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CONVERSION OF DIESEL TRUCKS TO OPERATE ON NATURAL GAS IS RATIONAL WAY TO DECREASE EXHAUST EMISSION

DYZELINIŲ SUNKVEŽIMIŲ KONVERSIJA DARBUI GAMTINĖMIS DUJOMIS YRA RACIONALUS DEGINIŲ EMISIJOS MAŽINIMO BŪDAS

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The paper is dedicated to methods of conversion diesels without and with turbocharging to operate on natural gas.

The most simple and cheap method in case of naturally aspirated engines consists in use of transistorized ignition system and gas ejection with stoichiometric gas-air mixture at idle and full load conditions and lean mixture at all other conditions.

In second case microprocessor ignition and control system is used. The third method applies to the V-type engines. In this version special design gas supply system is used to ensure equal mixture at both the rows of cylinders.

As applied to turbocharged engines it has been found that use of base diesel charging system is not the best solution. It is necessary to develop a new system to get high torque back up. Also special catalyst should be chosen to minimize methane in the exhaust gases.

Naturally aspirated diesel engine, supercharged diesel engine, conversion to natural gas, catalytic converters, emission control.

Introduction

Russia possesses the highest established stock of natural gas (NG) resources. In spite of this use of NG in Russian transport sector is not great. In table 1 world data on use of NG in automobile transport is given.

Table 1. World data on conversion of automobile transport to operate on natural gas (December 2009).

1 lentelė. Pasaulio valstybių duomenys apie automobilių transporto konversiją darbui natūraliomis gamtinėmis dujomis (Gruodis 2009).

№	Country	Number of vehicles	Number of gas stations	NG consumption
1	Pakistan	2 250 100	3 000	2 025,09
2	Argentina	1 793 449	1 835	2 650,92
3	Iran	1 638 284	981	2 124,00
4	Brazil	1 614 404	1 769	1 975,20
5	India	700 000	500	624,00
6	Italy	587 577	732	588,00
7	China	500 000	1 339	450,00
8	Columbia	296 261	458	540,00
9	Bangladesh	180 000	463	256,32
10	Thailand	158 002	369	79,00
11	Bolivia	122 812	128	315,36
12	Ukraine	120 000	224	552,00
13	Egypt	110 100	119	406,80
14	Russia	103 000	235	321,48
15	Armenia	101 352	275	342,00
16	USA	100 000	816	660,00
17	Germany	77 000	835	129,12
18	Peru	73 839	77	98,16
19	Bulgaria	60 236	76	156,00
20	Uzbekistan	47 000	43	51,00

It may be seen that Russia occupies 14-th position as regards to number of automobiles end 15-th position in list of gas supply stations. It is evident that fast progress should be ensured in near future to harmonize NG stock and use of NG in Russian automobile transport. The paper is dedicated to methods of diesel engine conversion to operate on NG.

The conversion of diesel trucks to operate on natural gas brings about several advantages:

— increase of world energy reserves;
— decrease of engine noise, harmful emission species and emission of particles;
— lowering of expenses on lubricating oil and fuel (in many countries);
— increase of engine life.

However, the lowering of the gaseous emissions, particularly emission of nitrogen oxides and unburned hydrocarbons (methane inclusive) turns out to be a serious problem. The paper deals with the above mentioned problem for the naturally aspirated and turbocharged engines. As regards the naturally aspirated engines, it turns out necessary to use not only the well known ways (operation on stoichiometric mixture with three way catalytic converters and oxygen sensors), but also in the case of the V-type engine to develop a new type of gas supply and gas supply control systems to keep air fuel mixture strength close to stoichiometry at high loads and at idle condition in both engine blocks.

Development of a naturally aspirated natural gas engines

At part loads, lean mixture is ensured to increase engine operating efficiency. Attention was paid to the development of catalysts that may be effective in oxidizing methane. This development has been done in cooperation with Central Scientific Research Institute (NAMI, Moscow). The results of the experiments justified the undertaken development.

In the case of turbocharged engines operation on lean mixture seems to be beneficial to get low nitrogen oxides emission. At lean mixture, the temperature of the exhaust gases is rather low and, hence, the oxidation of methane turns out to be a serious problem. Investigations helped to solve the problem by design of a two-stage catalytic convener with palladium catalyst.

