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METHOD AND APPARATUS FOR ELECTRICAL DEHYDRATION

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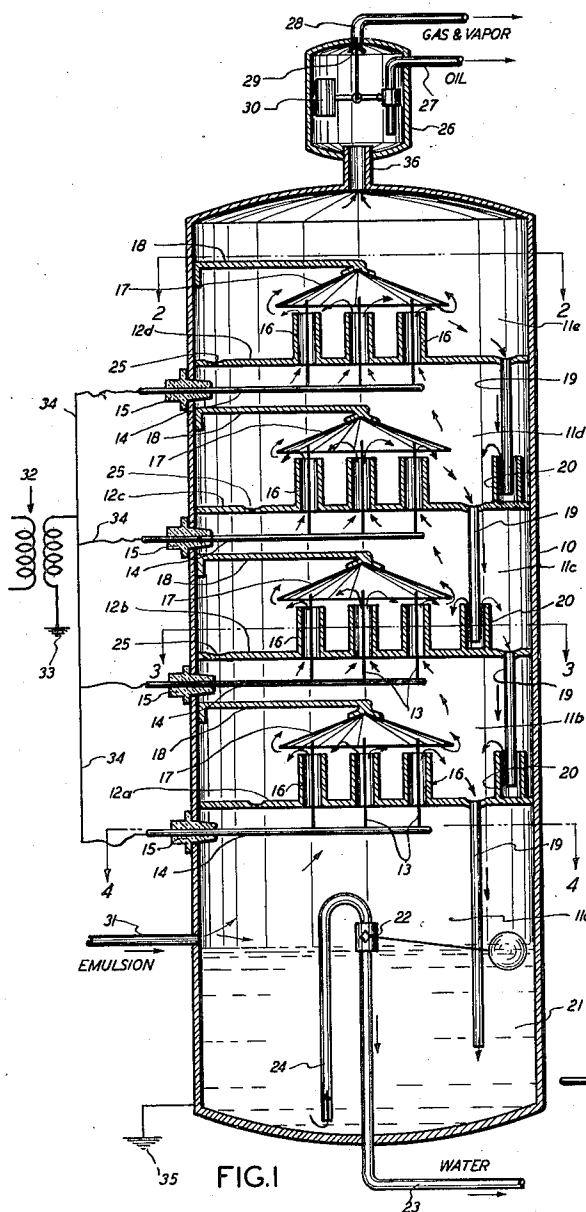


FIG. 1

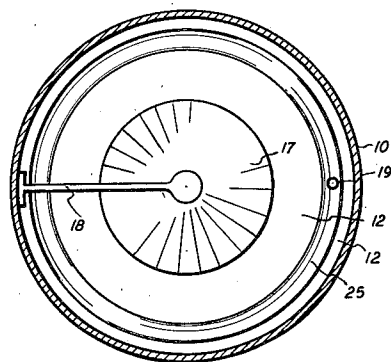


FIG. 2

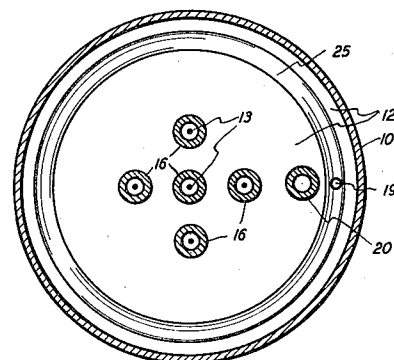


FIG. 3

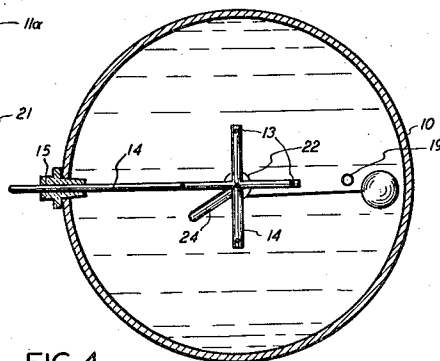


FIG. 4

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METHOD AND APPARATUS FOR ELECTRICAL DEHYDRATION

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7 Claims. (Cl. 204—24)

The object of my invention is to provide means and a method for simultaneously resolving and separating the phases of an emulsion of the water-in-oil type, and more specifically a petroleum emulsion.

