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(54) Title: MARINE FUEL

(57) Abstract: Marine fuel, obtained by mixing petroleum heavy fuels, like fuel oil with additives, which are shale oil products like fractions 180-230 °C, 230-320 °C and 320-360 °C, shale fuel oil, shale oils marks A and B, refined distillate shale oil D-1, fuel for small boilers TMK. The used fuel oil is M-100 (GOST 10585-99) which is heated up to +60...+90 °C, and mixing is provided in automatic mixing units or by pumping from vessel to vessel. The marine fuel corresponds to the ISO 8217:1996 standard, but is more environmentally-friendly, has lower kinetic viscosity and lower pour point

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Marine fuel

Technical field

[0001] This invention is in the field of marine fuels, in particular liquid carbonaceous marine fuels, which are composed mainly of hydrocarbon mixtures.

Background Art

[0002] Several marine fuels that are 50-70% (hereinafter percentage by weight, w/w) mixtures of fuel oil with an additive (30-50% diesel fuel) are commonly known. The problem with such marine fuels is their instability and incomplete combustion. Other mixtures of oil residues and residual fuels with various oil distillates, incl. gas oil and diesel fuel, are also well known.

[0003] One such marine fuel has been described, for instance, in Russian Federation patent **RU 2084494** (UFIM G NEFTYANOJ TEKHN UNI) 20.07.1997 , where 50-75% fuel oil has been mixed with additives, which include oil sludge and residual oil (both contributing 12,5-25%) that have been dehydrated in two or three stages.

[0004] Adding depressants in small doses to marine fuels in order to improve their properties is also known. Such a solution has been described, for instance, in Russian Federation patent **RU 2154665** (VASIL EV

ROSTISLAV L VOVICH) 20.08.2000 , where up to 0.05% of depressant can be added to the marine fuel.

[0005] Russian Federation patent **RU 2155211** (EPERERABATYVAJUSHCHIJ ZD; SYZRANSKIJ NEFT AOOT) 27.08.2000 , where fuel oil has been mixed with additives, such as 5-30% long residue, up to 25% oil distillate wide vacuum fracture 260-510 °C or high temperature cracking products of up to 25% long residue, and oil distillate wide vacuum fraction 260-510 °C, 20-25% light gas oil, 15-40% hydro-fined diesel fuel and up to 0.05% depressant can be regarded as the closest known solution to this invention.

Disclosure of Invention

[0006] International marine fuel standard ISO 8217:1996 permits the content of sulphur 3.5-5.0%, vanadium content 150-600 mg/kg, and aluminium content with silicon up to 80 mg/kg. The allowed pour point is between 0 °C and +30 °C.

[0007] The aim of this invention is to create a marine fuel with a different composition from known solutions on the basis of fuel oil and shale oil products, which would be, due to the small content of sulphur and other harmful additives in shale oil products, more environmentally-friendly (sulphur content in marine fuel 1.7-2.3%, vanadium content 62-114 mg/kg, aluminium content with silicon 18-38 mg/kg, lower heavy metal content),

have smaller kinematic viscosity and a lower pour point (from -19 °C to +19 °C) than the standard marine fuels in accordance with ISO 8217:1996.

[0008] In order to achieve the aim of this innovation, one or several of the following additives, which are oil shale products, are mixed with fuel oil M-100 (GOST 10585-99): shale oil fractions 180-230 °C, 230-320 °C and 320-360 °C, shale fuel oil, shale oil marks A and B, refined distillate shale oil D-1 and fuel for small boilers TMK (see Tables 1.1 and 1.2).

Table 1.1 Technical characteristics of fuel oil and additives mixed in the marine fuel corresponding to this invention

Technical characteristics	Fuel oil M-100, GOST 10585-99	Shale oil fraction 180-230 °C	Shale oil fraction 230-320 °C	Shale oil fraction 320-360 °C	Shale fuel oil
Engler viscosity, °E					
at 20 °C		1.14			
at 50 °C			2.3	6-20	
at 80 °C	16.0		1.3	3-5	max 3.0
at 100 °C	6.8			3.1	
Kinematic viscosity, cSt					
at 20 °C		2.4			

Technical characteristics	Fuel oil M-100, GOST 10585-99	Shale oil fraction 180-230 °C	Shale oil fraction 230-320 °C	Shale oil fraction 320-360 °C	Shale fuel oil
at 50 °C at 80 °C at 100 °C	 118 50		14.6 4.1	43.8- 148.0 20.0- 36.2 21.2	 max 20.0
Density, g/cm^3 at 15 °C at 20 °C		0.855	 0.970	 1.015- 1.039	 1.000
Partial ash weight, %	0.05- 0.14	0.003	0.01	0.02	max 0.3
Partial water weight, %	max 1.0	-	0.2	0.1	max 3.0
Partial sulphur weight, %	0.5-3.5	1.0	0.65	0.59	max 0.8
Partial weight of mechanical additives, %	max 1.0	0.008	0.025	0.17	max 0.7