There are many naturally aspirated diesel engines that are not suitable for emission control. At the same time if conversion of those engines into natural gas engines was properly done it would be possible to not only decrease noise and particle emission, but also ensure considerable improvement in the emission of nitrogen and carbon oxides as well as hydrocarbon emission, methane inclusive.

Let us first consider what kind of difficulties one encounters while converting a naturally aspirated diesel engine into a natural gas engine. In the case of a central gas supply with the help of gas air mixture device, to get the same power and torque as in the base diesel engine, air-to-fuel equivalence ratio should to be decreased. Brake mean effective pressure p_e of the engine in the case of engines with internal mixture formation may be given as in eq. (1):

$$p_e = \frac{H_u \eta_i}{\alpha l_0 (l + d)} \eta_v \rho_0 \eta_m \tag{1}$$

where H_u – is lower calorific value, l_0 – stoichiometric ratio, η_i – indicated efficiency, α – relative air-to-fuel ratio, d – amount of water vapor mass contained in one kg of air, η_v – volumetric efficiency, ρ_0 – density of air at engine inlet, η_m – mechanical efficiency of the engine.

In the case of engines with external air fuel mixture formation mode the equation (2) can be applied.

$$p_e = \frac{H_u}{\alpha l_0 (l + d) + l} \eta_i \eta_v \rho_{ch} \eta_m \tag{2}$$

Here the volumetric efficiency is being determined taking into account the fact that air – gas mixture is sucked into engine. In this equation, ρ_{ch} is density of air gas charge at the ambient conditions.

For both modes of the air fuel mixing, the equation may be written in the form (1), if the volumetric efficiency is determined on the basis of air supply. The equations may be used to assess the necessary mixture strength change to preserve the value of mean effective pressure.

The reasons for the air-to-fuel equivalence ratio to be decreased in the case of the external gas – air mixing linked with the intention to keep the power and torque of a natural gas engine the same as for the base diesel engine are as follows:

1. Considerable decrease of air supply and, hence, air determined volumetric efficiency owing to high partial volume of a natural gas;
2. Decrease of indicated efficiency as a result of lower compression ratio and lower air-to-fuel equivalence ratio;
3. Increase of inlet duct resistance due to the application of a diffuser.

The distributed gas injection into the manifold ducts instead of a central gas supply may help in the increase of relative air-to-fuel ratio. However, numerical analysis with the help of computer model revealed that this increase is insufficient to get very low nitrogen oxides emission, as the adoptable value of relative air-to-fuel ratio to ensure a considerable decrease of nitrogen oxides is approximately 1.5–1.55. A radical solution may be the use of the internal air gas mixing but this requires a change of cylinder head casting which is not economically justified in all cases. In the case of maintaining the same natural gas compositions, the calorific value of gas air mixture may be slightly lower than in the case of using diesel fuel.

As our experiments show, to preserve power and torque of the base diesel engine, the relative air-to-fuel ratio should be decreased from 1.55–1.6 in diesel version to 1.1–1.2 for the natural gas modification. At this values of the relative air-to-fuel ratio in the case of homogeneous mixture nitrogen oxides concentration in the exhaust gases is quite high. Cooled exhaust gas recirculation turned out not to be very effective. At full load, the recirculation of 4.1–4.5 percent of cooled exhaust gases related to the fresh charge (on mass bases) decreased the concentration of nitrogen oxides by 15–30% (at different engine speeds). However, the decrease of engine power was quite considerable – 4–11%.

The atomized water injection to air-gas mixture in the inlet manifold has been investigated as well. The amount of water injected was 5% of the fresh charge mass. This way was very efficient as the concentration of NO decreased by 2.5–3.9 times at different engine speeds. However the engine power decreased by 7–8% at the same time. The decrease of engine power may be explained by partial evaporation of water in the inlet manifold, by the increase of in-cylinder charge heat capacity and by the evaporation of water during air-gas mixture combustion. Taking into account the necessity to keep water tank aboard of automobiles (or buses) at the climatic conditions like that in Russia, this way to get low nitrogen oxides emission cannot be approved.

