Технічні науки

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PARADOXICAL PHENOMENA AND PROPERTIES DISCOVERED IN EMULSIONS

Paradoxical Phenomena and Properties Discovered in Fuel Emulsions Obtained in Closed Dynamic Flows of Liquid Components

Summary. *In this publication, the author revisits the issue of three-dimensional hydraulic shape memory in emulsions obtained using a proprietary complex method and a multifunctional apparatus invented specifically for this purpose.*

The technology and apparatus were tested on a water-in-oil emulsion, where diesel fuel No. 2 was used as the oil phase and regular drinking water with a hardness salt concentration of up to 200 mg/L was used as the aqueous phase.

During the design of the test bench, the latest trends in the application of emulsions as fuel were taken into account, including their use in modern diesel engines, diesel generators, industrial boilers, and turbines.

For diesel engines and boilers, one of the most challenging aspects of the fuel injection and combustion process is fuel flow separation before the high-pressure pump. In this stage, the majority of the fuel flow is directed to the high-pressure pump (which today operates at pressures of 2000 bar and above) before being injected into the combustion chamber of a boiler or the cylinders of an engine, while a smaller portion is returned to the fuel tank.

When using conventional single-component diesel fuel, this principle does not cause any issues.

However, in the case of emulsified fuels, such a fuel supply method leads to instability in the emulsion, disrupting its homogeneity and uniform distribution of water and oil (diesel fuel) throughout the volume.

Keywords: *Paradoxical phenomena in fuel emulsions, Paradoxical properties of fuel emulsions, Closed dynamic flow, Test bench, Diesel fuel, Latest trends in emulsion application, Emulsion restoration and revitalization.*

Method for Preparing an Emulsion with Microcapsule Formation

The method of preparing an emulsion with the formation of microcapsules has made it possible to achieve full revitalization and restorative recovery of the emulsion in minimal time (less than a second).

The device used for producing such emulsions of various types is exceptionally simple and compact in design. It has a cylindrical shape with no moving parts and functions as a **static mixer**, where the emulsion formation process takes no more than a fraction of a second.

This device is highly versatile and operates efficiently within a pressure range of **3 to 50 bar** (notably, the fuel system pressure in a modern diesel engine is approximately **3 bar**).

For comprehensive testing, a complete system was developed, incorporating the emulsion production device and a dedicated tank for **revitalization and restorative recovery of the emulsion**, along with all necessary peripheral components and pumps for this process.

A key role in the development of this system was played by **innovative solutions proposed by Oleksandr Zaitsev**, an expert in **smart fuel system modernization for intelligent transportation technologies**. His extensive experience in organizing **smart transport enterprises** allowed for the timely optimization of the system's technical parameters and the achievement of **acceptable test results**.

Relevance to Urban Infrastructure and Environmental Impact

Within the **ecosystem and infrastructure of modern urban management**, one of the most critical environmental factors is the **level of pollution caused by vehicle exhaust emissions**. Any **effective solutions for reducing the toxicity of engine exhaust gases** can significantly improve the ecological situation while simultaneously **reducing fuel costs for urban transport systems**.

Based on the **innovative ideas of Oleksandr Zaitsev**, a system was developed that delivered **positive results**.

The system was structured as follows:

Fig. 1

This system is integrative, as both the initial production of the emulsion and its restoration and revitalization are carried out using the same unit, while employing identical technological methods.

The working diameter of the device is only 25 millimeters, ensuring a throughput of 50 liters per hour for the initial formation of the emulsion and 25 liters per hour for its restoration and revitalization, operating at a linear pressure of 3 bar.

The following image shows a 10-gallon emulsion tank installed in the fuel system of a modern production diesel engine with a displacement of 2.4 liters.

Fig. 2.

In this tank, the process of restoring the properties and qualities of the emulsion takes place, which is based on the paradoxical property of the emulsion obtained using the invented apparatus – the emulsion possesses three-dimensional hydraulic memory of its form.

What is the significance of this interpretation of the distinguishing feature of the invented emulsion?

According to the results of more than 1000 tests on a diesel engine using this emulsion, it has been determined and proven that:

• The emulsion, after some time following its formation, undergoes destruction and separates into two layers: one consisting of diesel fuel with water as an impurity and the other consisting of water with diesel fuel as an impurity.

