

**APPARATUS FOR REFINING OPPORTUNITY CRUDE AND REFINING METHOD
THEREOF**

[0001] This application claims the benefit of Korean Patent Application No.10-2009-0022541, filed on March 17, 2009, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a crude oil refining apparatus and method and, more particularly, to an apparatus for refining opportunity crude and a method for refining the same in order to prevent corrosion of the apparatus during refining and to manufacture low price alternative materials to heavy fuel oil.

Discussion of the Related Art

[0003] Opportunity crude means oil with a constitutional composition and physical properties clearly different from general crude oil and the opportunity crude is generally mined and produced in a small amount. According to production area, opportunity crude may be referred to by different names. For instance, opportunity crude produced in Sudan is called Dar Blend while opportunity crude produced in Chad is called Doba Blend, although characteristics of Dar Blend crude oil are substantially similar to those of Doba Blend crude oil.

[0004] As disclosed above, in order to satisfy a flash point of more than 70°C for bunker fuel C-oil produced through refining from the foregoing opportunity crude, which is a standard for defining the bunker fuel C-oil, it may be necessary to remove low boiling point components present at a concentration 3 to 4% in the opportunity crude.

[0005] For removal of such 3 to 4% low boiling point components contained in the opportunity crude, most oil refinery companies generally have conducted refining processes using corrosive materials under ordinary pressure conditions, causing severe corrosion of a refining apparatus.

[0006] The corrosive materials may contain high concentrations of salts such as calcium chloride, magnesium chloride, etc. which are decomposed at high temperature to generate hydrochloric acid, causing severe corrosion of a refining apparatus. Moreover, an acid fraction (such as a naphthenic acid fraction, content thereof often being indicated by TAN (total acid number)) may cause corrosion of a reboiler provided in a distillation column.

[0007] If a content of the acid fraction is increased, the crude oil may have a very high viscosity. The opportunity crude is in a solid state at room temperature since it has a very high TAN value, as compared to general crude oils.

[0008] The opportunity crude has less than 0.1% sulfur content. Therefore, corrosion problems caused by sulfur content are not so significant for oil refiners.

[0009] Crude oil used by the oil refiners is prepared by adding a small amount of opportunity crude to general crude oil and the amount of the opportunity crude corresponds to a capacity of a desalting device (usually an electrical desalting device, for example, a desalter manufactured by NATCO Group). The crude oil passing the desalting device is heated to 360 to 380°C in a furnace, fed into a distillation column at ordinary pressure to produce naphtha, gasoline, kerosene, diesel, etc., followed by processing under vacuum in further processes so as to recover diesel residue while generating high boiling point materials.

[0010] A content of salts contained in the crude oil passing the desalting device has been controlled to less than 1.5 parts per thousand barrels (PTB). However, with advanced desalting technologies in recent years, criterion for salt content at an outlet of the desalting device is lowered to about 0.15 PTB in order to prevent corrosion of a refining apparatus which in turn minimizes frequency of plant repair and/or maintenance, thereby improving productivity.

[0011] Meanwhile, a temperature for decomposition of magnesium chloride is about 200°C and hydrogen chloride gas is generated during decomposition. For desalting operation,

some additives such as chemicals and emulsifying agents for pH control are required. In a refinery process, a variety of corrosion inhibitors such as phosphoric acid ester are used to prevent corrosion of a reboiler caused by acid fraction.

[0012] As to direct manufacture of an alternative fuel to the bunker fuel C-oil using opportunity crude, the opportunity crude has a high salt content and increased TAN, thus often exhibiting a viscosity of about 170cP (at 60°C) which is beyond a desirable viscosity of 5cP (at 60°C) for desalting operation. As a result, the opportunity crude may not be applied to a desalting process.

[0013] Such desalting process also entails additional problems in terms of operating and installation costs. Accordingly, research and investigations into improved operating conditions for preventing corrosion and/or into development of alternative processes are required. In addition, based on such research and investigations, there is still a requirement for technologies to produce improved bunker fuel C-oil generally used as fuel. In consideration of problems in storage and/or delivery of fuel, an additional viscosity enhancer may be added to the fuel in order to supply a low viscosity fuel locally demanded by some users even when the fuel has desired flash points.

[0014] FIG. 1 shows a schematic configuration of a conventional crude oil refinery process to explain a process of refining opportunity crude.

