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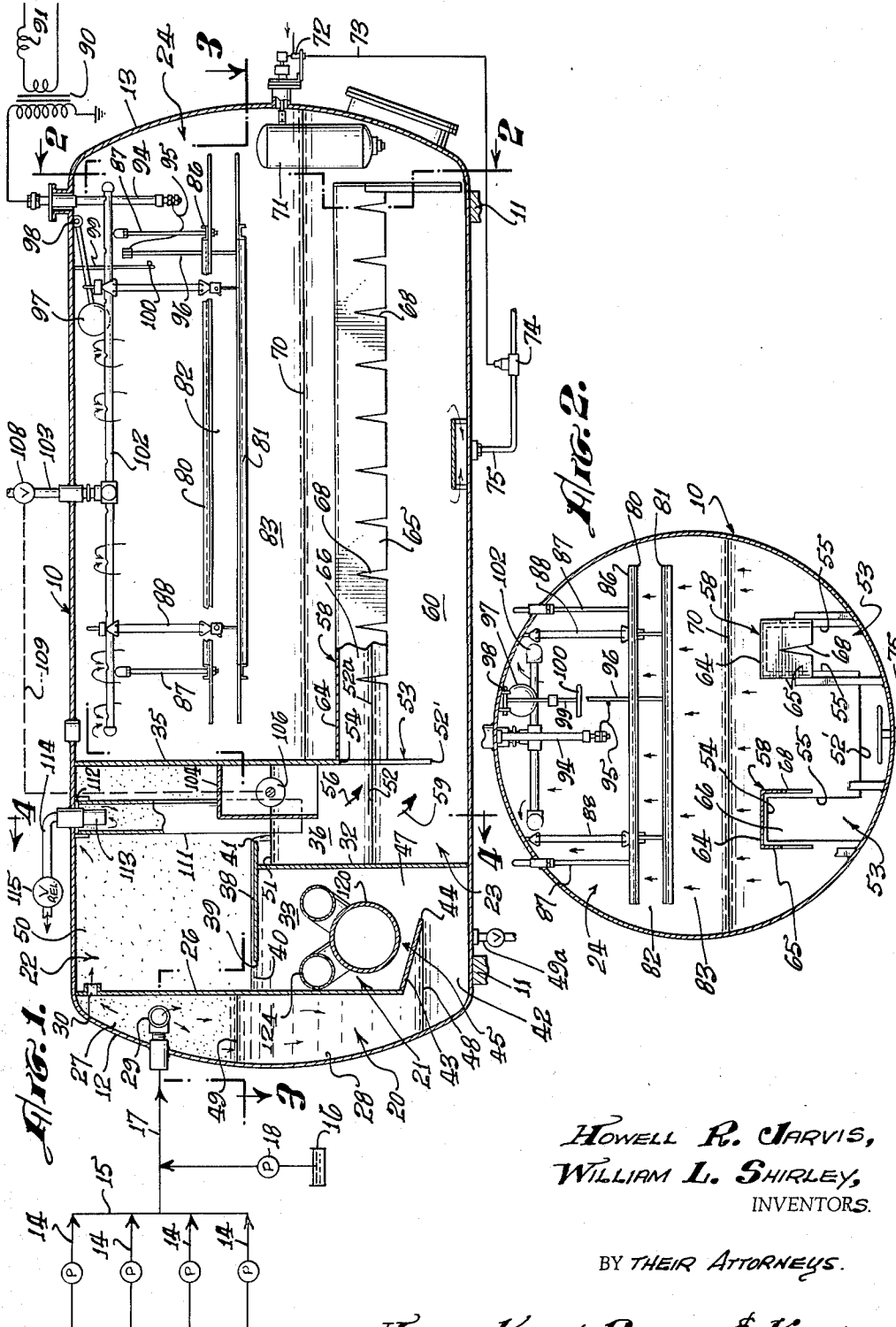
H. R. JARVIS ET AL

