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OPTIMIZATION OF GAS SUPPLY SYSTEMS IN VEHICLES

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Annotation. The article provides a comprehensive scientific overview of the fuel supply system used in automobiles, the mechanisms for utilizing compressed and liquefied gases, methods for adapting engines to gaseous fuels, the operating principles of reducers and mixers, as well as the process of forming the gas–air mixture. The technical, ecological, and economic advantages, along with practical limitations, of converting automobiles to gaseous fuels are analyzed. The study includes scientific recommendations aimed at improving the efficiency of gas engines, enhancing fuel economy, and ensuring environmental safety.

Keywords: gas supply system, compressed gas, liquefied gas, reducer, evaporator, mixer, gas–air mixture, engine efficiency.

Аннотация. В статье представлен всесторонний научный обзор системы подачи топлива, используемой в автомобилях, механизмов использования сжатых и сжиженных газов, методов адаптации двигателей к газообразному топливу, принципов работы редукторов и смесителей, а также процесса образования газовоздушной смеси. Анализируются технические, экологические и экономические преимущества, а также практические ограничения переоборудования автомобилей на газообразное топливо. В исследовании приводятся научные рекомендации, направленные на повышение эффективности газовых двигателей, улучшение топливной экономичности и обеспечение экологической безопасности.

Ключевые слова: система подачи газа, сжатый газ, сжиженный газ, редуктор, испаритель, смеситель, газовоздушная смесь, эффективность двигателя.

Annotatsiya. Maqolada avtomobillarda qo‘llaniladigan yoqilg‘i ta’minoti tizimi, siqilgan va suyultirilgan gazlardan foydalanish mexanizmlari, dvigatellarni gazsimon yoqilg‘iga moslashtirish usullari, reduktorlar va aralashtirgichlarning ishlash tamoyillari, shuningdek, gaz-havo aralashmasini hosil qilish jarayoni haqida keng qamrovli ilmiy sharh berilgan. Avtomobillarni gazsimon yoqilg‘iga aylantirishning texnik, ekologik va iqtisodiy afzalliklari, amaliy cheklovlari tahlil qilingan. Tadqiqot gaz dvigatellarining samaradorligini oshirish, yoqilg‘i tejamkorligini oshirish va ekologik xavfsizlikni ta’minlashga qaratilgan ilmiy tavsiyalarni o‘z ichiga oladi.

Kalit so‘zlar: gaz ta’minoti tizimi, siqilgan gaz, suyultirilgan gaz, reduktor, bug‘latgich, aralashtirgich, gaz-havo aralashmasi, dvigatel samaradorligi.

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INTRODUCTION.

Currently, the use of gas fuel in road transport is considered an important factor in energy efficiency, environmental safety, and economic efficiency. Gas engines use natural, industrial or synthetic fuels in compressed (CNG — Compressed Natural Gas) or liquefied (LPG — Liquefied Petroleum Gas) form. Such fuels are stored in special metal cylinders under high pressure and are fed to the engine through the vehicle's gas cylinder system.

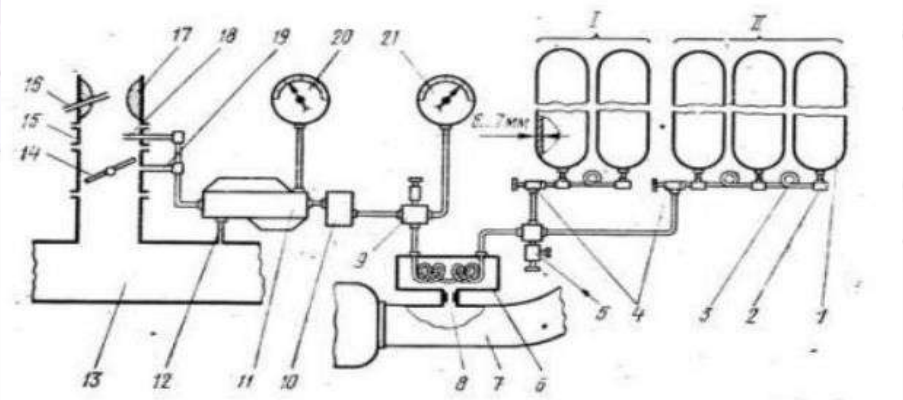
When converting diesel and gasoline engines to gas fuel, the main mechanical parts remain unchanged, but the fuel supply, combustion control, gas mixture preparation, and safety systems are completely re-equipped.