[0015] As shown in FIG. 1, a conventional crude oil refinery apparatus includes a crude oil storage tank 10, a desalter 20, a furnace 30, an atmospheric distillation column 40 and a vacuum distillation column 50.

[0016] The crude oil storage tank 10 includes crude oil, wherein the crude oil may include various dissolved solids, such as salts, iron oxides, sands, etc.

[0017] The desalter 20 receives the stored crude oil from the crude oil storage tank 10 in order to remove a salt fraction contained in the crude oil, which is preheated to 170 to 260°C. Here, the desalter 10 may also include a small amount of opportunity crude, other additives such as chemicals and/or emulsifiers for pH control, and/or various corrosion inhibitors such as phosphoric acid ester for preventing corrosion of the apparatus caused by acid fraction.

[0018] The furnace 30 heats a mixture of crude oil and opportunity crude passed through the desalter 20 to a temperature of 360 to 380°C required for atmospheric distillation thereof. Here, the temperatures may be varied depending on distillation of crude oil or types of resulting products.

[0019] The atmospheric distillation column 40 is an apparatus for separation of the crude oil into LPG, naphtha, kerosene, diesel, bunker fuel C-oil, and so forth, based on boiling point differences. Constitutional components in the crude oil may be separated on a principle that these components have inherent evaporation characteristics at different pressures and temperatures. Briefly, the distillation column 40 may separate mixed distillates into respective ones based on internal temperatures and pressures of the column, which are classified along height of the column. Since the distillation column is operated at ordinary pressure close to atmospheric pressure, it is often called an "atmospheric distillation column."

[0020] The atmospheric distillation column 40 usually has about 30 to 40 trays therein and the oil stream in the column may be separated by contacting a liquid component, which was condensed on an upper tray and flowed downward, with a vapor component which was evaporated on a lower tray and flowed upward.

[0021] The atmospheric distillation column 40 may also remove about 3 to 4% low boiling point fraction contained in the opportunity crude.

[0022] The vacuum distillation column 50 is operated under vacuum to recover the remaining diesel residue in the oil

separated through the atmospheric distillation column 40 while producing high boiling point oil.

[0023] As for the foregoing structural oil refinery apparatus, the opportunity crude is added to general oil in a small amount satisfying a capacity of the desalter 20. The oil passing through the desalter 20 is fed into the atmospheric distillation column 40 via a furnace 30 so as to prepare naphtha, gasoline, diesel, kerosene and so forth, while vacuum operating the vacuum distillation column 50 may produce high boiling point materials. During such vacuum operation, bunker fuel C-oil widely employed as fuel may also be generated.

[0024] However, oil refinery technologies only using the opportunity crude are still not developed.

[0025] In particular, when the opportunity crude is used to directly prepare an alternative fuel to the bunker fuel C-oil, the opportunity crude having a high salt content and increased TAN as described above may not be applied to a desalting process. The desalting process encounters additional problems such as operation and/or installation at great costs.

[0026] The present invention is directed to solve the problems described above in regard to conventional technologies and an object of the present invention is to provide an apparatus for refining opportunity crude, capable

of detecting appropriate operating conditions not to influence corrosion of the apparatus and capable of refining the opportunity crude without a desalting device under vacuum operating conditions to prevent corrosion of the apparatus so as to produce bunker fuel C-oil, thereby producing low cost fuels and contributing to cost reduction.

[0027] Another object of the present invention is to provide a process for refining opportunity crude using the refinery apparatus described above.

SUMMARY OF THE INVENTION

[0028] To achieve these objects and other advantages and in accordance with the purpose of the invention, there is provided an apparatus for refining opportunity crude, including: an opportunity crude storage tank; a vacuum distillation column to receive the stored opportunity crude from the storage tank, then, to remove a low boiling point fraction under vacuum while producing bunker fuel C-oil as kerosene having a flash point of more than 70°C; and a storage part to receive and store the bunker fuel C-oil produced from the vacuum distillation column.

[0029] The present invention also provides a process for refining opportunity crude, including: receiving the opportunity crude from a storage tank and removing a low boiling point fraction under vacuum while producing bunker

fuel C-oil having a flash point of more than 70°C; chilling the low boiling point fraction to produce a low boiling point condensed oil; storing the bunker fuel C-oil having the flash point of more than 70°C; and mixing the bunker fuel C-oil having the flash point of more than 70°C with a pour point enhancing oil so as to produce a low viscosity bunker fuel C-oil.