Hence it was decided to try the following way. To design gas supply and gas supply control systems in such a way as to obtain stoichiometric charge at high engine loads and idle conditions, to use three way catalyst, and to switch to lean mixtures at part loads (α= 1.5–1.55). The application of lean mixtures at part loads may at the same time decrease nitrogen oxides emission and improve bus or truck efficiency in big cities operating conditions. Comparison of gas consumption by Russian NE bus turned out to be lower than that obtained in the course of road tests in Brussels and Ireland [1] – [4].

Two ignition systems may be used. The first – transistorized system with distributor (Fig. 1) and the second – microprocessor type system (Fig. 2). In the last case electronic control of mixture strength is performed by microprocessor.

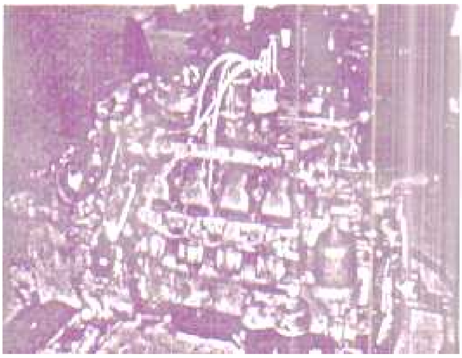

Fig. 1. Overall view of a naturally aspirated gas engine with transistorized ignition systems
1 pav. Bendras nepripučiamo dujinio variklio tranzistorinės uždegimo sistemos vaizdas

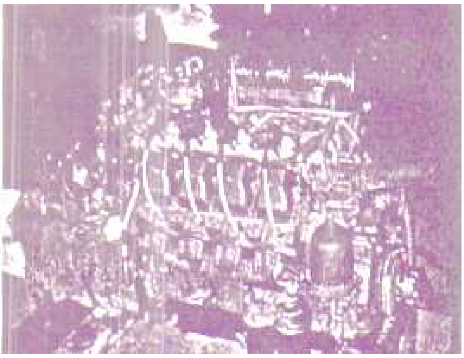

Fig. 2. Overall view of a naturally aspirated gas engine with microprocessor ignition and control systems
2 pav. Bendras nepripučiamo dujinio variklio tranzistorinės uždegimo ir valdymo sistemų vaizdas

One of the most difficult tasks to be solved was the development of a three-way catalyst that could efficiently decrease the amount of methane in the exhaust gases. Several catalysts have been tried.

Results obtained with palladium catalyst

Experiments were carried out on the KAMAZ engine (power output 145 kW, rated speed 2200 rpm, 8 cylinders V-type, bore and stroke in mm 120x120). In Table 2 the results of the experiments are shown demonstrating the efficiency of palladium catalyst in terms of HC, methane inclusive emissions, at part loads and lean mixtures.

It is necessary to retard the ignition considerably. It also seems that even at temperatures at the inlet of the catalyst that amount to 450°C, the platinum catalyst is ineffective in terms of hydrocarbons (methane) oxidation. It is also evident that both the catalysts are effective as regards the decrease in CO concentration. Taking into account all results of the experiments, it seems that palladium catalyst is preferable.

One may see that the catalyst is quite efficient as regards to decrease CO and HC content. The concentration of NO$_x$ is low as a result of the lean homogeneous mixture combustion.

Table 2. The results of the experiments demonstrating the efficiency of palladium catalyst in terms of HC emissions.
2 lentelė. Bandymų rezultatai, atspindintys paladžio katalizatoriaus efektyvumą HC emisijai.

n [rpm]	Gas Consumption [kg/h]	Air Consumption [kg/h]	Relative air-to-fuel ratio	Torque [Nm]	Temperature at catalyst inlet [^{o}C]	Content of exhaust gas components in ppm at the inlet of catalyst	Content of exhaust gas components in ppm at the outlet of catalyst
1400	12.45	318.56	1.497	348	420	CO - 800 HC - 5400-4800 NO$_x$-380-4l0	CO -50 HC - 640 NO$_x$ - 410
	6.25	160.58	1.507	68	430-440	CO - 820-780 HC - 3900-4200 NO$_x$ - 38-40	CO - 50 HC - 225-300 NO$_x$ - 50-60

In Table 3 the results of the experiments are shown, demonstrating the efficiency of palladium catalyst in terms of NO$_x$ decrease in the block of the V-type engine, which most probably gets the proper close to stoichiometry air – fuel mixture strength.