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ELECTRIC DEHYDRATOR

Filed March 7, 1962

2 Sheets-Sheet 1



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WILLIAM L. SHIRLEY,
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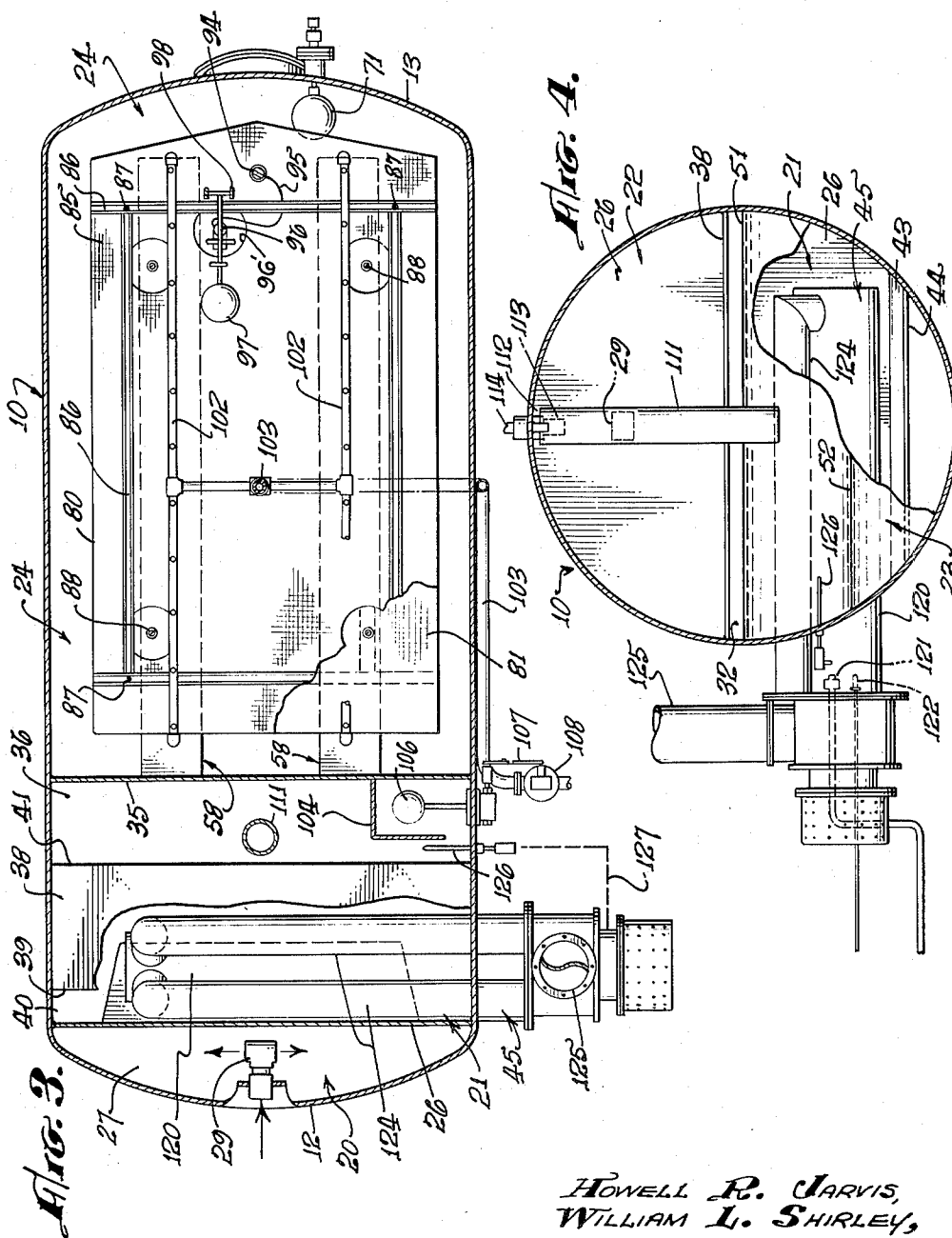
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1

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ELECTRIC DEHYDRATOR

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21 Claims. (Cl. 204—302)

Our invention relates to the electric treatment of emulsions of the water-in-oil type ranging from somewhat temporary dispersions to tight emulsions that will not settle on long standing. The continuous phase of such emulsions may be crude oil or other oils of relatively high resistivity. The dispersed phase of such emulsions are usually aqueous and when separated are referred to herein merely as water irrespective of purity or salt content, it being understood that the term is inclusive of the brine found in crude oils and the aqueous material of other emulsions. The emulsions with which the invention is concerned may be naturally occurring or may be the result of prior processing of oils. The invention will be exemplified with reference to the electric resolution of crude oil emulsions with or without the aid of chemicals added thereto to facilitate such electric resolution.

There is an increasing need for an inexpensive electric dehydrator of simple construction that can operate for long periods of time without supervision. It is an object of the invention to provide such a dehydrator that is well adapted to the electric resolution of crude oil emulsions as produced from the ground or after preliminary settling in storage tanks.

Many emulsions contain dissolved or entrained gases which are desirably separated therefrom before subjection to the action of an electric field. It is an object of the invention to provide an improved electric dehydrator in which gas separation is effected within the dehydration unit itself.

It is also an object of the invention to provide an improved structure by which a complete separation of the water is achieved in a simple and economical way without application of excessive heat. This is in contradistinction to existing non-electric separators which heat the emulsion to facilitate its resolution and which thereby remove and waste valuable lighter fractions of the oil. It is an object of the invention to reduce or minimize the usual demulsifying heat requirements and to conserve the lighter fractions or light ends of the oil so that the gravity of the oil is maintained during dehydration and volume losses due to vaporization are avoided. The resulting oil can thus often be sold at a higher price. Minimization or elimination of heat also reduces problems arising from scale and corrosion of the treating equipment.

Some of the dispersed material of many emulsions can be initially coalesced and/or extracted and separated by gravity separation or a water-washing step. It is an object of the invention to provide space within the electric dehydrator separate from the main treating chamber therein to water-wash the incoming emulsion. A further object is to water-wash the emulsion by upward passage thereof through a body of wash water in an upright passage in such way that any impurities or dispersed-phase material thus extracted will leave the top of the upright passage for subsequent separation in a later zone.

The invention is further characterized by a process and apparatus in which the emulsion flows downward in an oil-continuous environment, then upward in a water-continuous environment, e.g., through the aforesaid body of wash water, and then into an electric field. Water-in-oil type emulsions are often encountered which contain also some emulsion of the reverse or oil-in-water type. Downward flow through an oil-continuous environment helps

2

to break the oil-in-water type emulsion that is present. Upward flow through a water-continuous environment helps to break the water-in-oil type emulsion and particularly so if the steps are performed in this sequence. In addition, water-wet solids in the emulsion break out during the upward flow in the water-continuous environment and drop to the bottom to be trapped out of the system and thus make subsequent electric treatment of the emulsion easier. Heat applied to the water-continuous environment facilitates such removal of water-wet solids. It is an object of the invention to provide such a process and a compact electric treater in which such steps can be performed.

Further objects and advantages of the invention reside in the internal partitioning of a container to provide zones for sequential preliminary treatment of the emulsion before entry into the electric field. Other objects and advantages reside in the manner in which the preliminarily treated emulsion is distributed in the main treating chamber preparatory to subjection to the action of a high-voltage electrostatic field. Still further objects and advantages will be apparent to those skilled in the art from the following description of an exemplary embodiment of the invention described as used in the resolution of crude oil emulsions.

