



(12) **EUROPEAN PATENT APPLICATION**  
 published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**03.07.2013 Bulletin 2013/27**

(51) Int Cl.:  
**F02M 27/04 (2006.01)**

(21) Application number: **10856487.3**

(86) International application number:  
**PCT/RU2010/000470**

(22) Date of filing: **26.08.2010**

(87) International publication number:  
**WO 2012/026841 (01.03.2012 Gazette 2012/09)**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR**

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(54) **METHOD AND DEVICE FOR CHANGING THE MOLECULAR COMPOSITION OF LIQUID HYDROCARBON FUEL**

(57) The invention relates to engine building, in particular to technologies for producing liquid fuel of improved quality. The invention makes it possible to improve the chemical structure of the fuel and to increase the combustion heat thereof. The method for changing the structure of the molecular composition of liquid hydrocarbon fuel under the action of an electric field comprises placing the fuel between electrodes to which an electric potential is fed. The parameters of the alternating electric field and the fuel mass in the treatment zone are

determined according to an empirical equation. The device comprises a body with electrodes for acting with an electric field on the stream of fuel in a treatment chamber. The body is one of the electrodes, and the other internal electrode is placed in the treatment chamber and is arranged coaxially with respect to the body. The electrode power source is in the form of an alternating voltage generator. The internal electrode is hollow. An additional electrode which is electrically connected to the body is placed coaxially within the internal electrode.

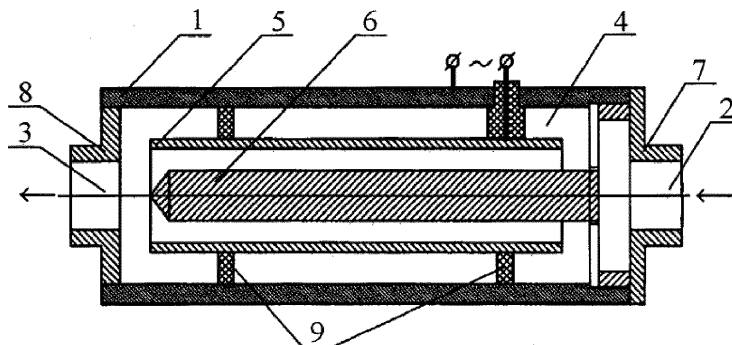


Fig. 1

## Description

### Scope of Use

[0001] The invention relates to the technology for improved quality liquid hydrocarbon fuel generation and can be used in various industrial processes, such as petrochemical industry, as well as for the preparation of liquid hydrocarbon fuel for the combustion process in a variety of power plants in order to increase efficiency and improve environmental performance.

### Prior Knowledge

[0002] There is a method of electrical processing of liquid fuel and a liquid fuel activator (patent RU No 2032107, cl. F02M 27/04, published on 27/03/1995).

[0003] According to this method, liquid fuel before dispersing is activated in the 250-300 Hz and 20-25 kV pulse current electric field and separated into flows of opposite polarity.

[0004] Liquid fuel activator comprises of a housing with inlet and outlet pipes, electrodes placed inside the activator and connected to a source of high voltage, and a semi-permeable membrane to separate the charged currents.

[0005] The disadvantages of this method and the activator are as follows:

- separation of the processed fuel into two bipolar flows does not ensure a full processing of the entire fuel flow, as after fractionation only a part of the processed fuel is combusted;
- use of the 250-300 Hz and 20-25 kV pulse current electric field reduces operational safety of the equipment used.

[0006] The closest to the claimed method in regards to the technical substance and the achieved result is the method of fuel processing, which consists of passing the fuel flow through the fuel pipe section with variable frequency AC voltage electrodes. A layer of dielectric material is placed in the processing chamber between electrodes of different polarities. The parameters of electromagnetic effect on fuel are set in accordance with the experimental ratio and the numeric values (patent RU No 20385506, cl. F02M 27/04, published on 27/06/1995 - prototype).

[0007] The disadvantages of this method are as follows. The fuel is further energised and broken into small fractions by the electromagnetic field due to the additional energy potential. Thus, due to the smaller fractions of fuel it is combusted more completely without changing the molecular composition of the fuel and increasing its combustion value.

[0008] The closest to the claimed device in regards to the technical substance is the device for the fuel processing containing a chamber-shaped housing with input and

output ports and equipped with at least two electrodes of different polarities to use electrostatic field in order to influence a fuel flow in the processing chamber, which are connected to the power supply, thus, the housing serves as one of the electrodes, and the other internal electrode placed in the processing chamber is located coaxially to the housing (patent RU No 2156879, cl. F02M 27/04, published on 27/09/2000 - prototype).