Table 3. Results of experiments, demonstrating the efficiency of palladium catalyst in terms of NO$_x$ emission.
3 lentelė. Bandymų rezultatai, atspindintys paladžio katalizatoriaus efektyvumą NO$_x$ emisijai.

M [N·m]	Relative air-to-fuel ratio	CO, left inlet	block outlet	CO, right inlet	block outlet	HC, left inlet	block outlet
690	1.03-1.05	1800	80	4400	1650	1620	75
720	0.95-1,01	2700	100	1310	420	1500	990
M [N·m]	Relative air fuel ratio	HC, right inlet	block outlet	NO$_x$, left inlet	block outlet	NO$_x$, right inlet	block outlet
690	1.03-1.05	1680	210	1850	1500	1800	90
720	0.95-1,01	1500	75	1700	250	2500	1500

The conclusions made from these experiments are as follows

1. Mixture strength may be considerably different for each of the blocks of a V-type engine.
2. It seems that palladium catalyst is more universal as regards to decrease in hazardous component concentrations.

In Table 4 the results of experiments at minimum idle speed are given (for 750 rpm).

It is clear from the analysis of Table 4 that one must maintain temperature of the exhaust gases sufficiently high by retarding ignition in order to effectively decrease content of methane at the exhaust.

Table 4. Results of experiments at minimum idle speed.
4 lentelė. Bandymų rezultatai, dirbant minimaliais tuščiosios eigos sūkiais.

N	GMP/degrees before TDC [CA]	Catalyst		Concentration of components [ppm]			α	Exhaust temp. t_{ecx}[^{o}C]
		Block	Point of measurement	CO	HC	NO_x		
1	0	left (Pt)	inlet	500	194	17	1.46	295
			outlet	100	-	25		200
		right (Pd)	inlet	500	1440	39	1.53	285
			outlet	10	1440	63		200
2	0	left (Pt)	inlet	600	940	6	1.48	310
			outlet	0	-	12		190
		right (Pd)	inlet	500	720	10	1.45	310
			outlet	10	550	24		190
3	-5	left (Pt)	inlet	600	940	8	1.5	360
			outlet	10	680	19		190
		right (Pd)	inlet	400	440	9	1.52	370
			outlet	10	400	26		190
4	-7,5	left (Pt)	inlet	500	820	9	1.59	450
			outlet	10	570	15		195
		right (Pd)	inlet	400	540	10	1.6	460
			outlet	10	10	16		200

Conception of gas supply system control

Fig. 3 presents a scheme of a gas supply system developed to establish and stabilize the air-to-fuel equivalence ratio close to stoichiometry in the case of running the V-type engine at full load and idle conditions.

