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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

This article examines paradoxical properties discovered in water-in-oil fuel emulsions produced using a multifunctional device developed by the author. The studies were conducted using No. 2 diesel fuel and drinking water with a hardness salt concentration of up to 200 mg/L. Particular attention is given to applications in diesel engines, diesel generators, industrial boilers, and turbines.

The paper presents an integrative system for primary and restorative emulsion production that enables repeated re-emulsification using identical technological principles. Results from more than 1,000 tests showed that after phase separation, the emulsion can restore its original structure through short-term hydrodynamic activation. This phenomenon is described as three-dimensional hydraulic shape memory and is associated with nanoscale capsules preserved within the separated phases. The restored emulsion retained its original performance characteristics and demonstrated potential for applications in related fields, including hydroponic and irrigation systems, indicating the need for further research and technological adaptation.

Keywords: *Emulsion, Fuel Emulsion, Phenomena and Properties of Fuel Emulsion, Paradoxical Phenomena and Properties of Fuel Emulsion, Hydraulic Shape Memory in Emulsion, Three-Dimensional Hydraulic Shape Memory in Fuel Emulsion, Integrative System, Fuel Injection and Combustion Process, Latest Systems and Trends in the Use of Emulsions as Fuel, High-Pressure Pump, Comprehensive Testing, Hardness Salt Concentration, Emulsion Stability, Emulsion Stability Disturbances, Pressure in the Engine Fuel Line, Static Mixer, Tank for Restorative Emulsion Production*

In the present publication, the author returns to the issue of three-dimensional hydraulic shape memory in an emulsion obtained using a complex method invented by the author and produced with a multifunctional apparatus specifically developed for this purpose.

Testing of the technology and the apparatus was carried out using a water-in-oil type emulsion, where No. 2 diesel fuel was used as the oil phase and ordinary drinking water with a hardness salt concentration of up to 200 milligrams per liter was used as the water phase.

During the development of the testing system, the latest trends in the application of emulsions as fuel were taken into account for modern diesel engines, diesel generators, industrial boilers, and turbines.

Figure 1.

Figure 2. *This system was configured as follows:*

This system is integrative, since both the primary production of the emulsion and the repeated restorative production of the emulsion are carried out using the same unit, while employing identical technological methods.

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

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

Figure 3.

The re-emulsification process takes place in this tank and is based on a paradoxical property of the emulsion produced using the invented apparatus – the emulsion possesses 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 was determined and demonstrated that:

– after a certain period following its formation, the emulsion undergoes structural degradation 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 impurity content does not exceed 5%;

– under short-term hydrodynamic activation (within 15–25 seconds) of the degraded emulsion, it completely returns to its original state – a liquid medium consisting of three-dimensional capsules containing micro- and nanoscale water droplets surrounded by diesel fuel shells.

Figure 4.

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

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

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

Figure 5.

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

Figure 6.

This image shows the liquid before the beginning of the re-emulsification process.

It should be noted that the degradation of the emulsion also exhibits signs of paradoxical behavior, since microscopic examination reveals emulsion capsules with a characteristic multilayer structure both in the formed water-dominant layer and in the diesel fuel-dominant layer. In this structure, the core of the spherical capsule consists of 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, while the formation process is extremely short and efficient, requiring minimal energy consumption.

In addition, the re-emulsification process also increases the stability and durability of the re-emulsified product, which is particularly important for many fields where so-called secondary emulsions are used. One example is the application of this method for preparing emulsions for hydroponic systems in greenhouse agriculture, where maintaining the emulsion structure for as long as possible is of critical importance.

Figure 7.

This image was taken at the beginning of the re-emulsification process. As can be seen, the liquid in the intake pipe is transparent, although it has a greenish tint due to the diesel fuel.

The liquid is supplied to a conventional centrifugal pump and then returned back to the tank.

As can be seen, the liquid returns already having a white color, with the upper inlet serving as a signal inlet and the main return inlet located at the lower part of the tank.

Thus, when considering this process in relation to hydroponic systems used in modern greenhouses, these technological approaches demonstrate significant potential for continuous and practically unlimited regeneration of hydroponic liquids and solutions, with the additional potential capability of electrochemically modifying the acidity of the water within the emulsion.

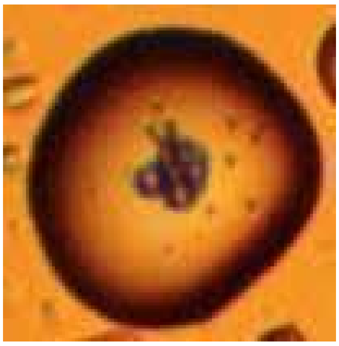
Figure 8.

This image shows the emulsion after several seconds of treatment – its appearance fully corresponds to the original appearance of the emulsion.

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

The same results were also obtained in industrial boilers and diesel generators.

Figure 9.