• In both cases, the impurity content does not exceed 5%.

• With a brief (within 15–25 seconds) hydrodynamic activation of the destructured emulsion, it fully returns to its initial state – a liquid medium consisting of three-dimensional capsules with micro- and nano-sized water droplets surrounded by diesel fuel shells.

Fig. 3.

The image shows the emulsion after formation. This emulsion contains 20% water (the water is drinking water without additional purification, with a mineral salt content of approximately 200 milligrams per liter).

Approximately one hour after preparation, the emulsion undergoes deconstruction and takes the form shown in the following photographs.

Two layers are visible, and these layers are transparent, indicating that the particle size in this liquid does not exceed 200 nanometers (otherwise, if the particle sizes were larger, the liquid would not be transparent).

Fig. 4.

The liquid (emulsion) was sampled two days after the initial preparation of the emulsion.

As the test results showed, the water content in the emulsion, using the adopted mixing method, allows the effective use of fuel emulsion with up to 50% water content.

Furthermore, this enables the use of liquid condensed from exhaust gases in the emulsion composition.

Fig. 5.

This image shows the liquid before the process of restoration and revitalization of the emulsion's properties and characteristics begins.

It should be noted that the destruction of the emulsion also exhibits paradoxical characteristics, as both in the water-dominant layer and in the diesel fuel-dominant layer, the emulsion capsules with a characteristic multi-level structure are visible under the microscope. In these capsules, the core of the spherical capsule is a microdroplet of water surrounded by a diesel fuel shell.

During hydrodynamic activation in the re-emulsification process, new capsules begin to form around the preserved capsules. The formation process is extremely brief and efficient with minimal energy expenditure.

Additionally, the re-emulsification process also increases the stability and resilience of the re-emulsified product, which is crucial for many industries where so-called secondary emulsions are used. For example, this method is applied to prepare emulsions for hydroponic systems in greenhouse farming, where maintaining the structure of the emulsion for as long as possible is important.

