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FEATURES OF THE USE OF LIQUEFIED PETROLEUM GAS WITH THE ADDITION OF DIMETHYL ETHER AS A FUEL FOR A CAR WITH A SPARK IGNITION ENGINE

Otabayev Nodirjon Ibragimovich
PhD in Technics, Associate Professor,
Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: n.otaboev@ferpi.uz

Odilov Odiljon Zokirovich
PhD in Technical Sciences, Associate Professor,
Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: o.z.odilov@mail.ru

Jorayev Vohidjon Islomojon ogli
Master's Student, Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: vohidjonjorayev95@gmail.com

Abstract

The article presents the results of research on a passenger car with a spark ignition internal combustion engine running on liquefied petroleum gas (LPG) with the addition of dimethyl ether (DME). Comparative results obtained on base (gasoline, LPG) and composite gas (DME concentration 5, 10, 15% in LPG composition) fuels are presented.

Keywords: passenger car, liquefied petroleum gas, dimethyl ether.

Introduction

The analysis of the performed scientific and technical developments very clearly shows that the use of alternative motor fuels and energy in the field of transport, in particular road transport, is the most rational and affordable solution to modern energy and environmental problems.

The most modern direction in this area is the use of dimethyl ether (DME) as a motor fuel, which will significantly reduce oil production and refining, increase the use of environmentally friendly alternative motor fuels of non-petroleum and biological origin, reduce fuel supply tension, increase operational, including environmental indicators of vehicles operating on this type of fuel.

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The transfer of diesel and gasoline vehicles to DME power supply in whole or in part with minimal design and adjustment changes solves a number of environmental problems of transport and this connection is a very urgent task.

The Main Part

In the last decades of the twentieth century, researchers in many countries of the world, especially Austrian, Danish and American, are actively carrying out scientific and practical work on the use of DME as a substitute for diesel fuel [1, 2, 3].

Most of these scientific papers are devoted to the use of DME as an environmentally friendly substitute for diesel fuel (DF) and DME is considered in them as a new, versatile, efficient and environmentally friendly motor fuel that does not contain aromatic hydrocarbons, sulfur and is characterized by combustion efficiency, high cetane number (55-60 versus 40-55 for petroleum diesel fuel) and the absence of soot, nitrogen oxides and carbon dioxide in exhaust gases, which is especially important for large cities [4, 5, 6].

However, in most of these works, it was found that when using DME as the main fuel (complete replacement of DF), the control and design of the fuel supply system become more complicated (structural and technological changes to compensate for the low calorific value and viscosity of DME compared to DF) and a number of problems arise related to with unstable diesel operation.

A number of scientific works have been carried out related to the use of a mixture of liquefied petroleum gas (LPG) and DME as motor fuel for an internal combustion engine (ICE) with spark ignition [7, 8, 9, 10].

These papers note that the use of DME as an additive to LPG leads to some reduction in ICE power and torque values compared to the base fuel, as well as a decrease in emissions of harmful substances - carbon monoxide (CO) and hydrocarbon (CH) compared to base fuels.

However, at the same time, there are no results of scientific works related to studies of speed-acceleration characteristics and environmental (including greenhouse gas emissions) indicators of cars running on LPG with DME additives.

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Purpose and Problem Statement

Based on the foregoing, the purpose of this work was to study the performance of a passenger car with a spark ignition engine running on composite gas fuel (a mixture of LPG and DME).

Description of the comparative properties of fuels, and the experimental vehicle.

Comparative analysis is performed by studying the quality indicators of various fuels under study (Table 1).

