

Alisa Khabarova

PRINCIPLES OF BUILDING A SMART HOME ECOSYSTEM AND INFRASTRUCTURE

Innovative transformation of smart real estate into
a supersystem with real-time online control

2026

Arrow Science & Technology

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Principles of building a smart home ecosystem and infrastructure

/ Khabarova A., – Urbana : Arrow Science & Technology, LLC –
2026. – 30 p.

ISBN 978-1-967596-53-9

The article examines modern approaches to the comprehensive optimization of fuel systems for thermodynamic energy equipment in the context of developing smart real estate infrastructure. Particular attention is paid to technologies for the dynamic mixing, homogenization, and activation of diesel fuel, fuel blends, and emulsions designed to improve combustion efficiency, reduce fuel consumption, and decrease the concentration of harmful compounds in exhaust gases. The article considers the design features of fuel flow turbulence stabilization systems and the principles of their integration into the fuel lines of diesel engines, boilers, gas turbines, and other energy equipment. It also analyzes comparative testing methods, technology efficiency assessment criteria, and requirements for measuring equipment, including the monitoring of pressure, flow rate, fuel mixture composition, and exhaust gas parameters. Special attention is given to experimental studies of diesel-methanol blends, diesel-water emulsions, and integrated fuel compositions, as well as systems for their re-blending and restoration of a homogeneous structure. The importance of coordinating the technical characteristics of innovative solutions with investment, patent and licensing, and project strategies is emphasized. The presented test results demonstrate the practical applicability of the developed systems for energy equipment, diesel engines, and fuel station infrastructure. In conclusion, the article notes that the integrated combination of innovative fuel technologies, online monitoring systems, testing methods, and investment support can become an important element in improving the energy efficiency and environmental sustainability of modern smart real estate.

Keywords: *Modern trends; integrated optimization technologies; fuel systems; thermodynamics; energy equipment; protective coding; digital storage media; digital information storage devices; resonance method; principles of information processing*

Subscribe to print 10/14/2026. Format 60×84/16.

Offset Paper. Arno Pro. Pec. liter. 14. Circulation of 300 copies.

Typeset in Arrow Science & Technology, LLC, USA.

Publishing by Arrow Science & Technology, LLC

805 Silver St., Urbana, IL 61801

ISBN 978-1-967596-53-9

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INTRODUCTION

Since the emergence of the theory and infrastructure systems of smart real estate, issues related to energy, thermodynamic energy equipment, and energy supply at minimal cost and with minimal harmful environmental impact have become particularly critical.

Since these issues are very broad, the author provides readers with introductory information on this topic in order to identify the strategy and the most effective trends in the development of this field.

MODERN TRENDS IN THE DEVELOPMENT OF TECHNOLOGIES FOR THE COMPREHENSIVE OPTIMIZATION OF FUEL SYSTEMS FOR THERMODYNAMIC ENERGY EQUIPMENT

In recent years, specialists and manufacturers have carried out extensive work to identify and select the most practical and effective technical solutions aimed at the comprehensive optimization of processes for preparing and supplying fuel mixtures to the combustion chambers of thermodynamic equipment.

Experimental installations have been tested on diesel engines, boilers, diesel – generators, gas turbines, and other thermodynamic equipment.

As part of this systematic search, researchers and designers have focused primarily on technical solutions for modifying fuel preparation systems and the associated systems for supplying fuel to the combustion chambers of thermodynamic equipment.

It should be noted that, at the same time, new developments have emerged in this technological field in the so-called practical aspect, involving an integrative synthesis of the effectiveness of technical ideas with the capabilities and interests of investment partners.

In this type of research, the conclusions, recommendations, and assessments of multidisciplinary specialists who are equally proficient in technological and design methods as well as in the specifics of investment support at all stages and phases of

projects are of particular interest to innovative technology developers.

In this regard, developments, publications, inventions, and investment strategies created comprehensively by well-known specialists with the participation of the author of this publication are exceptionally important for the integrated practice of design and its implementation.

In these original and, to some extent, unique developments, a clear logical connection can be observed between the investment strategy and the corresponding stages and phases of project development that meet its requirements and constraints.