[0009] Disadvantages of this device are as follows:

- use of complex and expensive technology for the production of dielectric material of  $4 \times 10^{-6}$  to  $0.5 \times 10^{-3}$  thickness;
- limited application due to the low melting temperature of the dielectric material;
- insufficient mechanical resistance to mechanical abrasion and impurities present in the fuel;
- influencing a fuel flow by the electrostatic field and placing a dielectric material between the electrodes of different polarities does not provide structural changes of the molecular composition of the fuel and the increase of its combustion value.

### Disclosure of the Invention

[0010] The technical object of the invention is to create the method of and device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field that improve the chemical structure of fuel and increase its combustion value.

[0011] The object of the invention is achieved by providing the method of changing the molecular composition of the liquid hydrocarbon fuel in the electric field, which involves placing the fuel between the electrodes with electric potential, which, according to the invention, includes parameters of the alternating electric field and the mass of fuel in the processing zone determined in accordance with the following empirical relationship:

$$f/E = v\sigma/IM,$$

where:

- f - oscillation frequency of the electric field - 1/s,
- E - amplitude of the electric field intensity - V/m,
- v - fuel viscosity -  $m^2/s$ ,
- $\sigma$  - electric conductivity of fuel -  $Ohm^{-1} \cdot m^{-1}$ ,
- I - leakage current in the processing zone - A,
- M - molecular mass of fissionable hydrocarbons in the processed fuel - amu

[0012] Regarding this method of changing the molecular composition of liquid hydrocarbon fuel under the influence of an electric field, the following conditions are preferable:

- the fuel mass in the processing zone is determined in accordance with the following ratio:

$$m = (V_c - V_e) \times \rho$$

where:

m - fuel mass in the processing zone - kg,  
 V<sub>c</sub> - volume of the processing zone - m<sup>3</sup>,  
 V<sub>e</sub> - total volume of electrodes placed in the processing zone - m<sup>3</sup>,  
 ρ - fuel density - kg/m<sup>3</sup>;

- fuel processing is carried out in its stationary position relative to the electrodes;
- fuel processing is carried out in the course of its movement through the processing zone.

**[0013]** The object of the invention is also achieved by creating a device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field, which comprises of a housing with inlet and outlet ports equipped with electrodes to use an electric field in order to influence a fuel flow in the processing chamber, which are connected to the power supply, whereby the housing serves as one of the electrodes, and the other internal electrode placed in the processing chamber is located coaxially to the housing; according to the invention, the power supply is made in the form of the AC generator, and the inner electrode is hollow where an additional electrode electrically coupled to the housing is coaxially placed, whereby the length of the inner electrode corresponds to the following formula:

$$L = (Q/v)^{1/2},$$

Where:

L - length of the middle electrode - m,  
 Q - volume throughput of the processed fuel - m<sup>3</sup>/s,  
 v - fuel velocity in the processing chamber - m/s.

**[0014]** Regarding this device for changing the molecular composition of liquid hydrocarbon fuel under the influence of an electric field, the following conditions are preferable:

- sectional area of the inlet port and sectional area of the processing chamber are determined by the  $S_{in} \leq S_c$  ratio, where  $S_{in}$  - sectional area of the inlet port,  $S_c$  - sectional area of the processing chamber;
- Inlet and outlet pipes are installed in the housing where inlet and outlet ports are located respectively;

- insulating inserts are installed between the housing and the inner electrode.
- The claimed method and device allow for a change in the molecular composition of liquid hydrocarbon fuels under the influence of an alternating electric field that provides an improvement of the chemical structure of the fuel and increases its combustion value.

#### 10 Brief Description of Drawings

#### [0015]

Fig.1 shows a longitudinal section of the device that changes the molecular composition of the liquid hydrocarbon fuel under the influence of an electric field.

#### Best Mode of Implementation of the Invention

**[0016]** The claimed method is implemented in the device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field, which contains the housing 1 with inlet and outlet ports 2 and 3, and is equipped with electrodes in order to use an electric field to influence the fuel flow in the processing chamber 4, which are connected to a power source (not shown in the drawing), the housing 1 is one of the electrodes, and the other internal electrode 5 in the processing chamber 4 is located coaxially to the housing 1, the power supply is made in the form of the AC generator, and the inner electrode 5 is hollow where the additional electrode 6 electrically coupled to the housing 1 is coaxially placed, whereby the length of the inner electrode 5 corresponds to the following formula:

$$L = (Q/v)^{1/2}.$$

**[0017]** Regarding this device for changing the molecular composition of liquid hydrocarbon fuel under the influence of an electric field, the following conditions are preferable:

- sectional area of the inlet port 2 and sectional area of the processing chamber 4 are determined by the  $S_{in} \leq S_c$  ratio;
- Inlet and outlet pipes 7 and 8 are installed in the housing where inlet and outlet ports 2 and 3 are located respectively;
- insulating inserts 9 are installed between the housing 1 and the inner electrode 5.