Referring to the drawings:

FIG. 1 is a vertical sectional view of one embodiment of the improved electric dehydrator of the invention, FIG. 2 being a transverse sectional view taken along corresponding lines of FIG. 1.

FIG. 3 is a sectional plan view taken along the line 3—3 of FIG. 1; and

FIG. 4 is a transverse sectional view taken along the line 4—4 of FIG. 1.

The invention can be incorporated in any suitable upright or horizontal container but is exemplified as including a container 10 much longer in axial length than width mounted on supports 11 in substantially horizontal position, the container being closed by heads 12 and 13. Emulsion from one or more wells or storage tanks can be pumped through lines 14 to a manifold 15 and thence to the dehydrator. Although not essential in all instances, it is usually desirable to introduce a small amount of a chemical demulsifying agent into the emulsion ahead of the dehydrator. This agent may be of any known type and will be selected with reference to its ability to aid the electric resolution to be described. It can be pumped from storage 16 into a line 17 by a metering pump 18.

The interior of the container 10 is partitioned to provide an entrance section or chamber 20, a water-wash and/or heater section 21, a gas-separating section 22, an emulsion-delivery or pre-separation section 23 and a main treating section or chamber 24. The entrance chamber 20 is formed between an end partition 26 and the head 12 and provides a gas space 27 and an emulsion space 28. The incoming emulsion may be discharged at any position in the entrance chamber 20 but preferably discharges into the gas space 27 through a laterally-ori-ficed distributor 29 so that initial gas separation takes place in the entrance chamber. The gas space 27 is in open communicating with the gas-separating section 22 as through an opening 30.

An upstanding partition 32 separates the sections 21 and 23. It is spaced from the end partition 26 to define an upright passage 33 constituting an important part of the waterwash and/or heater section 21. The upstanding partition 32 is separated from a transverse partition 35 to form therebetween a delivery chamber or well 36 acting as a settling space. At the upper end of the upstanding partition 32 and preferably near the midsection of the container is a weir which may comprise merely the top edge of the partition 32 but which is illustrated as

comprising a deck 38 traversing the width of the container and attached to such top edge of the partition. This deck provides an upstream edge 39 near the top of the upright passage 33 forming with the end partition 26 an entrance passage 40 for the gas-separating section 22. The deck 38 provides also a discharge lip 41 above the well 36.

The lower end of the emulsion space 28 is in open communication with the lower end of the upright passage 33. In the preferred arrangement the end partition 26 terminates short of the bottom of the container to provide a passage means 42 for this purpose. The end partition 26 may provide a sloping baffle 43 having a lip 44 spaced from the upright partition 32 to provide an opening on the opposite side of the upright passage 33 from the passage 40 so that emulsion rising in the passage will flow diagonally and across the heat-transfer surfaces of a heater 45 to be described. Alternatively the baffle 43 may provide metering orifices to evenly distribute the emulsion across the upright passage 33.

A body of wash water 47 is maintained in the upright passage 33. Its upper boundary will be within the entrance passage 40 during operation of the device. The lower portion of this body continues leftward into the emulsion space 28 forming an emulsion-water interface 48 determined by the position of the lip 44. The column of wash water in the upright passage 33 hydrostatically balances the column of emulsion in the emulsion space 28. As the emulsion is of lower specific gravity than the wash water it follows that the emulsion-gas interface 49 in the entrance chamber 20 will be slightly above the deck 38.

From the structure thus far described it will be apparent that the emulsion flows downward in the emulsion space 28, through the emulsion-water interface 48 and the passage means 42 to rise as emulsion masses through the body of wash water 47 in the upright passage 33. The heater 45 can be used to control the temperature of the body of wash water and thus the temperature of the washed emulsion rising in the entrance passage 40, heating being largely by heat transfer from the water to the emulsion. Some of the water masses of the emulsion may be washed out or released during rise in the upright passage 33 but it is preferable that the excess water thus added to the body of wash water 47 should flow upwardly through the passage 40 along with the washed emulsion. Any water wet solids settling in the passage 33 can be periodically flushed out through a valved pipe 49a. This or a similar pipe can also be used to introduce a chemical treating agent that is partly or completely water soluble into the body of wash water 47 if this is desired.

At the top of the passage 33 the mixture spreads over and flows along the top surface of the deck 38. Gas separation is facilitated by thus flowing a thin stream of the washed emulsion along the deck, the separated gas rising in a gas space 50 of the gas-separating section 22. In addition some water settles to the top surface of the deck to form an underlying water layer or film. This promotes coalescence of the water droplets in the remainder of the emulsion as it flows as a thin upper layer above and in contact with the underlying water layer or film. This is a mechanical coalescing action and supplements the previous mechanical coalescing actions in a manner to prepare the emulsion stream for better separation in the well 36 and better electric treatment in the main treating chamber 24. The emulsion stream drops from the discharge lip 41 into the well 36 to an emulsion-gas interface 51 and separates to some extent therebelow to form an emulsion-water interface 52 within the well.

The transverse partition 35 terminates in a lower edge 52' and provides a passage means interconnecting the lower interiors of the well 36 and the main treating chamber 24. This passage means is exemplified as comprising two cutouts or notches 53 cut in the partition upwardly

from the lower edge 52' thereof. Each notch has a top wall 54 disposed at a level above the emulsion-water interface 52 and spaced side walls 55 extending to the lower edge 52'. The washed emulsion which separates in the well 36 above the interface 52 thus flows rightward through the upper portions of the notches 53, as indicated by the arrow 56, into the upper interior of a distributor 58 to be described. The water masses settling from the emulsion in the well 36 drop to the interface 52 and move rightward at a lower level, as indicated by the arrow 59, through lower portions of the notches 53 or the space below the lower edge 52' to join a body of separated water 60 in the main treating chamber 24. It is a feature of the invention that a portion of this body of separated water extends into the lower end of the well 36 and that the emulsion-water interface 52 continues at the same level into the distributor 58 as an interface 52a therein. The number of notches 53 and distributors 58 will depend on such factors as size of the container, the characteristics of the emulsion undergoing treatment and the type of electrodes employed to establish the electric field into which the emulsion will flow upon discharge from the distributors, etc. One or more of such distributors can be used.