Figure 1. Three-dimensional model of a linear device for online stabilization of the fuel mixture flow turbulence level between the low-pressure fuel pump and the high-pressure fuel pump

From the perspective of the author of this article, whose developments link the coordination of investment criteria and design parameters through a specific algorithm, the fundamental professional knowledge and experience of smart technology developers in both technology and targeted financing of innovative projects play an exceptionally important role, and their proper and harmonious combination is essential to the commercial success of a project.

Using one of the most in-demand projects in the energy sector as an example, we will examine the importance and significance of combining the stages and phases of a project's technological development with a targeted investment strategy linked to the stages and phases of project development and the results obtained upon their completion.

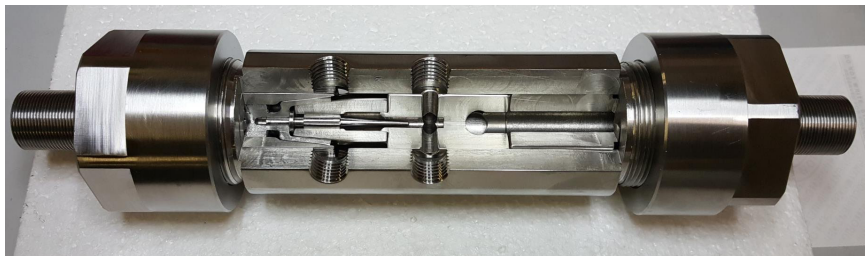


Figure 2. Internal structure of the system for online mixing, homogenization, and stabilization of the turbulent fuel mixture flow regime

As the practice of innovative project development demonstrates, one of the most challenging issues is determining the criteria by which a newly developed technology is evaluated and by which its compliance with the corresponding parameters established by investors is compared by developers and investors.

One of the achievements of the development team headed by the author of this publication is the proposal that the achieved results and the control parameters established by investors should be compared on the basis of the Patent – Licensing Strategy developed by the author and its main basic operational algorithm.

Undoubtedly, the fact that the author of the Patent – Licensing Strategy and its six basic algorithms, presented in the first part of this book, is also an active inventor, including in the energy and fuel sectors, facilitates understanding and increases confidence in his highly effective recommendations and developments.

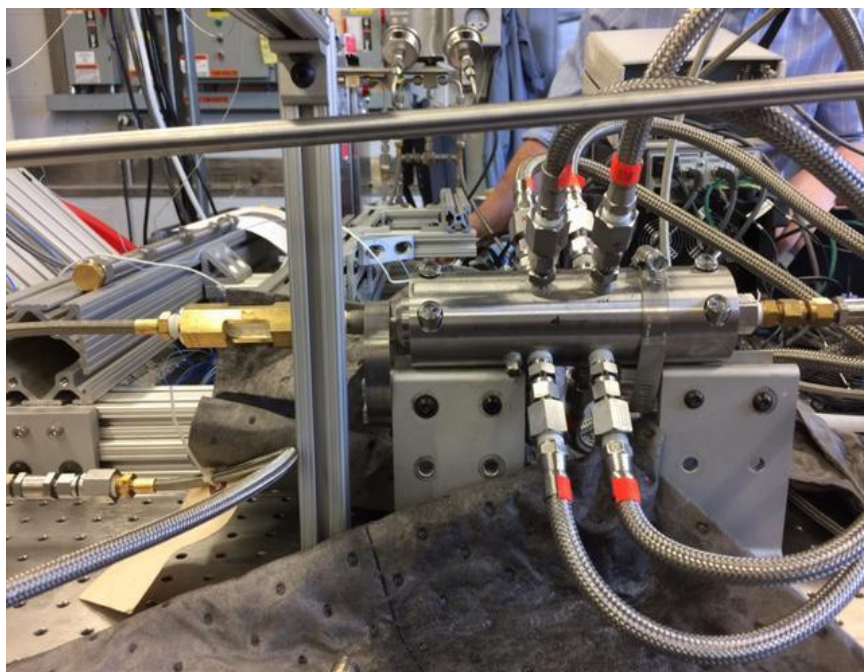


Figure 3. Objectives and Scope of Comparative Testing of the Diesel Fuel Pre-Mixing and Activation System

As can be seen from the figure, the system contains a minimum number of parts, which remain stationary during operation.

Demonstration of the capabilities of the device and technology for dynamic mixing and activation of diesel fuel with real-time stabilization of its flow before it is supplied to the burner, combustion chamber, or injection nozzles of the engine cylinders.