**[0018]** The claimed method is implemented in the device for changing the molecular composition of liquid hydrocarbon fuel under the influence of an electric field as follows.

**[0019]** Fuel is supplied through the inlet port 2 of the inlet pipe 7 to the processing chamber 4 and divided into two flows: first flow - between the housing 1 and the inner electrode 5, second flow - between the inner electrode 5 and the additional electrode 6. Change of the molecular composition of the processed fuel occurs under the influence of an alternating electric field produced on the internal electrode 5. In addition, the molecules of heavy hydrocarbons, the carbon skeleton of which consists of 18 or more carbons, are split into lighter molecules, the carbon skeleton of which consists of 5 ÷ 10 carbons. The resulting light molecules are mostly alkanes, which have a higher combustion value than heavy molecules and are oxidised during combustion to CO<sub>2</sub> and H<sub>2</sub>O. Restructured fuel leaves the processing chamber 4 through the outlet port 3 of the outlet pipe 8. Insulating inserts 9 allow for the supply of AC electric potential to the inner electrode 5, centering the inner electrode 5 on the longitudinal axis of the processing chamber 4, and determination of the required distance between the housing 1 and the inner electrode 5. Furthermore, the introduction of the additional electrode 6 reduces the electric field intensity and the supply power.

**[0020]** Technical results of the claimed invention are confirmed by the chemical research data, mass spectrometry and the internal combustion engine indicator diagrams, which showed the decrease of heavy aromatic hydrocarbons and the increase of light alkanes in the processed fuel. In particular, the concentration of decane (C<sub>10</sub>H<sub>22</sub>) increased by 3.5 times, the concentration of xylene (C<sub>8</sub>H<sub>10</sub>) increased by 8 times, and the concentration of heavy aromatics (C<sub>18</sub>H<sub>20</sub> and C<sub>18</sub>H<sub>22</sub>) decreased to zero in the processed fuel. As a result, the combustion value increased by at least 10%. Indicator diagrams of internal combustion engines, which worked on the processed fuel, show a decrease in the time of combustion of fuel mixture in the cylinders of the engine and an increase of the combustion value. Thermotechnical measurements of the boilers showed an increase of the combustion value, an increase of efficiency of the boilers, and a reduction of the toxicity of exhaust gases.

### Industrial Applicability

**[0021]** The use of the claimed invention in various industrial processes, such as petrochemical industry, as well as for preparation of liquid hydrocarbon fuel for the combustion process in a variety of power plants in order to increase efficiency and improve environmental performance, ensures its industrial applicability.

### Claims

1. The method of changing the molecular composition of the liquid hydrocarbon fuel in the electric field, which involves placing the fuel between the electrodes with electric potential and differs in that the

parameters of the alternating electric field and the mass of fuel in the processing zone are determined in accordance with the following empirical relationship:

$$f/E = v\sigma/IM,$$

where:

f - oscillation frequency of the electric field - 1/s,  
 E - amplitude of the electric field intensity - V/m,  
 v - fuel viscosity - m<sup>2</sup>/s,  
 σ - electric conductivity of fuel - Ohm<sup>-1</sup>·m<sup>-1</sup>,  
 I - leakage current in the processing zone - A,  
 M - molecular mass of fissionable hydrocarbons in the processed fuel - amu

2. The method of changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 1, which differs in that the fuel mass in the processing zone is determined in accordance with the following formula:

$$m = (V_c - V_e) \times \rho$$

where

m - fuel mass in the processing zone - kg,  
 V<sub>c</sub> - volume of the processing zone - m<sup>3</sup>,  
 V<sub>e</sub> - total volume of electrodes placed in the processing zone - m<sup>3</sup>,  
 ρ - fuel density - kg/m<sup>3</sup>,

3. The method of changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 1, which differs in that the fuel processing is carried out in its stationary position relative to the electrodes.

4. The method of changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 1, which differs in that the fuel processing is carried out in the course of its movement through the processing zone.

5. The device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field, which comprises of a housing with inlet and outlet ports equipped with electrodes connected to the power supply to use an electric field in order to influence a fuel flow in the processing chamber, whereby the housing serves as one of the electrodes, and the other internal electrode placed in the processing

chamber is located coaxially to the housing, which differs in that the power supply is made in the form of the AC generator, and the inner electrode is hollow where an additional electrode electrically coupled to the housing is coaxially placed, whereby the length of the inner electrode corresponds to the following formula:

$$L = (Q/v)^{1/2},$$

where

L - length of the middle electrode - m,  
 Q - volume throughput of fissionable hydrocarbons in the processed fuel m<sup>3</sup>/s,  
 v - fuel velocity in the processing chamber - m/s.