[0030] It is to be understood that both the foregoing general description and the following detailed description are exemplary for clearly understanding objects, features and other advantages of the present invention and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0032] FIG. 1 is a schematic configuration view illustrating a process of refining opportunity crude in a conventional oil refinery apparatus;

[0033] FIG. 2 is a schematic configuration view illustrating an apparatus for refining opportunity crude according to the present invention;

[0034] FIGS. 3 and 4 are graphs showing corrosion tests by TAN; and

[0035] FIG. 5 is a flow chart illustrating a process for refining opportunity crude according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Hereinafter, other purposes, characteristics and other beneficial features of the present invention will become apparent from the following detailed description with reference to exemplary embodiments, taken in conjunction with the accompanying drawings.

[0037] FIG. 2 is a schematic configuration view illustrating an apparatus for refining opportunity crude according to the present invention.

[0038] As shown in FIG. 2, the refinery apparatus of the present invention comprises an opportunity crude storage tank 110, a heat exchanger 120, a vacuum distillation column 130, a reboiler 140, a chiller 150 and a storage part 160.

[0039] The opportunity crude storage tank 110 stores the opportunity crude wherein the opportunity crude may include various components required to be removed in order to satisfy a standard flash point for bunker fuel C-oil of more than 70°C,

for example, 3 to 4% of components with low boiling points of less than 70°C such as butane, pentane, cyclopentane, methylpentane, dimethylbutane, dimethylpentane, normal hexane, etc.

[0040] The opportunity crude may include representative salts (for example, calcium chloride, magnesium chloride, etc.) decomposed at a high temperature to generate hydrochloric acid, causing severe corrosion of an apparatus. The opportunity crude may also have large acid fraction (often indicated by TAN) such as naphthenic acids, possibly causing corrosion of the reboiler in the distillation column.

[0041] A pour point of the opportunity crude is about 38°C and the opportunity crude may be placed in the storage tank 110 at about 50°C, at which temperature the opportunity crude has a viscosity of about 250cP.

[0042] The viscosity of the opportunity crude is lower than that of the bunker fuel C-oil at a temperature above the pour point. However, owing to a content of acid fraction, the opportunity crude may become a hard solid, like chocolate, at room temperature. Accordingly, a pipeline for feeding the opportunity crude from the storage tank 110 to the vacuum distillation column 130 may have a reboiler 140 equipped with a steam jacket or a steam tracing device to prevent the opportunity crude from hardening in the pipeline.

[0043] Briefly, the heat exchanger 120 for exchanging heat between a product and a raw material to recover heat as well as the reboiler 140 supplying a heat source to the distillation column are installed between the storage tank 110 and the vacuum distillation column 130.

[0044] The following Table 1 shows a relationship between true boiling point (TBP) and yield (% by volume) of ingredients contained in the opportunity crude and Table 2 indicates representative physical properties of the opportunity crude.

[0045] TABLE 1

TBP(°C)	Less than 5°C	5 to 75°C	75 to 155°C	155 to 235°C	235 to 350°C	350 to 360°C	More than 360°C
Yield (vol%)	0.05	1.24	2.43	4.51	14.10	25.42	75.25

[0046] In view of inherent characteristics, the opportunity crude has very small distributions for gasoline and kerosene portions as compared to general crude oil. Table 1 showed results of the TBP test carried out using a 15-tray glass type distillation column with a reflux ratio of 5:1.

[0047] TABLE 2

Physical properties	Specific gravity, 15°C	Sulfur content, %	Pour point, °C	Salt, ptb	TAN, mgKOH/g	Viscosity, cST/50°C
data	0.909	0.1	38.3	2.8	4.5	450

[0048] The vacuum distillation column 130 receives the opportunity crude fed from the reboiler 140 while being heated to a certain temperature, then, removes 3 to 4% of low boiling point fraction and produces the bunker fuel C-oil having a flash point of more than 70°C.

[0049] That is, the vacuum distillation column 130 is operated under vacuum without using a desalting device so as to refine oil while preventing corrosion of an oil refinery apparatus, thereby producing the bunker fuel C-oil having a flash point of more than 70°C.