1. Tasks to be addressed when conducting comparative tests of the device (system) and tasks related to testing the device when the test results need to be presented to investors.
 - 1.1. The objective of the tests is to evaluate the effectiveness of the technology for preliminary mixing and activation of diesel fuel before supplying the mixture, emulsion, or blend to a standard burner.
 - 1.2. The purpose of this type of testing is to compare the results of the system when using the device for preliminary dynamic mixing and activation of diesel fuel and when operating without the specified device.
 - 1.3. When evaluating the performance results of the proposed device, the basis for comparison should include the main criteria characterizing the operation of the device, as well as indirect criteria (coordinated with the initial technical requirements, the technical specifications for the project and its stages and phases, which, in turn, are aligned with applicable international standards).
 - 1.4. The main comparison criteria should include – the specific consumption of diesel fuel required to achieve identical combustion parameters; the concentration

of nitrogen compounds and carbon compounds in the exhaust gases under identical combustion parameters.

- 1.5. The indirect comparison criteria should include – the amount of oxygen required for the process; the amount of air required for the process; the total volume of exhaust gases (all under identical combustion parameters and in full compliance with the requirements and limitations of applicable standards).
- 1.6. The purpose of the comparative tests also includes evaluating the effectiveness of the device when operating with diesel fuels of different viscosities; when operating with methanol and ethanol; and with biofuel.

As noted by the author of this article, in order to determine compliance with the initial technical requirements and technical specifications, it is most appropriate to use approaches and methodologies that take into account all relevant aspects of the interaction and combination of investors' requirements for intermediate test results and compliance with the technical specifications, which are also agreed upon with the investors.

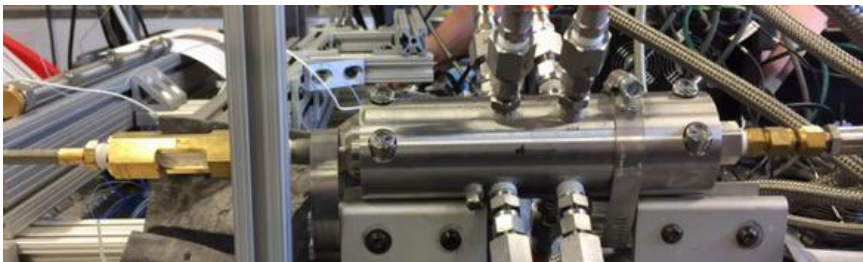


Figure 4. The system undergoing testing at one of the leading research centers in the United States, where it was tested for integration into the fuel line of a gas turbine

It is also important to note that the comprehensive system for evaluating test results developed by the author of this publication makes it possible to identify potential problems at an early stage and to adjust project development plans in a timely manner – before the process reaches an irreversible stage.



Figure 5. Parameters for Monitoring and Regulation of Diesel Fuel and Compressed Air Supply

2. Parameters to be monitored and regulated in the pipelines supplying diesel fuel and compressed air to the device.
 - 2.1. In all supply pipelines, the pipeline pressure must be monitored and regulated. Particular attention should be paid to monitoring the pressure drop of the fuel mixture as it passes through the channels of the device for homogenization and stabilization of pulsation phenomena in the fuel flow. All developers of thermodynamic equipment consider the absence of a pressure drop in the fuel mixture flow to be one of the key factors for the successful integration of an innovative system into the fuel line of thermodynamic equipment.
 - 2.2. In all supply pipelines, the flow rate must be monitored and regulated, with particular attention paid to the absence or substantial minimization of pulsations and turbulence surges.

- 2.3. Based on the flow rate and pressure data, a comprehensive assessment of the quantity and volume of the working medium supplied to the device must be performed, and the mixing proportions must be determined.
- 2.4. For compressed air, it is necessary to provide the capability to regulate and measure pressures of 3, 4, 5, 6, 7, and 8 atmospheres.
- 2.5. For compressed air, it is necessary to provide an equal flow rate through all four supply pipelines within the range of 0.3 liters per second to 2.5 liters per second at a pressure of 8 atmospheres. For turbines, the flow rate should be provided at a pressure of 30 atmospheres.
3. Requirements for the instruments necessary for testing the device for dynamic mixing and activation of diesel fuel before its continuous supply to the burner.
 - 3.1. The accuracy of the measuring instruments must meet the accuracy requirements established by applicable international standards and applicable local standards if they differ from international standards by imposing stricter requirements.



