INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

MATHEMATICAL MODEL OF DIESEL INTERNAL COMBUSTION ENGINE SUBSYSTEM

Otabayev Nodirjon Ibragimovich
PhD in Technics, Associate Professor, Department of Land Transport Systems and their Exploitation, Fergana Polytechnic Institute, Fergana, Uzbekistan
Email: n.otaboyev@ferpi.uz

Abstract

The main task of a diesel engine is to convert the thermal energy of fuel into mechanical energy. The effectiveness of this transformation is most fully reflected in the specific effective fuel consumption, which defines the economy, and the effective efficiency, which describes the excellence of the work process.

Keywords: Diesel, effective power, heat, temperature, energy, mechanics, effective fuel consumption.

Introduction

The main task of the engine is to convert the thermal energy of the fuel into mechanical energy. The effectiveness of this transformation is most fully reflected in the specific effective fuel consumption, which defines the economy, and the effective efficiency, which describes the excellence of the work process. These two indicators are closely related to each other [1-7].

Specific effective fuel consumption is determined by the following ratio [48]:

$$ge = 103G_{fuel}Ne \quad (1)$$

Here: G - fuel - hourly fuel consumption of the engine, kg/h;

Ne - effective power, kW.

The efficiency can be found in the following expression [8-19]:

$$\eta e = 3600Ne / G_{fuel}Ni \quad (2)$$

Where: Ni- the low calorific value of fuel, kJ/kg;

According to a number of studies [20-28], effective power is one of the parameters describing the technical condition of the engine and its cylinders. In addition, the effective power should not be significantly more or less than the plate (nominal), because. The operation of the car also depends on it. The technical condition of the cylinder, in turn, depends on its tightness, friction losses, as well as the correct and timely delivery of fuel to it.

In other words, the technical condition of the cylinder depends on the technical condition of the mechanical system of the engine (KSHM, timing, turbocharger) and the technical condition of the fuel supply system. At the same time, the car engine consists of several cylinders, the technical condition of which may differ from each other. In this case, the complexity of determining the technical condition of the engine and its main systems should be minimal [29-34]. The above conditions make it possible to form the target functions of the subsystem of the internal combustion engine - to minimize the specific effective fuel consumption and to maximize the amount of information about the technical condition during diagnostics:

$$\begin{cases} N_e^{fact\, e^{fact\, g_e \to \min}} = N_e^{nom} \pm \Delta N_e \\ J_i = H_x^{T_{pr} \to \min} - H_i \to \max \end{cases} \quad (3)$$

Here: Ne - fact and Ne - name - actual and nominal (passport) valid engine power; ΔN_e - tolerance to power changes;

T_{pr}- time of failure of ATS with ATPS during search, identification and elimination of the causes of failure, h;

Hx- the initial entropy of the object (probability of the presence of a fault in it, determined using the received diagnostic parameter);

H- the probability of failure after diagnosis.

To build a mathematical model of a diesel engine, we represent the engine in the form of functionally interconnected individual blocks. The first of them is the engine itself (ICE), which includes the crank mechanism (KShM), gas distribution mechanism (GRM), lubrication and cooling systems. In simplified form, from the ECM's side, input behaviour is the law of fuel supply required depending on the speed, heat and load regimes determined by the operating conditions of the entire vehicle.

Other units of the subsystem are the intake manifold, the exhaust manifold, and the turbocharger, which consists of a centrifugal turbine and a centrifugal compressor. The need to consider the listed blocks separately is due to the presence of gas-dynamic processes that directly affect the operation of the ECM in the car, including the feedback mode. In addition, the parameters of the air supply are closely related to the operation of the diesel engine [32-40].