[0050] The vacuum distillation column 130 exhausts boiling ingredients at a top part while producing 96 to 97% of products at a bottom part thereof. In order to save energy and minimize heat decomposition, the vacuum distillation column is operated under optimal processing conditions for heat exchange between the product and the crude oil through the heat exchanger 120, wherein the temperature of the product obtained after heat exchange by the heat exchanger 120 is maintained at 60 to 70°C so as to manage the product in the storage part 160 and to easily load the product to a ship or tanker truck.

[0051] Table 3 shows results of an overhead cut (O/H cut) test for a distillation column under vacuum (operating at a temperature of less than 150°C for corrosion prevention) in order to determine satisfaction of flash points. Using a

theoretical 15-tray glass type distillation column, a batch mode test was carried out under non-reflux conditions and results thereof are shown in Table 3. Briefly, Table 3 shows relations between O/H cut rates at 150°C and flash points.

[0052] TABLE 3

Pressure, Kg/cm ² g	0	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8
Pressure, mmHg	0	-76	-152	-228	-304	-380	-456	-532	-608
O/H cut, %	0.8	1.2	1.4	1.7	2.1	2.6	3.2	-	-
Btm flash point, °C	-	-	-	58	68	72	76	-	-

[0053] Table 4 shows results of an O/H cut test for a distillation column under vacuum (operating at a temperature of less than 130°C for corrosion prevention) in order to determine satisfaction of flash points. Using a theoretical 15-tray glass type distillation column, a batch mode test was carried out under non-reflux conditions and results thereof are shown in Table 4. Briefly, Table 4 shows relations between O/H cut rates at 130°C and flash points.

[0054] TABLE 4

Pressure, Kg/cm ² g	0	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8
Pressure, mmHg	0	-76	-152	-228	-304	-380	-456	-532	-608
O/H cut, %	-	-	-	0.6	0.9	1.3	1.7	2.4	3.3
Btm flash point, °C	-	-	-	-	-	-	57	70	77

[0055] The chiller 150 condenses the low boiling point fraction separated from the vacuum distillation column 130

then liquefies the same by a vacuum pump (not shown), so as to minimize a capacity of the vacuum pump while stably operating the distillation process.

[0056] More particularly, if the chiller 150 is mounted on a front end of a vacuum pump to liquefy the low boiling point fraction, thus considerably reducing a capacity of the vacuum pump while stably operating the distillation process. Therefore, it may be possible to eliminate the conventional problem in that a large scale vacuum pump to remove 3 to 4% of low boiling point fraction is required to satisfy the flash point of more than 70°C using the vacuum distillation column 130.

[0057] Table 5 shows results of operating a theoretical 10-tray pilot distillation column under vacuum. Table 5 indicates results of a continuous mode operation while Tables 3 and 4 show results of batch mode operations. A condenser comprises a chiller using dry ice in order to condense the lower boiling fraction by non-reflux operation.

[0058] TABLE 5

	unit	1	2	3	4	5	6	7	8	Average
Operating pressure	mmHg	450	453	455	450	455	450	458	455	453.25
Bottom temperature	°C	150	148	147	151	147	150	146	147	148.25
Fuel feed temperature	°C	55	55	55	55	55	55	55	55	55
Fuel	l/Hr	15	15	15	15	15	15	15	15	15

feed content										
O/H cut content	cc/Hr	485	480	480	485	480	490	480	485	483.13
O/H chlorine	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
Btm Flash point	°C	75	72	72	75	72	76	72	75	73.63
Btm pour point	°C	40.2	40.3	40.3	40.5	40.3	41.1	40.3	40.3	40.41
Btm viscosity	cSt, 50°C	450	450	450	450	450	450	450	450	450
Btm TAN	ptb	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

[0059] Table 5 shows results of a test carried out by taking eight (8) samples at 3 hour intervals after the operating process is stabilized, condensing O/H low boiling point materials (less than 5°C, 5 to 75°C) at less than 5°C through dry ice, and collecting the condensed materials.

[0060] The chiller 150 uses dry ice to condense the separated low boiling point fraction from the vacuum distillation column 140 and discharges the condensed oil having a low boiling point.

[0061] The storage part 160 receives and stores the distilled bunker fuel C-oil from the vacuum distillation column 130, receives a pour point enhancing oil from outside, and blends the stored bunker fuel C-oil with the pour point enhancing oil to prepare a low viscosity alternative to the bunker fuel C-oil.