The first method is to convert a diesel engine into a full-fledged spark-ignition engine. In this case, the compression ratio in the cylinders is reduced to 8–9 units, and the engine is equipped with a system that provides spark ignition and gas cylinder devices. This technology brings the engine's operating cycle closer to that of a gasoline engine.

The second method is a mixed (gas-diesel) mode, which allows the engine to run on gas and diesel fuel simultaneously. In this case, the engine is equipped with a gas cylinder device, with the gas being mixed with air through a mixer and sucked into the cylinders along the intake manifold. At the end of the compression stroke, a certain amount of diesel fuel is sprayed into the cylinders; it acts as the initial spark required for combustion. In this method, diesel consumption is approximately 20 percent of the consumption in a normal diesel process. Most importantly, this method does not require drastic changes in engine design and is widely used, especially for automotive engines and many stationary installations.

The working cycle of gas engines is practically no different from the working cycle of gasoline engines. The set of all devices that are installed for the use of a car engine in gas fuel is called a gas cylinder device. Gas cylinder devices are divided into two types: compressed gas systems and liquefied gas systems. Their common structural feature is that gas is always released from cylinders under high pressure. Therefore, a special reducer is included in the system. The reducer reduces the gas pressure, stabilizes it, and controls the gas flow transmitted to the engine.

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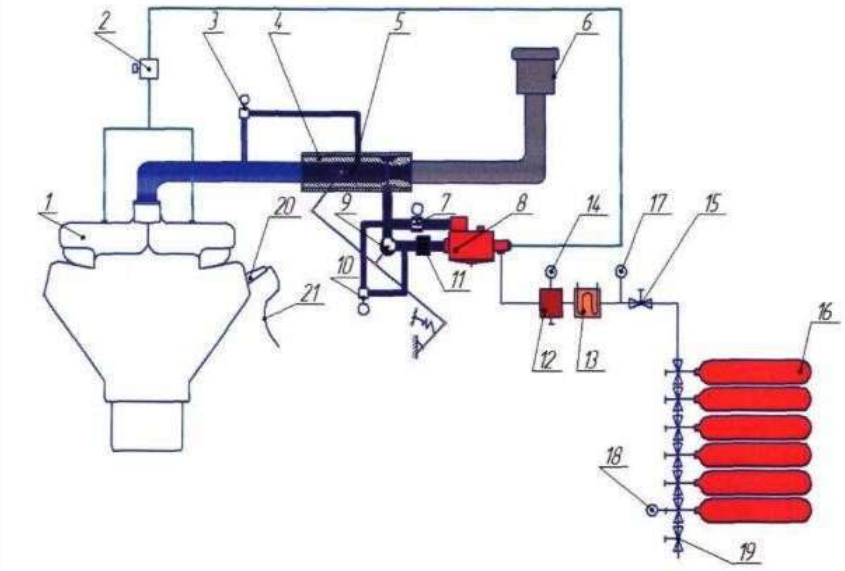
1-picture. Principle diagram of gas cylinder equipment powered by compressed gas