Table 1. Comparative indicators of various motor fuels

Indicators	*Fuel* Petrol	Diesel fuel	CNG	LPG		DME
Chemical formula	C_8H_{18}	$C_{15}H_{32}$	CH_4	C_3H_8	C_4H_8	C_2H_6O
Molecular mass	114,5	190	16	44	58	46,07
Elemental Composition:						
C	85.5	86	74.6	82	82	52.2
H	14.4	13	25.4	18	18	13
O	0.1	one	—	—	—	34.8
C/H ratio	5.3	6.62	2.93	4.55	4.55	4.02
Density, g/cm³ (kg/m³)						
liquid phase	0.72	0.85	0.5	0.509	0.582	0.68
gas phase	1.07	1.23	0.68	2.018	2.703	-2.1
Net calorific value, MJ/kg of fuel	44	42	49.5	46.5	45.5	28.4
combustible mixture d=Nmax	3.1	2.09	2.63	3.02	3.02	1.06
Ignition temperature	470...530	290...310	680...700	475...580	475...580	235
(self-ignition), °C	-220	-430	-570	-520	-520	-350
Flammability limit in air, %						
lower	1.4	0.6	5.3	1.8	1.8	3.4
upper	7.4	6.5	fifteen	9.5	9.5	eighteen
Flammability limit in air, %						
lower	1.4	0.6	5.3	1.8	1.8	3.4
upper	7.4	6.5	fifteen	9.5	9.5	eighteen
Excess air coefficient corresponding to:						
flammable limit	0.7...1.1	0.9...5.0	0.7...1.3	0.7...1.2	0.7...1.2	3.4...34
maximum power	0.85...0.95	1.3...1.5	1.05...1.15	0.3...1.05	0.3...1.05	3.0...4.5
The theoretically required amount of air for complete combustion of fuel, kg/kg	14.85	14.35	17.1	15.2	15.2	9

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It follows from the above data that at certain concentrations of DME in the composition of LPG, the anti-knock resistance of the composite gas fuel may change.

In accordance with the World Fuel Charter, the following requirements are imposed on the octane number of motor gasoline or other fuels for an internal combustion engine with spark ignition (tab. 2.)

Table 2. Limit values of octane numbers of modern motor gasolines

Name of indicator	*Brand of gasoline*	*Limit values*	
		Min.	Max.
Research Octane	91	91	-
Octane number by the motor method	91	82	-
Research Octane	95	95	-
Octane number by the motor method	95	85	-
Research Octane	98	98	-
Octane number by the motor method	98	88	-

DME is known to have a fairly high (over 55) cetane number (CN), which is related to the octane number (ON) of gasoline by the following formula:

CN = 60-ON/2 or CN = (120 - ON)/2 (1)

Then the ON values of gasoline or motor fuels for a spark ignition internal combustion engine is determined by the formula:

ON = 120 - 2CN (2)

The results of the performed analytical calculations of the change in ON of composite gas fuels are presented in the form of a table (Table 3.)

Table 3. The octane number of various motor fuels

Fuel	Octane number-ON	Changing the ON value	Actual value ON	Note
LPG	100-105	-	100	Norm
DME	ten	-	ten	-
LPG95+DME05	96	four	96	Norm
LPG90+DME10	91	9	91	Norm
LPG85+DME15	86.5	13.5	86.5	Limitation

Thus, the limiting concentration of DME in the composition of LPG according to the permissible ON value or according to the antiknock resistance of the composite gas fuel is no more than 10%. It should be added that this concentration may change somewhat according to the results of experimental studies.

At the same time, a regression equation was obtained, obtained by the least squares method for calculating the ON of composite gas fuel, depending on the concentration of DME in the composition of LPG

ON = - 1.18 KDME +100.6 (3)

The obtained composite gas fuels (a mixture of LPG and DME) were investigated during field testing of a NEXIA III vehicle equipped with a universal power system.

In the process of field tests, the speed and acceleration indicators (Table 4) of the NEXIA III car operating on various fuels were obtained using the KORSUS-DATRON test complex.

Table 4. Speed and acceleration performance of the car NEXIA III

No.	*Fuel*	*vmax, km/h*	*Acceleration time to 100 km/h, s*
one	Gasoline AI-91	179	15.2
2	LNG	178	16.0
3	LPG	176	15.6
four	LPG95+DME05	174	15.6
5	LPG90+DME10	177	15.7
6	LPG85+DME15	166	16.5

Calculated comparative indicators of various motor fuels for a spark ignition internal combustion engine have been established, which allows further stages of the necessary research to be carried out.