Figure 6. System with a working diameter of 30 millimeters, prepared for installation on the test bench

4. Methodology and procedure for comprehensive testing.
 - 4.1. The device for dynamic mixing and activation of diesel fuel must be installed in the existing fuel preparation system, which has been previously tested using the existing technology.
 - 4.2. Instruments for monitoring the flow rate and pressure in these pipelines must be installed on all supply pipelines.
 - 4.3. Devices for regulating the flow rate and pressure, respectively, must be installed on all supply pipelines before the instruments monitoring the pressure and flow rate in these pipelines.
 - 4.4. The tests must be conducted both with and without oxygen supply.
 - 4.5. The instruments used to monitor all parameters of the combustion process and all instruments used to monitor the composition and quantity of exhaust gases must be completely identical for burner tests conducted using existing technologies and using the device for dynamic mixing and activation of diesel fuel.
5. Questions for the company at whose production facilities the testing will be conducted.
 - 5.1. What is the capacity of the air compressor (flow rate and achievable pressure range)?
 - 5.2. With what accuracy can the compressed air flow rate be measured and regulated?
 - 5.3. With what accuracy can the diesel fuel flow rate be measured and regulated?
 - 5.4. With what accuracy can the compressed air pressure level be measured and regulated?

- 5.5. With what accuracy can the diesel fuel pressure level be measured and regulated?
 - 5.6. What diesel fuel flow rate and pressure are optimal for burners of the same type and size used with existing technologies?
 - 5.7. What oxidizer flow rate (air and oxygen separately) is optimal for burners of the same type and size when used with existing technologies?
 - 5.8. Is there a practice of replacing one type of diesel fuel with another during testing? If so, what is the procedure for such replacement, and how much time is required to replace one type of diesel fuel with another?
6. Test results for burners of the same type and size using existing fuel mixture preparation technologies.
 - 6.1. Fuel mixture flow rate.
 - 6.2. Total volume of exhaust gases.
 - 6.3. Concentration of nitrogen oxides and compounds in the exhaust gases (all categories) in absolute values and in accordance with the requirements of applicable standards.
 - 6.4. Concentration of toxic nitrogen compounds in the exhaust gases in absolute values and in comparison with the requirements of applicable standards.
 - 6.5. Concentration of toxic carbon compounds in the exhaust gases in absolute values and in comparison with the requirements of applicable standards.
 - 6.6. Concentration of carbon oxides and compounds in the exhaust gases (all categories) in absolute values and in accordance with the requirements of applicable standards.

- 6.7. Exhaust gas temperature (in absolute values and in accordance with the requirements of applicable standards).
7. Approximate methodology for comparative evaluation of test results.
- 7.1. A fully equivalent basis for comparison across all critical parameters.
- 7.2. Completely identical dimensions and units for all monitored and compared parameters, including external factors (atmospheric pressure, humidity, ambient temperature, diesel fuel temperature, composition of the original diesel fuel, degree of its purification, and supply pipeline parameters, including nominal diameter, construction material, and quality of the internal surface finish).
- 7.3. Completely identical time factors (to eliminate the influence of average values over a prolonged combustion period compared with a short-term combustion period).

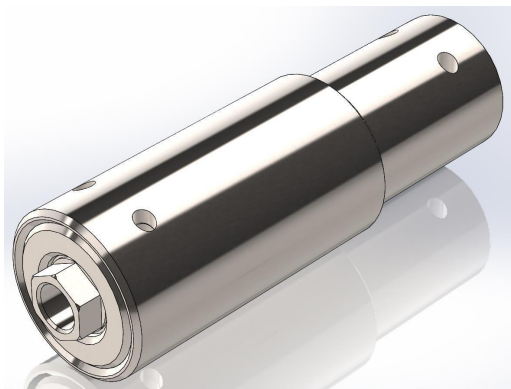


Figure 7. Model of the system with the primary function – stabilization of the fuel mixture flow turbulence level in the fuel pipelines of thermodynamic equipment, including gas turbines

As can be seen from the model, connecting the system presents no difficulties, which allows it to be installed in virtually any pipeline configuration without any significant modifications. The system does not require special setup or adjustment and is ready for installation in the condition shown in the figure.