The principle scheme of equipment with gas cylinders is 1-cylinder; 2-Connecting fittings; 3-steel pipes; 4-consumption crane; 5 - filling crane; 6-heater; 7-exhaust gas system pipe; 8-dosing machine; 9 - main crane; 10-filter; 11-reducer; 12 - pipe connecting pipe; 13 - inlet pipe; 14-gas valve; 15-base; 16-sprinkler; 17-diesel mixer; 18-injector; 19-salt working pipe; 20-low pressure manometer; 21-high pressure manometer. The compressed gas at a pressure of 20 MPa is divided into two groups (I and II) and stored in five steel cylinders 1, each with a volume of 50 l, installed under the loading platform. Cylinders are connected to each other by connecting fittings 2 and pipes 3. As a result of the differentiation of the car frame, the pipes are provided with compensators so that 3 does not break.The compressed gas at a pressure of 0 MPa is divided into two groups (I and II) and is stored in a steel cylinder 1, each with a volume of 50 l, installed under the loading platform. Cylinders are connected to each other by connecting fittings 2 and pipes 3. As a result of the differentiation of the vehicle frame, the pipes are provided with compensators to prevent damage to the 3. Gas from the cylinders 1 is discharged through the exhaust valve 4 to the heater 6 main valve 9, then it is cleaned in the filter 10 and passes through the reducer 11.

In the reducer 11, the gas pressure is reduced to atmospheric pressure.'s. In the reducer 11, the gas pressure is reduced to atmospheric pressure. Diagram of the placement of gas equipment in the car 1 ventilation pipe; 2-hermetic box; 3-fittings; 4, 11 Tee; 5-mixer; 6-dispenser; 7-Control Unit; 8-filter electromagnetic gas valve; 9-reducer 21-connector; 10-electromagnetic gasoline valve; 12-internal heater; 13-heater button; 14 - high pressure pipe; 15-duralumin cylinder; 16-ejectors; 17-transition pipe; 18-Cast device. Due to the sudden drop (expansion) in gas pressure, if it contains moisture, it can freeze and disrupt the normal operation of the system. Therefore, the gas is passed through the heater 6. The heat of the gases used to heat the gas is used. 7.8. When the engine is not running, the reducer closes the gas pipeline. Due to a sharp decrease (expansion) in the az pressure, if it contains

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moisture, it can freeze and disrupt the normal operation of the system. Therefore, the gas is heated through 6. The heat of the gases used to heat the gas is used 7.8. When the engine is not running, the reducer closes the gas pipeline. In a running engine, as a result of the rarefied gas, the gas passes from the nozzle 18 to the diesel mixer 17 and, mixing with air, forms a gas-air mixture. In Salt mode, the gas is injected directly into the bottom of the gas through the pipe 19. The gas pressure in the cylinders and the amount proportional to it are controlled using a high-pressure manometer 21. The operation of the reducer is controlled using a low-pressure pressure gauge 20. Both pressure gauges are mounted on the dashboard in the car interior. The cylinders are filled with gas through valve (tap) 5.



2-picture. The gas is removed from the liquid phase through an exhaust valve installed above it.

The device shown in the picture is universal and, thanks to the backup gasoline fuel system, allows you to work normally on gasoline, if you are careful. In liquefied gas-powered devices, the transition of gas to a vapor state occurs in a special heat exchanger, namely, in the evaporator. A distinctive feature of a liquefied gas device is that its operating pressure does not depend on the amount of gas in the cylinder, but on the structural composition of the gas mixture and ambient temperature to determine the amount of liquefied gas in the cylinder, unlike a compressed gas device. A special level indicator must be installed on the liquefied gas device. The liquefied gas is stored in 20 cylinders of 225 liters, which are installed under the platform and attached to the left side of the frame. The exhaust valves are mounted on the front wall of the cylinder, through which gas passes from the cylinder gauge (troy) 19 to the speed valve 18.

