REAL-TIME FLOW HOMOGENIZATION OF VARIOUS FLUIDS IN PIPELINES. POSSIBLE USE CASES OF DYNAMIC HOMOGENIZATION TECHNOLOGIES IN FUEL SYSTEMS OF THERMODYNAMIC EQUIPMENT.

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The article provides a brief description of technology parts that determine the nature of technology application in various technical and commercial situations.

In all cases we are talking about the same type of device that performs the operations of dynamic mixing and simultaneous dynamic homogenization of liquid and gaseous physical environments.

This article explains all the possible aspects of the technology and device on which it is implemented.

Since we began to consider dynamic reagent-free homogenization as a basic process that allows to increase the accuracy of non-contact monitoring of the state of liquids in pipelines controlled by aerial photography or using unmanned aerial vehicles, it is highly desirable to track all possible places of implementation (certainly in which this technology will definitely demand)

Consider the general conditions depending on the characteristics of the new technology.

Fuel clots may occur in hydrocarbon liquid fuels during storage which may further cause problems with injection and homogeneous combustion.

The higher the viscosity of the fuel, the real probability of the formation of clots and other types of fuel heterogeneity is much higher and for the introduction of the proposed

options for on-line contactless monitoring technologies, it is necessary to take into account the level of homogenization as accurately as possible.

A few general requirements and conditions:

As an example, take a diesel engine, as part of a diesel generator power plant.

Dynamic homogenization fuel system, for example, is mounted in the engine fuel system on the fuel line between the engine fuel pump and the engine high pressure pump.

During the passage of fuel through the dynamic homogenization system, homogenization occurs in the flow according to the level of turbulence, after which the high-pressure pump completes the dynamic homogenization process in a possible volume and in the corresponding dimensional factor in the three-dimensional coordinate system.

Dynamic homogenization fuel system does not require any additional energy sources and additional structural elements.

The system of dynamic homogenization of fuel can also be used in processes and devices for homogenization in parallel with the recirculation of fuel in storage tanks during the production of fuel and during its storage at gas stations.

Consider the types of internal combustion engines in which the complex technology of dynamic homogenization of fuel and fuel mixtures can be applied.

The dynamic homogenization system has minimal dimensions and an optimal geometric shape and therefore can be mounted on any internal combustion engine

Figure 1. Device for dynamic on-line homogenization of pipelines with a flow rate of up to 100 liters per hour under pressure from 3 bar to 15 bar.

As shown by numerous tests there is no pressure drop in the mains during homogenization, all pulsations and fluctuations are substantially smoothed out, without additional energy costs; As can be seen from the figure, the device is very compact - the outer diameter is only 40 millimeters, with a working diameter - 30 millimeters, the length of the device is 220 millimeters

For comparison, we consider industrial systems that can operate in the fuel lines of large power plants, for example, gas turbines of power plants of 20 and 25 megawatts.

Figure 2.

Figure 2 shows online dynamic homogenization systems with a working diameter of 200 and 250 millimeters, designed for consumption of 10,000 liters per hour and 15,000 liters per hour.

At such facilities, the role of the homogenizing system is multifunctional, since in addition to stabilizing and unifying the hydrodynamic parameters of the fuel flows, they at the same time solve other problematic issues, most importantly the decisive goals of increasing the efficiency of such equipment.

Recently, the formation of fuel mixtures power equipment in the fuel line using biofuels, ethanol and, especially, methanol has become particularly acute, since such mixtures do not create toxic waste and also lower the specific cost of fuel.

For such fuel types, if the mixture is formed with, for example, diesel fuel, homogenization plays an important role not only as a stabilizing factor, but also as a

factor that prevents, for example, water in the mixture, when evaporating, cause micro-explosions and disrupt the flame from the burner.

If the fuel mixture is homogenized, microcapsules are formed in it in which the core of, for example, methanol has a shell of diesel fuel.

When injected, such core evaporates first and breaks the shell into micro particles, no larger than 0.5 - 0.8 micron, which contributes to a much more efficient and complete combustion, with higher efficiency.

Most importantly, with such a fuel mix structure, evaporation energy is not being lost, and this gives an additional 1.5 - 2.5 percent fuel economy, which at a cost of 10,000 liters per hour, can save more than \$ 100,000 per unit per year.

Modern engines, incorporating a high-pressure pump, can be equipped with a system of dynamic homogenization of the fuel mixture with absolutely no minimum modifications of the fuel system.

Equipping the system with dynamic homogenization can be carried out both on stationary internal combustion engines and on internal combustion engines installed on vehicles.

The system of dynamic homogenization can be equipped with an additional system for the formation of two types of fuel emulsions, - compressible emulsion and incompressible emulsion.

Dynamic homogenization system allows you to effectively emulsify up to eight additional components in the emulsion.

The system of dynamic homogenization without modification can effectively dissolve combustible gases in the stream of liquid hydrocarbon fuel before being injected into the

combustion chamber, both on stationary internal combustion engines and on internal combustion engines installed on vehicles.