[0062] In this regard, the pour point enhancing oil is added to the bunker fuel C-oil in order to satisfy inherent

flash point of a product, since some consumers demand easy handling and/or management of the product at room temperature. Therefore, the pour point enhancing oil as an oil composite with a high boiling point and a relatively low viscosity may be effectively used to produce the alternative oil.

[0063] FIGS. 3 and 4 are graphs illustrating results of corrosion tests using TAN.

[0064] As shown in FIGS. 3 and 4, according to data disclosed in Critical Review of Naphthenic acid corrosion (paper No. 380), SET Laboratories, Inc. (12873 Capricorn Drive Stafford, Texas, USA), it can be seen that corrosion caused by TAN does not occur at a temperature of less than 150°C.

[0065] Table 6 shows results of a test upon a mixture obtained by adding the pour point enhancing oil to a product from the opportunity crude refinery.

[0066] TABLE 6

Btm, %	98	95	93	90	88	
Oil composite, %	2	5	7	10	12	Economical oil mixture
Pour point, °C	39.1	36.4	33.5	30.5	26.5	

[0067] As shown in Table 6, the pour point of the opportunity crude product was about 40°C, which is higher than that of B-heavy oil (Bunker-B, pour point of 10°C) and that of C-heavy oil (Bunker-C, pour point of 30°C or more). In order to impart the opportunity crude product with fluidity at room

temperature which in turn enables easy use thereof, a low viscosity oil composite was added to the product and the mixture was tested. From the test results, it was found that adding 10 to 12% of oil composite to the product produces an economical oil mixture.

[0068] FIG. 5 shows a flow chart illustrating a process for refining the opportunity crude according to the present invention.

[0069] As shown in FIG. 5, the opportunity crude refining process of the present invention includes placing the opportunity crude in an opportunity crude storage tank S100.

[0070] Here, some components which are required to be removed in order to satisfy a standard flash point for bunker fuel C-oil of more than 70°C, for example, some components with low boiling points of less than 70°C such as butane, pentane, cyclopentane, methylpentane, dimethylbutane, normal hexane, and so forth, are included in an amount of 3 to 4% in the opportunity crude.

[0071] In other words, the opportunity crude may include representative salts (for example, calcium chloride, magnesium chloride, etc.) decomposed at a high temperature to generate hydrochloric acid, causing severe corrosion of an apparatus. The opportunity crude may also have large acid fraction (TAN) such as naphthenic acids, possibly causing corrosion of the reboiler provided in the distillation column.

[0072] A pour point of the opportunity crude is about 38°C and the opportunity crude may be placed in the storage tank at about 50°C, at which temperature the opportunity crude has a viscosity of about 250cP.

[0073] The viscosity of the opportunity crude is lower than that of the bunker fuel C-oil at a temperature above the pour point. However, owing to a content of acid fraction, the opportunity crude may become a hard solid, like chocolate, at room temperature.

[0074] A pipeline for feeding the opportunity crude from the storage tank to the vacuum distillation column may have a steam jacket or a steam tracing device for heating the opportunity crude to a desired temperature, so as to prevent the opportunity crude from hardening in the pipeline S120.

[0075] The vacuum distillation column exhausts boiling ingredients at a top part while producing 96 to 97% of products at a bottom part thereof. In order to save energy and minimize heat decomposition, the vacuum distillation column is operated under optimal processing conditions for heat exchange between the product and the crude oil through the heat exchanger S130.

[0076] In this case, the temperature of the product obtained after heat exchange by the heat exchanger is maintained at 60 to 70°C so as to manage the product in the

storage part and to easily load the product to a ship or a tanker truck.

[0077] Next, a heavy oil and/or bunker fuel C-oil alternative is produced from the opportunity crude stored in the storage tank while removing about 3 to 4% of low boiling fraction contained in the opportunity crude under vacuum S140.

[0078] Then, the low boiling point fraction is subjected to chilling under vacuum and condensation using a vacuum pump to produce low boiling point condensed oil S150.

[0079] The heavy oil and/or bunker fuel C-oil alternative obtained under vacuum is stored S160.

[0080] In addition, a pour pint enhancing oil is added to the produced heavy oil and/or bunker fuel C-oil alternative to finally produce a low boiling point alternative to bunker fuel C-oil S170.