Engine 1; 2-electromagnetic valve; 3.10-electric control valves; 4-Mixer;5-gas air cap; 6-gas air intake filter; 7-gas cap; 8-low - pressure reducer; 9-separator; 11 filter cleaner; 12-high-pressure gas reducer; 13-liquid heating; 14, 17, 18

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pressure gauges; 15 - main crane; 16-cylinder part; 19-filling crane car liquefied gas supply system Scheme: 1-Inlet Collector; 2-reducer only working system mixer; 3-pipe between reducer and Mixer; hose between car. inlet pipe from the 4th reducer; 5-pipe between the solenoid valve of the starting system from the reducer; 6 - pipe between the evaporator and the reducer; 7-gas mixer; 8-gas reducer; 9 - gas reducer filter; 10-starting system electromagnetic valve; 11 tubes between the mixer from the starting system valve; 12-high pressure hose between the solenoid valve and the evaporator; 13 - evaporator; 14-backup system; 15-electromagnetic valve; 16.17 pipes; 18-speed valve; 19-cylinder three (three).- pipe between the reducer and the solenoid valve of the starting system; 6 - pipe between the evaporator and the reducer; 7-gas mixer; 8 - gas reducer; 9-gas reducer filter; 10-starting system electromagnetic valve; 11 tubes between the mixer from the start system Valve; 12 - high pressure hose between the solenoid valve and evaporator; 13-evaporator; 14-backup system; 15-electromagnetic valve; 16.17 pipes; 18-speed valve; 19-cylinder three (three). The gas from tee 19 passes through pipes 16, 17 to the electromagnetic valve 15. When the contact is made, the gas is transferred through the high-pressure hose 12 to the evaporator 1 installed in the engine's intake manifold 13.

From the evaporator 13, the gas enters the two-stage reducer 8 and reduces its pressure. Before the first stage of the reducer, a filter 9 is installed, from the cavity of the second stage of the reducer, the gas passes to the gas metering and saving device, and from it the required amount of gas is sent to the mixer 7 in accordance with the operating mode of the engine. The engine start system includes an electromagnetic start valve 10 with measuring nozzles, tubes, and shut-off valves. When starting a cold engine, after the start valve is connected, the gas under pressure passes through the first stage of the reducer into the mixing system through the 2nd tube. The operation of the 23 supply system is controlled by a pressure gauge installed in the driver's cabin. The gas pressure after the first stage of the reducer should be 0.15 MPa. The function of the gas reducer is to reduce

The main function of the reducer is to automatically control the amount of gas supplied to the mixer in accordance with the operating modes of the engine and to regulate the pressure of the gas exiting the cylinder to completely cut off the gas flow when the engine is stopped.

A comparison of the technical and economic characteristics of gas and diesel fuels shows that gaseous fuels have a number of significant advantages over liquid fuels. First of all, gaseous fuel is often available as a local raw material and is characterized by its economic affordability. The use of gas in spark-ignition engines significantly improves the process of forming the combustible mixture: gas mixes with air in various proportions quickly and evenly, resulting in optimal

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distribution of the mixture throughout the cylinders. The flame spread range of gases is wider than that of liquid fuels, and the combustion process is complete even if the mixture contains a large amount of air. These factors serve to simplify the devices that form the combustible mixture and reduce the amount of environmentally harmful emissions.

Other advantages of gas include: it is widespread, inexpensive and has large natural reserves; no tar, Black Moth or ash is formed during the combustion process; the proportion of environmentally harmful substances in the composition of waste products is much lower; gas can be easily transported over long distances through pipelines and is convenient to store in a centralized state. Also, the oil degradation process is significantly slower in engines running on gaseous fuels. This is due, firstly, to the absence of condensation of fuel vapors on the cylinder walls, and secondly, to the low formation of soot and deposits in the combustion chamber. As a result, the engine's service life before overhaul can be increased by 1.5–2 times.

However, there are also some disadvantages to gas fuels. The most important negative feature is the high level of explosion hazard of many gaseous fuels (especially methane, hydrogen, and natural gas). Therefore, it is necessary to strictly adhere to fire safety rules and technical regulations when using gas appliances. In addition, gaseous fuel fills the cylinders less than liquid fuel, which leads to a slight decrease in engine power.