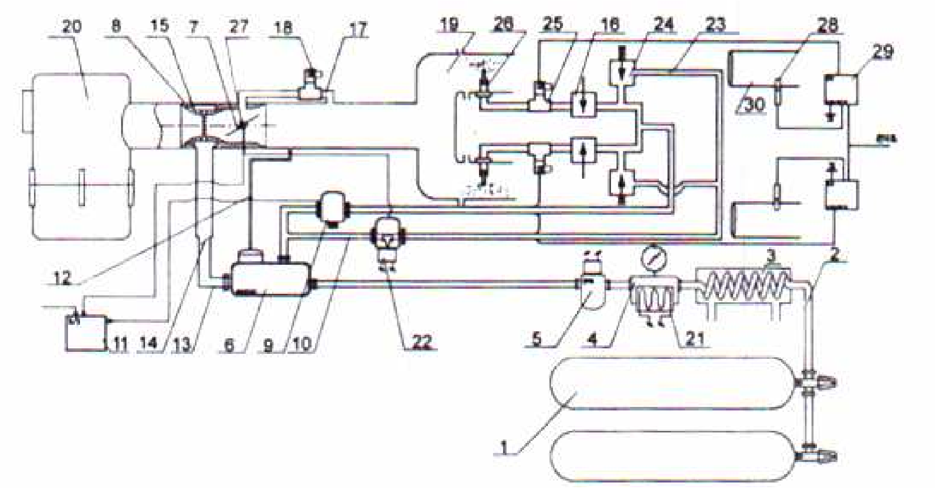

Fig. 3. Electronic gas supply and control system: 1 – gas vessels, 2 – high pressure gas line, 3 – gas heater, 4 – high pressure reducer, 5 – electromagnetic valve-filter, 6 – two stage low pressure reducer, 7 – throttle, 8 – air-gas mixer, 9 – valve for additional gas supply, 10 – idle gas supply duct, 11 – electronic control unit, 12 – vacuum duct, 13 – main channel, 14 – main gas throttle, 15 – diffuser, 16 – hand operated throttle, 17 – by-pass channel, 18 – by-pass valve, 19 – inlet manifold, 20 – air filter, 21 – electric heater, 22 – electromagnetic valve, 23 – channel for gas supply at idle, 24 – needle to adjust idle gas supply, 25 – control valve with stepper motor drive, 26 – gas nozzle, 27 – throttle position sensor, 28 – oxygen content pick-up, 29 – electronic control unit, 30 – exhaust manifold

3 pav. Elektroninė dujų tiekimo ir valdymo sistema: 1 – dujų balionai, 2 – didelio slėgio dujų linija, 3 – dujų šildytuvas, 4 – didelio slėgio reduktorius, 5 – elektromagnetinis vožtuvas-filtras, 6 – dviejų laipsnių mažo slėgio reduktorius, 7 – droselis, 8 – oro-dujų maišytuvas, 9 – vožtuvas papildomoms dujoms tiekti, 10 – tuščiosios eigos dujų tiekimo vamzdis, 11 – elektroninis valdymo blokas, 12 – vakuumo vamzdelis, 13 – pagrindinis kanalas, 14 – pagrindinis dujų droselis, 15 – difuzorius, 16 – ranka valdomas droselis, 17 – praleidimo kanalas, 18 – praleidimo vožtuvas, 19 – įsiurbimo kolektorius, 20 – oro filtras, 21 – elektrinis šildytuvas, 22 – elektromagnetinis vožtuvas, 23 – kanalas dujoms tiekti dirbant tuščiąja eiga, 24 – adatinis vožtuvas tiekiamų dujų kiekiui reguliuoti, 25 – valdymo vožtuvas su žingsninio variklio pavara, 26 – dujų purkštukas, 27 – droselio padėties jutiklis, 28 – deguonies mėginio imtuvas, 29 – elektroninis valdymo blokas, 30 – išmetimo kolektorius

Valve 22 is closed at all operating conditions except idle conditions. Throttles 16 are controlled manually to get close to stoichiometry mixture strength in both blocks at high loads. Valve 25 with electromagnetic drive maintains the necessary mixture strength in both the blocks adding gas supply through valve 9, which opens electronically at the main throttle position 7 close to full opening. At partial opening of the throttle 7 valve 9 is closed and lean mixture is obtained by hand control of the throttle 14. Hand operated needles 24 are included to establish gas supply close to stoichiometric to both blocks at idle conditions.

City bus engines operate at part loads in a variety of conditions. The development of the above described natural gas engines ensures stoichiometric air-gas mixtures at full load and idle conditions and the use of lean mixture strengths at part loads, ensures decrease of gas consumption.

The development of turbocharged versions of natural gas engines

In addition to the well-known advantages of turbocharged diesels, natural gas engines have one more advantage – engine operation on lean homogenous mixtures results in very low nitrogen oxides emission.

In the case of natural gas engines designed for a big city buses and trucks to get high torque one should use controlled turbocharging. The ability to ensure high torque by the change of relative air-to-fuel ratio cannot be utilized in natural gas engines in the way it may be used in diesels. In order to get low nitrogen oxides emission, natural gas engine should operate within a rather narrow air-to-fuel ratio interval (1.4–1.65), whereas in diesels one may use much wider interval, say 1.6–2.4.

Fig. 4 presents a schematic drawing of a natural gas engine with controlled turbocharging and catalytic converters for each engine block of a V-type engine.

In this case, a two-stage gas pressure reducer is used. Natural gas is injected into the inlet manifold trough a controlled profiled valve and nozzles. Catalytic converter is located at a distance equal to 1.5 m from the exhaust outlet. Table 5 presents the results of the experiments at steady 13-step cycle operating conditions.