The functional diagram of the "diesel internal combustion engine" subsystem is shown in Fig. 1.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

The mathematical model of the subsystem is based on the basic physical laws, so the system includes the equation of the law of conservation of energy (the first law of thermodynamics), the law of conservation of mass, the equation of state, and the equation. Heat transfer, equations of motion of mechanical links (dynamics of rotational movement of a rigid body). The law of conservation of energy (the first law of thermodynamics) can be written in the following form [50]:

$$\frac{dp}{dt}=\frac{k-1}{v}\left(\frac{dQ}{dt}+h_bG_b-h_pG_p+H_gG_g-\frac{k}{k-1}p\frac{dV}{dt}\right. \quad (4)$$

Similarly, we write the law of conservation of mass [51]:

$$\frac{dm}{dt}=G_b-G_g+G_{fuel}+G_p \quad (5)$$

Here: G_b, G_g, G_p - specific enthalpies of the air charge passing through the inlet, piston rings to the crankcase and exhaust gases passing through the outlet, respectively, J/kg;

G_b - the mass flow of air passing through the inlet gas distribution bodies, kg/s;

G_g - the mass flow of air passing through exhaust gas distribution bodies, kg/s;

G_{fuel} - mass fuel consumption, kg/s;

G_p - mass flow through the leaks of the cylinder-piston group, kg/s.

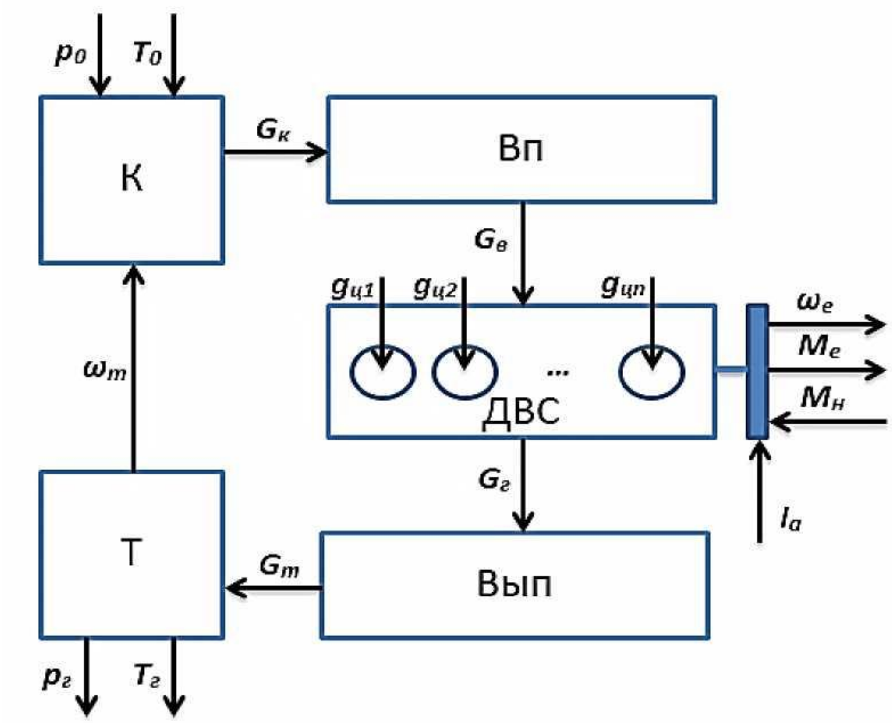

Figure 1. Functional diagram of the "Diesel internal combustion engine" subsystem

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 3, Issue 9, Sep. 2022

Conclusion

1. The developed theoretical basis of the diagnostic methodology Applications for cars with diesel engines equipped with common rail fuel supply systems include:

– A complex mathematical model of the operation process of the car in the "Battery fuel supply system-Diesel internal combustion engine-Car-Environment" system;

– A set of targeted functions that ensure the improvement of the efficiency of the use of vehicles with ATPS;

– A scientific and methodological approach to the analytical study of the influence of ATPS technical status parameters and its operation strategy on the output parameters of diesel engine vehicle performance in the "ADAS" system.

