

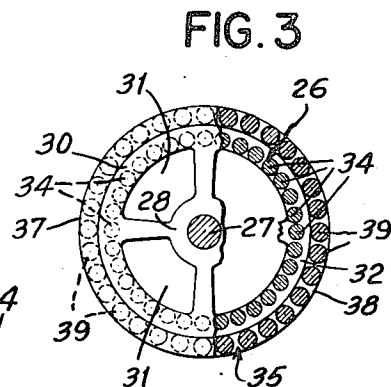
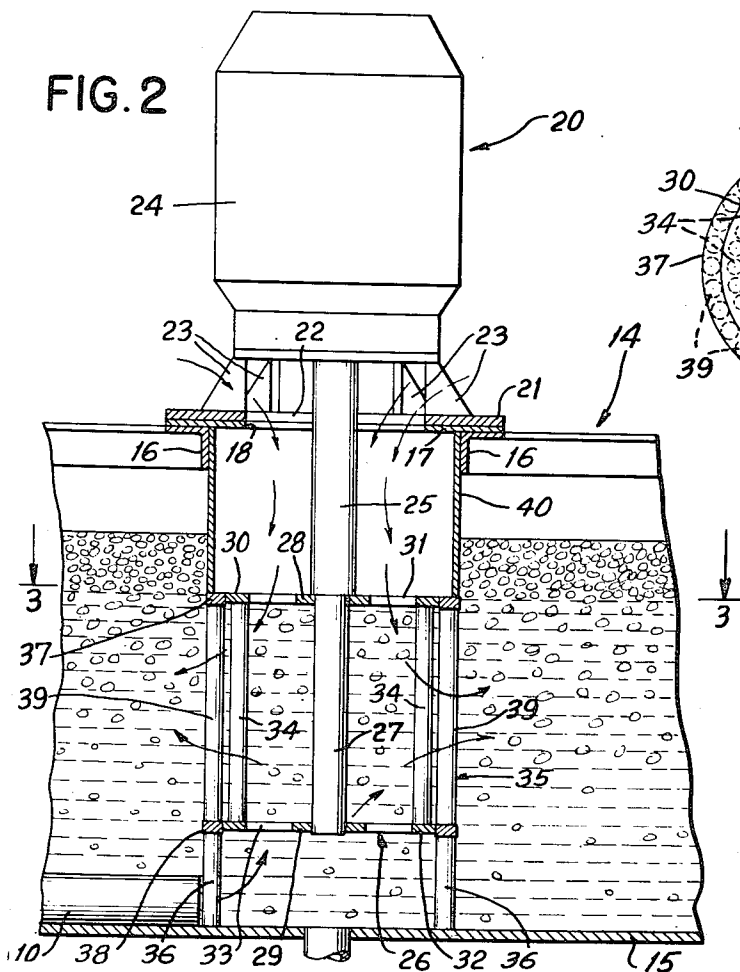
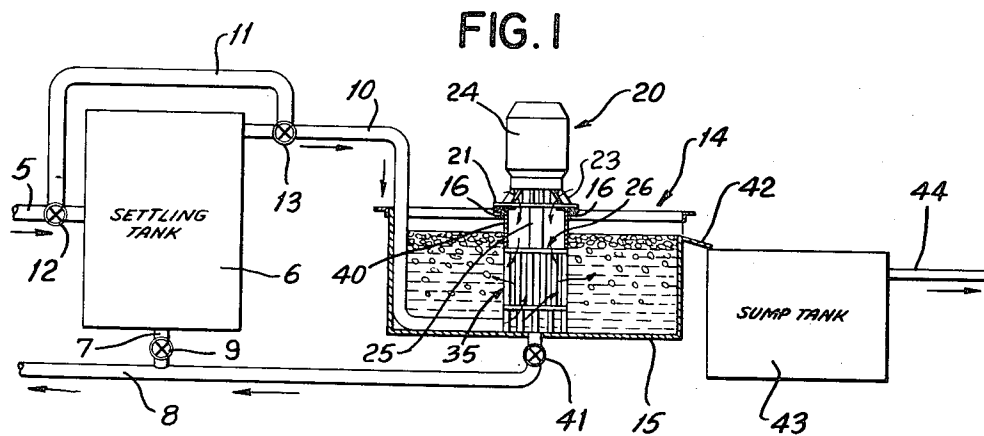
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METHOD OF AND APPARATUS FOR REMOVING ENTRAINED MOISTURE FROM OIL

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**METHOD OF AND APPARATUS FOR REMOVING
ENTRAINED MOISTURE FROM OIL**

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This invention relates to a novel method and apparatus for removing entrained or occluded moisture from substantially water-immiscible liquid compositions.