Technical characteristics	Fuel oil M-100, GOST 10585-99	Shale oil fraction 180-230 °C	Shale oil fraction 230-320 °C	Shale oil fraction 320-360 °C	Shale fuel oil
Coking property, %	0	0.01	max 0.2	4.37	2.0
Flash point, °C in an open crucible in a closed crucible	110	58	120 101	120-190 119	min 67
Pour point, °C	25	max (-35)	max (-30)	-5-(-19)	max (-15)
Heat value, kcal/kg	9530-9680	10000	9500	9300	min 9300

Table 1.2 Technical characteristics of additives mixed in the marine fuel corresponding to this invention

Technical characteristics	Shale oil mark A	Shale oil mark B	Refined distillate shale oil D-1	Fuel for small boilers TMK
Engler viscosity, °E at 20 °C at 50 °C	 max 2.48	 max 6.55		 max 1.7

Technical characteristics	Shale oil mark A	Shale oil mark B	Refined distillate shale oil D-1	Fuel for small boilers TMK
at 80 °C at 100 °C			max 3.0	
Kinematic viscosity, cSt at 20 °C at 50 °C at 80 °C at 100 °C	max 16	max 48	max 20.0	max 8.3
Density, g/cm^3 at 15 °C at 20°C	max 0.985	max 1.008	1.000	0.900
Partial ash weight, %	max 0.01	max 0.05	max 0.1	max 0.02
Partial water weight, %	max 1.0	max 0.5	max 1.5	max 0.6
Partial sulphur weight, %	max 0.7	max 0.7	max 0.8	max 0.8
Partial weight of mechanical additives, %	max 0.025	max 0.12	max 0.25	max 0.048

Technical characteristics	Shale oil mark A	Shale oil mark B	Refined distillate shale oil D-1	Fuel for small boilers TMK
Coking property, %	0.2	max 5.0	2.0	0.15
Flash point, °C in an open crucible in a closed crucible	 min 97	 min 67	 min 67	 min 50
Pour point, °C	max (-25)	max (-20)	max (-20)	max (-30)
Heat value, kcal/kg	min 9600	9300	min 9300	min 9790

[0009] The mixing of fuel oil and its additives is conducted, for instance, in automated mixing units in industrial units, marine terminals, onboard ships, or by the way of pumping from vessel to vessel.

Mode(s) for Carrying Out the Invention

[0010] One or several of the following additives, which are shale oil products, are mixed with fuel oil M-100 (GOST 10585-99), which has been heated up to +60 °C...+90 °C: shale oil fractions 180-230 °C, 230-320 °C and 320-360 °C, shale fuel oil, shale oil marks A and B, refined distillate shale oil D-1 and fuel for small boilers TMK (see Tables 1.1 and 1.2). The combinations of different additives provide a number of marine fuels of varying composition in accordance with the following examples.

[0011] EXAMPLE 1. 50% fuel oil M-100 that has been heated up to +60 °...+90 °C is mixed with the additive, which is a 50% shale oil fraction 180-230 °C

(Table 1.1). The obtained marine fuel corresponds to marine fuel RMA 10 (Table 2.1) in terms of all its characteristics.

[0012] EXAMPLE 2. 55% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with additives, which are a 30% shale oil fraction 180-230 °C and a 15% shale oil mark B (Tables 1.1 and 1.2). The obtained marine fuel corresponds to marine fuel RMA 10 (Table 2.1) in terms of all its characteristics.

[0013] EXAMPLE 3. 60% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with additives, which are a 20% shale oil fraction 180-230 °C and a 20% shale oil fraction 230-320 °C (Table 1.1). The obtained marine fuel corresponds to marine fuel RMB 10 (Table 2.2) in terms of all its characteristics.

[0014] EXAMPLE 4. 70% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with an additive, which is a 30% shale oil fraction 180-230 °C (Table 1.1). The obtained marine fuel corresponds to marine fuel RMB 10 (Table 2.2) in terms of all its characteristics.

[0015] EXAMPLE 5. 60% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with an additive, which is a 40% fuel for small boilers TMK (Tables 1.1 and 1.2). The obtained marine fuel corresponds to marine fuel RMC 10 (Table 2.3) in terms of all its characteristics.

[0016] EXAMPLE 6. 60% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with additives, which are a 30% refined distillate shale oil D-1 and

a 10% shale oil fraction 180-230 °C (Tables 1.1 and 1.2). The obtained marine fuel corresponds to marine fuel RMD 15 (Table 2.4) in terms of all its characteristics.