While various types of distributors 58 can be employed, the one illustrated is particularly effective in uniformly exuding streams of the washed emulsion at a large number of horizontally-spaced positions in the lower interior of the main treating chamber 24. It has the further feature that the areas of all of the exudation orifices can be uniformly increased or decreased by a drop or rise of the interface 52a. As illustrated, each distributor is of the inverted-pan type providing a top wall 64 and depending side walls 65 connected to the transverse partition 35 near the top and respective side walls of the cutout or notch 53. The distributor thus provides a downwardly-open distributor chamber 66. The side walls 65 depend below the interface 52a and provide downwardly-diverging exudation orifices 68 on the three closed sides of the distributor. These exudation orifices have narrow upper apex portions in an upper horizontal plane above the interface 52a and wider lower portions in a lower horizontal plane below such interface. As a consequence the emulsion will exude through those upper portions of the orifices above the interface 52a, the emulsion-discharge portions of the orifices being bounded downwardly by a heavier liquid, here the separated water. A gravity-flow equal-distribution and equal-discharge of the washed emulsion is thus effected at a plurality of points in a pattern determined by the location of the exudation orifices 68.

In normal operation an oil-water interface 70 is present in the main treating chamber 24. If this interface is maintained at a level above the interface 52a, as is usually preferable, the emulsion issuing from the exudation orifices 68 will be further washed during rise through the body of separated water. The position of the interface 70 is maintained substantially constant by a level-control means of known type, shown as including a float 71 actuating a valve 72 controlling the flow of a gas through a line 73. The gas pressure in turn controls the setting of a valve 74 in a line 75 which withdraws water from the body of separated water 60.

Any suitable electrode system can be employed for establishing a high-voltage electrostatic field in that portion of the main treating chamber 24 above the interface 70 to treat the rising emulsion. Such an electric field will coalesce the dispersed water particles of an emulsion into masses of sufficient size to gravitate to the body 60. As shown, upper and lower foraminous electrodes 80 and 81 define two treating spaces comprising a main treating space 82 between the electrodes and an auxiliary treating space 83 between the lower electrode 81 and the body of separated water 60. Each electrode may comprise a sheet of metallic screen 85 (FIG. 3) supported by a suitable framework 86. Hangers 87 suspend the upper electrode

5

80 from the container to maintain this electrode at ground potential. The lower electrode 81 is suspended from the container by insulators 88 and is energized by a high voltage transformer 90. The A.C. potential applied to the primary of this transformer is suitably controlled as by a choke coil 91. The high-voltage terminal of the secondary winding is connected through an inlet bushing 94 to a conductor 95 which is in turn connected to a post 96 rising from the electrode 81 through an opening 96' (FIG. 3) of the upper electrode 80.

A low-level safety device is provided to short-circuit the electrodes should the main treating chamber 24 not remain filled with liquid. This includes a float 97 pivoted at 98 to drop if an oil-gas interface should develop. To the pivot arm of this float is attached an arm 99 carrying a contact 100 which engages the post 96 to ground it through the float arm upon lowering of the float, thus short-circuiting the electrodes.

The treated oil largely free of dispersed water is suitably withdrawn from the upper end of the main treating chamber 24. Such withdrawal is preferably through a multi-orifice pipe network 102 comprising two longitudinal pipes centrally connected to a riser pipe 103 extending to a position outside the container. The longitudinal pipes preferably have upwardly-facing orifices distributed throughout the upper interior of a main treating chamber 24 to aid in establishing a uniform-flow rising mass of emulsion and treated oil in this chamber.

The treated oil effluent is preferably increased and decreased respectively upon rise and fall of the emulsion-gas interface 51 in the well 36. Stated in other words the treated oil effluent is controlled to keep this interface substantially constant in position. To accomplish this the transverse partition 35 supports a housing 104 depending below the interface near one side wall of the container and shielding a float 106 from the stream dropping from the discharge lip 41. The housing is open at the bottom and at one side as best shown in FIGS. 1 and 3 so that the emulsion-gas interface therein corresponds in position to the interface in the remainder of the well. The up and down motion of the float 106 is transmitted by a link 107 (FIG. 3) outside the container to a valve 108 in the treated-oil effluent line 103. FIG. 1 shows the valve 108 diagrammatically, the dotted line 109 indicating the operative connection between the valve and the float 106. Actuation of the valve 108 indirectly controls the gas withdrawal, as will be described.

While any suitable gas-withdrawal means can be employed for removing the separated gas from the gas space 50, the preferred structure includes an upright pipe 111 suspended with its upper end a slight distance below the top of the container 10 to provide an orifice means 112 and with its open lower end below the interface 51. A smaller-diameter pipe 113 depends a short distance into the pipe 111 and communicates with an effluent pipe 114 through which the flow is controlled by an adjustable pressure-release valve 115 which is set to maintain a desired back pressure on the dehydrator. As the interface 51 drops and the flow of treated oil is restricted by the valve 108 this restriction causes the pressure inside the container to increase. The increased pressure in the gas space 50 rises above the value at which the adjustable valve 115 is set thereby starting or increasing the gas effluent through the pipe 114. The gas discharging there-through is free of suspended particles of oil or light fractions thereof, such particles separating from the gas either in the gas space 50 or within the pipe 111. The latter provides a confined space which with the reverse flow of the gas, indicated by the arrows, induces separation of such particles. The separated particles can drop from the open lower end of the pipe 111 to become a part of the treated-oil effluent of the dehydrator.