While the invention may be advantageously employed for the removal of entrained or occluded moisture from various water-immiscible liquids, such as vegetable oils and the like, it is particularly useful in removing moisture which causes haze to appear in fuel oils, lubricating oils, diesel oils and the like, and is hereinafter described with reference to the treatment of such liquids. But, as will be obvious from the description that follows, the method and apparatus of this invention are broadly applicable to the removal of entrained moisture from water-immiscible compositions which are liquid at the operating temperature and are not injured by intimate contact with the air or other gas used in the method as the moisture absorbing and removing agent.

Fuel oils, lubricating oils, diesel oils and the like, during storage and transportation, usually develop haze, that is, water clouds due to entrainment of moisture particles. Also, as a consequence of certain oil refinery operations, the amount of haze in the oils is frequently increased.

Oil refineries have, for many years, experienced considerable difficulty in removing haze from their oils for the purpose of obtaining clear and bright oils. The methods heretofore employed by such refineries for the removal of haze have been unsatisfactory because of high initial, maintenance and operating costs.

The present invention provides a novel, efficient and relatively inexpensive method and apparatus for dehazing such oils and equivalent water-immiscible liquids.

Accordingly, the primary object of this invention is to provide an improved method and apparatus for removing entrained or occluded moisture from substantially water-immiscible liquid compositions, such as various hydrocarbon oils.

Another object of the invention is to provide an improved method for dehazing oils, whereby to render the same brighter and clearer.

A further object of the invention is to reduce the moisture content of substantially water-immiscible liquid compositions, such as oils having entrained moisture, in a simple, effective and economical manner.

To the end that the foregoing objects may be readily attained, a preferred and recommended method of practicing the invention comprises simultaneously introducing a moisture-containing hydrocarbon oil and air into a treating zone. The oil is subjected to vigorous mechanical agitation in the treating zone, thereby effecting intimate contact between the air and the oil, to obtain a mixture of the ingredients; and the mixture is successively compressed and permitted to expand to effect separation of moisture particles from other components of the composition and absorption of the moisture particles by the air in the mixture. The air carrying absorbed moisture particles produces foam bubbles which rise to the surface of the oil in the treating zone. The foam and treated

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oil are transmitted into a settling tank, where the foam is permitted to break, allowing the air-absorbed moisture to escape, and the treated oil, now in clear, bright condition, is withdrawn.

The oil admitted into the treating zone is at a temperature substantially below its flash point and preferably within the range of 90 to 170° F., depending on the type and characteristics of the oil. The air admitted into the treating zone may be at atmospheric pressure and temperature. While air is preferred for reasons of economy, any other suitable gas that is non-reactive with oil and that is capable of absorbing moisture may be used in lieu of air. Therefore, the expression "air," as used in this description and in the claims, has reference to air, gases that may be used in place of air, or combinations thereof.

The compression and expansion of the mixture, referred to above, is caused in part by the forcing of the mixture between the staves of the rotor and stator and in part by the turbulence, or eddying wake, due to the mixture flowing around the staves, thereby creating varying pressures within the mixture.

The enumerated objects, as well as other objects, together with the advantages attainable by the practice of this invention, will be readily understood by persons skilled in the art, from the detailed description that follows, taken in conjunction with the accompanying drawing, that respectively describe and illustrate a preferred arrangement of apparatus for carrying out the invention.

In the drawing:

Fig. 1 is a generally schematic representation of the apparatus, certain parts being shown in central, vertical cross-section.

Fig. 2 is an enlarged view of a portion of Fig. 1, certain additional parts being shown in vertical cross-section; and

Fig. 3 is a view taken along line 3—3 of Fig. 2, parts being omitted for better illustration of other parts.

Referring now to the drawing, wherein like reference numerals denote corresponding parts in the various views, and more particularly to Fig. 1, a supply conduit 5 transmits oil to be treated from a source (not shown) to a settling tank 6. Tank 6 is utilized in instances where the oil contains free water. The free water settles from the oil in this tank and is withdrawn by way of a drain conduit 7, which establishes communication between the bottom of the tank and a water discharge conduit 8. Withdrawal of water from tank 6 is controlled by a valve 9 in conduit 7. Oil and residual entrained moisture collect in the upper portion of the settling tank and are withdrawn by way of an oil feed conduit 10.

If the oil to be treated does not contain a substantial quantity of free water, it may be transmitted from conduit 5 to conduit 10 by way of a conduit 11 that bypasses tank 6. Three-way valves 12 and 13, at the junctures of conduit 11 with conduits 5 and 10, respectively, are ported so as to control the flow of oil either through the tank or through the bypass conduit, as desired. In either case, the oil is next transmitted into a treating zone 14.

