size 120x130 with a turbo-charging system and a charge air intercooler. A distinguishing feature of KAMAZ engine is distributed phased gas injection into each cylinder which makes it possible to adjust an air-fuel mixture for each cylinder individually, if required, to reach minimal contaminant emissions. All those enable to achieve:

- Better environment due to lack of carbon black in the combustion materials and noise reduction due to softer combustion at the lower compression.
- No oil washing out from the cylinder liner walls, no carbon formation, no gumming of piston rings, and therefore lower wear of the cylinder-piston system.
- Gas fittings of the engine are much simpler and cheaper that precision diesel fittings, maintenance costs are lower.
- High unification of gas engine design with diesel modifications.
- Due to reduction of fuel costs a car payback period and transport costs decrease.

2.2. Characteristics of modern KAMAZ gas engines

Assemblies and parts as follows have been changed, adjusted and re-designed:

- piston with improved combustion chamber;
- improved cylinder head with a hole for spark setting;
- original intake manifolds, adjusted for setting an electromagnetic gas regulator etc.

Gas engines are equipped with an electronic engine control system which performs functions as follows:

- Gas supply control at all types of engine operation;
- Engine start and stop control;

- Control overt point of ignition;
- Maintaining fixed frequency of engine rotation at idling operation;
- Limitation in maximum rotation per minute;
- Maintaining working mixture content which meets the requirements to economic efficiency and toxicity of exhaust gases;
- Engine protection during emergency operations;
- Engine control during emergency operations;
- Centralized diagnostics of the system elements;
- Alarming on emergency and critical operation of the engine and the system.

Figure 1.Municipal bus NEFAZ-5297 and gas engine V8ЧН12/13 KAMAZ 820.61-260 for buses.

NEFAZ-5297 buses with gas engines (Table 2) produced by JSC KAMAZ are used in such cities as Naberezhnye Chelny, Yekaterinburg, Krasnodar. Results of the natural gas use as a fuel for means of automobile transportation show not only saving of conventional fuels but decrease in environmental pollution, which is very important for big cities. Minimum temperature for a sure start of a cold engine is -45 degrees Celsius. First overhaul period of the installed engines is 800,000 km of bus operational kilometers.

Table 2.Technical characteristics of KAMAZ 820.61-260 gas engine

MAIN PARAMETERS AND DIMENSIONS	VALUES
Engine type	Four-stroke with forced spark ignition
Number and position of engines	V-8, arranged at 90^0
Ignition sequence	1-5-4-2-6-3-7-8
Cylinder diameter and piston stroke, mm	120×130
Cylinder capacity, l	11.76
Compression rate	12.0
Indicatedpower, kW (h.p.), notless	191 (260)
Rated revolutions of crank shaft, min^{-1}	2200
Crankshaft revolutions corresponding to the maximum torque, min^{-1}	1300…1500
Maximum torque, N·m (kgf·m)	931 (95)
Microprocessor control unit	M 20

Improvement of environmental parameters of the bus engine is reached due to using natural gas as a motor fuel and equipping exhaust gas system with a catalyst. However growing pool of gas-using buses has revealed a problem of insufficient study of operational and environmental characteristics as well reliability of engines working on CNG (GOST R 41.49-2003…; Zvonov 1981, Klementyev, A. Development of theory; Kulchistkiy 2000, Kutenev 1979).

2. 3. Requirements on pollutant emissions in exhaust gases of municipal bus engines

Main parts of emissions into the atmosphere are for municipal buses, which routes lay in the most populated areas. Bus stops are the most problematic points of the routes as there the buses operate at the most dangerous in terms of emissions modes (engine braking, idle running, acceleration) (Kutenev, V., 1979; Abanteriba, S. The Analysis of the Lubrication…; Mourelatos, Z. An Efficient Journal…; Rajagopal, K. On an inconsistency).

To solve the problem of heavy traffic it is possible to bring back big municipal buses and to reduce environment pollution of the cities - buses with low pollutant emissions in exhaust gases may be used. Single bus Citaro by Daimler AG equipped with EURO-4 emission standard engine, power 210 kW (286 h.p.) emits 0.03 g/kW*h of solids and 3.5 g/kW*h nitrogen oxides into the atmosphere. But toxicity of exhaust gases of buses depends on on-route time and loading conditions (Wang, D. Lubrication Analysis…, Yuan, Y. Engine Lubrication System Analysis by…, Zhang, C. Fast Analysis of Crankshaft Bearings…).