The method of resolving emulsions which consists in subjecting them to the action of a high tension electrical field was disclosed by Cottrell and others as early as 1911 (see U. S. Patent 987,115), is very well known and understood and needs but the briefest description.

In general terms, the emulsion is passed between opposite charged electrodes on which a high potential is impressed. This potential produces a static electrical field between the electrodes and, under the influence of this field, electrical charges are imparted to the suspended water particles. These charges cause the particles to approach each other and to coalesce to larger particles and droplets which finally attain such dimensions as to settle out of the oil.

This is purely a static effect and ceases if any material leakage or conduction between the electrodes occurs. The tendency of the liberated water particles is to arrange themselves along the lines of force at such minute intervals as to form conductive "chains" by breaking down the dielectric oil layer between them. When this occurs, the static field is dissipated by conduction and the resolving effect ceases until the field is re-established.

In order to maintain the integrity of the field and the continued functioning of its resolving effect, it is necessary to maintain a dielectric barrier between the electrodes at all times. To this end several methods have been proposed. Cottrell (Patent 987,115) dilutes the emulsified oil with relatively dry oil, by which step the distance between the water particles and the thickness of the dielectric oil barrier between them is increased. Fisher (Patent 1,838,928) interposes a barrier layer of relatively dry oil between one of the electrodes and a layer or stream of emulsion which is in contact with the opposite electrode. Peek (Patent 1,170,184) interposes a solid dielectric barrier such as glass between one of the electrodes and a layer of emulsion which is in contact with the opposite electrode. McKibben (Patent 1,276,386) sweeps the water particles out of the field as fast as they are formed, thus maintaining in the field a constantly renewed supply of emulsion which, prior to resolution, has usually a high dielectric value.

The method of the instant application adopts the latter alternative and is directed to a specific

method and means for passing a constantly renewed supply of emulsion through a succession of high intensity fields into interposed zones of quiescence from which free water is drained back to a common outlet point without passing through any preceding field.

The objects and advantages of the invention may best be understood with reference to the attached drawing, in which: Fig. 1 is a vertical section and internal elevation of a preferred form of apparatus which may be used to illustrate the method employed; Fig. 2 is a sectional plan view on the line 2—2 of Fig. 1; Fig. 3 is a similar view on the line 3—3 of Fig. 1, and Fig. 4 is a similar view on the line 4—4 of Fig. 1.

Referring to the drawing, a substantially closed shell 10, which may be of any preferred dimensions, is divided into a series of compartments 11a, 11b, etc. by a series of flat partitions 12a, 12b, etc. Each of these partitions is provided with one or more vertical tubular members 16, projected upwardly as shown. Accurately centered in each tubular member is a wire or slender rod 13 of metal, these rods being supported by rigid conductive rods 14 which pass to the exterior of the shell through insulators 15.

Over the tubular members in each compartment I prefer to place a baffle or hood 17, which may be flatly conical as shown, or flat or dished, as may be preferred. The purpose of these hoods is to prevent undue disturbance of the liquid contents of the chambers, and while they are useful they are not strictly essential to the operation of the device. These hoods may be supported by the arms 18 or otherwise as convenient.

Each partition plate is provided with a downspout 19 which is sealed in a cup 20 affixed to the plate next below, the purpose being to provide sealed water drains through which water separating in each compartment will pass to finally join a water body 21 in the bottom of the shell. From this body water is withdrawn through a pipe 23 controlled by a float valve 22 and provided with a downward extension 24. This is a convenient method for maintaining a substantially constant water level in the apparatus, but a manual valve or the conventional external siphon. The upper face of each plate may also be provided with a shallow groove or channel 25 for directing water into the downspout 19.