Table 5. The results of the experiments at steady 13-step cycle operating conditions.

5 lentelė. Bandymų rezultatai, gauti esant 13-pakopų ciklo darbo sąlygoms.

Engine type	Emission [g/(kW·h)]		
	CO	HC	NO_x
Engine with controlled turbocharging and one catalytic converter	0,584	17,06	2,06
Engine with controlled turbocharging and two catalytic converters	0,5	1,00	1,7

It may be seen from the table 5 that the requirements of Euro 5 are met as regards to carbon oxide and nitrogen oxides emissions. However, the emission of hydrocarbons is very high.

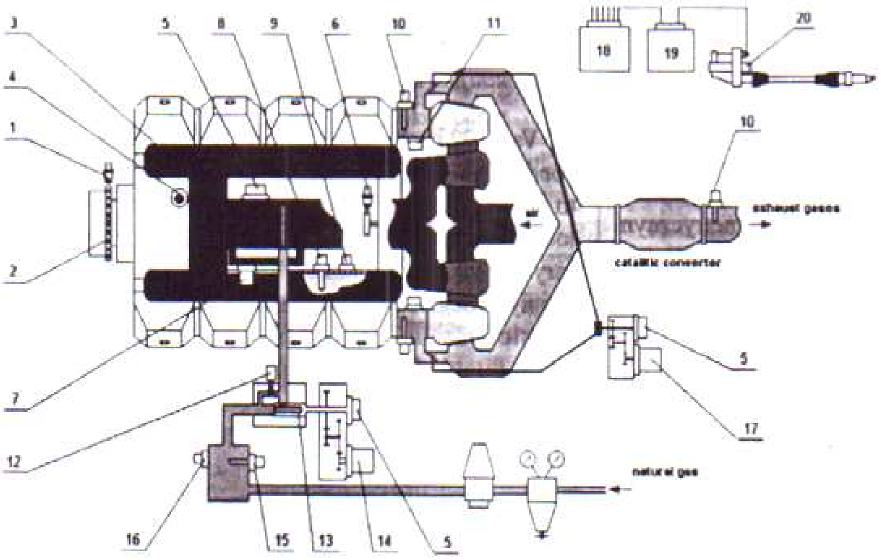

Fig. 4. A schematic drawing of the engine: 1 – rpm sensor, 2 – special disc, 3 – throttle, 4 – coolant temperature sensor, 5 – location sensor, 6 – faze sensor, 7 – by - pass valve, 8 – inlet mixture temperature sensor, 9 – inlet mixture pressure sensor, 10 – thermocouple, 11 – turbine inlet gas temperature sensor, 12 – idle operation valve, 13 – main gas control valve, 14 – stepper motor of gas control valve, 15 – gas temperature sensor, 16 – gas pressure sensor, 17 – exhaust gas by-pass valve stepper motors, 18 – control unit, 19 – ignition control module, 20 – ignition coil

4 pav. Variklio schema: 1 – sūkių jutiklis, 2 – specialus diskas, 3 – droselis, 4 – aušinimo skysčio temperatūros jutiklis, 5 – padėties jutiklis, 6 – fazės jutiklis, 7 – praleidimo vožtuvas, 8 – įsiurbiamo mišinio temperatūros jutiklis, 9 – įsiurbiamo mišinio slėgio jutiklis, 10 – termopora, 11 – į turbiną patenkančių dujų temperatūros jutiklis, 12 – tuščiosios eigos valdymo vožtuvas, 13 – pagrindinis dujų valdymo vožtuvas, 14 – dujų valdymo vožtuvo žingsninis variklis, 15 – dujų temperatūros jutiklis, 16 – dujų slėgio jutiklis, 17 – deginių praleidimo vožtuvo žingsninis variklis, 18 – valdymo blokas, 19 – uždegimo valdymo modulis, 20 – uždegimo ritė

Fig. 5 shows a schematic drawing of second natural gas engine with controlled turbo-charging and two catalytic converters for each block of the same V-type engine. In this case 3-stage gas pressure reducer is used. Gas pressure is reduced down to atmospheric.