Conditions of the engine influences on operation parameters of a vehicle including are environmental safety. More than one third of all faults (36.9 %) are due to engine problems. (Kuznetsov 2001)

Operating conditions of buses are characterized by high diversity (different traffic intensity, passenger capacity utilization, distance between stops etc.) (Yakunin 2003) For Moscow, for example, municipal bus operating conditions are as follows in Table 3. (Nefedov 1976, Ryabchinckiy 2000, Samoylov 2008, Umnyashkin 2006)

Table 3.Operating conditions of municipal buses in Moscow

Traffic condition	Route category		
	Easy	Medium	Heavy
Acceleration	35%	40%	45%
Steady motion	28%	20%	9%
Deceleration	5%	6%	6%
Idle operation	32%	34%	40%

To evaluate how much this or that category of transport means contaminates the city atmosphere in-operation test of a means of transport is performed under typical traffic conditions, which results in development of so called driving cycles that with some degree of certainty show primary traffic conditions of a means of transport under the city conditions.

2. 4. In-operation tests of municipal buses

To find out main loading conditions of gas engine during bus operation on route, in-operation tests of municipal buses have been performed in Krasnodar. In-operation tests of buses under conditions of intensive traffic show that idle operation and maximum torque operation prevail. It is almost impossible to cover all operation conditions in different countries and accept uniform testing cycle to evaluate toxicity of exhaust gases for trucks and buses, but introduction of uniform methods to define toxic components of exhaust gases, nomenclature of used devices and equipment makes it possible to compare test results.

A bus is equipped with gas engine V8ЧН12/13 power 260 h.p. and 3-speed automatic transmission gearbox (gear range $i_I = 6.0$; $i_{II} = 1.43$; $i_{III} = 1.0$). A portable computer was used to register main parameters of the bus operation, the computer was connected to the terminal of the engine ECU. Figure 2 to 5 show the test results.

The experience shows that bus traffic conditions differ a lot from a regular car traffic conditions. To prove the above it is enough to say that number of application of brakes per 1 km is 1.35 times higher, and clutch release – 2.48 times higher, forced stops 1.54 times higher (Nefedov 1976).

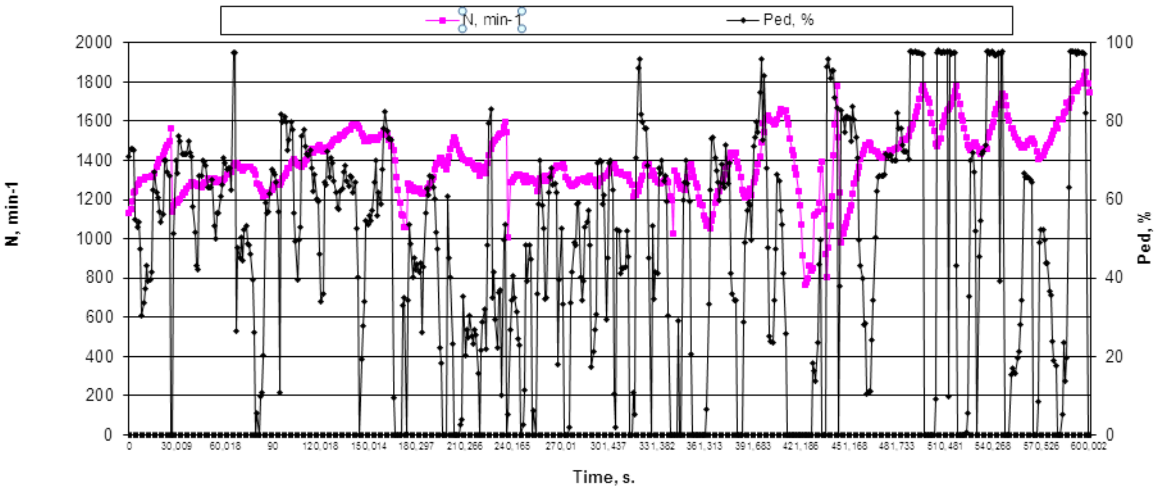


Figure 2. Change of revolution of engine crankshaft and accelerator pedal position.