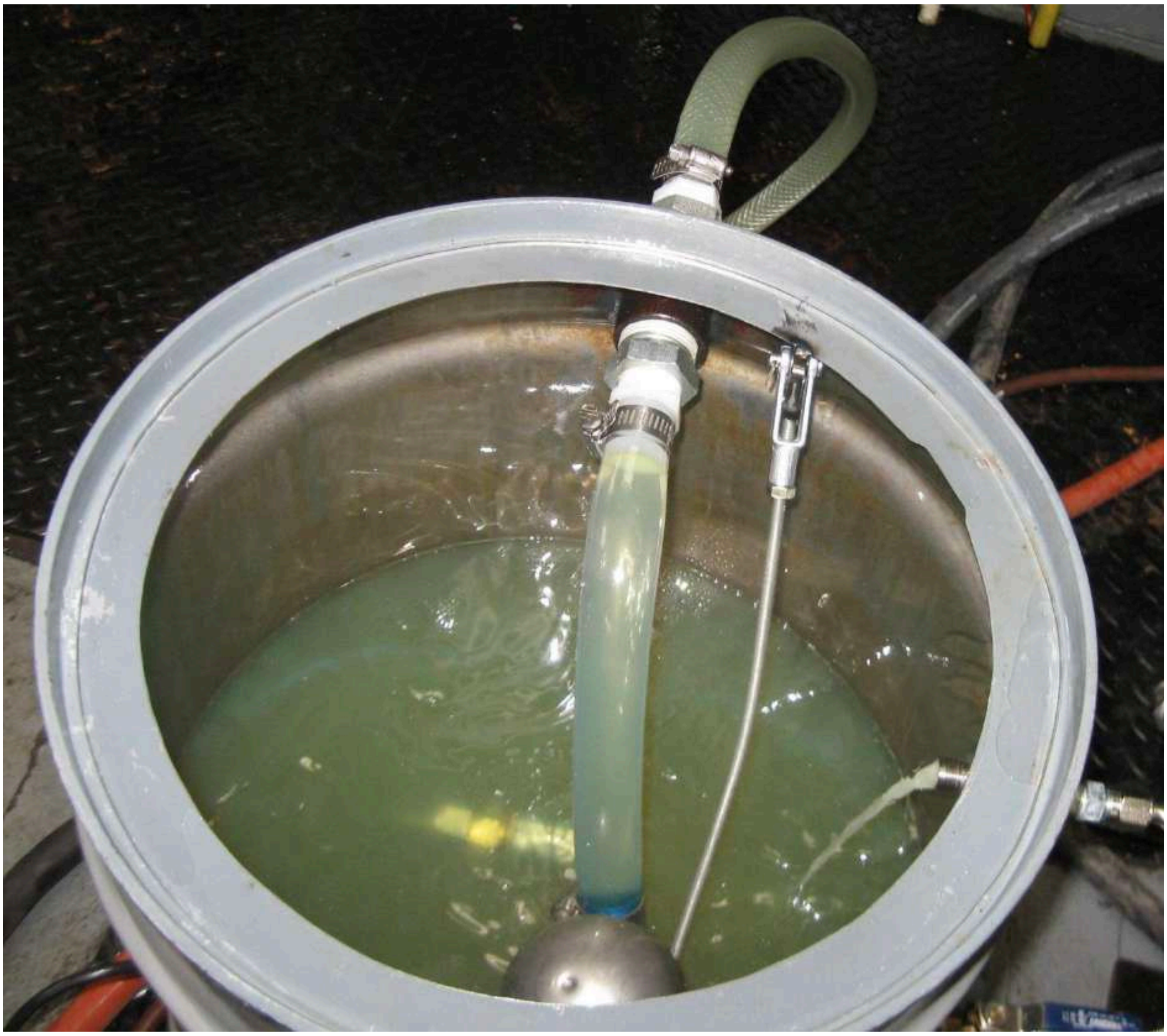

Fig. 6.

This photo was taken at the moment the process of restoring and revitalizing the emulsion began. As seen in the intake pipe, the liquid is transparent, although it has a greenish tint from the diesel fuel.

The liquid is fed into a regular centrifugal pump and returned back to the tank.

As seen, the liquid returns already white in color, with the upper inlet being the signal one, and the main return inlet located at the bottom of the tank.

Thus, when considering this process in relation to hydroponic systems in modern greenhouses, it is possible to recognize the significant potential in these technological methods for the constant and virtually endless regeneration of hydroponic liquids and solutions, with the potential ability to electrochemically alter the acidity of the water in the emulsion.