Dynamic homogenization is a fairly universal process that can be applied to many types of equipments and practically to all types of liquid fuels without any serious adaptive solutions.

Using dynamic homogenization technology, any type of liquid hydrocarbon fuel can be processed, including almost all types of biofuels.

Any kind of gasoline-based fuel mixtures can be processed using dynamic homogenization technology, including mixtures with ethanol and methanol, as well as mixtures with various activating additives.

Diesel fuel has many varieties, the characteristics of which are very different and depends on climatic conditions.

If we take for comparison the basic types of diesel fuel in the United States, then as the cleanest and lightest diesel fuel No. 2 and the heaviest and most viscous - diesel fuel No. 6 will require homogenization before injection, especially in winter.

If we consider different grades of fuel oil, especially with a high sulfur content, it turns out that only the homogenization of conventional fuel oil without the addition of lighter fuel allows for all the benefits of homogenization, to reduce fuel consumption by up to 10%

Recently, new types of regenerated fuel have also appeared on the basis of all types of diesel fuel and fuel oil mixed with bio-fuel and other products of the processing or regeneration of hydrocarbon raw materials.

As an example, we can consider such types of fuel mixtures as - JP-8 and JP-10 in the USA, which also require homogenization and can become the basis for a homogenized fuel mixture using the homogenization technology.

Any kind of liquid bio-fuel can be processed using dynamic homogenization technology.

Despite the fact that gasoline is the most homogeneous type of liquid fuel and due to the reasons for using gasoline, it is practically used only in the form of a blend with ethanol, which contains at least 10-15% of ethanol, homogenization of gasoline and its blends has also become relevant.

Fuel mixtures based on gasoline, such as mixtures of gasoline with ethanol and mixtures of gasoline with methanol, can have the effect of gravitational separation of water from the hydrocarbon portion of the fuel mixture during prolonged storage.

The system of dynamic homogenization in gasoline engines using a mixture of gasoline and ethanol or a mixture of gasoline and methanol as fuel is mounted between the fuel pump and the engine high-pressure pump.

During the passage of the fuel mixture in which water is separated from gasoline through a dynamic homogenization system, homogenization occurs in the flow according to the level of turbulence, after which, in the high-pressure pump, the process of dynamic homogenization is completed in the volume and in the micron size factor in the three-dimensional coordinate system.

In the process of homogenization, water in the form of micro-droplets is uniformly distributed in the volume of the hydrocarbon mixture of the fuel and after that the mixture is transformed into a micro or nano-emulsion.

In accordance with the test results of an emulsion obtained using a dynamic homogenization system, the soot concentration in exhaust gases is reduced by 97% and the level and speed of heat implementation increase by at least 35%

For installation of a dynamic homogenization system on a gasoline engine, no original additional elements are required and no structural changes are required in the engine itself.

Figure 3. A device for on-line homogenization of gasoline and fuel mixtures based on gasoline for engines with a flow rate of 45 liters per hour, with a working diameter of 25 millimeters; The figure shows the device in disassembled form.

The figure clearly shows how technologically advanced the device is made, primarily because of all internal parts and the case are a system of coaxial cylindrical and conical surfaces, for all of which the device case, in addition, is a specific caliber determining the position of each part and ensuring the accuracy of all working channels of the device due to including dimensional combinations allowing to achieve the so-called Bernoulli's principle and provide the necessary level of cavitation natural disruption in the flow of homogenized fuel or any other process and operating fluids.

For much more viscous diesel fuels and fuel compositions, the need for homogenization is even more evident both for clean diesel fuel, and for mixtures based on diesel fuel and methanol and for emulsions from diesel fuel and water, both emulsions types like water to oil in which the water content does not exceed 20%, - and oil to water, - in which the water content is - 50%.

The preparation of fuel mixtures from diesel fuel and ethanol or methanol is extremely difficult due to the large difference in viscosity of these materials.

The system of dynamic homogenization of fuel mixtures can prepare a high-quality and homogeneous mixture of diesel fuel and ethanol or methanol in fractions of a second, directly in the pipeline and in any desired proportion.

A dynamic homogenization system in diesel engines using a mixture of diesel fuel and ethanol or a mixture of diesel fuel and methanol as fuel is mounted between the fuel pump and the high-pressure pump of a diesel engine.

During the passage of the fuel mixture in which water is separated from gasoline through a dynamic homogenization system, homogenization occurs in the flow in terms of turbulence, after which the high-pressure pump completes the dynamic homogenization process in the volume and size factor in the three-dimensional coordinate system.

In the process of homogenization, water in the form of micro-droplets is uniformly distributed in the volume of the hydrocarbon mixture of the fuel and after that the mixture is transformed into a micro or nano-emulsion

In accordance with the test results of an emulsion obtained using a dynamic homogenization system, the soot concentration in exhaust gases is reduced by 97% and the level and speed of heat sales increase by at least 35%.

For installation of a dynamic homogenization system on a diesel engine, no original additional elements are required and no structural changes are required in the engine itself.

Figure 4. Internal device details.