6. The device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 5, which differs in that the sectional area of the inlet port and the sectional area of the processing chamber are determined by the  $S_{in} \leq S_c$  ratio, where  $S_{in}$  - sectional area of the inlet port,  $S_c$  - sectional area of the processing chamber.
7. The device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 5, which differs in that the inlet and outlet pipes are installed in the housing where inlet and outlet ports are located respectively.
8. The device for changing the molecular composition of the liquid hydrocarbon fuel in the electric field according to paragraph 5, which differs in that the insulating inserts are installed between the housing and the inner electrode.

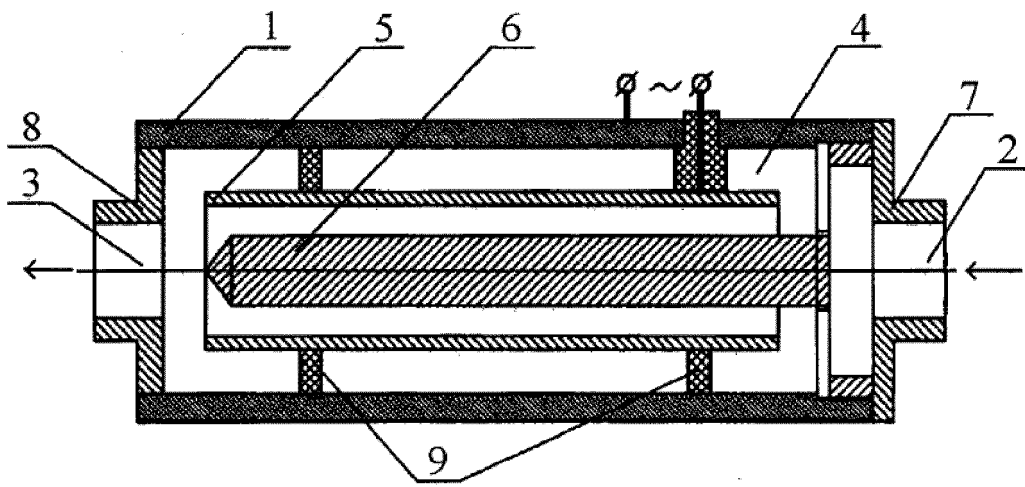


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/RU 2010/000470

A. CLASSIFICATION OF SUBJECT MATTER		F02M 27/04 (2006.01)	
According to International Patent Classification (IPC) or to both national classification and IPC			
B. FIELDS SEARCHED			
Minimum documentation searched (classification system followed by classification symbols) F02B 51/00-51/04, F02M 27/00-27/04, 51/00-51/08, 57/00, 57/04, F02P 13/00, H01T 13/00-13/56			
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched			
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)			
C. DOCUMENTS CONSIDERED TO BE RELEVANT			
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	
X	RU 2038506 C1 (FEDOTOV ALEKSANDR DEMYANOVICH) 27.06.1995, the abstract, figure 1	1-4	
Y	RU 2156879 C1 (LYZHENKOV VASILY NIKOLAEVICH) 27.09.2000, the abstract, figure 1	5-8	
Y	RU 2078241 C1 (NELYABINSKY GOSUDARSTVENNY TEKHNICHESKY UNIVERSITET) 27.04.1997, the abstract, figure 1	5-8	
A	JP 8014121 A (INABA EIKO) 16.01.1996	1-8	
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input type="checkbox"/> See patent family annex.	
* Special categories of cited documents:		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"A" document defining the general state of the art which is not considered to be of particular relevance		"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"E" earlier application or patent but published on or after the international filing date		"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		"&" document member of the same patent family	
"O" document referring to an oral disclosure, use, exhibition or other means			
"P" document published prior to the international filing date but later than the priority date claimed			
Date of the actual completion of the international search 29 April 2011 (29.04.2011)		Date of mailing of the international search report 05 May 2011 (05.05.2011)	
Name and mailing address of the ISA/  Facsimile No.		Authorized officer  Telephone No.	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/RU 2010/000470

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

**SEE SUPPLEMENTAL SHEET**

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.



**There is no technical relationship between the inventions claimed in independent claims 1 and 5 involving one or more of the same or corresponding special technical features that define a contribution over the prior art.**

**The first group of inventions consists of a method for altering the structure of the molecular composition of a liquid hydrocarbon fuel, the special technical features of which are that an alternating electric potential is fed to the fuel, which is situated between electrodes, in accordance with given relationships between voltage and frequency.**

**The second group of inventions consists of a device for altering the structure of the molecular composition of a liquid hydrocarbon fuel, the special technical feature of which is an additional electrode, which is connected to a housing and is coaxially arranged inside an inner hollow electrode.**

**The special technical features of the first group of inventions can be realized irrespective of the presence of the additional electrode cited as the special technical feature of the second group of inventions, i.e. they do not constitute the same or corresponding special technical features.**

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- RU 2032107 [0002]
- RU 20385506 [0006]
- RU 2156879 [0008]