Test results – multifunctional diesel engine fuel tank – performance verification.

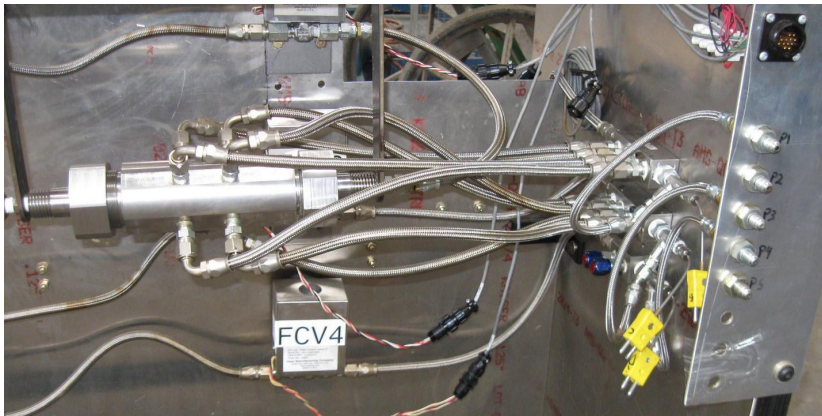


Figure 8. Characterization of Dynamic Fluid-Mixing Technology for the Preparation of Diesel–Methanol Fuel Blends

TEST RESULTS – DIESEL ENGINE MULTIFUNCTIONAL FUEL TANK “CONCEPT PROVE”

Characterization of Dynamic mixing of fluids technology for preparation of Diesel/methanol fuel blends

Dynamic mixing in the flow of the components being mixed is an integrative process of mixing, homogenization, and activation with the simultaneous formation of microcapsules and, in some cases, nanoscale capsules in the substances being mixed.

When fuel blends are mixed, this process becomes even more advanced. This is particularly evident when mixing diesel fuel (which, in the general context, is considered as oil) with methanol (which, in the same context, can be considered as water).

At the same time, methanol has specific properties that result in the mixture acquiring new and unusual characteristics that are not inherent in fuel blends known to date (for example, ethanol-based blends).

Some time after preparation, the fuel blend of diesel fuel and methanol separates into two fractions: a lighter fraction containing methanol (95%) in a stable association with diesel fuel (5%), and a heavier fraction containing diesel fuel (98%) in a stable association with methanol (2%).

Although both of these fractions (for example, in a storage tank) have fairly distinct and clearly separated volumes, even the slightest agitation causes the mixture to return to its original encapsulated and homogeneous form within a few seconds.

This phenomenon has been repeatedly tested and has demonstrated 100% repeatability.

The principle of a universal fuel tank for a modern diesel engine is based on this phenomenon. Such a fuel tank can be used both for conventional diesel fuel and for fuel blends consisting of diesel fuel and methanol.

In addition to the structural components of a conventional diesel engine fuel tank, the universal fuel tank contains a homogeneous re-mixing system, including a centrifugal pump whose inlet is connected to the upper layer of the mixture in the tank and whose outlet is introduced into the lower layer of the mixture in the tank.

Characterization of dynamic mixing of fluids technology for preparation of diesel/water fuel emulsions

Dynamic mixing in the flow of the components of an emulsion being mixed is an integrative process of mixing, emulsion formation, homogenization, and activation with the simultaneous formation of microcapsules and, in some cases, nanoscale capsules in the substances being mixed.

When fuel emulsions are mixed without the use of chemical stabilizers or materials that promote emulsion formation, this process becomes even more advanced. This is particularly evident when mixing diesel fuel (which, in the general context, is considered as oil) with ordinary tap water (which, in the same context, can be considered as water). In other words, this is a water-in-oil emulsion.

At the same time, the use of ordinary tap water containing at least 200 milligrams of salts per liter and having relatively high conductivity has specific characteristics that result in the

fuel emulsion acquiring new and unusual properties that are not inherent in fuel emulsions known to date (for example, those based on distilled or deionized water, which has either very low conductivity or is a dielectric).

Some time after preparation, the fuel emulsion consisting of diesel fuel and tap water separates into two fractions: a lighter fraction containing diesel fuel (98%) in a stable association with microspheres of tap water (approximately 2% by weight), and a heavier fraction containing tap water.