For the purpose of comparative research on various fuels (gasoline, CNG, LPG, LPG with various DME additives), speed-acceleration indicators (maximum speed, acceleration time up to 100 km/h,) were obtained. The results obtained showed close to the results of the base car.

Conclusion

Based on the work performed on the use of LPG with DME additives as a motor fuel for a spark ignition engine, it was found that the upper concentration of DME in the composition of LPG is limited by the anti-knock resistance of the composite fuel.

The obtained speed and acceleration indicators (maximum speed, acceleration time up to 100 km/h) of a car running on composite gas fuel containing 6-10% DME (LPG90+DME10) with LPG composition are almost the same as the results of the base car.

References

1. Льотко, В., Луканин, В. Н., & Хачиян, А. С. (2000). Применение альтернативных топлив в двигателях внутреннего сгорания.
2. Базаров Б.И., Калауов С.А., Васидов А.Х. (2014). Альтернативные моторные топлива. Ташкент. SHAMS ASA. 189 с.
3. Вагнер, В. А., & Гвоздев, А. М. (2006). Использование диметилового эфира в качестве добавки к дизельному топливу. *Омский научный вестник*, (5 (39)), 81-83.
4. ТУ 20.14.63 – 025- 05761695 – 2017. Эфир диметиловый жидкий. Технические условия.
5. Марков, В. А., Гайворонский, А. И., Грехов, Л. В., & Иващенко, Н. А. (2008). Работа дизелей на нетрадиционных топливах.
6. Базаров, Б. И., Калауов, С. А., Сидиков, Ф. Ш., & Усманов, И. И. (2016). Особенности использования диметилового эфира в качестве моторного топлива. *Химия и химическая технология*, *51*(1), 62-64.
7. Ахматжанов, Р. Н., Калауов, С. А., & Базаров, Б. И. (2016). Системный подход к использованию композиционных моторных топлив на основе спиртов и эфиров. *European science*, (3 (13)), 35-38.
8. Feng, Y., Chen, T., Xie, H., Wang, X., & Zhao, H. (2020). Effects of injection timing of DME on Micro Flame Ignition (MFI) combustion in a gasoline engine. In *Internal Combustion Engines and Powertrain Systems for Future Transport 2019* (pp. 24-42). CRC Press.
9. Flekiewicz, M., & Kubica, G. (2013). The effects of blending dimethyl ether with LPG on the engine operation and its efficiency. *Combustion Engines*, *52*(3), 86-95.

10. Anggarani, R., Wibowo, C. S., & Sukaraharja, R. (2015). Performance and emission characteristics of dimethyl ether (DME) mixed liquefied gas for vehicle (LGV) as alternative fuel for spark ignition engine. *Energy Procedia*, *65*, 274-281.
11. Абдурахмонов, А. Г., Одилов, О. З., & Сотволдиев, У. У. (2021). Альтернативные пути использования сжиженного нефтяного газа с добавкой деметилового эфира в качестве топлива легкового автомобиля с двигателем искрового зажигания. *Academic research in educational sciences*, *2*(12), 393-400.
12. Salomov, U. R., Moydinov, D. A., & Odilov, O. Z. (2021). The Development of a Mathematical Model to Optimize the Concentration of the Components of the Forming Adhesive Composition. *Development*, *8*(9).
13. Salomov, U., Yusupov, S., Odilov, O., & Moydinov, D. (2022). Theoretical Substantiation of the Advisability of Using Adhesives When Sealing the Core of Car Radiators and Diagnosing Radiators with a Thermal Load. *International Journal of Engineering Trends and Technology*, *70*(1), 81-92.
14. Zokirzhonovich, O. O. (2021). Use of Low-Carbon Technologies on Vehicle Transport. *International Journal of Innovative Analyses and Emerging Technology*, *1*(5), 15-17.
15. Dabi, M., & Saha, U. K. (2019). Application potential of vegetable oils as alternative to diesel fuels in compression ignition engines: A review. *Journal of the Energy Institute*, *92*(6), 1710-1726.
16. Technical regulation of the Customs Union TR CU 013/2011 “On requirements for motor and aviation gasoline, diesel and marine fuel, jet fuel and fuel oil
17. Bazarov, B. I., Kalauov, S. A., & Vasidov, A. K. (2014). Alternative motor fuels. *Monograph. Tashkent: SHAMS ASA*.
18. Brown, C. (2013). *Gas-to-Liquid–A Viable Alternative to Oil-Derived Transport Fuels?*. Oxford Institute for Energy Studies.
19. Mikhailovsky A. A., Terentyeva N. A. (2015). Obtaining synthetic hydrocarbons from natural gas using GTL technology. *Bulletin of the Technological University*. 18(23), 31-36.
20. Kozin V.G., Solodova N.L., Bashkirtseva N.Yu., Abdullin A.I. (2009). Modern technologies for the production of motor fuel components. Kazan, 311 p.