The electric treater of the invention will desirably be operated at temperatures substantially below those possible when treating the emulsion by chemical or electric

6

action alone and at temperatures very substantially below those required to resolve the emulsion in the older heater-settling equipment. Crude oil emulsions are preferably resolved in the dehydrator of the invention while at or near ambient temperature. In many instances the heater 45 is employed only during cold seasons when the ambient temperature is abnormally low. In other instances and where difficult emulsions are encountered the heater may be used to maintain the temperature in the range of about 60–120° F. with higher temperatures being seldom if ever required, the treating temperature being typically about 30–100° F. lower than when attempting to resolve the emulsion by the older heater-setting equipment. The dehydrator is at all times operated at relatively low temperatures to avoid loss of lighter fractions.

During periods when heating is desired, this heat is preferably applied to the water and emulsion in the upright passage 33. The heater illustrated is particularly effective in this regard and comprises a burner housing 120 extending laterally into the container. A burner 121 and a pilot 122 produce products of combustion which move toward the closed inner end of the housing 120 to an internal flue passage means comprising a pair of pipes 124 which communicate with an external stack 125 rising to a level substantially above the top of the container 10. The burner 121 may be manually controlled but is preferably thermostatically controlled by means of a heat-responsive element 126 (FIGS. 3 and 4) connected by a suitable control, shown diagrammatically by the dotted line 127, to the burner 121 in controlling relationship and in such manner as to maintain substantially uniform the temperature of the emulsion entering the main treating space 24.

As an example of the operation of the invention and its efficacy as compared with a conventional thermochemical dehydrator, in which the emulsion was broken by heat and pressure aided by chemical action but without the use of any electric field, the following data are presented comparing such electric and non-electric units of equal diameter, respectively designated as treaters A and B.

	Treater B (Nonelectric)	Treater A (Electric)
Untreated crude:		
API gravity.....	35.1	35.1
Basic sediment, percent.....	18.4	18.6
Water, percent.....	7.5	5.8
Total BS&W, percent.....	25.9	24.4
Throughput (bbls. per day).....	452	947
Treating temperature, ° F.....	145	60
Treated crude:		
API gravity.....	33.6	34.7
Basic sediment, percent.....	0.2	0
Water, percent.....	0.6	.03
Total BS&W, percent.....	.8	.03

The amounts of chemical added in the two treaters were virtually the same but it will be observed that the electrical dehydrator of the invention was able to treat more than twice the amount of emulsion at a temperature 85° F. lower as compared with the thermochemical dehydrator, all while producing a higher-gravity and more valuable oil of far less BS&W content.

As another example, the operation of one treater of the invention (container 6' x 12') was compared with the operation of two dehydrators of the heater-settling type (each container 6' x 22') between which the stream of emulsion was divided, the amounts of chemical employed being virtually the same. The treating rate for the single treater of the invention was 947.6 bbls./day as compared with 904 bbls./day for the two older-type and much larger treaters (452 bbls./day per treater). The temperature of treatment was 60° F., as compared with 145° F., a reduction of 95° F. resulting in a saving in gas for heating of \$12.70/day. The average gravity of the treated oil was 34.7° A.P.I. as compared with 33.6°, the increased

value from the gravity increase being \$18.95/day and the increase due to a 1.8% volume savings being an additional \$48.11/day, resulting in a total daily saving of \$79.76.

In another example the operation of one treater of the invention (container 8' x 12') was similarly compared with the operation of two dehydrators of the heater-settling type (each container 6' x 22') on a difficult emulsion. The treating rate of the single electric treater was 936 bbls./day as compared with 548 bbls./day for the two older and larger treaters. Operating temperatures was lower by 42° F. (118° F. as compared with 160° F.), resulting in a saving in heating gas of \$23.40/day. Savings or augmented value due to increased gravity (25.5° A.P.I. as compared with 24.05°) was \$46.80/day and from increased volume (15.16 bbls./day) was \$44.26, making the total savings \$114.46/day in favor of the electric treater of the invention.

For purpose of simplicity in description the foregoing material refers to various liquid-liquid "interfaces." In all instances and particularly as concerns the interfaces 52 and 70 these interfaces may be zones of transition between water-continuous and oil-continuous systems, often being shallow zones containing sludge or components undergoing separation, all as distinct from a planar junction of bodies of oil and water. This is well understood in the art.

Similarly the liquid bodies in the several zones have usually been designated by the simpler terms "emulsion," "water" and "oil." It is to be understood that the material in the emulsion space 28 below the interface 49 is predominately oil-continuous, as is also the material in the upper portion of the well 36. The material around the heater in the upright passage 33 and in the bottom of this passage and the entrance chamber 20 is predominately water-continuous. The oil in and above the electrode system is oil-continuous and is in the process of separation. Correspondingly the above-quoted terms are not to be construed as referring to pure systems free of contaminating substances but to the predominantly oil-continuous or water-continuous systems mentioned above.

Various changes and modifications can be made without departing from the spirit of the invention as defined in the appended claims.