Although both of these fractions (for example, in a storage tank) have fairly distinct and clearly separated volumes, even the slightest agitation causes the emulsion to return to its original encapsulated and homogeneous form within a few seconds.

This phenomenon has been repeatedly tested (more than 300 tests) and has demonstrated 100% repeatability.

The principle of a universal fuel tank for a modern diesel engine is based on this phenomenon. Such a fuel tank can be used both for conventional diesel fuel and for fuel emulsions consisting of diesel fuel and water.

In addition to the structural components of a conventional diesel engine fuel tank, the universal fuel tank contains a system for repeatedly returning the emulsion to its initial state before the onset of the hydrodynamic destruction process, including a centrifugal pump whose inlet is connected to the upper layer of the mixture in the tank and whose outlet is introduced into the lower layer of the mixture in the tank.

Characterization of Dynamic mixing of fluids technology for preparation of Diesel/methanol/water integrated fuel nano – compositions

Dynamic mixing in the flow of the components of an integrated fuel mixture is an integrative process of mixing, homogenization, and activation with the simultaneous formation of microcapsules and, in some cases, the formation of nanocapsules in the substances being mixed.

When integrated fuel mixtures are mixed, this process becomes even more advanced. This is particularly evident when mixing diesel fuel (which, in the general context, is considered as oil) with a mixture of methanol and water (which, in the same context, can be considered as water).

Methanol is premixed with water (the most effective mixtures of methanol and tap water have a proportion of 75% methanol and 25% water).

At the same time, the methanol-water mixture itself has specific characteristics that result in the integrated fuel mixture acquiring new and unusual properties that are not inherent in fuel mixtures known to date (for example, ethanol-based mixtures, in which the presence of water is an entirely negative factor).

Some time after preparation, the integrated fuel mixture consisting of diesel fuel and methanol premixed with water separates into two fractions: a lighter fraction containing diesel fuel (95%) in a stable association with microspheres of the methanol-water mixture (5%), and a heavier fraction containing the methanol-water mixture (98%) in a stable association with microspheres of diesel fuel (2%).

Although both of these fractions (for example, in a storage tank) have fairly distinct and clearly separated volumes, even

the slightest agitation causes the integrated fuel mixture to return to its original encapsulated and homogeneous form within a few seconds.

This phenomenon has been repeatedly tested and has demonstrated 100% repeatability, while the ability to restore the hydrodynamic parameters of the mixture was equally maintained for integrated fuel mixture volumes ranging from 50 liters to 1,000 liters. It should be noted that the ability to recover automatically was also maintained during prolonged storage of the integrated fuel mixture after its initial preparation (the tested storage period exceeded several months for both light and heavy diesel fuel).

The principle of a universal fuel tank for a modern diesel engine is based on this phenomenon. Such a fuel tank can be used both for conventional diesel fuel and for integrated fuel compositions consisting of diesel fuel and methanol mixed with water.

In addition to the structural components of a conventional diesel engine fuel tank, the universal fuel tank contains a system for re-initiating the formation of the re-emulsion, including a centrifugal pump whose inlet is connected to the upper layer of the mixture in the tank and whose outlet is introduced into the lower layer of the mixture in the tank.

Characterization of Diesel /methanol fuel blends for diesel engine

The following variants of fuel blends and integrated fuel compositions have been experimentally obtained and repeatedly tested: light fuel blends based on No. 2 diesel fuel and methanol, and light integrated fuel compositions based on No. 2 diesel fuel and a mixture of methanol and tap water.

As a rule, the proportion of methanol in such fuel blends ranges from 10% to 30%, while the most effective integrated fuel composition has proven to be one in which methanol is premixed with tap water in a proportion of 75% methanol and 25% water.

An exceptionally important factor present in both fuel blends and integrated fuel compositions should be noted.

This factor is the presence of a significant amount of dissolved oxygen in these compositions. This factor fundamentally changes the ratio between the weight of the fuel and the amount of oxygen required for its complete combustion.

This phenomenon can be explained quite simply.

The stoichiometric ratio between the weight of No. 2 diesel fuel and air during combustion is 1:14.6, meaning that 14.6 kilograms of air are required for the complete combustion of 1 kilogram of diesel fuel. At the same time, only 6.4 kilograms of air are required for the combustion of 1 kilogram of methanol.