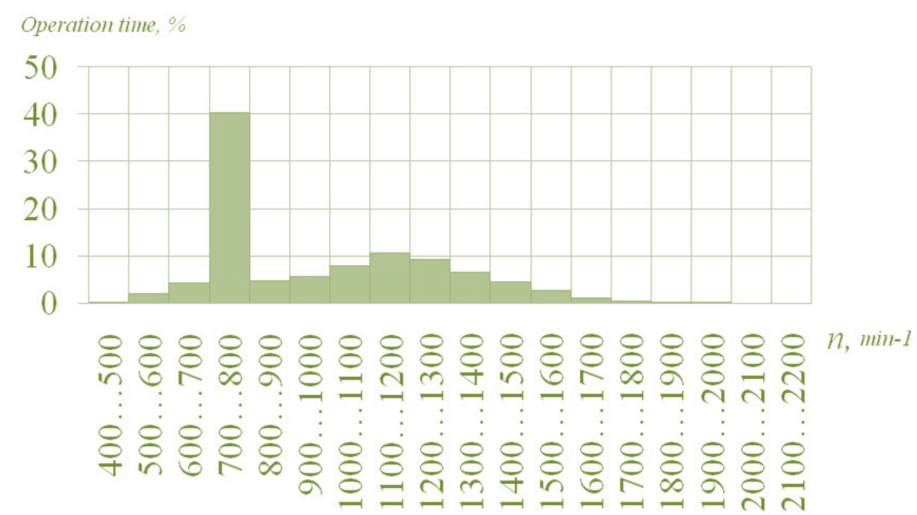


Figure 3.Timing at different revolutions of an engine crankshaft when bus is on the route.

Traffic conditions of buses and therefore loading cycles of the engine are characterized by a great variety of factors, for example, such as distance between stops, number of lanes, traffic intensity etc. Uniform velocity motion is followed by braking, stop and further acceleration.

High traffic intensity of city roads, frequent stops lead to the situation when operating at constant speed is less than 30% of the total bus operation time on the route and acceleration is around 50 %.

It is established that that high number of application of brakes is typical of the bus operation, number of application of brakes per 1 km is 1.35 times higher, and clutch release – 2.48 times higher, forced stops 1.54 times higher.

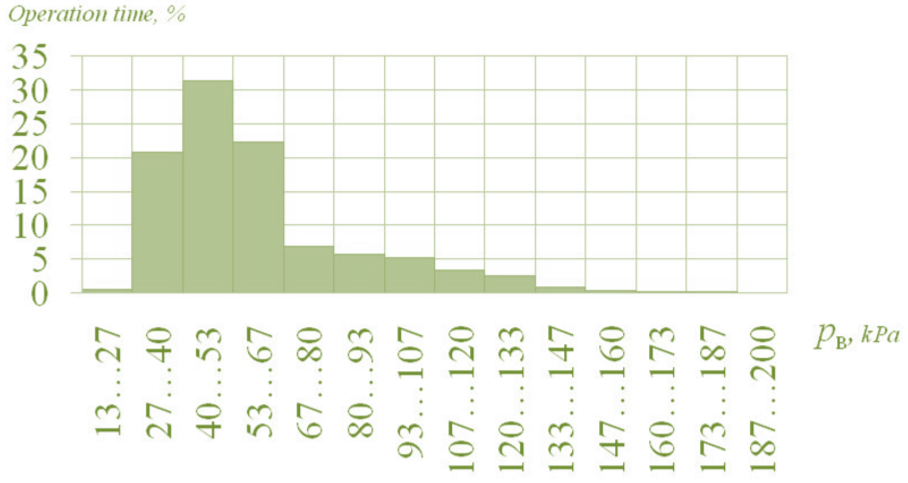


Figure 4. Timing at different pressures in the engine intake manifold when the bus is on the route.