21. Bazarov B.I., Sidikov F.Sh., Odilov O.Z. et al. (2019) Modern trends in the use of alternative motor fuels. *Journal of Advanced Research in Technical Science*. Vol. 2. p.186-188.
22. Folkson, R. (Ed.). (2014). *Alternative fuels and advanced vehicle technologies for improved environmental performance: towards zero carbon transportation*. Elsevier.
23. Bazarov, B. I., Otabaev, N. I., Odilov, O. Z., Meliev, H. O., & Axynov, J. A. (2020). Features of Using Liquefied Petroleum Gas with Addition of Dimethyl Ether as Fuel of Car with f Spark-Ignition Engine. *International Journal of Advanced Research in Science, Engineering and Technology*, *7*(11), 15695-15698.
24. Imamovich, B. B., Nematjonovich, A. R., Khaydarali, F., Zokirjonovich, O. O., & Ibragimovich, O. N. (2021). Performance Indicators of a Passenger Car with a Spark Ignition Engine Functioning With Different Engine Fuels. *Annals of the Romanian Society for Cell Biology*, 6254-6262.
25. Worldwide Fuel Charter. Gasoline and diesel fuel. 2019. 105 p.
26. GOST 3 2 5 1 1 -2013 (EN 590:2009) EURO DIESEL FUEL Specifications
27. O'z DSt 3134:2011 Synthetic diesel fuel component. Specifications
28. GOST 3122-67 (ST SEV 2877-81) Diesel fuels. Method for determining the cetane number
29. GOST 27768-88 (ST SEV 5871-87) Diesel fuel. Determination of cetane index by calculation method
30. ISO 4264:2018 Petroleum products. Calculating the Cetane Index of Medium Distillate Fuels Using a Four-Variable Equation [In Russian: ISO 4264 Petroleum products – Calculation of cetane index of middle-distillate fuels by the four variable equation]
31. EN 590:2009 Automotive fuels - diesel - requirements and test methods (MOD)
32. Pustovalova L.M., Nikanorova I.E. Technique of laboratory work. -M.: Phoenix, 2004. 288 p.
33. Xusanjonov, A. S., & Otaboev, N. I. (2018). Improving Of Steerability Of Automobiles With Rotation Of X-Type Of His Rear Wheels Relatively Of Front Wheels. *Scientific-technical journal*, *22*(2), 131-133.
34. Axunov, J. A. (2022). Analysis of young pedestrian speed. Academicia Globe: Inderscience Research, 3 (04), 193–195.