Thus, the complete combustion of 1 kilogram of a fuel blend containing 30% methanol and 70% diesel fuel requires only 11.72 kilograms of air – 24.57% less.

This is a significant, but not the only, factor contributing to the increased efficiency and economy of a diesel engine using fuel blends based on diesel fuel and methanol.

The thermodynamic mechanism of combustion of integrated fuel compositions has not yet been fully studied.

As a rule, their characteristics are close to the characteristics of the fuel blends described above.

Characterization of Diesel / water fuel emulsions for diesel engine

Fuel emulsions for use as a fuel mixture in modern diesel engines are well known.

Fuel emulsions prepared using a device and method that together provide dynamic mixing in the flow of the components of an integrated fuel mixture or emulsion are encapsulated micro- or nanocompositions.

The mechanism of capsule formation and the hydrodynamic mechanism of capsule re-formation have not yet been fully studied, but the phenomenon of shape memory retention by the capsule components has been studied and tested in considerable depth. This phenomenon makes it possible, after separation of the emulsion fractions, to achieve almost instantaneous restoration of the capsules or hydrodynamic restoration of the emulsion – returning the emulsion to its original form and three-dimensional ratio of its constituent components.

The most commonly used emulsions are water-in-oil emulsions with a ratio of 80% diesel fuel and 20% tap water.

Fuel blends preparation system for gas stations [conceptual version]

Based on the experience gained and the results of experimental tests, it is currently considered most appropriate for fuel stations to have the following equipment for the preparation of fuel blends and refueling of vehicles.

- A diesel fuel tank with all necessary pumping, filtration, monitoring, measuring, and control infrastructure.
- A methanol tank with all necessary pumping, filtration, monitoring, measuring, and control infrastructure.

- A device connected to the specified tanks for dynamic mixing, homogenization, and activation of fuel blends, the outlet of which should be connected to the inlet of the vehicle's fuel tank.

This configuration has undergone a series of trials and tests and, as a result, has demonstrated sufficiently reliable performance and operational reliability.

Fuel emulsions preparation system for gas stations [conceptual version]

Based on the experience gained and the results of experimental tests, it is currently considered most appropriate for fuel stations to have the following equipment for the preparation of fuel emulsions and refueling of vehicles with them.

- A diesel fuel tank with all necessary pumping, filtration, monitoring, measuring, and control infrastructure.
- A tap water tank with all necessary pumping, filtration, monitoring, measuring, and control infrastructure, including special automatic filters intended for water purification.
- A device connected to the specified tanks for dynamic mixing, emulsion formation, homogenization, and activation of fuel mixtures, the outlet of which should be connected to the inlet of the vehicle's fuel tank.

This configuration has undergone a series of trials and tests and, as a result, has demonstrated sufficiently reliable performance and operational reliability.

Fuel blends integrated tank for diesel engine [conceptual version]

Taking into account the specific features of a diesel engine fuel system, the fuel tank must include a system for supplying fuel to the fuel line, a system for returning excess fuel to the tank, and the associated online monitoring systems.

The fuel tank of a diesel engine using an emulsion of No. 2 diesel fuel and ordinary tap water as fuel must additionally include systems for monitoring the liquid (emulsion) level in the tank and for recirculating the fuel mixture (emulsion) within the tank.

Since the component of the fuel mixture containing methanol with diesel fuel dissolved in it (approximately 5% by weight) is located in the upper level of the tank, while diesel fuel with methanol dissolved in it (approximately 2% by weight) is located in the lower level of the tank, the recirculation system supplies liquid from the upper level to a pump (primarily a centrifugal pump) and returns this liquid to the lower level.

This process is called – mixture re-formation – and it makes it possible to maintain the nanostructure of the fuel mixture in a stable state.

Fuel from the tank is supplied by a fuel pump to the dynamic mixing and homogenization system, from where it is fed into the high-pressure pump of the diesel engine.

The purpose of the preliminary tests is to verify the ability of the engine fuel pump to supply the fuel mixture to the inlets of the dynamic mixing and homogenization system in a proportion of 60% to the central inlet and 40% to the integrated radial inlet, while maintaining equal pressure in all inlet channels.

Fuel emulsions integrated tank for diesel engine [conceptual version]

Taking into account the specific features of the diesel engine fuel system, the fuel tank must include a system for supplying fuel (emulsion) to the fuel line, a system for returning excess fuel (emulsion) to the tank, and the associated online monitoring systems.