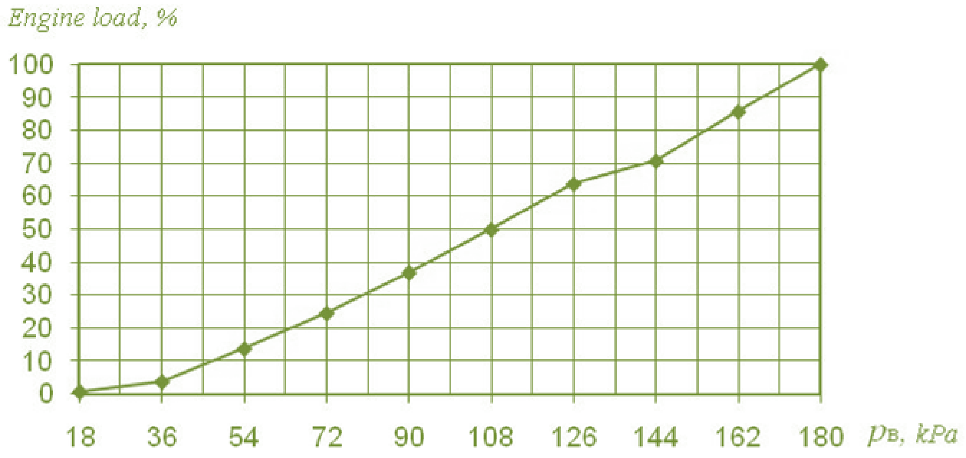


Figure 5. Loading condition of gas engine V8ЧН12/13 at the crankshaft revolution n = 1400 min^{-1}.

Idle operation of the engine is 56% of the time on the route, average speed on the route is 23.4 km/h, maximum speed on the route is 56.6 km/h, and engine power of more than 70 kW and revolution of the engine crankshaft of more than 1600 min^{-1} are practically unused during operation on the route.

2. 5. Bench tests of gas engine V8ЧН12/13 with an exhaust gas catalyst

Air ratio (*ALFA*) is the most important parameter in the operation of an engine. Correctly adjusted air-fuel mixture ensures optimal combustion intensity at different engine operation modes and improves environmental safety parameters as well as increases engine fuel efficiency.

Electronic engine control system with distributed fuel injection is installed on the test unit – gas engine V8ЧН12/13, allows adjusting fuel injection of the engine ECU. Required air-fuel mixture is ensured by changing open period of electromagnetic gas regulator and pre-set air pressure at the intake manifold with a throttle.

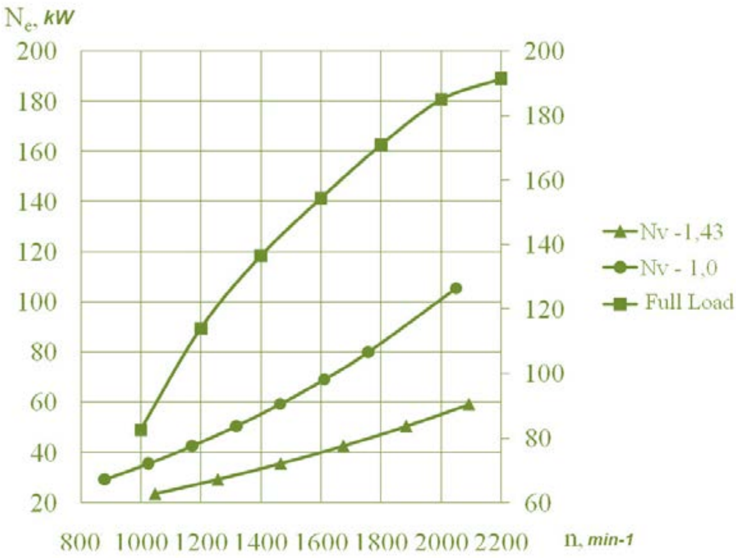
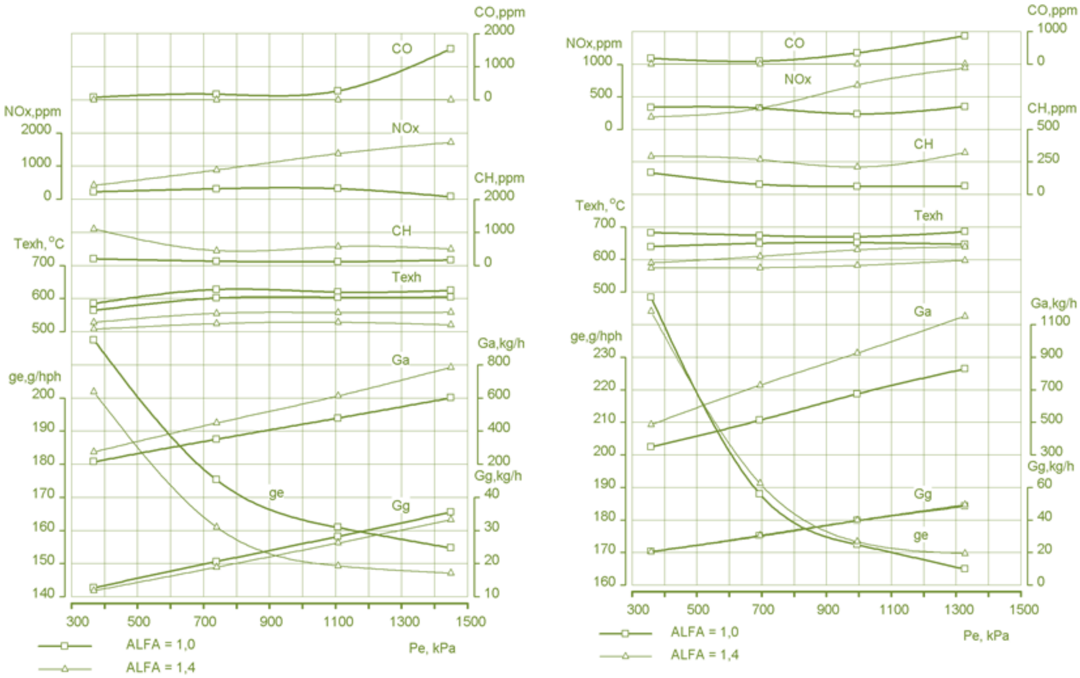


