

MUHANDISLIK

& IQTISODIYOT

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ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

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- 05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
- 05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
- 05.01.03 – Informatikaning nazariy asoslari
- 05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellashtirish
- 05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
- 05.02.00 – Mashinasozlik va mashinashunoslik
- 05.02.08 – Yer usti majmualari va uchish apparatlari
- 05.03.02 – Metrologiya va metrologiya ta'minoti
- 05.04.01 – Telekommunikatsiya va kompyuter tizimlari, telekommunikatsiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
- 05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
- 05.05.05 – Issiqlik texnikasining nazariy asoslari
- 05.05.06 – Qayta tiklanadigan energiya turlari asosidagi energiya qurilmalari
- 05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
- 05.08.03 – Temir yo'l transportini ishlatish
- 05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
- 05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
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- 10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti
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- 08.00.03 – Sanoat iqtisodiyoti
- 08.00.04 – Qishloq xo'jaligi iqtisodiyoti
- 08.00.05 – Xizmat ko'rsatish tarmoqlari iqtisodiyoti
- 08.00.06 – Ekonometrika va statistika
- 08.00.07 – Moliya, pul muomalasi va kredit
- 08.00.08 – Buxgalteriya hisobi, iqtisodiy tahlil va audit
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- 08.00.14 – Iqtisodiyotda axborot tizimlari va texnologiyalari
- 08.00.15 – Tadbirkorlik va kichik biznes iqtisodiyoti
- 08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
- 08.00.17 – Turizm va mehmonxona faoliyati

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INCREASING THE EFFICIENCY INDICATORS OF DIESEL ENGINES BY IMPROVING THE COOLING SYSTEM

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Abstract. The paper investigates methods for improving the performance of diesel engines through the optimization of the cooling system. Particular attention is paid to the thermal load increase observed when spark-ignition engines are converted to operate on natural gas. Experimental studies were conducted on a gas-fueled engine installed in a diesel-gas microbus. The results highlight the importance of optimizing the temperature regime of gas engines. Based on the analysis, design and operational recommendations are proposed to improve the cooling system, enabling a reduction in cooling temperature from 120 °C to 90 °C.

Keywords: cooling systems, performance indicators, spark ignition, gaseous fuel, fuel and economic indicators.

Annotatsiya. Mazkur maqolada dizel dvigatellarini ish samaradorligini sovitish tizimini optimallashtirish orqali oshirish usullari tadqiq etilgan. Ayniqsa, uchqun bilan o't oldiriladigan dvigatellarni tabiiy gazda ishlashga o'tkazishda kuzatiladigan issiqlik yuklamasining ortishiga alohida e'tibor qaratilgan. Eksperimental tadqiqotlar dizel-gaz mikroavtobusiga o'rnatilgan gaz yonilg'isida ishlovchi dvigatelda olib borildi. Olingan natijalar gaz dvigatellarida harorat rejimini optimallashtirish muhimligini ko'rsatadi. Tahlil asosida sovitish tizimini takomillashtirish bo'yicha konstruktiv va ekspluatatsion tavsiyalar ishlab chiqildi, bu esa sovitish haroratini 120 °C dan 90 °C gacha pasaytirish imkonini beradi.

Kalit so'zlar: sovitish tizimi, effektiv ko'rsatkichlar, uchqun bilan o't oldirish, gazsimon yonilg'i, yonilg'ilar, iqtisodiy ko'rsatkichlar.

Аннотация. В статье исследуются методы повышения эффективности дизельных двигателей за счёт оптимизации системы охлаждения. Особое внимание уделяется увеличению тепловой нагрузки, наблюдаемой при переводе двигателей с искровым зажиганием на работу на природном газе. Экспериментальные исследования были проведены на газовом двигателе, установленном на дизельно-газовом микроавтобусе. Полученные результаты подчёркивают важность оптимизации температурного режима газовых двигателей. На основе проведённого анализа предложены конструктивные и эксплуатационные рекомендации по совершенствованию системы охлаждения, позволяющие снизить температуру охлаждения с 120 °C до 90 °C.

Ключевые слова: системы охлаждения, показатели эффективности, искровое зажигание, газообразное топливо, топливные и экономические показатели.