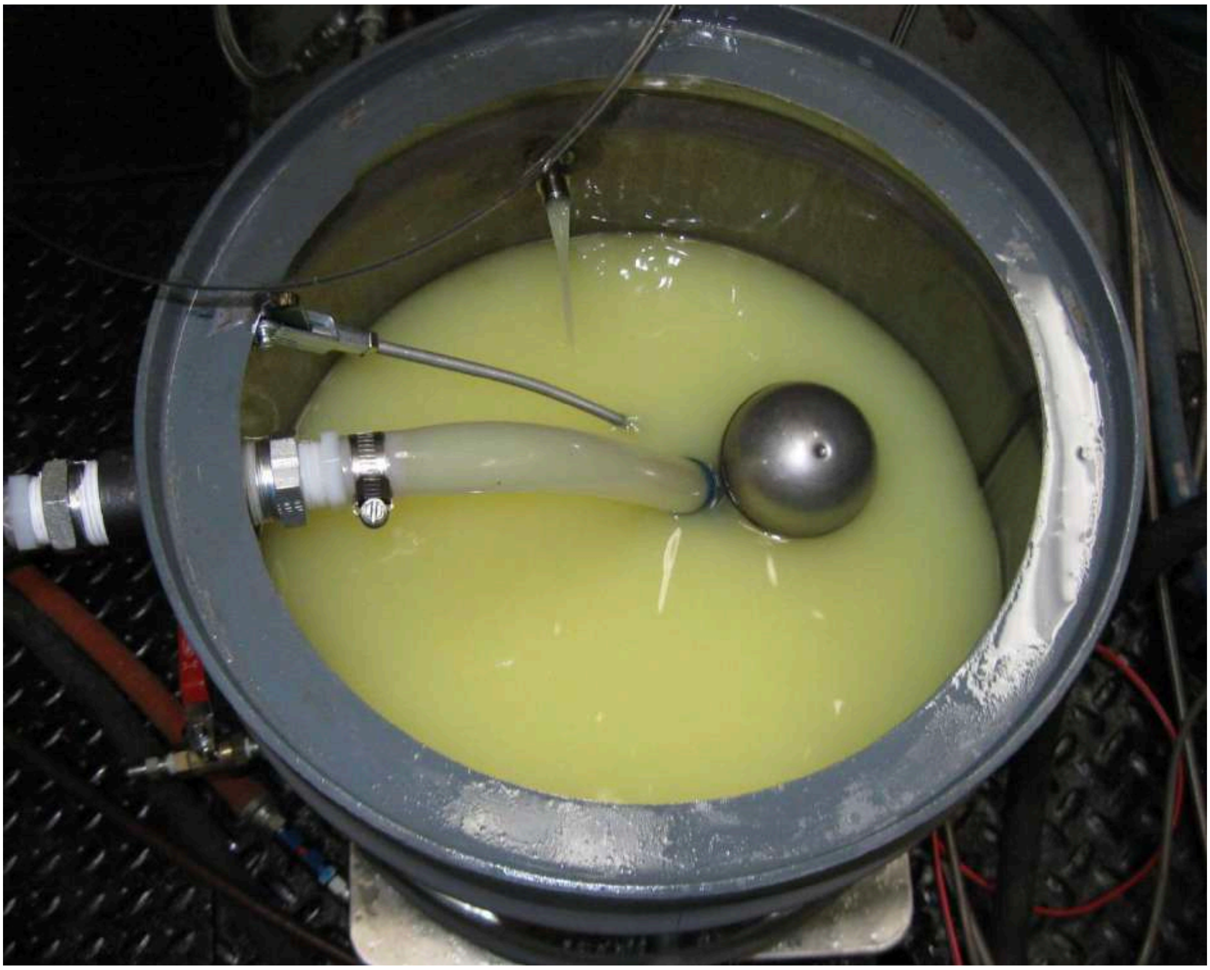

Fig. 7.

This photo shows the emulsion after several seconds of treatment – it visually completely matches the original appearance of the emulsion.

The engine performance results using both the newly produced emulsion and the emulsion restored through the revitalization process are fully identical.

The same results were obtained on industrial boilers and diesel generators.

Fig. 8.

In the photo, the emulsion capsules are shown under a microscope, with their three-dimensional structure clearly visible.

Within the core of the capsule, several spherical nuclei are visible – these are also capsules.

They have significantly smaller dimensions than the main capsule (for instance, if the size of the large capsule ranges from one to three micrometers, the internal capsules have a size of no more than 300 nanometers, with measurements indicating capsules as small as 120 nanometers).