To the upper end of the shell is attached an oil outlet pipe 36, which may be extended to any tank where oil and gas may separate. A convenient means for separating these fluids at the treater outlet, which is useful in case any out-

let pressure is to be carried, is shown in Fig. 1. This means comprises a relatively small vessel 26 fixed above the outlet 36 and having an oil outlet pipe 27 fixed in its wall and reaching substantially to the bottom of the vessel. A gas and vapor outlet 28 is sealed and unsealed by a valve 29 which is operated by a float 30, thus maintaining a body of oil sealing the oil outlet and permitting gas to escape only as its accumulation depresses the oil level and carries the float below the position at which the valve is closed.

A step-up transformer generally indicated at 32 has its primary winding connected to any source of alternating current supply, one terminal of the secondary winding being grounded as at 33, the other secondary terminal being connected through the branched cable 34 to all the electrode rods 14—14, and the shell being grounded as indicated at 35. This connected, the tubular elements 16—16 function as grounded electrodes and the rods 13—13 centred therein as live electrodes.

The above described apparatus is operated in the following manner. Emulsion or emulsified oil, which may be preheated to any desired temperature, is introduced to the lower compartment 11a through an inlet pipe 31. Any water which may accompany the emulsion settles in this compartment and joins the water body 21.

The emulsion slowly rises through this compartment and passes into the next compartment 11b through the tubular members 16 affixed to plate 12a. A desired potential, as of the order of 5,000 volts to 12,000 volts, being impressed on the electrodes, a highly concentrated field is established between the rod 13 and the tubular element 16, and in passing through these fields the emulsion is partially resolved in the manner above described, the resolution products being an oil containing a residual of emulsion and also water drops in suspension. The velocity through the tubular elements is so controlled that the water drops are carried out of the field as fast as they are liberated and are thus prevented from forming conductive water chains.

Passing through the tubular elements, the resolution products enter the next chamber 11b and, if the hood 17 is used, are deflected into the lower part of that chamber. By reason of the large area and the extreme retardation of velocity, whatever water has been set free from the emulsified form settles to the bottom of this chamber and is immediately carried away through the downspout 19 to join the water body 21 in the lower compartment.

The oil so deprived of free water and of a portion of its emulsion content rises in the chamber and passes through the tubular elements 16 affixed to the next higher plate 12b, being again subjected to a high electrical stress in passing through the fields and again deprived of a portion of the emulsion content by conversion into free water and removal of the water in the next compartment. This process is repeated as many times as there are plates and the rate of flow through the apparatus is so controlled that the oil will be completely dehydrated or reduced to a maximum water content by the time it reaches the outflow spout 36.

The flow of oil through the entire apparatus being in an upward direction, any gas or vapor carried into the lowermost compartment with the entering emulsion or generated in any part of the apparatus is carried upwardly with the oil and is finally discharged with the treated oil

through the outlet spout 36. Water separating in each compartment flows downwardly to finally reach the bottom compartment but is not contacted with the rising oil except where it overflows the cups 20; so that there is no tendency for remixture of water with oil.

In passing through the tubular elements affixed to each plate there is a small drop in pressure. The spacing of the plates 12 must therefore be such that the difference in weight between the water column inside and the oil column outside the downspout 19 will be greater than the pressure drop through the plate drained by the downspout. If this precaution be not taken, the downflow of water will be prevented and the 15 downspouts will act as bypasses in diverting oil around the tubular elements in which it is to be treated.

The structure shown is adapted to the treatment of any emulsion in which water is the dispersed phase, no matter how refractory, and will produce a complete resolution of the emulsion and final separation of the phases of the emulsion in a single pass through the treater.

