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METHOD FOR DISPOSAL OF CRUDE OIL RESIDUES CONTAINED IN MARINE TANKER CARGO COMPARTMENTS**Edward G. Maddock, Fairlawn, N.J., assignor to Cities Service Tankers Corporation, New York, N.Y., a corporation of Delaware****No Drawing. Filed May 2, 1966, Ser. No. 546,547****4 Claims. (Cl. 114—74)****ABSTRACT OF THE DISCLOSURE**

A method for disposing of crude oil residues remaining in tanker cargo tanks by washing the tanks with water, settling the resulting water-oil mixture to effect separation into water and oil layers and utilizing the recovered crude oil from the oil layer as fuel for the propulsion system of the tanker.

This invention relates to a method for disposing of crude oil residues remaining in marine tanker cargo compartments after the bulk of the crude has been discharged therefrom.

Since the end of World War II, pollution of the seas by crude oil has become an increasingly serious problem. One cause of pollution has been the practice of washing the crude oil vessel's tanks at sea and discharging the washings or "slops" overboard. More particularly, in the operation of a tanker it is necessary to clean from about $\frac{1}{4}$ to about $\frac{1}{2}$ of the cargo tanks on the return voyage to the loading port, and refill these tanks with sea water as ballast to enable the tanker to be safely handled during the berthing operation, after which the clean ballast water is pumped overboard to make room for fresh crude oil cargo. For many years it was the practice of the industry to pump the slops recovered from the tank cleaning operation overboard in non-prohibited areas on the ballast voyage to the loading port. However, even though carried out at a considerable distance from land, the discharge of slops has added to the pollution of the seas and the concomitant killing of marine, plant and bird life as well as great damage to coasts and beaches.

More recently, a method known as "load-on-top" has been proposed to restrict pollution of the seas due to the pumping of slops overboard. In accordance with this method, the tank washings are collected in one or more of the ship's cargo tanks, commonly called "slop tanks."

The slops are permitted to settle in the slop tanks to effect separation into an oil phase floating on top of a water phase. The water is then slowly withdrawn from the bottom of the tank and discharged to the sea until an oil slick is observed in the discharge. At this point, there is left in the bottom of the slop tank a small amount of free water on top of which is a layer of oil residue which contains some water emulsified therewith. Fresh crude oil cargo is loaded on top of the retained oily residue when the vessel reaches the loading port, and the whole is discharged together at the discharge port, e.g. a refinery.

The "load-on-top" system has a number of serious disadvantages, among which is the fact that some refineries object to receiving cargo contaminated with the oily residues from tank washings. One reason for the refineries' position is that the salt water present with the oil recovered from the tank washings causes serious corrosion of the metal work in the refinery units.

Accordingly, it is one object of the present invention to provide a method for disposing of crude oil residues remaining in cargo tanks after the bulk of the crude has been discharged therefrom.

It is another object of the invention to provide a

method for disposing of tanker crude oil residues without polluting the seas.

It is still another object of the invention to efficiently utilize the crude oil residues recovered from unloaded cargo tanks.

Various other objects and advantages of the invention will become apparent to those skilled in the art from the following detailed description thereof.

Briefly, the present invention contemplates washing one or more dirty crude oil tanks in the usual manner to form a mixture of oil and water, sometimes referred to hereinafter for simplicity as "slops," passing the slops to a settling zone to effect separation thereof into a lower water layer and an upper oil layer, and thereafter discharging a major portion of the water contained in the settling zone, substantially free of oil, overboard from the tanker, and recovering a mixture of substantially all of the oil and a minor amount of water and ultimately burning the oil. An important advantage of the invention is that the heat given off by burning the recovered crude oil may be efficiently utilized. Thus, in accordance with a preferred embodiment of the invention, the recovered crude oil may be utilized as a fuel for the propulsion system of the tanker. For example, the recovered crude oil may be supplied to one or more burners associated with the steam generating machinery to generate steam for operating the vessel's propulsion system.

More particularly, the washing of the unloaded cargo tanks may be accomplished by employing conventional industry practices and equipment designed for this purpose. In most modern tankers, the tank cleaning operation is accomplished mechanically by the Butterworth System, in accordance with which water and steam under high pressure are sprayed into the unloaded tank by means of a revolving spray head lowered therein. Washing the tank by the Butterworth System effectively removes crude oil residue from the interior walls and bottoms of the tank.

As was noted above, it is common practice on the ballast voyage of a tanker to thoroughly clean from about $\frac{1}{4}$ to about $\frac{1}{2}$ of the cargo tanks. The slops from each tank cleaned are, in accordance with the invention, consolidated in a lesser number of slop tanks than the cargo tanks washed, and are permitted to settle therein to effect separation of the slops into an oil phase and a water phase. Preferably, a single slop tank is used for this purpose. After the slops are transferred from the cleaned cargo tanks, the tanks may be filled with sea water as ballast to provide the tanker with sufficient stability and trim so that it can be safely handled during the berthing operation at the loading port. After berthing is complete, the clean sea water ballast is pumped overboard prior to loading crude oil cargo.