Figure 6.Typical duty cycle of gas engine of a municipal bus on the route, speeds 2 (i_{II} = 1.43) and 3 (i_{III} = 1.0) as compared to the fuel-load curve (FLC).

To estimate impact of the air ratio on the engine operating temperature, environmental and economic efficiency parameters, bench tests of a gas engine with an exhaust gas catalyst have been performed. Adjustment of air-fuel mixture was made with adjustments on fuel supply ECU. The engine was tested according to the methods described in GOST R 41.49-2003 (Regulation 49 UN EEC), ESC cycle (under engine loading of 25, 50, 75, 100%) with two options of ECU adjustments:

- *Option* 1: stoichiometric ratio of the air-fuel mixture (*ALFA*= 0.99…1.0);
- *Option* 2: lean air-fuel mixture (*ALFA* = 1.39…1.4).

Figure 7 show loading parameters of gas engine V8ЧН12/13 at different revolutions of the engine crankshaft.



a) n= 1190 min⁻¹; *b) n = 1730 min⁻¹.*

Figure 7. Loading parameters of gas engine at revolutions of the engine crankshaft

Table 4 shows obtained specific emission values of the exhaust gases. It is clear that nitrogen oxide (NO_x) content and bulk volume of hydrocarbons (CH) in the exhast gases is lower when the engine operated using the stoichiometric air-fuel mixture (option 1). In this case, CO concentration in the exhaust gas under option 1 of the engine operation is higher as compared to the values obtained under option 2.

Table 4. Specific emission values of the exhaust gases of engine V8ЧН12/13, obtained using the methods as per Regulation 49 UN EEC

Option	NO_x, g/kW*h	CH, g/kW*h	**CO,** g/kW*h
ALFA = 0.99…1.0	1.45	0.09	1.98
ALFA = 1.39…1.4	7.9	0.38	0.01

It is clearly seen when the endine loading grows. Based on this it is possible to draw the conclusion that a catalyst is more effective in reducing NO_x and CH concentration when the engine works on the stoichiometric air-fuel mixture. Higher CO concentration may be explained by the fact that it is necessary to have extra CO in the exhaust gases to reduce NO_x to N_2.

Conclusion

Higher effectiveness of an exhaust gas catalyst during the engine operation under option 1 can be explained with higher exhaust gas temperatures, which provides for faster heating and more effective maintaining of the temperature inside the catalyst. However, high temperatures have a negative impact on the service life of parts of an engine injection system, namely manifolds, turbines and bearing boxes of turbochargers, as well as cylinder/piston system.

Findings

- Lean air-fuel mixture with α = 1.39…1.4 is a better option in terms of fuel efficiency, which can be clearly seen at low revolution of the engine crankshaft.
- Stoichiometric air-fuel mixture with α = 0.99…1.0 ensures better as compared to the lean air-fuel mixture environmental safety parameters of the engine, but leads to increase of the exhaust gas temperature.
- Higher exhaust gas temperatures (T_{eg}) of stoichiometric air-fuel mixture at 70…100 °C leads to higher combustion intensity of the cylinder/piston system, turbocharger and injection system which has a negative impact on the service life of the parts.
- It is necessary to make thermo metering of a piston, cylinder head, turbocharger and matching computation considering higher temperatures as compared to diesel engines.