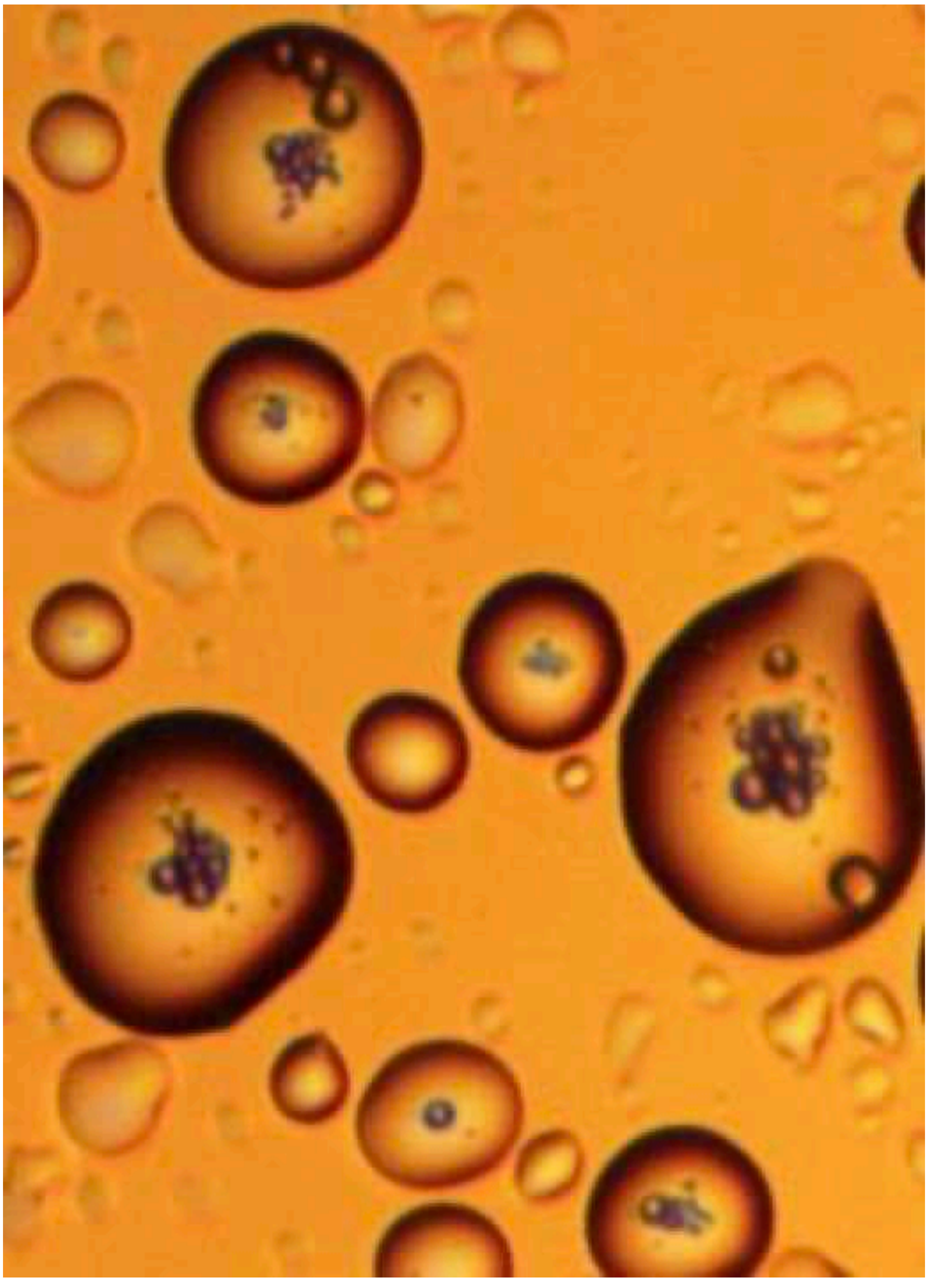

Fig. 9.

During the emulsification separation process, the smallest capsules remain in the layers, with sizes ranging from 100 to 200 nanometers (as shown by the chemical analysis of the separated layers, which indicated a 5% diesel fuel impurity in water and a 5% water impurity in diesel fuel).

Thus, due to these impurities, the process of rehabilitative restorative revitalization of the emulsion takes place, in which nanoscale capsules once again become the centers of microcapsules. This process clearly exhibits a three-dimensional nature, and since it occurs within a liquid medium, it is referred to as hydraulic.

Since after separation the emulsion takes on a completely different form, and after rehabilitative restorative revitalization it fully returns to its original state, we have every reason to believe that the emulsion possesses three-dimensional hydraulic shape memory (of the emulsion capsules).

This phenomenon has been fully confirmed when operating with emulsion volumes of 1000 liters and activating it through simple stirring.

All of this was carried out on an industrial boiler with a capacity of 10 tons of steam per hour, using emulsion proportions of 20%, 40%, and 50% water. In all proportions, the results of the emulsion returning to its original form were fully confirmed, even after 3 months from the initial preparation of the emulsion.