INTRODUCTION

Taking into account the global trend toward the widespread use of natural gas as an alternative fuel for automotive transport, especially buses and minibuses equipped with spark-ignition engines, the problem of improving engine cooling systems becomes particularly relevant. The transition of engines to natural gas operation is accompanied by changes in the working process, which often lead to an increase in thermal stress on engine components. Therefore, it is necessary to address a number of key scientific and technical challenges, including the analysis of cooling system designs and operating processes, identification of the

causes of increased thermal loads on engine parts during conversion to gas fuel, and the development of effective measures aimed at enhancing cooling system performance.

LITERATURE VIEW

Numerous researchers have contributed to the study of cooling systems of automobile and transport engines, including Gureev A.A., Grigorev M.A., Kavtaradze R.Z., Kostin A.K., Levin M.I., Liventsev F.L., Lukov N.M., Nikolenko A.V., Petrichenko R.M., Petrichenko M.R., Razuvaev A.V., and others. Their works mainly focus on the influence of coolant temperature on engine heat intensity, power output, fuel efficiency, wear resistance, as well as the specific features of engine operation and improvement of cooling efficiency under high-altitude and hot climate conditions. However, despite the significant volume of research, only a limited number of studies are devoted to spark-ignition internal combustion engines operating on gaseous fuels, which highlights the insufficient investigation of this issue.

RESEARCH METHODOLOGY

The development of modern engine design is closely associated with increasing specific power, improving fuel economy, and meeting stringent environmental requirements. These trends inevitably lead to a rise in the thermal intensity of the main components forming the combustion chamber, primarily due to changes in heat transfer conditions. The expansion of temperature limits within the engine operating cycle results in increased thermal loads on critical components, while simultaneously contributing to a reduction in harmful emissions in exhaust gases.

It is well established that most modern internal combustion engines operate under thermal conditions close to optimal only at nominal operating modes. Even under these conditions, the temperatures of engine components and systems do not always correspond to optimal values from the standpoint of maximum efficiency. This is largely explained by the need to maintain a temperature reserve to ensure reliability in case of deviations in cooling system parameters. Under partial load conditions, which are characteristic of real-world vehicle operation, deviations of component and system temperatures from optimal values become more pronounced due to insufficient control of the engine thermal regime [1].

One of the most promising approaches to reducing harmful emissions and improving fuel and economic performance of automobile engines is the enhancement of the working process through the use of alternative fuels combined with the optimization of temperature regimes of engine systems and components. The temperature of highly thermally loaded parts, such as the cylinder and cylinder head, as well as the temperatures of coolant, lubricating oil, fuel, and intake air, have a significant influence on the technical, economic, and environmental performance of engines.

ANALYSIS AND RESULTS

For diesel and spark-ignition engines, the coolant temperature at the engine outlet (T_{co}) and the oil temperature (T_o) are typically maintained within the ranges of 350-365 K and 340-360 K, respectively [2, 3]. Maintaining these parameters within optimal limits is especially critical for gas-fueled engines, where deviations can lead to increased thermal stress and reduced durability.

Taking into account the methods and methodologies of the conducted theoretical researches with the use of the mathematical apparatus of the regression analysis realized on the ECM, the maintenance tests have been carried out.

Practical significance and implementation of the research results consist in recommendations to improve the cooling system and to reveal the specific effect of cooling system temperatures on the power and fuel and economic performance of the engine with spark ignition when operating on gas fuel.

Scientific novelty of the research was indicated on the basis of the research and practical analysis of cooling systems of automobile engines with different power systems operating on diesel or gas, scientifically substantiated improvement of the cooling system, which allows reducing the thermal stress of engine parts and improving its performance.

The structure and composition of the work include the identified and studied problems related to the operation of gas-powered buses and minibus engines, the results of theoretical and experimental research on the selected subject.

Design features of gas engines

Gas fuel has evolved from an alternative to a separate type of motor fuel. The first deep theoretical and experimental studies of automotive gas equipment date back to the pre-war and post-war period. They were devoted to the analysis of stable operation and regulation of gas pressure, as well as the study of its impact on



the operation of the gas engine. As a result, the basis for calculating gas-cylinder equipment (GCE) was laid down.

Analysis of the operation of modern engine cooling systems

The cooling system is designed for forced removal of heat from engine parts flowing with hot gases to ensure their optimal and stable thermal condition [5].

Depending on the way the heat exchange between the engine elements and the environment is organized, there are systems with intermediate coolant (liquid cooling circulating systems) and systems without intermediate coolant (air cooling systems and liquid cooling flow system).