References

1. Otaboyev, N. I., Qudbiyev, N. T., & Qudbiyeva, G. A. Q. (2022). Yo‘l-transport tizimida ekologiya masalalari. *Scientific progress*, *3*(2), 909-916.
2. Bazarov B. I., Otabayev N.I., Odilov O. Z.(2022) Получение синтетических углеводородов из природного газа по технологии GTL. *Научный журнал механика и технология*,1(6), 122-131.
3. Abduraxmonov, A. G., Xodjayev, S. M., Otaboyev, N. I., & Abduraximov, A. A. (2022). Formation of products from powdered polymers by rotational and blowing method. *European International Journal of Multidisciplinary Research and Management Studies*, *2*(03), 41-51.
4. Otaboyev, N. I., Qosimov, A. S. O., & Xoldorov, X. X. O. (2022). Avtopoezd tormozlanish jarayonini organish uchun avtopoezd turini tanlash. *Scientific progress*, *3*(5), 87-92.
5. Xujamkulov, S., Abdubannopov, A., & Botirov, B. (2021). Zamonaviy avtomobillarda qo’llaniladigan acceleration slip regulation tizimi tahlili. *Scientific progress*, *2*(1), 1467-1472.
6. 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).
7. Meliboyev, A., Khujamqulov, S., & Masodiqov, J. (2021). Univer calculation-experimental method of researching the indicators of its toxicity in its management by changing the working capacity of the engine using the characteristics. *Экономика и социум*, (4-1), 207-210.

8. Fayziev, P. R., Tursunov, D. M., Khujamkulov, S., Ismandiyarov, A., & Abdubannopov, A. (2022). Overview of solar dryers for drying lumber and wood. *American Journal Of Applied Science And Technology*, *2*(04), 47-57.
9. Xujamqulov, S. U. O. G. L., & Masodiqov, Q. X. O. G. L. (2022). Avtotransport vositalarining ekspluatatsion xususiyatlarini kuzatish bo'yicha vazifalarni shakllantirish. *Academic research in educational sciences*, *3*(4), 503-508.
10. Masodiqov, Q. X. O. G. L., Xujamqulov, S., & Masodiqov, J. X. O. G. L. (2022). Avtomobil shinalarini ishlab chiqarish va eskirgan avtomobil shinalarini utilizatsiya qilish bo'yicha eksperiment o'tkazish usuli. *Academic research in educational sciences*, *3*(4), 254-259.
11. Khujamkulov, S. U., & Khusanjonov, A. S. (2022). Transmission system of parallel lathe machine tools. *ACADEMICIA: An International Multidisciplinary Research Journal*, *12*(2), 142-145.
12. Umidjon o‘g‘li, K. S., Khusanboy o‘g‘li, M. Q., & Mukhammedovich, K. S. (2022). The formation of tasks for overview of operating properties of vehicles. *American Journal Of Applied Science And Technology*, *2*(05), 71-76.
13. Khujamqulov, S. (2022). A method of conducting experiments on the production of car tires and the disposal of obsolete car tires. *Science and innovation*, *1*(A3), 61-68.
14. Qobulov, M., Jaloldinov, G., & Masodiqov, Q. (2021). Existing systems of exploitation of motor vehicles. *Экономика и социум*, (4-1), 303-308.
15. Сотволдиев, У., Абдубаннопов, А., & Жалилова, Г. (2021). Теоретические основы системы регулирования акселерационного скольжения. *Scientific progress*, *2*(1), 1461-1466.
16. Khodjaev, S. M., & Rakhmonova, S. S. (2022). Saving resources in the operation, maintenance of automotive equipment. *American Journal of Interdisciplinary Research and Development*, *5*, 18-27.
17. 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.
18. Xodjayev, S., Xusanjonov, A., & Botirov, B. (2021). Transport Vositalari Dvigatellarida Dimetilefir Yoqilg’isidan Foydalanish. *Scientific progress*, *2*(1), 1531-1535.
19. 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.