[0017] EXAMPLE 7. 70% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with an additive, which is a 30% shale oil mark A (Tables 1.1 and 1.2). The obtained marine fuel corresponds to marine fuel RME 25 (Table 2.5) in terms of all its characteristics.

[0018] EXAMPLE 8. 80% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with an additive, which is a 20% shale oil fraction 230-320 °C (Table 1.1). The obtained marine fuel corresponds to marine fuel RME 25 (Table 2.5) in terms of all its characteristics.

[0019] EXAMPLE 9. 75% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with additives, which are a 20% shale oil fraction 230-320 °C and a 5% shale oil fraction 320-360 °C (Table 1.1). The obtained marine fuel corresponds to marine fuel RME 25 (Table 2.5) in terms of all its characteristics.

[0020] EXAMPLE 10. 75% fuel oil M-100 that has been heated up to +60 °C ...+90 °C is mixed with an additive, which is a 25% shale fuel oil (Table 1.1). The obtained marine fuel corresponds to marine fuel RME 25 (Table 2.5) in terms of all its characteristics.

[0021] EXAMPLE 11. 85% fuel oil M-100 that has been heated up to +60°...+90 °C is mixed with additives, which are a 10% shale oil fraction 230-320 °C and

a 5% shale oil fraction 320-360 °C (Table 1.1). The obtained marine fuel corresponds to marine fuel RMG 35 (Table 2.6) in terms of all its characteristics.

Table 2.1 Technical characteristics of marine fuel RMA 10 that corresponds to ISO 8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RMA 10	Example 1	Example 2
Density, kg/m^3 at 15 °C	max 975.0	913	937
Kinematic viscosity, cSt at 50 °C at 100 °C	 max 50.0 max 10.0	 8.5 3.0	 18.0 5.1
Flash point, °C	min 60	69	70
Pour point, °C in winter in summer	 max 0 max 6	 -19	 -6
Coking property, % according to Conradson	max 10	5.5	6
Partial ash weight, %	max 0.1	0.07	0.05
Partial water weight, %	max 0.5	0.2	0.2
Partial sulphur weight, %	max 3.5	1.7	1.8
Vanadium content, mg/kg	max 150	60	68

Technical characteristics	RMA 10	Example 1	Example 2
Aluminium plus silicon, mg/kg	max 80	18	19
Partial weight of mechanical additives, %	max 0.1	0.1	0.07

Table 2.2 Technical characteristics of marine fuel RMB 10 that corresponds to ISO 8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RMB 10	Example 3	Example 4
Density, kg/m^3 at 15 °C	max 981.0	948	931
Kinematic viscosity, cSt at 50 °C at 100 °C	 max 50.0 max 10.0	 29.1 6.4	 25.7 6.6
Flash point, °C	min 60	94	92
Pour point, °C in winter in summer	 max 24 max 24	 12	 7
Coking property, % according to Conradson	max 10	6.5	7.6
Partial ash weight, %	max 0.1	0.05	0.06
Partial water weight, %	max 0.5	0.2	0.2
Partial sulphur weight, %	max 3.5	1.8	2.0

Technical characteristics	RMB 10	Example 3	Example 4
Vanadium content, mg/kg	max 150	76	92
Aluminium plus silicon, mg/kg	max 80	24	27
Partial weight of mechanical additives, %	max 0.1	0.08	0.09

Table 2.3 Technical characteristics of marine fuel RMC 10 that corresponds to ISO 8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RMC 10	Example 5
Density, kg/m^3 at 15 °C	max 981.0	950.4
Kinematic viscosity, cSt		
at 50 °C	max 50.0	30.0
at 100 °C	max 10.0	6.6
Flash point, °C	min 60	80
Pour point, °C		
in winter	max 24	5
in summer	max 24	
Coking property, % according to Conradson	max 14	10.7
Partial ash weight, %	max 0.1	0.04
Partial water weight, %	max 0.5	0.2
Partial sulphur weight, %	max 3.5	1.8
Vanadium content, mg/kg	max 300	78

Technical characteristics	RMC 10	Example 5
Aluminium plus silicon, mg/kg	max 80	25
Partial weight of mechanical additives, %	max 0.1	0.1

Table 2.4 Technical characteristics of marine fuel RMD 15 that corresponds to ISO 8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RMD 15	Example 6
Density, kg/m^3 at 15 °C	max 985.0	962
Kinematic viscosity, cSt at 50 °C at 100 °C	 max 100.0 max 15.0	 60.7 10.6
Flash point, °C	min 60	80
Pour point, °C in winter in summer	 max 30 max 30	 -3
Coking property, % according to Conradson	max 14	6.7
Partial ash weight, %	max 0.1	0.05
Partial water weight, %	max 0.8	0.2
Partial sulphur weight, %	max 4.0	1.8
Vanadium content, mg/kg	max 350	80
Aluminium plus silicon, mg/kg	max 80	26
Partial weight of mechanical additives, %	max 0.1	0.09