Flow-through liquid cooling system is structurally the easiest to manufacture and operate (Fig. 1). On the ground transport the circulation two-circuit systems where heat removal is carried out in air, and a cooling liquid is used as the intermediate heat-carrier circulating on the closed contour have received the greatest distribution.

The design of the liquid cooling system is largely determined by the accepted way of organizing the circulation of liquid. According to the abovementioned feature there are systems: thermosiphon systems, with forced circulation of liquid and mixed cooling systems.

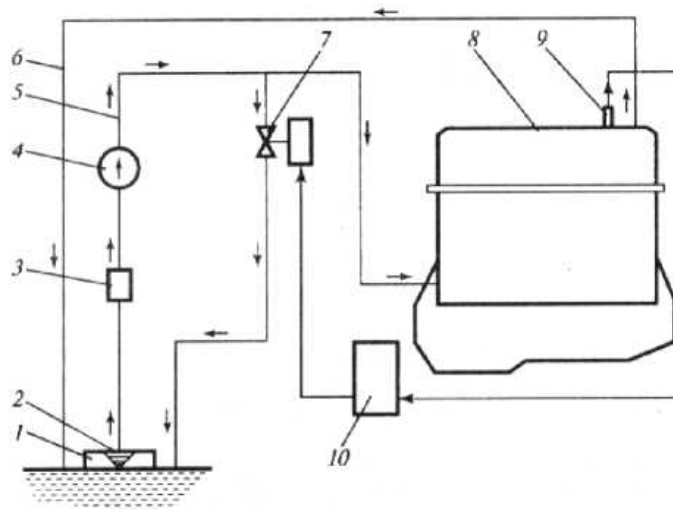


Fig.1. Principle diagram of liquid cooling flow system:

1 - Inlet box; 2 - filter; 5 - check valve; 4 - pump; 5 - mains line supply of water to the engine; 6 - mainline water output engine; 7 - controlled valve; 8 - engine; 9 - temperature gauge; 10 - control unit

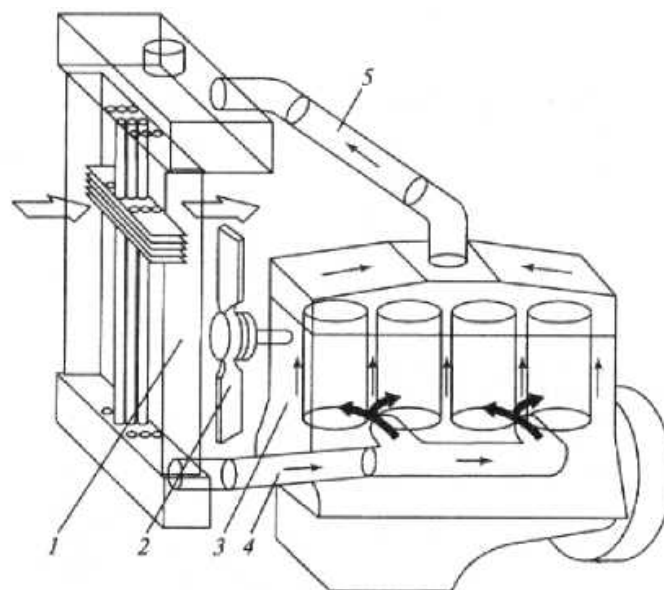


Fig.2. Principle scheme of the thermosiphon cooling system:

1 - Radiator; 2 - fan; 3 - cylinder block; 4 - coolant supply hose from the radiator to the cylinder block; 5 - coolant drain hose from the cylinder block to the radiator

In a thermosiphon system (Fig. 2), liquid circulation occurs due to the difference in temperature and density in different areas of the liquid circuit. Such cooling system is the simplest and most inexpensive, but at its acceptable dimensions, thermomechanical is not sufficiently effective. For intensive circulation of liquid in it, a significant temperature difference of Δt_i on the radiator (about $30\text{ }^{\circ}\text{C}$) is required. Otherwise, low liquid velocities can lead to local overheating and significant temperature gradients in the cooled engine elements.

Due to the noted deficiencies in modern transport ICE, thermosiphon cooling systems are not used. The system with forced circulation of the cooling agent is currently one of the main types of cooling systems for auto-tractor engines. Forced circulation of the intermediate coolant along the entire circuit is carried out by the liquid pump 6 (Fig. 3). The cooling agent is supplied through the lower zone of the cylinders [5].