The treating zone comprises a tank 15 having an open top, across which there is provided a pair of angle supports 16. A plate 17 having a central opening 18 (Fig. 2) is secured to the angle supports. Mounted on plate 17 is a driving unit 20 that includes a base plate 21, having a central opening 22 aligned with opening 18 in plate 17, a plurality of spaced upstanding support members 23 and an explosion-proof electric motor 24, carried by members 23. The motor includes a rotary driving shaft 25 that extends into tank 15.

The driving unit is adapted to actuate a means positioned in tank 15, whereby to impart vigorous agitation

to and effect compression of materials admitted into the tank. This means, which will now be described, comprises a rotor 26 having a shaft 27 secured to the lower end of shaft 25 and rotatable therewith. The rotor also includes a pair of spaced parallel spiders 28 and 29 that are secured to opposite ends of shaft 27. Spider 28 has a rim 30 and is provided with a plurality of openings 31. Spider 29 is preferably identical with spider 28 and is provided with a rim 32 and openings 33. Disposed between rims 30 and 32 is a plurality of cylindrical, spaced-apart staves 34, best shown in Figs. 2 and 3.

Coaxial with and spaced from rotor 26 is a stationary stator 35, which includes a plurality of legs 36, a pair of parallel rings 37 and 38 and a plurality of cylindrical staves 39. These staves are parallel and spaced from each other and from staves 34. Staves 34 and 39 are similar in configuration and relative position to the corre-

through the openings between the staves of the rotor and the stator and, in the course of such movement, is compressed and then permitted to expand. As the mixture is forced through the openings between the staves of the rotor and those of the stator, oil-moisture or moisture-oil cells contained in the mixture are broken down, effecting separation of moisture particles from the oil. As the mixture expands, on passing outwardly beyond the stator staves, the moisture particles are absorbed by the air, in the form of foam which rises in tank 15. This foam and treated oil are transmitted by spillway 42 into sump tank 43, where the foam breaks and escapes to the atmosphere and the treated oil, now in bright and clear condition, is withdrawn by way of conduit 44.

Examples of refinery runs and results obtained by treating hydrocarbon oils in accordance with this invention and employing systems of apparatus, as above described, are set forth in the following tables:

Run No.	1		2		3		4		5		6	
Duration of Run in Hours	2		.75		2		2		2.25		3	
Charge Stock	Eastern Venezuela Virgin Oil.		Eastern Venezuela Virgin Oil.		Southern Louisiana Virgin Oil.		Kuwait Virgin Oil.		Untreated Catalytic Cracked Oil.		Western Venezuela Virgin Oil.	
Temperature of Stock in Treating Zone in °F.	101		99		104		108		109		108	
	a	b	a	b	a	b	a	b	a	b	a	b
Moisture Content of Charge Stock in p.p.m.	174	236	103	253	88	91	172	613	233	464	120	194
Moisture Content of Product in p.p.m.	104	105	67	86	62	63	148	148	96	128	61	66
Moisture Removed in p.p.m.	70	131	36	167	26	28	24	465	137	336	59	128
Weight Percent of Water Removed	40.2	55.5	35.0	66.0	29.5	30.8	14.0	75.9	58.8	72.5	49.2	66.0

In the table:

"p. p. m." denotes parts of moisture per million parts of oil, "a" refers to composite specimens, "b" refers to averages of specimens taken at the start, middle and end of the corresponding run.

sponding staves disclosed in Fagergren Patent 1,963,122, to which reference may be had for further details of construction.

An imperforate tubular air chamber 40 is positioned between stator ring 37 and plate 17. Air from the atmosphere is admitted into the rotor by way of the spaces between members 23, opening 22 in plate 21, opening 18 in plate 17, the interior of air chamber 40 and openings 31 in spider 28, in the order named.

As is shown in Fig. 1, feed conduit 10 extends downwardly along the side wall of tank 15 and thence along the bottom wall of that tank, terminating at stator 35, whereby to discharge oil to be treated in the region directly below rotor 26. Also, water discharge conduit 8 communicates with the interior of tank 15 and is provided with a control valve 41 for withdrawing accumulated water from this tank, as required.

A spillway 42 (Fig. 1) is secured to tank 15 and empties into a suitable receptacle, such as a sump tank 43, which receives foam and treated liquid from the upper portion of tank 15. Treated oil is withdrawn from tank 43 by a conduit 44.