Table 2.5 Technical characteristics of marine fuel RME 25 that corresponds to ISO

8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RME 25	Example 7	Example 8	Example 9	Example 10
Density, kg/m^3 at 15 °C	max 991.0	968	969	970	968
Kinematic viscosity, cSt at 50 °C at 100 °C	 max 225 max 25.0	 106.6 13.3	 148.0 18.0	 134.5 16.3	 113.6 14.4
Flash point, °C	min 60	142	123	102	129
Pour point, °C in winter in summer	 max 30 max 30	 16	 18	 15	 18
Coking property, % according to Conradson	max 15	7.0	6.7	7.8	8.2
Partial ash weight, %	max 0.1	0.02	0.03	0.02	0.06
Partial water weight, %	max 1.0	0.3	0.2	0.2	0.06
Partial sulphur weight, %	max 5.0	1.8	2.0	1.87	2.0
Vanadium content, mg/kg	max 200	96	106	99	102
Aluminium plus silicon,	max 80	30	31	28	32

Technical characteristics	RME 25	Example 7	Example 8	Example 9	Example 10
mg/kg					
Partial weight of mechanical additives, %	max 0.1	0.05	0.07	0.05	0.1

Table 2.6 Technical characteristics of marine fuel RMG 25 that corresponds to ISO 8217:1996 and the marine fuel corresponding to this invention

Technical characteristics	RMG 35	Example 11
Density, kg/m^3 at 15 °C	max 991.0	968
Kinematic viscosity, cSt at 50 °C at 100 °C	 max 390 max 35.0	 323.4 31.1
Flash point, °C	min 60	134
Pour point, °C in winter in summer	 max 30 max 30	 19
Coking property, % according to Conradson	max 18	9.6
Partial ash weight, %	max 0.15	0.07
Partial water weight, %	max 1.0	0.3
Partial sulphur weight, %	max 5.0	2.3
Vanadium content, mg/kg	300	114

Technical characteristics	RMG 35	Example 11
Aluminium plus silicon, mg/kg	max 80	38
Partial weight of mechanical additives, %	max 0.1	0.09

Claims

1. Marine fuel that has been obtained by mixing additives to fuel oil and, **characterised** in that the additives added to fuel oil are shale oil products.
2. Marine fuel according to claim 1, **characterised** in that fuel oil M-100, GOST 10585-99 has been used.
3. Marine fuel according to claim 1 and 2, **characterised** in that fuel oil has been heated up to +60°...+90 °C.
4. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 50% shale oil fraction 180-230 °C has been added to fuel oil.
5. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 30% shale oil fraction 180-230 °C and a 15% shale oil mark B have been added to fuel oil.
6. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 20% shale oil fraction 180-230 °C and a 20% shale oil fraction 230-320 °C have been added to fuel oil.
7. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 30% shale oil fraction 180-230 °C has been added to fuel oil.
8. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 40% fuel for small boilers TMK has been added to fuel oil.
9. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 30% refined distillate shale oil D-1 and a 10% shale oil fraction 180-230 °C have been added to fuel oil.

10. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 30% shale oil mark A has been added to fuel oil.
11. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 20% shale oil fraction 230-320 °C has been added to fuel oil.
12. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 20% shale oil fraction 230-320 °C and a 5% shale oil fraction 320-360 °C have been added to fuel oil.
13. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 25% shale fuel oil has been added to fuel oil.
14. Marine fuel according to claim 1, 2 and 3, **characterised** in that a 10% shale oil fraction 230-320 °C and a 5% shale oil fraction 320-360 °C have been added to fuel oil.

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10L1/08

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)
IPC 7 C10L

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 482 354 A (SWEENEY WILLIAM M ET AL) 13 November 1984 (1984-11-13) claim 12	1-14
X	WO 01/44410 A (ABBOTT DOUGLAS J ; BARBOUR ROBERT HOWIE (GB); RICKEARD DAVID J (GB); E) 21 June 2001 (2001-06-21) claims 1,9	1-14
X	US 3 284 336 A (CULBERTSON JR WILLIAM J ET AL) 8 November 1966 (1966-11-08) column 5, line 54 - line 62; claims 1,3	1-14
X	US 4 748 289 A (DOUGLAS ALLAN S) 31 May 1988 (1988-05-31) claims 1,6,7	1-14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
7 July 2004	13/07/2004

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB L25177A (CONSULTA) 21 December 1911 (1911-12-21) page 2, line 1 - line 37	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EE2004/000003

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