The consolidated slops from the tank cleaning operation are permitted to settle in the slop tank for a sufficient period of time to permit the formation of a lower water layer and an upper oil layer. If desired, conventional demulsification agents, which may, for example, be of the imide azaline type, or mechanical treatments may be utilized to effect a more rapid and complete breaking of the water-oil emulsion. In the case of certain crude oils, there will be a relatively sharp interface between the water and oil layers. However, in the case of other crude oils, for example certain Venezuelan crudes, the water and oil layers will be separated by an intermediate water-oil emulsion layer.

As noted above, following settling of the slops, a major portion of the water is discharged overboard from the tanker substantially free of oil and a mixture of substantially all of the oil with a minor amount of water is recovered from the slops tank. Separation of the water and oil layers formed in the slops tank may be accomplished in

a number of suitable ways. For example, a major portion of the water layer, e.g. 65% to 95% thereof, may be withdrawn from the bottom of the tank, leaving therein the oil layer, a small amount of free water and any oil-water emulsion not broken. In accordance with another suitable procedure, the oil layer and any oil-water emulsion layer which may be present, as well as a small amount of free water, e.g. up to about 35% of the total amount of water, may be skimmed off the top, for example by means of a pump floating on the oil. The water remaining in the slops tank may then be discharged overboard.

Since the water discharged overboard from the slops tank is substantially oil-free, it does not cause any significant pollution of the seas. Desirably, the discharge water will contain less than about 500 parts of oil per million parts of water, preferably less than about 100 p.p.m. of oil.

An important aspect of my present process is that the oil recovered from the tank slops is subsequently disposed of by burning. In accordance with a preferred embodiment of the invention, the heat given off by burning the oil is utilized. For example, it is contemplated by the invention to employ the recovered crude oil as a fuel for the propulsion system of the tanker. Thus, the crude oil may be supplied as the fuel to one or more burners in a steam generator, e.g. boiler, used to supply steam for driving the engines of the tanker.

In the case of crude oils characterized by a flash point of below 150° F., the apparatus disclosed and claimed in the copending application of Robert C. Morrell, Ser. No. 542,641, filed Apr. 14, 1966, may be advantageously employed for safely burning the crude oil as a fuel for generating steam to operate the vessel's propulsion system. In accordance with this apparatus, all crude oil conduits and valves located in the power plant area of the tanker, i.e. the boiler room and engine room, are arranged in a manner such that free oil vapors and drippings are not permitted to come in contact with any source of ignition in the power plant. For this purpose, the various oil-carrying conduits and valves required in the boiler room for supplying the crude oil to the burners may be mounted on the front of the boiler and covered by a hood arrangement which is vented to the atmosphere. A drip pan covered by a flame screen of suitable mesh size which would permit oil to enter the drip pan, but which would contain any fire developing therein, is positioned below the hood to collect any crude oil drippings from the valves and piping mounted on the boiler front. All crude oil-carrying conduits extending through the power plant area and not protected by the hood are, in accordance with the Morrell copending application, enclosed in a vapor tight duct.

Thus, when the crude oil recovered from the slops has a relatively low flash point, e.g. below 150° F., it may be pumped from the compartment in which it is collected to one or more burners associated with the steam generating apparatus of the tanker through a supply conduit which is enclosed in a vapor tight duct along the sections thereof which are located in the power plant area of the tanker, but are not covered by the protective hood.

However, when the crude oil recovered from the slops is characterized by flash point above 150° F., there is no need to provide the burning system with the above-noted safety features contemplated by the copending Morrell application. Thus, the crude oil may be supplied from the compartment in which it is recovered from the slops to the burners of the steam generator in a manner similar to that which is conventionally used for supplying bunker C or other high flash point fuels to the burners.

The crude oil recovered from the slops tank will, of course, contain water as well as various inorganic salts, which may be present in amounts up to about 60 pounds or more per 1000 barrels of crude. Due to the salts and water mixed therewith, difficulties may sometimes be experienced in burning the crude, and it is, therefore, desir-

able to regularly burn the crude in one or two burners of the steam generating machinery rather than in all of the boilers. This practice precludes a complete "blackout" occurring on the vessel, and furthermore minimizes corrosion difficulties. The corrosion problem may be alleviated by substantially reducing the salt content of the crude oil subject to burning. Thus, in accordance with a preferred embodiment of the invention, the crude oil subjected to burning contains less than about 20 pounds of inorganic salts per 1000 barrels of oil, preferably less than about 6 pounds/1000 barrels of oil. Instruments such as the "Salt-in-Crude Monitor," manufactured by Precision Scientific Development Company, are commercially available for use in determining the salt content of the crude oil. Furthermore, it is preferred that the water content of the crude oil subjected to burning be less than about 20% by weight, and more desirably less than about 5% by weight.