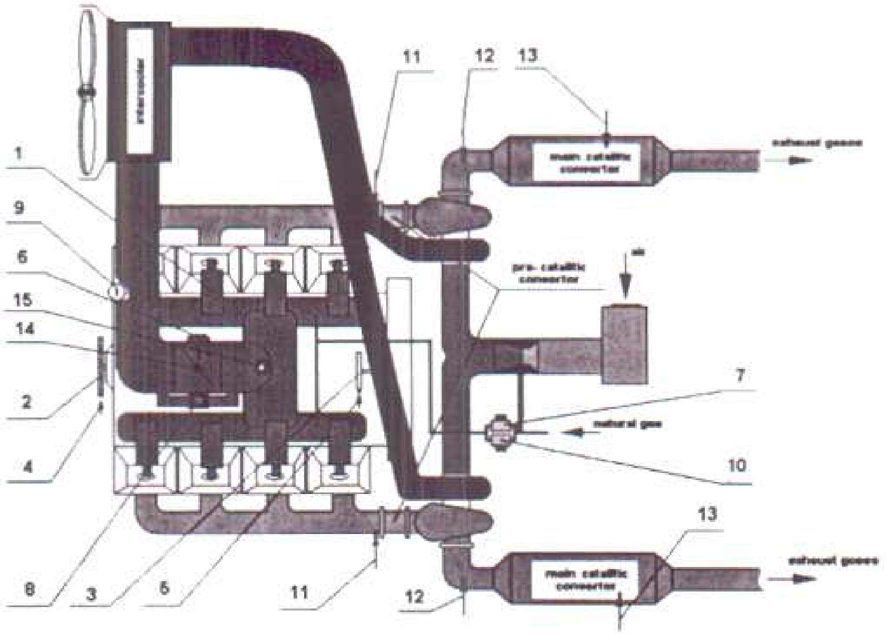

Fig. 5. Sketch of the engine: 1 – induction coil, 2 – special disc, 3 – synchronizing disc, 5 – synchronization sensor, 6 – throttle position sensor, 7 – starting valve with electromagnetic drive, 8 – controlled vulva for idle by-pass line operation, 9 – coolant temperature sensor, 10 – electromagnetic drive, 11,12,13 – thermocouples, 14 – throttle

5 pav. Variklio schema: 1 – indukcinė ritė, 2 – specialus diskas, 3 – sinchronizuojantis diskas, 5 – sinchronizavimo jutiklis, 6 – droselio sklendės padėties jutiklis, 7 – paleidimo vožtuvas su elektromagnetine pavara, 8 – valdoma anga tuščiosios eigos praleidimo linijos veikimui, 9 – aušinimo skysčio temperatūros jutiklis, 10 – elektromagnetinė pavara, 11,12,13 – termoporos, 14 – droselio sklendė

Natural gas is supplied into conventional gas air mixer located between the air cleaner and the compressors. Throttle is placed after the intercooler. Small size catalytic converters arc placed at the inlet of the turbines and main converters at a distance of 2 m from the outlet of the turbines. The experiments revealed that platinum catalysts are much less efficient regarding methane oxidation than palladium catalysts. It also turned out, that the concentrations of the emission components do not change in the pre-converters, but the efficiency of the main converters increases greatly due to the use of small converters located near the exhaust outlet where the gas temperature is high. It may be assumed that in the pre-converters some preliminary reactions start, which help in further oxidation of methane. In comparison to the previous results the content of hydrocarbons decreased by 17 times.

The decrease of HC is still insufficient to meet the requirements of the Euro 5 regulations. New converters of greater volume and with higher palladium concentration are to be designed to meet the Euro 5 demands.

In the experiments with both engines we noticed, that nitrogen oxides concentration is increased in the catalytic converters and the increase is greater in the case of higher hydrocarbons content. The increase is not very harmful and, hence, the Euro 5 regulations are met. During two last years we are working on development of a gas engines with efficiency at the level of base diesel engine [5]. Calculations according to ESC standard conditions revealed that in the case of equal efficiency (equal compression ratio end qualitative control) NG engine exhaust contains considerably less carbon dioxide. Difference reaches up to 25-27 percent.

Conclusions

In the case of the naturally aspirated the V-type engines with a central gas supply system the decrease of emission turns out to be a rather difficult problem.