All work surfaces are coaxial, the design has no moving parts and, thanks to mutual coaxiality, it is possible to achieve the accuracy of all working channels at a level of 25 microns with a maximum tolerance of 1 micron

References and patent-licensed materials:

Attachment 1

United States Patent Application	20180162377
Kind Code	A1
COLAVINCENZO; David D.	June 14, 2018

Hybrid Commercial Vehicle Thermal Management Using Dynamic Heat Generator

Abstract

A system and method are provided for hybrid electric internal combustion *engine* applications in which a motor-generator, a narrow switchable coupling and a torque transfer unit therebetween are arranged and positioned in the constrained environment at the front of an *engine* in applications such as commercial vehicles, off-road vehicles and stationary *engine* installations. The motor-generator is preferably positioned laterally offset from the switchable coupling, which is co-axially-arranged with the front end of the *engine* crankshaft. The switchable coupling is an *integrated* unit in which a crankshaft vibration damper, an *engine* accessory drive pulley and a disengageable clutch overlap such that the axial depth of the clutch-pulley-damper unit is nearly the same as a conventional belt drive pulley and *engine* damper. The front end motor-generator system includes an electrical energy store that receives electrical energy generated by the motor-generator when the coupling is engaged. When the coupling is disengaged, the motor-generator may drive the pulley portion of the clutch-pulley-damper to drive the *engine* accessories using energy returned from the energy store, independent of the *engine* crankshaft.

Attachment 2

United States Patent Application	20180163649
Kind Code	A1
Glugla; Chris Paul ; et al.	June 14, 2018

METHOD AND SYSTEM FOR PRE-IGNITION CONTROL

Abstract

Methods and systems are provided for improving the detection and mitigation of high speed pre-ignition. In one example, high speed pre-ignition is detected based on concurrent or sequential changes in an *integrated* knock sensor output in a knock window as well as a pre-ignition window. The high speed pre-ignition is addressed using cylinder fuel deactivation and/or *engine* load limiting to reduce the risk for run-away pre-ignition.

Attachment 3

United States Patent Application	20180171890
Kind Code	A1
KAMEI; Wittison	June 21, 2018

Dual Fumigation Homogeneous Charge Compression Ignition (DF-HCCI) Engine

Abstract

A dual fumigation homogeneous charge compression ignition (DF-HCCI) *engine* runs on low volatility internal combustion (IC) *engine* fuel such as diesel in combination with another IC *engine* fuel, both simultaneously fumigated in *engine* intake air stream. Both fumigated fuels mix with *engine* intake air and they are inducted together, at the same time, into *engine* combustion chamber where homogeneous charge compression ignition combustion takes place. Fumigation of two fuels, in which one fuel has low volatility, is done by a novel dual fuel fumigation system comprising of at least one ultrasonic atomizer. Combustion phasing control is done by varying proportions of fumigated fuels, EGR rate, and EGR temperature and additionally by controlling *engine* intake air temperature. *Engine* intake air is controlled to a desirable temperature by heat exchanger utilizing heat from *engine* and/or exhaust gas. A controller monitors inputs from relevant sensors and, based on these inputs, adjusts fumigation rates of fuels, EGR rates, EGR temperature and *engine* intake air temperature.

Attachment 4

United States Patent Application	20180171925
Kind Code	A1
PAVLOV; Kevin J.	June 21, 2018

SECONDARY FUEL INJECTION SYSTEM AND METHOD FOR DIESEL ENGINES

Abstract

A secondary fueling system for a diesel internal combustion *engine* includes an injector which injects an oxygen-containing secondary fuel into the *engine's* air intake system, a pump which pumps the secondary fuel to the injector, a sensor which senses pressure in the air intake system, and a secondary fuel controller which receives output signals from the sensor and pump, operator inputs for the *engine*, and data signals pertaining to operation of the *engine* from the main *engine* controller, determines an injection amount of the secondary fuel based thereon, and controls the pump based on the determined injection amount. The secondary controller may operate an additional control wherein the injection amount of secondary fuel determined by the programmed secondary fuel controller is modified based on at least one of topology conditions of roads on which the vehicle is traveling and considerations of efficient *engine* output in comparison to driver requests for *engine* output.

Attachment 5

United States Patent Application

20180179975

Kind Code

A1

Merlino; Gennaro ; et al.

June 28, 2018

ENGINE CONTROL SYSTEM INCLUDING FEED-FORWARD NEURAL NETWORK CONTROLLER

Abstract

An automotive internal combustion *engine* combusts an air/fuel mixture to generate a drive torque. An *engine* control unit (ECU) determines a torque request to output a fuel request signal indicative of an amount of the fuel to inject into a cylinder of the *engine*. The ECU includes neural network controller installed with a neural network to generate a fuel setpoint signal based on the torque request and to define a combustion model of the *engine*. The neural network generates a start of injection (SOI) signal indicating a start time at which to inject the fuel based a crankshaft angle. The ECU further outputs the fuel request signal based on the fuel setpoint and the SOI. A fuel injector injects the fuel into the cylinder based on the fuel request signal to generate the drive torque indicated by the torque request.