Accordingly, when the crude oil recovered from the slops tank contains excessive quantities of salts and water, it may be subjected to various chemical and/or mechanical treatments prior to burning for the purpose of reducing the salt and water contents to within the preferred ranges, just-noted. A particularly effective treatment involves passing the mixture of oil, oil-water emulsion and small amounts of free water recovered from the slops tank to a secondary settling tank having a vertical height greater than its diameter and a smaller volume than the slops tank. The salt-containing oil-water mixture is permitted to settle in the secondary settling tank to permit further separation into an upper oil layer and a lower water layer. A portion of the oil layer is recovered, for example by skimming off the top and is in a suitable condition for burning. The remaining salt-containing mixture of oil and water may then be centrifuged to effect more complete separation into an oil layer and a water layer. Following centrifuging, substantially all of the oil is recovered, e.g. by skimming off the top, and passed to the burners with the portion of oil previously recovered. The remaining salt water may be pumped overboard, particularly if the oil content thereof is sufficiently low, e.g. less than about 500 p.p.m., preferably less than about 100 p.p.m. Alternatively, the salt water may be retained on board to be combined with slops obtained from future tank cleaning operations.

While the invention has been described above in connection with certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as expressed in the appended claims.

Therefore, I claim:

1. Method for use on a crude oil tanker proceeding from a discharge port to a loading port which comprises:
 - (a) subjecting from about 1/4 to about 1/2 of the unloaded cargo tanks of the tanker, which tanks contain a residual quantity of crude oil, to thorough washing with water to form a mixture of water and crude oil, said mixture also containing inorganic salts;
 - (b) consolidating the salt-containing water-oil mixtures obtained from washing each tank in a first settling tank and therein effecting separation thereof into a first upper oil layer and a first lower water layer;
 - (c) discharging from about 65% to about 95% of said separated water substantially free of oil from the tanker and recovering a salt-containing mixture of substantially all of said separated oil and from about 5% to about 35% of said water;
 - (d) passing the salt-containing oil-water mixture recovered from said first settling tank to a second settling tank and therein effecting separation thereof into a second upper oil layer and a second lower water layer;
 - (e) recovering a portion of the separated oil from said

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second upper oil layer, and centrifuging a salt-containing mixture of said water and the remaining portion of said oil to effect separation into a third upper oil layer and a third lower water layer;

- (f) recovering substantially all of the oil from said third upper oil layer;
 - (g) burning said portions of oil recovered in steps (e) and (f) for fuel for the propulsion system of the tanker, said oil fuel containing less than about 20 lbs. of inorganic salts per 1000 barrels of oil and less than about 20% by weight water; and
 - (h) filling said washed cargo tanks with clean water as ballast.
2. Method as in claim 1 wherein said second settling tank has a substantially greater vertical height than diameter, and is smaller volume than said first settling tank.
3. Method for disposal of crude oil residues remaining in a plurality of cargo tanks of a marine tanker after the bulk of the crude oil cargo has been discharged therefrom which comprises:
- (a) subjecting a plurality of unloaded cargo tanks of the tanker, which tanks contain a residual quantity of crude oil, to thorough washing with water to form a mixture of water and crude oil;
 - (b) consolidating the water-oil mixtures obtained in step (a) in a first settling tank and therein effecting separation of such mixtures into a first upper oil layer and a first lower water layer;
 - (c) discharging from about 65 to about 95% of said separated water substantially free of oil from the tanker and recovering from the first settling tank all of said separated oil and from about 5% to about 35% of said water;
 - (d) subsequently introducing recovered oil and water into a second settling tank having a substantially greater height than diameter and being of smaller volume than said first settling tank and in said second settling tank effecting separation of oil and water into a second upper oil layer and a second lower water layer; and
 - (e) recovering oil from said second oil layer and burning the same for fuel in the propulsion system of the tanker.
4. Method for use on a crude oil tanker proceeding from a discharge port to a loading port which comprises:
- (a) subjecting a plurality of the unloaded cargo tanks

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of the tanker, which tanks contain a residual quantity of crude oil, to thorough washing with water to form a mixture of water and crude oil, said mixture also containing inorganic salts;

- (b) consolidating the salt-containing water-oil mixtures obtained from washing each tank in a first settling tank and therein effecting separation thereof into a first upper oil layer and a first lower water layer;
- (c) discharging from about 65% to about 95% of said separated water substantially free of oil from the tanker and recovering a salt-containing mixture of substantially all of said separated oil and from about 5% to about 35% of said water;
- (d) passing the salt-containing oil-water mixture recovered from said first settling tank to a second settling tank and therein effecting separation thereof into a second upper oil layer and a second lower water layer;
- (e) recovering a portion of the separated oil from said second upper oil layer, and treating a salt-containing mixture of said water and the remaining portion of said oil to effect separation into a third upper oil layer and a third lower water layer;
- (f) recovering substantially all of the oil from said third upper oil layer;
- (g) burning said portions of oil recovered in steps (e) and (f) for fuel for the propulsion system of the tanker, said oil fuel containing less than about 20 lbs. of inorganic salts per 1000 barrels of oil and less than about 20% by weight water; and
- (h) filling said washed cargo tanks with clean water as ballast.

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