20. Xodjayev, S., Xusanjonov, A., & Botirov, B. (2021). Gibrid dvigatelli avtomobillardan foydalanib ichki yonuv dvigatellari ishlab chiqargan quvvat samaradorligini oshirish va atrof-muhitga chiqarilayotgan zararli gazlarni kamaytirish. *Scientific progress*, *2*(1), 1523-1530.
21. Omonov, F. A., & Sotvoldiyev, O. U. (2022). Adaptation of situational management principles for use in automated dispatching processes in public transport. *International Journal of Advance Scientific Research*, *2*(03), 59-66.
22. Abduraxmonov, A., & Tojiboyev, F. (2021). Korxonada shinalar va harakatlanuvchi tarkibni tahlil qilish va tekshirilayotgan harakat tarkibining xususiyatlari O ‘. Sotvoldiyev. *Academic research in educational sciences*, *2*(11), 1357-1363.
23. Omonov, F. A., & Dehqonov, Q. M. (2022). Electric Cars as the Cars of the Future. *Eurasian Journal of Engineering and Technology*, *4*, 128-133.
24. Xusanjonov, A., Qobulov, M., & Abdubannopov, A. (2021). Avtotransport vositalaridagi shovqin so'ndiruvchi moslamalarda ishlatilgan konstruksiyalar tahlili. *Academic research in educational sciences*, *2*(3), 614-620.
25. Omonov, F. A. (2022). Formation and Analysis of Urban Passenger Traffic Control. *Eurasian Journal of Research, Development and Innovation*, *6*, 6-13.
26. Maxamat o’g’li, D. Q. (2022). Production Resources of Motor Transport Enterprises Planning and Analysis of the Effectiveness of the Provision of Motor Transport Services Costs of Motor Transport Enterprises. *Eurasian Research Bulletin*, *8*, 48-51.
27. Xusanjonov, A., Qobulov, M., & Ismadiyorov, A. (2021). Avtomobil Shovqiniga Sabab Bo'luvchi Manbalarni Tadqiq Etish. *Academic research in educational sciences*, *2*(3), 634-640.
28. 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.
29. Khusanjonov, A., Makhammadjon, Q., & Gholibjon, J. (2020). Opportunities to improve efficiency and other engine performance at low loads. *JournalNX*, 153-159.
30. Мелиев, Х. О., & Қобулов, М. (2021). Сущность и некоторые особенности обработки деталей поверхностно пластическим деформированием. *Academic research in educational sciences*, *2*(3), 755-758.

31. Qobulov, M., Ismadiyorov, A., & Fayzullayev, X. (2022). Analysis of the braking properties of the man cla 16.220 for severe operating conditions. *European International Journal of Multidisciplinary Research and Management Studies*, *2*(03), 52-59.
32. Khusenova, S. (2021). Modern gelling agents in ointment technology. *Интернаука*, (24-3), 36-38.
33. Alimova, Z. K., Sidikov, F. S., & Alimov, S. I. (2020). Reducing wear of engine parts by improving the antioxidant properties of engine oils.
34. Туракулов, М. Р., Кенжаев, С. Н., & Инсапов, Д. М. (2021). Анализ законов движения, задаваемых профилем кулачкового механизма топливного насоса. *Universum: технические науки*, (10-1 (91)), 37-40.
35. Рахимов, У. Т., Турсунов, Н. К., Кучкоров, Л. А., & Кенжаев, С. Н. (2021). Изучение влияния цинка Zn на размер зерна и коррозионную стойкость сплавов системы Mg-Nd-Y-Zr. *Scientific progress*, *2*(2), 1488-1490.
36. Нурметов, Х. И., Турсунов, Н. К., Кенжаев, С. Н., & Рахимов, У. Т. (2021). Перспективные материалы для механизмов автомобильных агрегатов. *Scientific progress*, *2*(2), 1473-1479.
37. Жураев, М. Н., Омонов, Б. Ш., & Кенжаев, С. Н. (2021). Формирование моделей управления объемами перевозок в соответствии с потребностями потребителей. *Universum: технические науки*, (5-2 (86)), 87-92.
38. Omonov, F. A., & Odilov, J. A. (2022). Development of organizational conditions for the introduction of situational management methods in public transport. *European International Journal of Multidisciplinary Research and Management Studies*, *2*(05), 109-112.
39. Khusanjonov, A. S. O., & Nosirjonov, S. I. O. (2021). Theoretical foundations of the acceleration slip regulation system. *ACADEMICIA: An International Multidisciplinary Research Journal*, *11*(9), 618-623.
40. Fayzullayev, E. Z., Raxmonov, I. S. O., & Nosirjonov, S. I. O. G. L. (2021). Tog'iqlim sharoitining transport xarakati xavfsizligiga ta'sirini o'rganish. *Academic research in educational sciences*, *2*(12), 53-56.