References:

[1] Abanteriba, S. (2000). The Analysis of the Lubrication Condition and Friction Losses of a Single Acting Cross Head Guide Shoe of a Low Speed Cross Head Diesel Engine. *Tribology Transactions,* 4(43): 665-670, 830-836, 847-851.

[2] Bakhmutov, S. (2014). Development of vehicles, weight more that 6 tons and buses with medium and high pasenger capacity with new generation gas engines of prospective environmetal standards. *International Scientific and Technical Conference Innovations in Machine Building, Minsk*.

[3] Bolbas, M. (2003). *Transport and environment.* Minsk: Technoprint.

[4] Klementyev, A. (n.d.). Development of theory for vehicle efficiency analysis when converting internal combustion engines into gas fuel engine. *Ph.D. thesis in Engineering Science.*

[5] Kulchinskiy, A. (2000). *Toxicity of automobile and tractor engines.* Vladimir: Vladimir State University.

[6] Kutenev, V., Arapov, V. (1979). *Reduction of polutant emissions by truck and bus engines.* R&D Institute of Automative Industry Information (NIINavtoprom).

[7] Kuznetsov, E., Boldin, A., Vlasov, V. *et al.* (2001). *Vehicle Technical Maintenance: College book. Ed. 4, revised.* Moscow: Nauka.

[8] Mourelatos, Z. (2003). An Efficient Journal Bearing Lubrication Analysis for Engine Crankshafts. *Tribology Transactions, 3*(44): 351-358.

[9] Nefedov, A., Vysochin, L. (1976). *Planning of an experiment and simulation of a vehicle operation parameters.* Lviv.

[10] Rajagopal, K., Szeri, A. (2003). On an inconsistency in the derivation of the equations of elastohydrodynamic lubrication. *Proceedings of the Royal Society A, 459*: 2772-2786.

[11] Ryabchinskiy, A., Trofimenko, Yu., Shelmakov, S. (2000). *Vehicle environmental safety. Edited by Lukanin V.M, A.M. of the Russian Academy of Science.* Moscow: MADI.

[12] Samoylov, A. (2008). *Commercial Transport Magazine, 4*.

[13] Tsvetkov, D. (n.d.). Improvement of operative correction of service standards for municipal buses due to operation condition metering. *Ph.D. thesis in Engineering Science.*

[14] Umnyashkin, V., Filkin, N., Muzafarov, R. (2006). *Fundamental study of vehicle performance.* Izhevsk: R&D Center Systematic and chaotic dynamics.

[15] Wang, D., Keith, T., Yang, Q., Vaidyanathan, K. (2004). Lubrication Analysis of a Connecting-Rod Bearing in a High-Speed Engine. *Tribology Transactions, 2*(47): 280-298.

[16] Yakunin, N. (2003). *Guidelines for control and monitoring over vehicle condition in operation.* Moscow: Mashinostroyeniye-1.

[17] Yuan, Y., Tao, W., Liu, E., Barber, G., Zou, Q., Guessous, L., Du, Z. (2007). Engine Lubrication System Analysis by Considering Aeration and Cavitation within the Rotating Oil Supply Passage. *Tribology Transactions,* 1(50): 39-49.

[18] Zhang, C., Zhang, H., Qui, Z. (1999). Fast Analysis of Crankshaft Bearings with a Database Including Shear Thinning and Viscoelastic Effects. *Tribology Transactions, 4*(42): 922-928.

[19] Zvonov, V. (1981). *Toxicity of internal combustion engines.* Moscow: Mashinostroyeniye.

*** *GOST P 41.49-2003, Regulation 49 UN EEC. Uniform provisions concerning the approval of compression ignition (C.I.) and natural gas (N.G.) engines as well as positive-ignition (P.I.) engines fuelled with liquefied petroleum gas (LPG) and vehicles equipped with C.I. and N.G. engines and P.I. engines fuelled with LPG, with regard to the emissions of pollutants by the engine (MOD).* (2004, January 7). Moscow: Izdatelstvo Standartov.

Call for Papers
Winter_Issue 2015

Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is a young interdisciplinary research journal, aimed to publish articles and original research papers that should contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences.

Journal will publish original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modeling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies, etc. This topic may include the fields indicated above, but are not limited to these.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in environmental management.

