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PARADOXICAL PHENOMENA AND PROPERTIES DISCOVERED IN FUEL EMULSIONS. (Paradoxical Phenomena and Properties Discovered in Fuel Emulsions Obtained in Closed Dynamic Flows of Liquid Components)

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Abstract:

In this publication, the author returns to the issue of three-dimensional hydraulic shape memory in emulsions obtained using a comprehensive method invented by him and implemented in a multifunctional apparatus also developed by him for this purpose.

Keywords: *Paradoxical phenomena and properties; Fuel emulsion; Closed dynamic flow of liquid emulsion components; Hydraulic shape memory; Hydraulic shape memory in emulsions; Three-dimensional hydraulic shape memory in emulsions; Multifunctional apparatus; Test bench formation; Trends in emulsion applications; Diesel engine; Boiler; Turbine; Injection process; Injection and combustion process; Hardness salt concentration; Fuel flow separation upstream of the high-pressure pump; Fuel injection into the combustion chamber; Fuel tank; Static mixer; Integrated testing; Modern production diesel engine; Paradoxical properties of emulsions; Working diameter of the device; Emulsion destruction also exhibits paradoxical features; Secondary emulsion*

The testing of the technology and the apparatus was carried out on water-in-oil type emulsions, in which diesel fuel No. 2 was used as the oil phase and ordinary drinking water as the aqueous phase, with a hardness salt concentration of up to 200 milligrams per liter.

In the formation of the test bench, the latest trends in the application of emulsions as fuel were taken into account, both for modern diesel engines and for diesel generators, industrial boilers, and turbines.

For diesel engines and boilers, the most challenging stage in the injection and combustion process is the separation of the fuel flow upstream of the high-pressure pump, when the majority of the fuel flow is directed to the high-pressure pump (today operating at pressures of 2,000 bar and higher), after which it is injected into the combustion chamber of the boiler or into the engine cylinders, while a smaller portion is returned to the fuel tank.

In the case of using single-component diesel fuel, this principle does not create any problems. However, when emulsions are employed, such a fuel supply method leads to disturbances in emulsion stability, as well as нарушению its homogeneity and uniformity in the volumetric distribution of water and oil (diesel fuel).

The emulsion preparation method based on the formation of microcapsules made it possible to achieve complete re-formation of the emulsion with minimal time expenditure (in less than one second).

The device itself for producing this type of emulsion of various kinds represents an exceptionally simple and compact cylindrical structure with no moving parts – a so-called static mixer – in which the emulsion formation process lasts no more than a fraction of a second.

This device is highly versatile and can operate at pipeline pressures ranging from 3 bar to 50 bar (in a modern diesel engine, the fuel line pressure is approximately 3 bar).

For comprehensive testing, a system was developed that included the device itself and a tank for emulsion re-formation, along with all associated peripheral components and pumps required for emulsion re-formation.

Figure 1.

This system was configured as follows:

Figure 2.

This system is integrative in nature, since both the primary production of the emulsion and the re-formation of the emulsion are carried out on the same unit, while identical technological methods are employed.

The working diameter of the device is only 25 millimeters, and at a line pressure of 3 bar it provides a throughput of 50 liters per hour for the primary formation of the emulsion and 25 liters per hour for the re-formation of the emulsion.

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

Figure 3.

In this tank, the emulsion re-formation process takes place, which is based on a paradoxical property of the emulsion obtained using the invented apparatus – namely, that the emulsion exhibits three-dimensional hydraulic shape memory.

What is the meaning of this interpretation of the distinctive feature of the invented emulsion?

Based on the results of more than 1,000 tests conducted on a diesel engine using the specified emulsion, it has been determined and demonstrated that:

- the emulsion, after a certain period following its formation, undergoes destruction and separates into two layers – one consisting of diesel fuel with a water admixture and the other consisting of water with a diesel fuel admixture;
- in both cases, the content of admixtures does not exceed 5%;
- under short-term (within 15–25 seconds) hydrodynamic activation of the destructured emulsion, it fully returns

to its original state – a liquid medium composed of three-dimensional capsules containing micro- and nanoscale water droplets surrounded by shells of diesel fuel.

Figure 4.

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

Approximately one hour after preparation, the emulsion undergoes destruction and acquires the appearance shown in the following photographs.

Figure 5.

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

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

Figure 6.

This photograph shows the liquid prior to the start of the emulsion re-formation process.

It should be noted that the destruction of the emulsion also exhibits paradoxical features, since in both the layer with a predominance of water and the layer with a predominance of diesel fuel, emulsion capsules with a characteristic multilevel structure are visible under a microscope. In this structure, the core of the spherical capsule is a microdroplet of water surrounded by a shell of diesel fuel.

During hydrodynamic activation in the re-emulsification process, new capsules begin to form around the preserved capsules, and the formation process is exceptionally short-term and highly efficient, with minimal energy expenditure.

In addition, the emulsion re-formation process also increases the stability and robustness of the re-formed emulsion in the final product, which is extremely important for many industries in which so-called secondary emulsions are used – for example, the application of this method for preparing emulsions for hydroponic systems in greenhouse farming, where preserving the emulsion structure for as long a period as possible is critical.

This photograph was taken at the moment the emulsion re-formation process begins. As can be seen, the liquid in the intake pipe is transparent, although it has a greenish tint due to the diesel fuel.

Figure 7.

The liquid is supplied to a conventional centrifugal pump and then returned back to the tank. As can be seen, the liquid returns already white in color, with the upper inlet serving as a signaling inlet, while the main return inlet is located in the lower part of the tank.