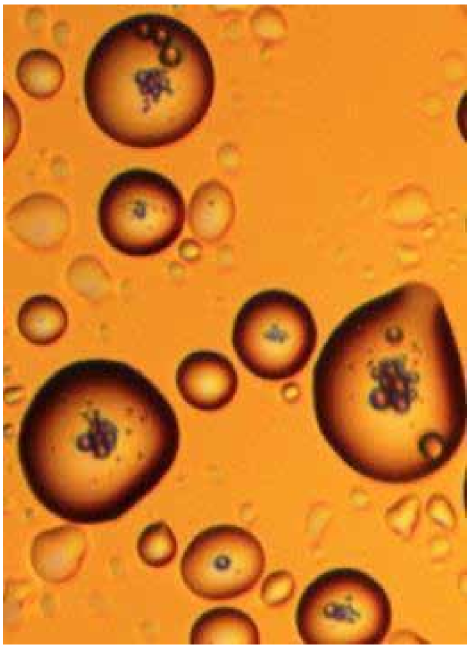


The image shows emulsion capsules under a microscope, where their three-dimensional structure is clearly visible.

Several spherical cores can be observed within the core of the capsule – these are also capsules.

They are significantly smaller in size than the main capsule itself (that is, if the dimensions of the larger capsule range from one to three micrometers, then the dimensions of the internal capsules do not exceed 300 nanometers each, with measurements recording capsules as small as 120 nanometers).

Figure 10.



During the phase separation of the emulsion, the smallest capsules remain within the separated layers, with sizes ranging from 100 to 200 nanometers (this is confirmed by chemical analysis of the separated layers, which showed a 5% diesel fuel admixture in water and a 5% water admixture in diesel fuel).

Thus, due to these residual components, the re-emulsification process takes place, during which nanocapsules once again become centers for the formation of microcapsules.

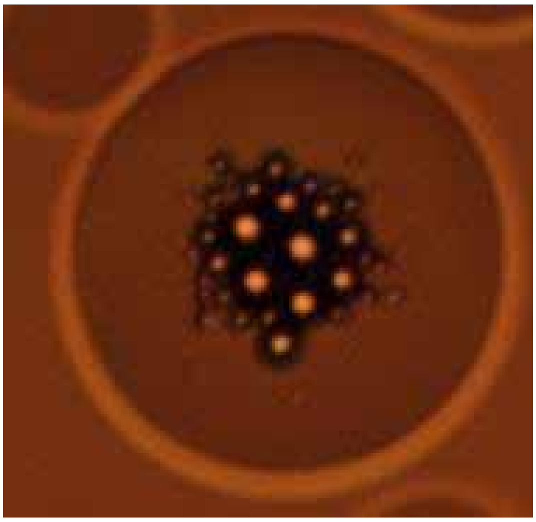
This process exhibits a clearly pronounced three-dimensional nature and, since it occurs within a liquid medium, it has been termed hydraulic.

Since after separation the emulsion acquires a completely different appearance, and after re-emulsification it fully returns to its original appearance, there is a valid basis to conclude that the emulsion possesses three-dimensional hydraulic shape memory (of the emulsion capsules).

This phenomenon was fully confirmed during experiments involving emulsion volumes of 1,000 liters with activation performed by simple stirring.

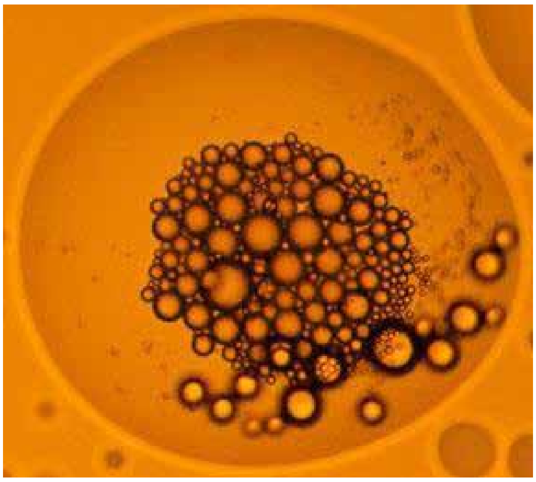
All of these tests were carried out on an industrial boiler with a steam production capacity of 10 tons per hour, using emulsion compositions containing 20%, 40%, and 50% water. For all proportions, the restoration of the emulsion to its original form was fully confirmed, even after three months from the initial preparation of the emulsion.

Figure 11.



Since the emulsion was also produced using heavy diesel fuel as a base, the image under the microscope shows the microcapsule structure of such an emulsion.

Figure 12.



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

Figure 13.

Figure 14.

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

The emulsion was prepared in advance (the period between emulsion production and combustion reached two months or more).

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

To evaluate the feasibility of applying emulsification and re-emulsification technologies in irrigation systems for modern greenhouses, the results demonstrated on relatively large liquid volumes showed a high potential for effectiveness.

The continuous presence of intensive hydrodynamic effects in hydroponic liquid emulsified solutions allows not only the preservation of emulsion properties and parameters but also the optimization of specific parameters and characteristics of the emulsified solution for further intensification of the agricultural production process itself.

It should be acknowledged that the preliminary information presented in this publication concerning paradoxes observed in the innovative emulsification process requires not only further consideration within fuel technologies but also detailed adaptation and integration into all possible related technological processes.

List of Used Literature, Patent and Licensing Information

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