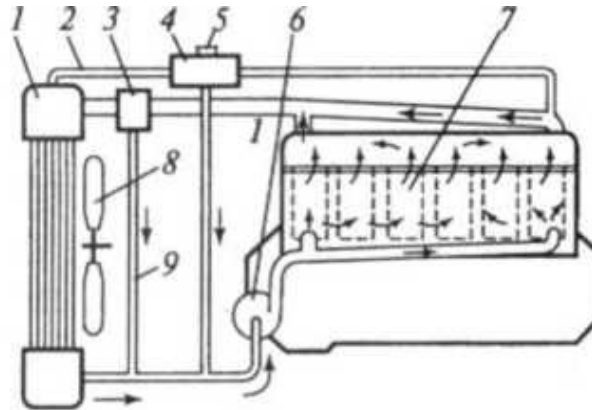


Fig.3. Principle scheme of the circulating liquid cooling system:

1 - Radiator; 2 - steam-air tube; 3 - thermostat; 4 - expansion tank; 5 - expansion tank plug; 6 - liquid pump; 7 - cylinder block jacket; 8 - Fan; 9 - bypass line

Mixed cooling systems (Fig. 4 a, b) the coolant from radiator 1 is supplied to the upper zone of the cylinder cooling jacket (Fig. 4 a) or to the cavity of the block head (Fig. 4 b), or to the cavity of the block head (Fig. 4 b). In the latter case, the engine cylinders are cooled by the thermosiphon effect. When the coolant is supplied to the block head, sometimes (with large linear engine sizes) the distribution pipes 10 are used (Fig. 4 b), which allow intensifying the cooling of the hottest areas of the combustion chambers. Such systems are mainly used on spark-ignition engines.

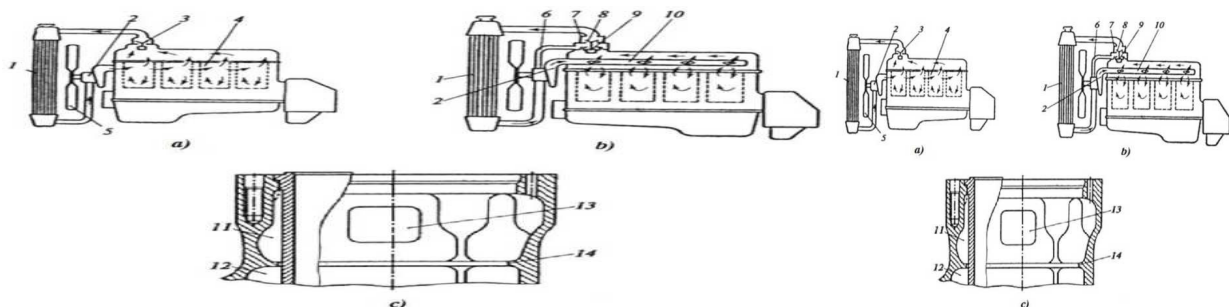


Fig.4. Scheme of mixed liquid cooling systems:

a - with liquid supply to the upper belt of the cylinder cooling jacket; b - with liquid supply to the cavity of the block head; c - two-cavity cooling system; 1 - radiator; 2 - liquid pump; 3 - single-valve thermostat; 4 - engine cooling jacket; 5 - fan; 6 - bypass line; 7 - two- valve thermostat; 8 - main thermostat valve; 9 - optional thermostat valve; 10 - distribution pipe; 11 - upper cylinder cooling cavity; 12 - lower cylinder cooling cavity; 13 - coolant supply length channel; 14 - partition

CONCLUSIONS AND RECOMMENDATIONS

Therefore, in the process of improving the performance of diesel engines by enhancing the cooling system, the following recommendations can be made:

1. Analyze the design features of gas engines;
2. Analyze the operation principles of modern engine cooling systems;



3. Carry out theoretical research of the cooling system of gas-powered buses and minibus engines, which would allow to reveal the reasons leading to the increase of thermal stress of the engine parts during conversion to gas fuel, which consists in the specifics and peculiarities of the working process;

4. Suggest ways to improve the gas engine cooling system;

5. Develop and propose variants for improvement of gas engine cooling system, which will reduce the cooling temperature from 120 to 90 °C.

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