Thus, when considering this process as applied to hydroponic systems in modern greenhouses, one can observe a substantial potential inherent in these technological methods for the continuous and virtually infinite regeneration of hydroponic liquids and solutions, with the additional potential capability of electrochemically modifying the acidity (pH) of the water in the emulsion.

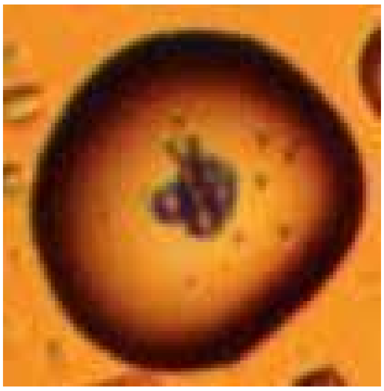
Figure 8.

This photograph shows the emulsion after several seconds of treatment; externally, it fully corresponds to the original appearance of the emulsion.

The engine performance results obtained with the newly produced emulsion and with the re-formed emulsion are completely identical.

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

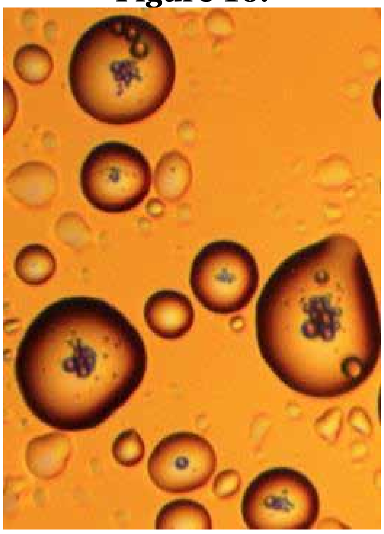
Figure 9.



The photograph shows the emulsion capsules under a microscope, with their three-dimensional structure clearly visible.

Several spherical cores are visible within the core of the capsule – these are also capsules. They differ in significantly smaller dimensions than the primary capsule (that is, if the size of the large capsule ranges from one to three micrometers, then the sizes of the internal capsules are each no more than 300 nanometers, and measurements have recorded capsules with sizes not exceeding 120 nanometers).

Figure 10.



During the phase separation of the emulsion, it is precisely the smallest capsules that remain within the layers – those with sizes of 100–200 nanometers (this is evident from the chemical analysis of the separated layers, which showed a 5% admixture of diesel fuel in water and a 5% admixture of water in diesel fuel).

Thus, it is due to these admixtures that the emulsion re-formation process takes place, in which nanoscale capsules once again become the centers of microcapsules.

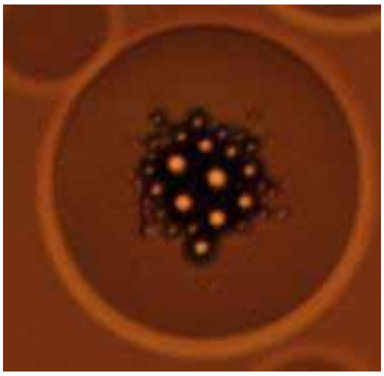
This process exhibits a distinctly three-dimensional character and, since it occurs in a liquid medium, it has been designated as hydraulic.

Since after separation the emulsion acquires a completely different appearance, and since after re-formation it fully returns to its original appearance, we have every reason to consider that the emulsion possesses three-dimensional hydraulic shape memory (of the emulsion capsules).

This phenomenon was fully confirmed when operating with emulsion volumes of 1,000 liters and activating them by simple stirring.

All of this was carried out on an industrial boiler with a capacity of 10 tons of steam per hour, at emulsion proportions of 20%, 40%, and 50% water. At all proportions, the results of the emulsion's restoration to its original appearance were fully confirmed, including after three months following the initial preparation of the emulsion.

Figure 11.



Since the emulsion was also produced on the basis of heavy diesel fuel, the micrograph shows the structure of a microcapsule of such an emulsion.

The next photograph shows an emulsion obtained with a water content of 25% in diesel fuel № 2.

Figure 12.

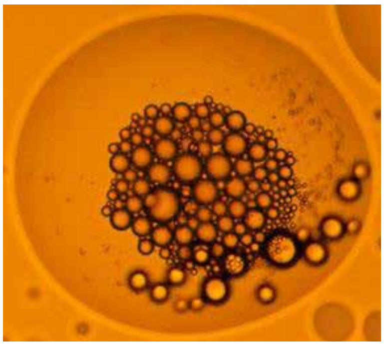


Figure 13.

Figure 14.

This photograph shows a tank containing 1,000 liters of emulsion equipped with a hydromechanical activator. This tank was installed on an industrial boiler with a capacity of 10 tons of steam per hour.

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

The use of a simple hydromechanical activator makes it possible to initiate the emulsion re-formation process with minimal electrical energy consumption (electricity consumption is within 7 cents per hour at a fuel emulsion consumption rate of 1,200 liters per hour).

To assess the feasibility of applying emulsion formation and emulsion re-formation technologies in irrigation systems of modern greenhouses, the results demonstrated in relatively large liquid volumes have shown a high potential for effectiveness.

The constant presence of intensive hydrodynamic воздействия on a hydroponic liquid solution with a formed emulsion makes it possible, in addition to merely preserving the properties and parameters of the emulsion, also to optimize certain parameters and characteristics of the formed emulsion in the solution for the further intensification of the agricultural production process itself.

It must be acknowledged that the primary informational material presented in this publication, concerning paradoxes in the innovative formation of emulsions in the process, requires, in addition to fuel technologies, detailed adaptation and integration into all possible related technological processes.

List of References, Patent and Licensing Information:

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.

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.

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.

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.

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.

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.

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.

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