For the purpose of briefly outlining the mode of operation of the above described system of apparatus, it is first assumed that oil, which does not contain an appreciable quantity of free water, is being transmitted by feed conduit 10 to the region of tank 15 below rotor 26, and that driving unit 20 is in active service, thereby imparting rotation to the rotor. The oil moves upwardly into the rotor through openings 33 in spider 29. The rotor imparts vigorous stirring and agitation to the oil in the stator. Due to the rapid movement of the oil in the rotor, a partial vacuum is created therein and air is inspirated into the rotor through the openings earlier described. The air so admitted into the rotor is brought into intimate contact with the oil and dispersed therein, in the form of fine bubbles. The resulting mixture of oil and air is moved outwardly, by centrifugal action,

The solubility of water in hydrocarbon oil is commonly known as the "haze point" of the oil. This varies with the temperature of the oil. At the haze point temperature of 0° F., hydrocarbon oils normally contain about 10 parts of moisture per million parts of oil; at haze point temperature of 30° F., 90 parts of moisture; and at haze point temperature of 50° F., 165 parts of moisture. A haze point temperature of 30° F. is considered excellent, while one of 50° F. is considered satisfactory.

The extent of moisture removal by the practice of this invention is dependent on a number of factors, including the characteristics of the particular composition undergoing treatment, the temperature of the composition during treatment, the rate of flow, the size and design of the treating zone and of the rotor-stator unit, the speed of rotation of the rotor and the amount of air introduced into the composition. The refinery runs identified in the foregoing tables employed a tank, corresponding to tank 15, that was 18" wide, 23" long and 14" deep, a driving unit having a ¾ horsepower, explosion-proof, electric motor operating at a speed of 1750 R. P. M., and a rotor-stator unit approximately 7" wide. The referred to charge stocks were continuously introduced into tank 15 at a rate of from 2 to 4 gallons per minute, depending on the particular stock, and were successfully dehazed at treating temperatures of from 99 to 118° F.

Treating equipment having a considerably greater capacity than that just described has also been used to effectively and economically dehaze oils in accordance with this invention. One arrangement of such equipment includes a treating tank, corresponding to tank 15, which is 66" wide, 84" long and 38" deep, a driving unit having a 15 horsepower, explosion-proof, electric motor operating at a speed of 490 R. P. M., and a rotor-stator unit approximately 24" wide. Tests have demonstrated that this equipment adequately dehazes oil at the rate of from 200 to 500 barrels per hour depending on the type and characteristics of the particular oil and its temperature.

during treatment. For example, No. 2 heating oil having a heavy moisture cloud was transmitted into this equipment at a rate of 450 barrels per hour and effectively de hazed at a temperature of about 118° F. to obtain a bright, clear product. Also, a light lubricating oil was satisfactorily de hazed when run through the equipment at the rate of from 200-300 barrels per hour and at a treating temperature below its flash point and within the range discussed earlier herein.

From the foregoing, it is believed that the method and apparatus for practicing the instant invention will be readily comprehended by persons skilled in the art. It is to be clearly understood, however, that various changes in the apparatus herewith shown and described and in the method of practicing the invention, outlined above, may be resorted to without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. In a method for removing moisture occluded in a substantially water immiscible liquid composition which is substantially free from water readily separable by gravity, the steps of (1) agitating said moisture containing liquid composition in the presence of gas to which said liquid composition is chemically substantially inert at the operating temperature to form an intimate mixture of said liquid composition with dispersed gas in the form of fine bubbles and cause repeated expansions and contractions in the mixture thereby contacting and evaporating occluded moisture into the dispersed bubbles of gas, (2) separating the dispersed gas carrying absorbed moisture from the unevaporated constituents in the mixture and (3) recovering all of the unevaporated constituents which constitute the relatively water-free water immiscible liquid product.

2. The method according to claim 1, in which the substantially water immiscible liquid composition is a liquid hydrocarbon oil composition, the gas is air, and the operation is conducted at a temperature below the flash point of said oil composition.

3. The method according to claim 1, in which the substantially water immiscible liquid composition is a liquid hydrocarbon oil composition, the gas is air drawn in from the surrounding atmosphere, and the operation is conducted at a temperature below the flash point of said oil composition and within a temperature range of 90 to 170° F.

4. In apparatus for removing occluded water from a water immiscible liquid free from water readily separable by gravity, a tank, means for continuously introducing the liquid to be treated at a predetermined rate into said tank near the bottom thereof, agitating means and associated baffle means for defining and maintaining a treating zone of violent agitation and turbulence in said tank substantially above the bottom and substantially below the top thereof, means associated with said agitating means for drawing into said zone of agitation and turbulence the liquid to be treated and a gas in order to form an intimate turbulent mixture of said liquid and finely dispersed gas, a relatively quiescent zone in said tank into which said mixture of treated liquid and finely dispersed gas can flow from said zone of agitation and turbulence and rise by gravity to the top of said tank, thereby allowing at least some of the dispersed gas to separate from the treated liquid by gravity, and means connected near the top of said tank by means of which the mixture of treated liquid and remaining gas continuously overflows to a receptacle wherein the remaining gas admixed therewith can separate by gravity and all unevaporated constituents of the treated liquid can be recovered.

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