We claim:

1. An electric dehydrator for water-in-oil type emulsions containing gases, said dehydrator including:

- (a) a container providing therewithin
 - (a₁) an upright passage,
 - (a₂) a main treating chamber,
 - (a₃) a well between said upright passage and said main treating chamber,
 - (a₄) there being a weir at the upper ends of said well and upright passage over which emulsion flows from said upright passage to said well,
 - (a₅) there being a gas space within said container above said weir;

- (b) passage means communicating between said well and the lower interior of said main treating chamber;

- (c) means for establishing a high-voltage electrostatic field in said main treating chamber at a level above said passage means;

- (d) means for flowing the emulsion upwardly in said upright passage, over said weir, downwardly in said well, through said passage means and thence upwardly in said main treating chamber to said electrostatic field for coalescence and separation of the water phase of said emulsion,

- (d₁) said coalesced water phase gravitating to the bottom of said main treating chamber to form a water body therein contacting the oil thereabove at an oil-water interface,

- (d₂) said last-named means including means delivering said emulsion to said upright passage at a lower position therein.

- (d₃) treated-oil withdrawal means withdrawing treated oil from the upper interior of said main treating chamber, and

- (d₄) means withdrawing separated water from the body thereof in the lower interior of said main treating chamber; and

- (e) gas-withdrawal means withdrawing separated gases from said gas space.

2. An electric dehydrator as defined in claim 1 in which said gas-withdrawal means includes

- (a) an upright pipe extending downward in said gas space to a position below said weir, and opening on the liquid in said well,

- (b) orifice means at the upper end of said pipe interconnecting the pipe interior with the top of said gas space,

- (c) a depending pipe of smaller diameter than said upright pipe depending therein and open to the interior of the larger upright pipe at a level below said orifice means, and

- (d) means conducting gas from said depending pipe to the exterior of said container.

3. An electric dehydrator as defined in claim 1 in which there is a gas-emulsion interface near the level of said weir, said dehydrator also including

- (a) a valve in said treated-oil withdrawal means,

- (b) means responsive to a change in the level of said gas-emulsion interface near the level of said weir, and

- (c) means operatively connecting said level-responsive means to said valve to control the treated oil withdrawal in response to changes in the level of said gas-emulsion interface.

4. An electric treater as defined in claim 3 including

- (a) a valve in said water-withdrawal means controlling the rate of water withdrawal and thus the interface between the oil in said main treating chamber and the body of separated water therein, and

- (b) means responsive to a change in the level of such oil-water interface in said main treating chamber for maintaining said oil-water interface at substantially a constant level lower than the level of said gas-emulsion interface, such level-responsive means including,

- (c) means operatively connecting said level-responsive means to said valve in said water-withdrawal means.

5. An electric dehydrator as defined in claim 1 including (a) a partition separating said well and said main treating chamber,

- (a₁) said partition extending to a position below said oil-water interface,

- (a₂) said passage means extending through said partition and providing a top portion and opposed side portions,

- (b) a distributor in said main treating chamber below said electrostatic field, said distributor comprising

- (b₁) an inverted pan providing a top wall and side walls depending therefrom forming a downwardly open distributor chamber,

- (b₂) said top and side walls being connected to said partition with said top wall above said top portion of said passage means and said side walls depending at positions adjacent said opposed side portions of said passage means whereby the emulsion flowing through said passage means is delivered to the upper interior of said distributor chamber.

6. An electric dehydrator as defined in claim 5 in which

- (a) the lower end of said well contains a body of separated water forming an emulsion-water interface with the emulsion therein, and in which

- (b) said passage means interconnects the lower interior of said distributor chamber and the lower interior

of said well to maintain emulsion-water interfaces therein at the same level,

- (c) the side walls of said inverted pan providing exudation orifices having upper portions above such level and lower portions below such level.

7. An electric dehydrator as defined in claim 1 in which said weir includes

- (a) a deck having
 (a₁) a discharge lip above said well discharging thereinto and
 (a₂) an upstream edge near the top of said upright passage receiving emulsion therefrom for flow along said deck to said discharge lip in gas-liberating relation.

8. An electric dehydrator for water-in-oil type emulsions containing gases, said dehydrator including:

- (a) a container;
 (b) a partition means in said container dividing the interior thereof into sections comprising
 (b₁) a heating section and
 (b₂) a main treating section having oil and water outlets respectively at its upper and lower ends.
 (c) a burner housing extending substantially horizontally into said heating section through a wall of said container;
 (d) a burner in said burner housing;
 (e) means for supplying fuel to said burner to heat the emulsion in said heating section;
 (f) an internal flue passage means in said heating section,
 (f₁) said internal flue passage means receiving products of combustion from said burner and conducting same to the exterior of said container;
 (g) a stack outside said container receiving the products of combustion from said internal flue passage means;
 (h) means for establishing a high-voltage electrostatic field in said main treating section;
 (i) means for flowing the emulsion to be treated through said heating section, into said main treating section and into said electrostatic field; and
 (j) means for withdrawing treated oil and separated water respectively from said oil and water outlets at the upper and lower ends of said main treating section.

9. An electric dehydrator for water-in-oil type emulsions containing gases, said dehydrator including:

- (a) a container;
 (b) partitions in said container dividing the interior thereof into
 (b₁) a water-wash section adapted to contain a body of wash water,
 (b₂) a gas-separating chamber providing a gas space having a gas outlet, and
 (b₃) a main treating chamber having oil and water outlets respectively at its upper and lower ends,
 (b₄) one of said partitions bounding said water-wash section and providing a weir at its upper end at the lower boundary of said gas-separating chamber;
 (c) means for establishing a high-voltage electrostatic field in said main treating chamber above a lower portion thereof; and
 (d) means for flowing the emulsion to be treated through said body of wash water, over said weir, into said lower portion of said main treating chamber and upward into said electrostatic field for sequential washing, gas separation and electric treatment thereof.