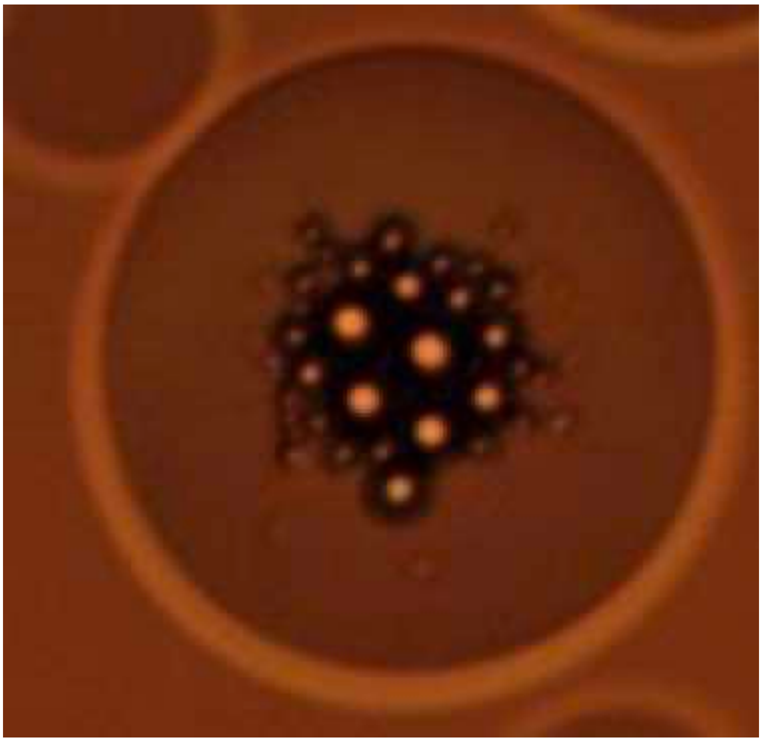

Fig. 10.

Since the emulsion was also produced based on heavy diesel fuel, the microscope image shows the structure of the microcapsule of this emulsion, obtained with diesel fuel No. 6.

In addition to its impact on fuel consumption, the emulsion also significantly reduces the noise level during engine operation, which also creates a positive effect for the urban street ecosystem in city environments.