35. Imamovich, B. B., Zokirjonovich, O. O., Ibragimovich, O. N., & Rashidovich, F. P. (2022). Method For Determining The Cetan Numbers Of Synthetic Diesel Fuel. *Journal of Positive School Psychology*, *6*(9), 3827-3833.
36. Oblayorovich, M. X., & Mukhamadbekovich, T. D. (2022). Analysis of the Impact of Hydraulic System Fluid Quality on the Efficient Operation of Universal-Type Tractors. *Eurasian Research Bulletin*, *6*, 103-108.
37. Xujamqulov, S. U., Masodiqov, Q. X., & Abdunazarov, R. X. (2022, March). Prospects for the development of the automotive industry in uzbekistan. In *E Conference Zone* (pp. 98-100).
38. Fayziyev, P. R., Ikromov, I. A., Abduraximov, A. A., & Dehqonov, Q. M. (2022). Organization of technological processes for maintenance and repair of electric vehicles. *International Journal of Advance Scientific Research*, *2*(03), 37-41.
39. Fayziyev, P. R., Ikromov, I. A., Abduraximov, A. A., & Dehqonov, Q. M. (2022). Timeline: History of the Electric Car, Trends and the Future Developments. *Eurasian Research Bulletin*, *6*, 89-94.
40. Sotvoldiev, U., Abdubannopov, A., & Zhalilova, G. (2021). Theoretical foundations of the acceleration sliding control system. Scientific progress, 2(1), 1461-1466
41. Ismadiyorov, A. A., & Sotvoldiyev, O. U. (2021). Model of assessment of fuel consumption in car operation in city conditions. *Academic research in educational sciences*, *2*(11), 1013-1019.
42. Qobulov, M. A. O., & Abdurakhimov, A. A. (2021). Analysis of acceleration slip regulation system used in modern cars. *ACADEMICIA: An International Multidisciplinary Research Journal*, *11*(9), 526-531.
43. Tursunov, D. M. (2022). Technical Diagnostics of Cars to Fulfill Their Status and Basic Rules. *Eurasian Journal of Engineering and Technology*, *10*, 121-123.
44. Qobulov, M. (2022). Improving the Management of the Number and Composition of Buses in the City of Fergana. *Eurasian Journal of Engineering and Technology*, *10*, 115-120.
45. Fayzullayev, X. (2022). Vehicle Motion Model with Wheel Lock. *Eurasian Journal of Engineering and Technology*, *10*, 68-73.
46. Nosirjonov, S. (2022). A Theoretical Approach to the Study of the Braking Process. *Eurasian Journal of Engineering and Technology*, *10*, 74-78.

47. Sotvodiyev, O. T. (2022). A Regional Look at Cars in A Mixed Park. *Eurasian Journal of Engineering and Technology*, *10*, 79-84.
48. Anvarjon, I. A. (2022). Research on polishing properties of gear oils and ways to improve them. *Innovative Technologica: Methodical Research Journal*, *3*(09), 13-21.
49. Ibragimovich, O. N. (2022). Mathematical model of diesel internal combustion engine subsystem. *Innovative Technologica: Methodical Research Journal*, *3*(09), 22-28.
50. Tursunov, D. M. (2022). Study of the stages of development of a gas-cylinder engine supply system. *Innovative Technologica: Methodical Research Journal*, *3*(09), 79-84.
51. Abdujalilovich, A. J. (2022). Analysis of the speed of children of the 46th kindergarten on margilanskaya street. *American Journal of Interdisciplinary Research and Development*, *5*, 9-11.
52. Axunov, J. A. (2021). Piyodani urib yuborish bilan bog'liq ythlarni tadqiq qilishni takomillashtirish. *Academic research in educational sciences*, *2*(11), 1020-1026.
53. Axunov, J. A. (2022). Ta'lim muassasalari joylashgan ko 'chalarda bolalarning harakat miqdorini o 'zgarishi. *Academic research in educational sciences*, *3*(4), 525-529.
54. Abdukhalilovich, I. I., & Abdujalilovich, J. A. (2020). Description Of Vehicle Operating Conditions And Their Impact On The Technical Condition Of Vehicles. *The American Journal of Applied sciences*, *2*(10), 37-40.
55. Masodiqov, Q. X. (2022). The study of theoretical and practical aspects of the occurrence of internal stresses in polymeric and paint-and-lacquer materials and coatings based on them, which have a significant impact on their durability. *Innovative Technologica: Methodical Research Journal*, *3*(09), 29-37.
56. IA, I. (2022). Adaptation of the vehicle supply system to work with compressed gas. *Innovative Technologica: Methodical Research Journal*, *3*(09), 48-56.
57. Abdujalilovich, A. J. (2022). Analysis of road accidents involving children that occurred in fergana region. *Innovative Technologica: Methodical Research Journal*, *3*(09), 57-62.
58. Abdurakhimov, A. A. (2022). The basics of determining the braking of vehicles in road traffic. *Innovative Technologica: Methodical Research Journal*, *3*(09), 63-78.