Nevertheless, the above analysis shows that the complex properties of gaseous fuel make it a very suitable fuel type for spark-ignition engines, and it can also be effectively used in diesel engines when appropriate systems are used.

Synthetic combustible gases are obtained through the processing of solid and liquid fuels, particularly through dry roasting, semi-coking, and other thermochemical methods. These gases are classified into low or high-calorie types according to their ability to allocate energy and are mainly used as fuel. In order to reduce the risk of explosion in the composition of synthetic gases, natural gas is added to them in a certain proportion. The mixing process takes place in special technological stations, and the finished product is delivered to consumers.

It should be remembered that most synthetic gases are explosive and contain components that can be harmful to human health. Therefore, it is necessary to strictly adhere to safety requirements when using such gases and comply with fire and explosion safety standards.

When using cars on gas fuel, two types of fuel are mainly used: compressed gas and liquefied gas. Each type of fuel requires a separate technical approach due to its physical and chemical properties, energy content, and safety requirements.

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Hydrocarbons whose critical temperature is higher than the ambient temperature transition from a gaseous state to a liquid state under low pressure. Such gases are called liquefied gases. To liquefy a gas, a certain temperature and a certain pressure must be present. For example, liquefying propane at 20 °C requires a pressure of approximately 0.85 MPa, while liquefying butane requires a pressure of 0.2 MPa.

Conversely, gases with a critical temperature below the operating temperature are usually stored compressed at high pressures up to 20 MPa and are called compressed gases. Unlike liquefied gases, compressed gases maintain their gaseous state under normal temperature conditions; they only liquefy when supercooled at very low temperatures (below –62 °C). Natural gas, compressed to a pressure of up to 20 MPa, is commonly used as a fuel in automobiles.

Natural gas is extracted from gas fields and its main component is methane. Methane releases about 49,800 kJ/kg of heat when burned. However, the volumetric heat capacity of natural gas in a compressed state under a pressure of 20 MPa does not exceed 7,000 kJ/m³, which is at least three times lower than the volumetric heat capacity of liquefied gas. The low volumetric heat capacity does not allow for storing a sufficiently large amount of gas in a car, even in high-pressure cylinders. Therefore, the driving range of vehicles running on compressed natural gas is approximately half that of vehicles running on gasoline or liquefied gas.

The octane number of methane is approximately 110 units, which indicates its high resistance to explosion. The widespread availability, relative cheapness, and environmental friendliness of natural gas make it a viable and promising alternative to diesel fuel, especially for vehicles operating in urban areas.

The analysis shows that the use of gaseous fuels in automotive and industrial engines is highly efficient from a technical, environmental and economic perspective. The rapid mixing of gaseous fuels with air, wide combustion range, high octane number, and clean combustion properties optimize the combustion process and increase the thermal efficiency of the engine. In addition, the use of gas fuel leads to a reduction in harmful emissions into the atmosphere, an increase in the service life of engine oil, and an increase in the overall operational reliability of the engine.

The analyzed data showed that the physicochemical properties of liquefied and compressed gases, the mechanisms of their storage and transportation, and their impact on engine energy efficiency differ significantly from each other. Although liquefied gases are more efficient due to their high volumetric heat capacity, compressed natural gas is distinguished by its environmental friendliness and economic affordability. Methane's high explosion resistance makes it a promising fuel type for spark-ignition engines.

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At the same time, it is necessary to strictly adhere to safety requirements when using gas appliances, since many types of gas are explosive and sometimes have toxic components. These factors place high demands on the quality and level of control of gas cylinder systems.These characteristics make the use of gas fuels in modern energy and transport sectors a more relevant and promising direction load, and extending engine life. These characteristics make the use of gas fuels in modern energy and transport sectors a more relevant and promising direction.

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