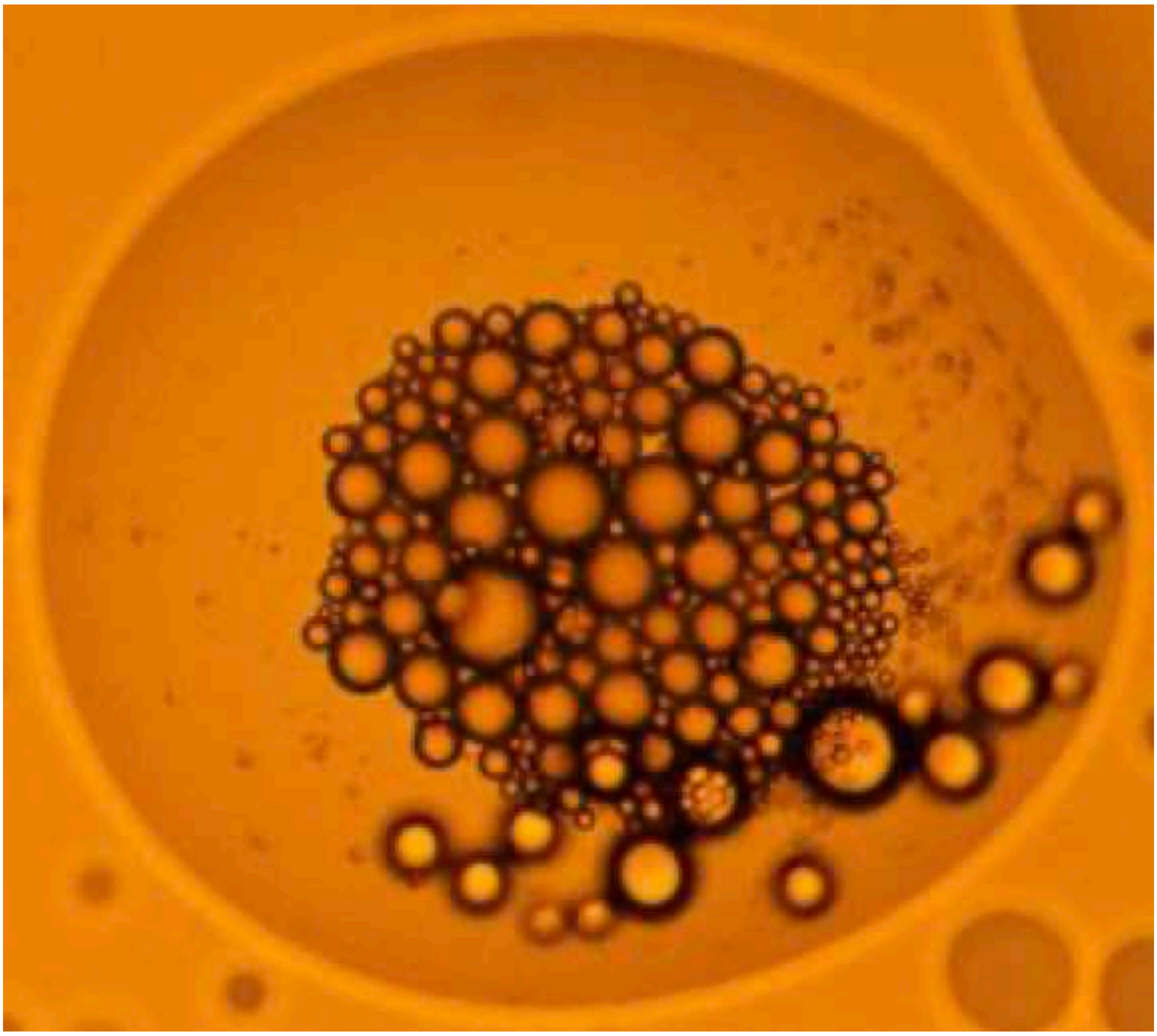

Fig. 11.

The Fig. shows a capsule of the emulsion with a water concentration of 20%. As seen, the size of the water micro-particles does not exceed 1 micron, which allows for the injection of a homogeneous fuel flow. As a result, the toxicity of the exhaust is significantly reduced, and the noise level during engine operation is drastically decreased.

Thus, in comparison with electric vehicles, the use of such emulsions is also highly cost-effective.

The next image shows the emulsion obtained with a 25% water concentration in diesel fuel No. 2.

Fig. 12.

This image shows a tank with 1000 liters of emulsion and a hydromechanical activator. The tank was installed on an industrial boiler with a steam output of 10 tons per hour.

The emulsion was produced in advance (the period from emulsion production to combustion could reach two months or more).

The application of the simplest hydromechanical activator allows for the initiation of the emulsion revitalization process with minimal electricity consumption (electricity consumption is within 7 cents per hour, with a fuel emulsion consumption of 1200 liters per hour).

To test the feasibility of using emulsion preparation technologies and the re-preparation of the same emulsion with revitalization technologies in the irrigation systems of modern greenhouses, the results demonstrated in relatively large volumes of liquid showed high efficiency potential.

The constant presence of intense hydrodynamic impacts on the hydroponic liquid emulsion solution not only preserves the properties and parameters of the emulsion but also optimizes specific parameters and properties of the solution with emulsion for further intensification of agricultural production processes.

It must be acknowledged that the primary informational material presented in this publication, regarding paradoxes in the innovative emulsion preparation process, requires not only fuel technologies but also detailed adaptation and integration with all possible related technological processes.

References, Patent, and Licensing Information:

Appendix 1

United States Patent Application	**20100243953**
Kind Code	**A1**
	September 30, 2010

Method of Dynamic Mixing of Fluids

Abstract

Methods are provided for achieving dynamic mixing of two or more fluid streams using a mixing device. The methods include providing at least two integrated concentric contours that are configured to simultaneously direct fluid flow and transform the kinetic energy level of the first and second fluid streams, and directing fluid flow through the at least two integrated concentric contours such that, in two adjacent contours, the first and second fluid streams are input in opposite directions. As a result, the physical effects acting on each stream of each contour are combined, increasing the kinetic energy of the mix and transforming the mix from a first kinetic energy level to a second kinetic energy

level, where the second kinetic energy level is greater than the first kinetic energy level.