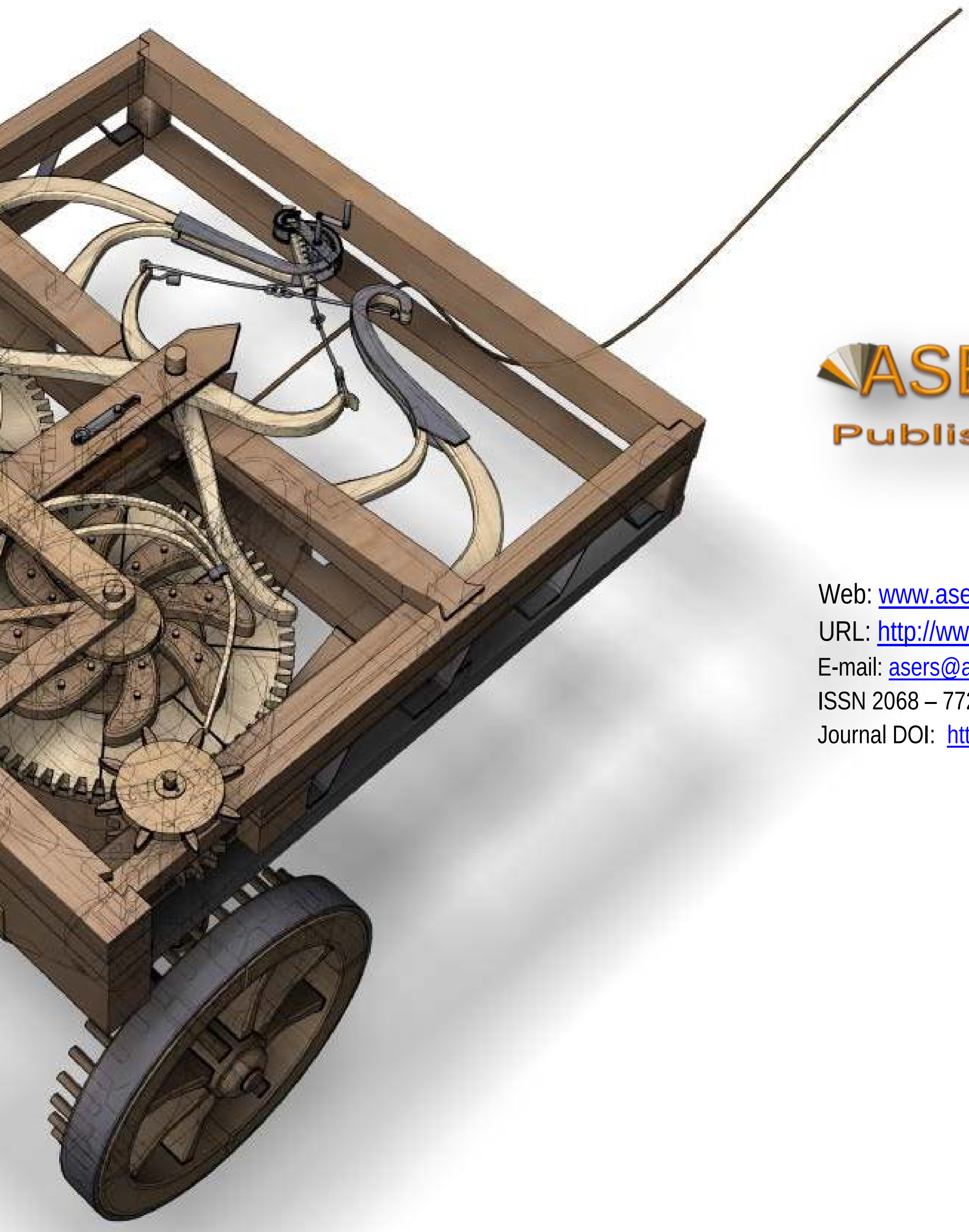
Journal of Environmental Management and Tourism is indexed in SCOPUS, RePEC, CEEOL, ProQuest, EBSCO and Cabell Directory databases.

All the papers will be first considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

Deadline for submission:	30th October, 2015
Expected publication date:	December, 2015
Website:	www.asers.eu/journals/jemt/
E-mail:	jemt@asers.eu

To prepare your paper for submission, please see full author guidelines in the following file: JEMT_Full_Paper_Template.doc, then send it via email at jemt@asers.eu.

ASERS



ASERS Publishing

Web: www.asers.eu
URL: http://www.asers.eu/asers-publishing
E-mail: asers@asers.eu
ISSN 2068 – 7729
Journal DOI: http://dx.doi.org/10.14505/jemt