The fuel tank of a diesel engine using a mixture of No. 2 diesel fuel and tap water as fuel must additionally include systems for monitoring the liquid level in the tank and for recirculating the fuel mixture (emulsion) within the tank.

Since the component of the fuel emulsion containing No. 2 diesel fuel with microdroplets of water distributed throughout its volume is located in the upper level of the tank, while the water is located in the lower level of the tank, the recirculation system supplies liquid from the upper level to a pump (primarily a centrifugal pump) and returns this liquid to the lower level.

This process is called – emulsion re-formation – and it makes it possible to maintain the nanostructure of the fuel emulsion in a stable state for delivery to the high-pressure pump.

Fuel (emulsion) from the tank is supplied by a fuel pump to the dynamic mixing and homogenization system, from where it is fed into the high-pressure pump of the diesel engine.

The purpose of the preliminary tests is to verify the ability of the engine fuel pump to supply the fuel emulsion to the inlets of the dynamic mixing and homogenization system in a proportion of 60% to the central inlet and 40% to the integrated radial inlet, while maintaining equal pressure in all inlet channels.



Figure 9. Fuel blends preparation system for gas stations, – feasibility study test

The specified equipment has undergone more than 350 test operations and has demonstrated high performance, efficiency, and the ability to handle all necessary functional loads encountered at a modern fuel – filling station.

The system was tested at a flow rate of 50 liters per hour (a device with a working diameter of 25 mm), at a flow rate of 100 liters per hour (a device with a working diameter of 40 mm, at an operating pressure of 3 bar), and at a flow rate of 250 liters per hour (a device with a working diameter of 40 mm, at an operating pressure of 7 bar). A device designed to operate at a flow rate of 1,000 liters per hour is currently in the final stage of development.

Fuel blends re – blending system [conceptual version]

To ensure the performance of all necessary operations in the emulsion re-formation process, a basic system design has been developed with a working volume of 40 liters and a capacity of 100 liters per hour with a continuous supply of re-prepared emulsion products.

The design includes a tank, a recirculation system comprising, in addition to the pump and pipelines, a monitoring system for controlling the liquid level in the tank, and a liquid flow activator through which the activated liquid is returned and dynamically introduced into the volume of liquid in the tank.

Fuel blends re – blending system, – feasibility study test

The performance and efficiency of the simulated re-mixing process were tested using two systems – one with a working volume of 40 liters and the other with a working volume of 1,000 liters.

A standard mechanical-hydraulic mixing system was used in the system with a working volume of 1,000 liters.

Both systems were tested under actual production conditions – the first on a production diesel engine with a displacement of 2.4 liters and the second on a standard boiler with a capacity of 6 tons of steam per hour.

The results of both tests demonstrated the full operability and sufficient efficiency of the equipment and the mixture re-formation process.

Fuel blends re – blending system [conceptual version for engine]

The fuel tank of a diesel engine, which can also be used in emergency electric generators of a smart real estate facility where a blend of diesel fuel and methanol is intended to be used as fuel, must, in addition to the conventional and standard components, include a mixture re-formation system while maintaining the original characteristics and parameters.

The mixture re-formation system can be hydro – mechanical and activating or mechanical only.

Both systems have been tested and have demonstrated sufficient performance and reliability.

Modification of a standard fuel tank for adaptation to the mixture re-formation system generally does not present any technical difficulties.

All necessary functions of a standard fuel tank are fully retained in a fuel tank equipped with a system for re-forming the mixture and maintaining its properties.

LIST OF REFERENCES AND PATENT INFORMATION SOURCES

1. **United States Patent Application No. 20100193445 A1.**
Foaming of Liquids. Published August 5, 2010.
2. **United States Patent Application No. 20100224497 A1.**
Device and Method for the Extraction of Metals from Liquids.
Published September 9, 2010.
3. **United States Patent Application No. 20100224506 A1.**
Process and Apparatus for Complex Treatment of Liquids.
Published September 9, 2010.
4. **United States Patent Application No. 20110069579 A1.**
Fluid Mixer with Internal Vortex. Published March 24, 2011.
5. **United States Patent Application No. 20120102736 A1.**
Micro-Injector and Method of Assembly and Mounting Thereof. Published May 3, 2012.