Appendix 2

United States Patent Application	**20100281766**
Kind Code	**A1**
	November 11, 2010

Dynamic Mixing of Fluids

Abstract

Methods, systems, and devices for preparation and activation of liquids and gaseous fuels are disclosed. Method of vortex cooling of compressed gas stream and water removing from air are disclosed.

Appendix 3

United States Patent Application	**20110030827**
Kind Code	**A1**
	February 10, 2011

FLUID COMPOSITE, DEVICE FOR PRODUCING THEREOF AND SYSTEM OF USE

Abstract

The current disclosure relates to a new fluid composite, a device for producing the fluid composite, and a method of production therewith, and more specifically a fluid composite made of a fuel and its oxidant for burning as part of different systems such as fuel burners, where the fluid composite after a stage of intense molecular between a controlled flow of a liquid such as fuel and a faster flow of compressed highly directional gas such as air results in the creation of a three dimensional matrix of small hallow spheres each made of a layer of fuel around a volume of pressurized gas. In an alternate embodiment, external conditions such as inline pressure warps the spherical cells into a network of oblong shape cells where pressurized air is used as part of the combustion process. In yet another embodiment, additional gas such as air is added via a second inlet to increase the proportion of oxidant to carburant as part of the mixture.

Appendix 4

United States Patent Application	**20110048353**
Kind Code	**A1**
	March 3, 2011

Engine with Integrated Mixing Technology

Abstract

The present disclosure generally relates to an engine with an integrated mixing of fluids device and associated technology for improvement of the efficiency of the engine, and more specifically to an engine equipped with a fuel mixing device for improvement of the overall properties by inline oxygenation of the liquid, a change in property of the liquid such as cooling form improved combustion, or the use of re-circulation of exhaust from the engine to further improve engine efficiency and reduce unwanted emissions.

Appendix 5

United States Patent Application	**20120085428**
Kind Code	**A1**
	April 12, 2012

EMULSION, APPARATUS, SYSTEM AND METHOD FOR DYNAMIC PREPARATION

Abstract

The invention relates to a fluid composite, a device for producing the fluid composite, and a system for producing an aerated fluid composite therewith, and more specifically a fluid composite made of a fuel and its oxidant for burning as part of different systems such as fuel burners or combustion chambers and the like. The invention also relates to an emulsion, an apparatus for producing an emulsion, a system for producing an emulsion with the apparatus for producing the emulsion, a method for producing a dynamic preparation with the emulsion, and more specifically to a new type of a stable liquid/liquid emulsion in the field of colloidal chemistry, such as a water/fuel or fuel/fuel emulsion for all spheres of industry.

Appendix 6

United States Patent Application	**20120103306**
Kind Code	**A1**

	May 3, 2012

ENGINE WITH INTEGRATED MIXING TECHNOLOGY

Abstract

The present disclosure generally relates to an engine with an integrated mixing of fluids (gas or liquid) device and associated technology for improvement of the efficiency of the engine, and more specifically to an engine equipped with a fuel mixing device for improvement of the overall properties of the system with an engine by either inline oxygenation of the liquid or dynamic activation of a fuel with a secondary fluid such as water resulting in a change in property of the input fluid to help with burning ratios, cooling for improved combustion, or the use of re-circulation of exhaust from the engine to further improve engine efficiency and reduce/recycle unwanted emissions or combustion releases such as water.

Appendix 7

United States Patent Application	**20140232021**
Kind Code	**A1**
	August 21, 2014

FLUID COMPOSITE, DEVICE FOR PRODUCING THEREOF AND SYSTEM OF USE

Abstract

The current disclosure relates to a new fluid composite, a device for producing the fluid composite, and a method of production therewith, and more specifically a fluid composite made of a fuel and its oxidant for burning as part of different systems such as fuel burners, where the fluid composite after a stage of intense molecular between a controlled flow of a liquid such as fuel and a faster flow of compressed highly directional gas such as air results in the creation of a three dimensional matrix of small hallow spheres each made of a layer of fuel around a volume of pressurized gas. In an alternate embodiment, external conditions such as inline pressure warps the spherical cells into a network of oblong shape cells where pressurized air is used as part of the combustion process. In yet another embodiment, additional gas such as air is added via a second inlet to increase the proportion of oxidant to carburant as part of the mixture.