To overcome these difficulties, an original gas supply system, ensuring precise control of air gas mixture strength at both engine blocks has been developed and is in the test stage. The Euro 3 regulations are met.

In the case of using Russian natural gas with stable high content of methane it is possible to work without detonation at high compression ratios. This, combined with lean mixture operation at part loads, ensures rather low heat consumption in bus operation.

In the case of turbocharged engines, low nitrogen oxides emission is obtained by lean mixture engine operation (relative air-to-fuel ratio in the range of 1.45—1.65). The problem of methane low emission may be solved by appropriate choice of catalytic converters. Achievement of EURO-5 requirements is possible.

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КОНВЕРСИЯ ДИЗЕЛЕЙ ГРУЗОВЫХ АВТОМОБИЛЕЙ ДЛЯ РАБОТЫ НА НАТУРАЛЬНОМ ГАЗЕ ЯВЛЯЕТСЯ РАЦИОНАЛЬНЫМ МЕТОДОМ УМЕНЬШЕНИЯ ЭМИССИИ ОТРАБОТАВШИХ ГАЗОВ

Аннотация

В статье рассматриваются методы конверсии как безнадувных дизельных двигателей, так и турбонадувных двигателей предназначенных для грузовых автомобилей работающих на натуральном газе.

Наиболее простой и дешевый метод конверсии безнадувных двигателей предусматривает применение транзисторной зажигательной системы и впрыскивание натурального газа с приготовлением стехиометрической газо-воздушной смеси для условий холостого хода и максимальной нагрузки и обедненной горючей смеси на всех остальных режимах работы.

Во втором случае используется микропроцессор зажигания и система управления. Третий метод предназначен для конверсии „V“-образных двигателей. В этой версии применяется система подвода газа специальной конструкции с тем, чтобы обеспечить горючую смесь одинакового состава для обоих рядов цилиндров.

В случае применения турбонадувных двигателей было установлено, что использование базовой надувной системы не является наилучшим решением вопроса. Необходимо разработать новую систему с тем, чтобы обеспечить высокую приспособляемость по крутящему моменту. Кроме того, для уменьшения эмиссии метана с отработавшими газами необходимо подобрать специальный катализатор.

Безнадувный дизельный двигатель, турбокомпрессорный дизельный двигатель, конверсия на натуральный газ, каталитические конвертеры, контроль эмиссии.

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DYZELINIŲ SUNKVEŽIMIŲ KONVERSIJA DARBUI GAMTINĖMIS DUJOMIS YRA RACIONALUS DEGINIŲ EMISIJOS MAŽINIMO METODAS

Reziumė

Straipsnyje nagrinėjami įprastų dyzelinių variklių ir turbokompresorinių sunkvežimių konversijos darbui natūraliomis gamtinėmis dujomis metodai.

Paprasčiausią ir pigiausią nepripučiamo dyzelinio variklio konversijos metodą sudaro tranzistorinės uždegimo sistemos panaudojimas ir dujų įpurškimas, užtikrinantis stechiometrinę dujų-oro degiojo mišinio sudėtį, varikliui veikiant tuščiosios eigos ir maksimalios apkrovos sąlygomis, ir liesą degųjį mišinį visiems kitiems darbo režimams.

Antruoju atveju yra naudojamas mikroprocesorinis mišinio uždegimas ir valdymo sistema. Trečiasis metodas naudojamas V – formos varikliams. Pagal šią versiją, tikslu užtikrinti vienodą degiojo mišinio sudėtį abejoms cilindrų eilėms yra naudojama specialios konstrukcijos dujų tiekimo sistema.

Turbokompresorinių variklių atveju yra nustatyta, kad bazinės dyzelinio variklio pripūtimo sistemos panaudojimas nėra geriausias sprendimas. Būtina sukurti naują pripūtimo sistemą, kuri užtikrintų didelę sukimo momento atsargą. Be to, reikia parinkti specialų katalizatorių metano dujų kiekiui deginiuose sumažinti.

Nepripučiamas dyzelinis variklis, pripučiamas dyzelinis variklis, konversija darbui natūraliomis dujomis, katalitiniai konverteriai, emisijos kontrolė.