10. An electric dehydrator as defined in claim 9 in which

- (a) another of said partitions depends below said weir

in spaced relationship with a wall of said container to provide an entrance chamber therebetween,

- (a₁) said water-wash section comprising an upright passage containing a body of wash water,
 (a₂) there being at least one opening interconnecting the lower ends of said entrance chamber and said upright passage,
 (b) said means for flowing said emulsion including
 (b₁) means for delivering said emulsion under pressure to said entrance chamber to flow downward therein,
 (b₂) said emulsion traversing said opening and rising in said body of wash water in said upright passage toward said weir and said gas-separating chamber.
 11. An electric dehydrator for water-in-oil type emulsions, said dehydrator including:
 (a) a container adapted to contain a body of separated water in its lower end;
 (b) an inverted-pan distributor submerged in said body,
 (b₁) said distributor providing depending side walls forming a distributor chamber opening downwardly on said body,
 (b₂) said side walls having exudation orifices having closed upper portions in an upper horizontal plane and lower portions in a lower horizontal plane;
 (c) a valve withdrawing water from said body of separated water;
 (d) means including a level-control means operatively connected to said valve to maintain the surface of said body of separated water above said upper horizontal plane of said closed upper portions,
 (d₁) separated water from said body thereof sealing the bottom of said distributor chamber and tending to rise therein toward said upper horizontal plane to progressively close said exudation orifices;
 (e) means for delivering a stream of emulsion to the upper interior of said inverted-pan distributor at a rate to create and maintain an emulsion-water interface within said distributor chamber opposite said orifices below said lower horizontal plane whereby the emulsion of such stream divides equally between those upper portions of said exudation orifices that are above said emulsion-water interface;
 (f) means for establishing a high-voltage electrostatic field in said main treating chamber above said distributor acting on the emulsion rising therefrom to coalesce water therein into masses of sufficient size to gravitate to said body of separated water; and
 (g) means for withdrawing treated oil from the top of said container.

12. An electric dehydrator for water-in-oil type emulsions, said dehydrator including:

- (a) a container adapted to contain a body of separated water in its lower end;
 (b) an upright partition within said container forming therein
 (b₁) a main treating chamber and
 (b₂) a laterally-opposite delivery chamber,
 (b₃) said partition providing a lower portion dipping into said body of separated water;
 (c) an inverted-pan distributor providing a top wall and side walls depending therefrom into said body of separated water,
 (c₁) said top and side walls forming a downwardly-open upwardly-closed distributor chamber,
 (c₂) said side walls providing exudation orifices in a shallow horizontal zone of said inverted-pan distributor,
 (c₃) said partition providing an opening laterally

11

- connecting the upper interior of said distributor chamber and said delivery chamber;
- (d) means for delivering a stream of the emulsion to said delivery chamber for flow through said opening into the upper interior of said distributor chamber; 5
- (e) means for maintaining water-emulsion interfaces in said delivery and treating chambers at substantially the same level,
- (e₁) said level being within said shallow horizontal zone of said inverted-pan distributor; 10
- (f) means for establishing a high-voltage electrostatic field in said main treating chamber above said distributor acting on the emulsion rising therefrom to coalesce dispersed water therein into masses of sufficient size to gravitate to said body of separated water; and 15
- (g) means for separately withdrawing streams of water and treated oil respectively from said body of separated water and the upper interior of said container. 20
13. An electric dehydrator for water-in-oil type emulsions containing gases, said dehydrator including
- (a) a container much longer in axial length than width closed by heads spaced from each other along the longitudinal axis of said container;
- (b) means for mounting said container with its longitudinal axis in a substantially horizontal position; 25
- (c) an end partition in one end of said container spaced therefrom to define therebetween an entrance chamber comprising
- (c₁) an upper gas space and 30
- (c₂) a lower emulsion space;
- (d) a transverse partition extending downward from the top of said container in widely spaced relation with the other of said heads to provide therebetween a main treating chamber, 35
- (d₁) the lower end of said main treating chamber being adapted to contain a body of separated water in a water zone thereof, the upper end of said main treating chamber above said body of separated water being adapted to be filled with an oil body; 40
- (e) an upstanding partition extending upward from the bottom of said container at a position between said end partition and said transverse partition,
- (e₁) said upstanding partition providing a top portion at a level between the axis of said container and the top thereof, 45
- (e₂) there being a gas space between said end and transverse partitions above said top portion of said upstanding partition communicating with said gas space of said entrance chamber, 50
- (e₃) there being an upright passage near said one end of said container bounded by said end and upstanding partitions openly communicating at its lower end with the lower end of said emulsion space to receive emulsion therefrom and conduct same upward in said upright passage, 55
- (e₄) there being a well between said transverse and upstanding partitions opening upwardly on said gas space between said end and transverse partitions, 60
- (e₅) said well openly communicating at its lower end with the water zone of said main treating chamber and the body of separated water therein, 65
- (e₆) said lower end of said well containing a body of separated water in open communication with said body of separated water in said main treating chamber;
- (f) a deck attached to said top portion of said upstanding partition, said deck providing 70
- (f₁) an upstream edge near the top of said upright passage and
- (f₂) a discharge lip at the top of said well discharging thereinto, 75