The structure shown has important advantages over other dehydrating apparatus heretofore disclosed. The rod and tube form of electrode, which has heretofore been used only in combination with the circulation of treated oil through the tube with the emulsion, is adapted to produce a highly concentrated and effective field. In the use here shown recirculation is avoided and the treatment materially increases the capacity of the apparatus. The arrangement of the settling chambers is such that turbulence is avoided and there is none of the tendency toward reemulsification and the formation of reversed emulsions which follows from turbulence in the oil and water body.

I claim as my invention:

1. An electrical dehydrator comprising: a shell; a horizontal partition dividing said shell into upper and lower chambers; a grounded electrode in the form of a tube projected from said partition and affording the sole means for the upward passage of liquid from said lower to said upper chamber; a live electrode in the form of an attenuated electrical conductor and means insulated from said shell for axially supporting said live electrode within said grounded electrode; means for maintaining a static electrical field between said electrodes and within said passage; means for introducing a flow of said emulsion into a medial portion of said lower chamber to flow through said field into said upper chamber; means independent of said tube for continuously draining water separating in said upper chamber into said lower chamber, said means being arranged to prevent the return of oil or emulsion from said upper to said lower chamber; means for preventing upward flow of liquid through said draining means; means for withdrawing oil from said upper chamber, and means for withdrawing water from said lower chamber.

2. Apparatus substantially as and for the purpose set forth in claim 1, including a deflector supported over and spaced from the upper end of said tube and arranged to direct the upward flow through said tube in a lateral direction into the body of liquid in said upper chamber.

3. Apparatus substantially as and for the purpose set forth in claim 1, including means interposed in said oil withdrawal means for separating from said oil any gas accompanying said oil.

4. An electrical dehydrator comprising: a ver-

5 tically arranged shell; a plurality of horizontal
partitions dividing said shell into superposed
chambers; a grounded electrode in the form of a
tube projected from each said partition and af-
10 fording the sole means for the passage of liquid
from one chamber to the next above; a live elec-
trode in the form of an attenuated electrical con-
ductor axially supported within each said ground-
ed electrode; means insulated from said shell for
15 supporting said live electrodes; means for main-
taining static electrical fields within said ground-
ed electrodes; means for introducing a flow of
emulsion into a medial portion of the lowermost
of said chambers and for maintaining a flow of
20 emulsion through each said chamber and through
one of said fields into the chamber next above;
means for withdrawing oil from the uppermost of
said chambers; means independent of said tubes
for continuously draining water settling in each
25 chamber into the chamber next below said means
being arranged to prevent the return of oil or
emulsion from a lower to an upper chamber;
means for preventing upward flow of liquid
through said water draining means, and means
30 for withdrawing water from the lowermost of
said chambers.

5. An electrical dehydrator comprising: a ver-
tically arranged shell; a plurality of horizontal
partitions dividing said shell into superposed
chambers, each said partition being provided with
at least one substantially unimpeded opening;
35 means for maintaining a static electrical field
in each said opening; means for passing emulsion

successively through said fields and said cham-
bers; a water drain pipe projected downwardly
from each said partition to approach the upper
surface of the partition next below, and a water
seal cooperating with said drain pipe to prevent
5 the passage of emulsion or oil therethrough.

6. Apparatus substantially as and for the pur-
pose set forth in claim 1, including means for
automatically maintaining a substantial body of
water in the lowermost of said chambers below
10 the level at which emulsion enters said chamber,
the drain pipe from the lowermost of said par-
titions having its lower end submerged in said
water body.

7. In a method of resolving petroleum emul-
sions in which water is the dispersed phase, the
steps comprising: establishing a succession of
electrostatic fields; passing a flow of emulsion at
a relatively high velocity successively through said
15 fields to produce progressive resolution of said
emulsion; retarding the flow of emulsion between
adjacent fields in separately confined and re-
latively quiescent bodies to permit sedimentation
of resolved water; returning said water out of
20 contact with said emulsion from each said body
to the preceding body as regards the direction of
emulsion flow; withdrawing resolved water from
only the first of said bodies; withdrawing resolved
oil from only the last of said bodies, and pre-
25 venting any return of emulsion from any body
to a preceding body.

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