[0081] The apparatus and process for refining opportunity crude according to the present invention has the following functional effects:

[0082] First, neither additives for preventing corrosion caused by TAN nor desalting device is required for operating a distillation column for the opportunity crude, wherein the opportunity crude is refined while preventing corrosion of an apparatus for refining the opportunity crude so as to produce a heavy oil (bunker fuel C-oil) alternative fuel having a

flash point of more than 70°C, thereby embodying an economical refinery process.

[0083] Second, a chiller is mounted on a front end of a vacuum pump to liquefy 3 to 4% of low boiling fraction, which is required to be removed by vacuum operation so as to satisfy a desired flash point, thereby minimizing a capacity of the vacuum pump, stably operating the distillation process, and maximally recovering effective ingredients from the opportunity crude.

[0084] Third, 96 to 97% of resulting product is obtained at a bottom part of the distillation column during the refinery process. In order to save energy and minimize heat decomposition, the product is heat exchanged with the crude oil and the temperature of the product obtained after heat exchanging is maintained at 60 to 70°C so as to manage the product in the storage tank and to easily load the product to a ship or tanker truck, thus saving energy and considerably reducing a size of heat source supply installation which in turn decreases investment costs.

[0085] Fourth, since some consumers demand easy handling and/or management of the product at room temperature, a pour point enhancing oil as an oil composite with a high boiling point and a relatively low viscosity may be effectively added to the product in order to satisfy inherent flash point of the product and to improve the pour point of the product,

thereby increasing product sales and ensuring economical merits thereof through diversification of existing markets for the product.

[0086] Although technical constructions and other features of the present invention have been described, it will be apparent to those skilled in the art that the present invention is not limited to the exemplary embodiments and accompanying drawings described above but may cover substitutions, variations and/or modifications thereof without departing from the scope of the invention defined in the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus for refining opportunity crude, comprising:

an opportunity crude storage tank;

5 a vacuum distillation column which receives the stored opportunity crude from the storage tank, then, removes a low boiling point fraction under vacuum while producing bunker fuel C-oil as a kerosene having a flash point of more than 70°C;

a storage part to receive the produced bunker fuel C-oil from the vacuum distillation column;

10 a reboiler for heating the opportunity crude flowing from the storage tank to the vacuum distillation column to a certain temperature;

a chiller for rapidly chilling the low boiling point fraction exhausted from the vacuum distillation column to produce a low boiling point condensed oil; and

15 a heat exchanger placed between the opportunity crude storage tank and the vacuum distillation column to exchange heat between a product and a raw material so as to recover the heat.

2. The apparatus according to claim 1, wherein the low boiling point fraction is exhausted at a top part of the vacuum distillation column and the bunker fuel C-oil having the
20 flash point of more than 70°C is discharged from a bottom part of the vacuum distillation column.

3. The apparatus according to claim 1, further comprising a vacuum pump for discharging the low boiling point condensed oil generated in the chiller.

25 4. The apparatus according to claim 1, wherein a pour point enhancing oil is added to the storage part to produce a low boiling point bunker fuel C-oil.

5. The apparatus according to claim 1, wherein the storage part stores the bunker fuel C-oil at 60 to 70°C.

6. The apparatus according to claim 1, wherein the vacuum distillation column is operated to treat the opportunity crude at 110 to 150°C under vacuum.

5 7. The apparatus according to claim 1, wherein the vacuum distillation column is operated in a batch mode or a continuous mode to produce the bunker fuel C-oil.

8. The apparatus according to claim 1, wherein a pipeline for feeding the opportunity crude from the storage tank to the vacuum distillation column is equipped with a steam jacket or
10 a steam tracing device to prevent the opportunity crude from hardening in the pipeline.

9. A process for refining opportunity crude, comprising:
receiving the opportunity crude from a storage tank and removing a low boiling point fraction under vacuum while producing bunker fuel C-oil having a flash point of more than
15 70°C;

chilling the low boiling point fraction to produce a low boiling point condensed oil;

storing the bunker fuel C-oil having the flash point of more than 70°C; and

mixing the bunker fuel C-oil having the flash point of more than 70°C with a pour point enhancing oil so as to produce a low viscosity bunker fuel C-oil.

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10. The process according to claim 9, wherein the chilling is performed using dry ice to condense the low boiling point fraction.

11. The process according to claim 9, wherein a pour point enhancing oil is added to the
25 bunker fuel C-oil in an amount of 10 to 12%.