12

- (f₃) said upstream edge and said discharge lip being spaced from each other in a direction axially of said container to provide an upwardly-facing flow surface of said deck bounding the lower end of said gas space;
- (g) passage means through said transverse partition having at least its upper portion above said body of separated water in said well;
- (h) an emulsion distributor in said main treating chamber providing a distributor chamber opening on said passage means,
- (h₁) said emulsion distributor having a plurality of exudation orifices;
- (i) means for establishing a high-voltage electrostatic field in said oil body of said main treating space at a level above said distributor;
- (j) means for flowing the emulsion downwardly in said entrance chamber, upwardly in said upright passage to said upstream edge, axially of said container along said flow surface of said deck to the discharge lip thereof, downwardly in said well, through said passage means to said distributor chamber, through said exudation orifices and upwardly into said electrostatic field for treatment therein;
- (k) means for withdrawing treated oil from the top of said main treating chamber;
- (l) means for withdrawing separated water from one of said bodies thereof; and
- (m) means for withdrawing gas from the upper interior of one of said gas spaces.
14. An electric dehydrator for water-in-oil type emulsions, said dehydrator including:
- (a) a closed container much longer in axial length than width mounted with its longitudinal axis substantially horizontal;
- (b) a depending partition and an upstanding partition within said container spaced from each other in the direction of said axis providing a settling space therebetween,
- (b₁) there being a main treating chamber within said container between said depending partition and one end of said container,
- (b₂) said depending partition providing an opening therethrough;
- (c) an inverted-pan distributor having top and side walls connected to said depending partition respectively at the top and sides of said opening therethrough,
- (c₁) said side walls having orifices therethrough distributed in a horizontal zone substantially throughout the axial length of said main treating chamber;
- (d) means for maintaining superimposed layers of emulsion and water in said settling space and inside said inverted-pan distributor in contact along an emulsion-water interface in said horizontal zone extending continuously from said settling space through said opening and along the length of the interior of said inverted-pan distributor,
- (d₁) said last named means including means for continuously delivering a stream of emulsion to said settling space, said emulsion flowing above said interface through said opening and through said orifices of said side walls to rise in said main treating space;
- (e) electrode means in said main treating space above said distributor bridged by the emulsion rising therefrom establishing a high-voltage electrostatic field acting on such rising emulsion to coalesce dispersed water therein,
- (e₁) said coalesced water settling in said main treating chamber to the bottom thereof;
- (f) and effluent means for withdrawing oil and separated water respectively from the top and bottom of said main treating chamber.

13

15. An electric dehydrator as defined in claim 14 in which said coalesced water settles in said main treating chamber to form therein superimposed bodies of oil and water respectively above and below an oil-water interface, and including means for maintaining said oil-water interface at a level higher than said emulsion-water interface inside said inverted-pan distributor, said last-named means including a valve in said water effluent means, a level-responsive means responsive to changes in level of said oil-water interface, and means operatively connecting said valve and said level-responsive means.

16. An electric dehydrator for water-in-oil type emulsions containing gases, said dehydrator including:

(a) a closed container much longer in axial length than width mounted with its longitudinal axis substantially horizontal;

(b) a depending partition and an upstanding partition within said container spaced from each other in the direction of said axis providing a settling space therebetween,

(b₁) there being a main treating chamber within said container between said depending partition and one end of said container;

(c) partition means in the space between said upstanding partition and the other end of said container providing an entrance chamber and a heater chamber interconnected at their lower ends at a level above the bottom of said container,

(c₁) said entrance chamber being adapted to contain superimposed bodies of gas and emulsion;

(d) means for flowing emulsion downward in said entrance chamber and thence upward in said heater chamber to said settling space, said means including means for delivering a stream of the gas-containing emulsion under pressure to said entrance chamber for preliminary separation of gas therefrom, the separated gas forming a body of gas at the top of said entrance chamber;

(e) a heating means in said heater chamber including a tubular housing extending from said container into said heater chamber;

(f) means conducting said emulsion from said settling space into a lower portion of said main treating chamber to rise therein;

(g) electrode means in said main treating chamber bridged by said rising emulsion establishing a high-voltage electrostatic field therein to coalesce dispersed water therein,

(g₁) said coalesced water settling in said main treating chamber to the bottom thereof;

(h) gas effluent means withdrawing gas from said body thereof to a position outside said container; and

(i) effluent means withdrawing oil and separated water respectively from the top and bottom of said main treating chamber.

17. An electric dehydrator as defined in claim 16 in which said partition means has a lower portion terminating in a lip above the bottom of said container, and in which said entrance chamber and said heater chamber are open downwardly toward the bottom of said container, water separating from said emulsion in said entrance chamber settling to a water zone in the bottom of said

14

container below said entrance chamber to form a body of water that is separated from the settled coalesced water in said main treating chamber, and including an effluent pipe opening on said body of water in said water zone.

18. An electric dehydrator as defined in claim 17 including means for maintaining the top of said body of water in said entrance chamber at a level at least as high as said lip to cause at least some of the emulsion moving from the bottom of said entrance chamber to said heater chamber to flow through the water of said body.

19. An electric dehydrator as defined in claim 16 in which the top of said upstanding partition extends transversely to said container at a level below the top thereof to provide a second gas space within said container above said heater chamber and said settling space, the emulsion flowing from said heater chamber to said settling space over the top of said upstanding partition, and including means for connecting both of said gas spaces to said gas effluent means.

20. An electric dehydrator as defined in claim 16 in which the top of said upstanding partition extends transversely of said container at a level below the top thereof to provide a second gas space within said container above said heater chamber and said settling space, the emulsion flowing from said heater chamber to said settling space over the top of said upstanding partition, and including a deck at the top of said upstanding partition extending transversely of said container below the top thereof, said deck providing a substantially horizontal surface over which said emulsion flows longitudinally of said container from said heater chamber to said settling space, said deck having an upstream edge near the top of said heater chamber and a discharge lip near the top of said settling space.

21. An electric dehydrator as defined in claim 16 in which the top of said upstanding partition extends transversely of said container at a level below the top thereof to provide a second gas space within said container above said heater chamber and said settling space, the emulsion flowing from said heater chamber to said settling space over the top of said upstanding partition, the gas in said second gas space contacting the emulsion in said settling space at a gas-emulsion interface, there being a valve in said oil effluent means controlling the flow of oil from the top of said main treating space, and including a level-responsive means responsive to the level of said gas-emulsion interface, and means operatively connecting said level-responsive means to said valve in said oil effluent means to maintain the level of said gas-emulsion interface substantially constant in position.

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