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3 Sheets-Sheet 1



Witnesses
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DEMULSIFIER

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3 Sheets-Sheet 3

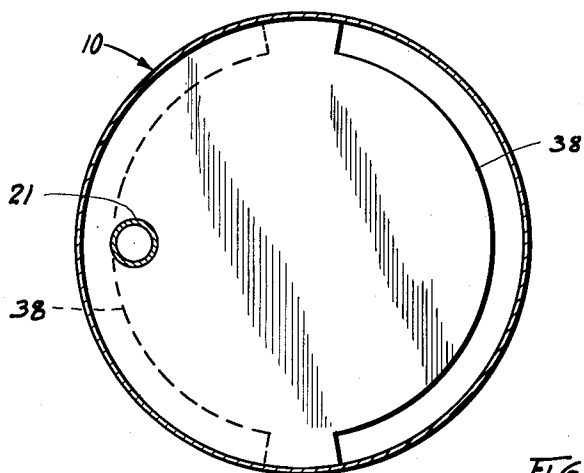


FIG. 3.

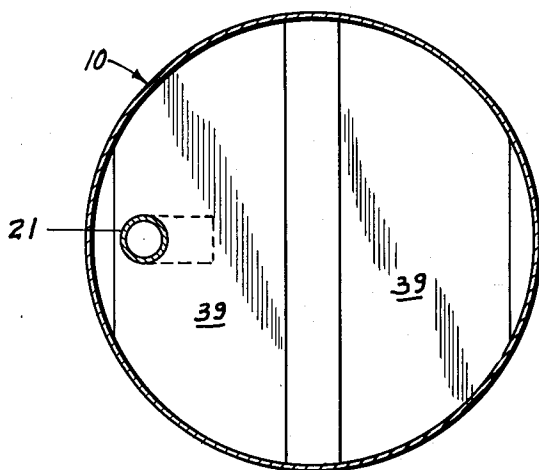


FIG. 4.

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DEMULSIFIER

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1 Claim. (Cl. 183—2.7)

This invention relates to a new and improved demulsifier which utilizes heat for emulsion breaking and applies such heat in an efficient and economical manner and particularly to a structural arrangement that reduces the tendency of the light fractions of oil to evaporate and provides for the recovery of a considerable portion of the light fractions that are evaporated.

Many attempts have been made to improve the operating balance of demulsifiers, for instance by vertically distributing the applied heat by means of successive and/or concentric up and down flows, by special types of heaters, special types of clarifiers and various other features. Some progress has been made but appreciable values are still being lost by unnecessary evaporation of light constituents of the oil, escape of unused heat, escape of unbroken emulsions, etc. In such respects the new demulsifier is greatly improved.

A particular feature and object of the invention relates to the control over the separation of gas and vapor. It is one of the paradoxes of oil treatment that heat must be applied to break undesirable emulsions but that the applied heat tends to evaporate and remove desirable light fractions of the oil. For a long time this problem was overlooked. More recently, mainly since the advent of mass utilization of higher quality products the loss of the light fractions was noted and regretted but no equipment was available, particularly for use in the localized leases or oil-producing installations feeding the pipe lines and storage deposits, to conserve the volatile values while driving off the emulsions.

It has now been discovered that both objects can be achieved without appreciable interference by means of a demulsifier design which differs radically from earlier ones in that it concentrates the applied heat between upper and lower portions of the unit; and it was found additionally that such design is highly efficient and economical even for the old and well-known object of basic heat economy.

It is a further object of the invention to provide an arrangement, as above described, wherein the structure is formed and arranged so as to control heat distribution therethrough, reducing the tendency to evaporate the lighter fractions and to further provide for a recovery of a substantial amount of the lighter fractions that do evaporate.

The details will be understood upon a study of the following description of a preferred embodiment.

In the drawing:

Figure 1 is a front elevation of a demulsifier in accordance with this invention, partly shown in vertical section along the lines 1—1 in Figure 2.

Figure 2 is a side elevation of the same demulsifier.

Figure 3 is a fragmentary sectional view taken along line 3—3 of Figure 1.

Figure 4 is a fragmentary sectional view taken along line 4—4 of Figure 1.

An upright cylindrical tank 10 is utilized which is suitably supported on a bottom structure 11 and shown as having dished top and bottom closures 12, 13. The inside

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of the tank is subdivided into a plurality of compartments, shown as disposed above one another and comprising an uppermost gas separator compartment 14, an underlying clarifier compartment 15, a still lower heater compartment 16 and a lowermost water knockout compartment 17. The heater 18 extends into the heater compartment 16 from the outside of the tank where it is equipped with conventional fuel supply means 19 and chimney means 20. The bottom of the gas separator compartment 14 communicates with the water knockout compartment 17 by a pipe or conduit 21, shown as running along the inside of the shell of the tank. An oil inlet pipe 22 discharges into the gas separator compartment 14 through an inlet 23 shown as disposed between the top and bottom of the compartment and which may be equipped with well known float valve control means or the like (not shown). In an upper part of the clarification compartment 15 an outlet 24 is provided which communicates with an oil outlet pipe 25, optionally in heat exchanging relation with the inlet pipe 22 as shown. Water separated from the oil can be withdrawn from the bottom head 13 at the bottom of the knockout chamber 17 through a pipe 26 and/or through the side wall of the tank adjacent the bottom of the heater chamber 16 through a pipe 27; said outlet pipes discharging normally through a suitably weighted outlet valve 28. Optionally water and/or sediment from the knockout chamber can be discharged through a manually opened and closed discharge valve 29, which can also be connected directly with the heater chamber by closing a manual valve 30. Gas and vapor released in the gas separator chamber 14 can be withdrawn at the top of said chamber through a pipe 31 equipped with suitable valving not shown; together with gas and/or vapor released in the clarifier or underlying compartments, which can freely enter the gas separator compartment through an equalizer pipe 32. An additional equalizer pipe 33 is provided between the outlets 26, 27 and the gas separator chamber in order to make sure that no gas or vapor accumulates under any condition in said outlets which are provided for the water. The gas outlet 31 is desirably protected by a mist extractor screen 34. A suitably loaded control valve 35 may be interposed on the oil outlet pipe 25 and a conventional safety valve 36 may be connected with the equalizer 33.

An important feature of the invention provides that a partition 37 of highly heat-permeable material such as uninsulated and suitably corrosion-proofed steel is interposed between the bottom of the gas separator compartment 14 and the top of the clarifier compartment 15, whereas partition means 38 of appreciably heat-insulating and also corrosion-proof material such as redwood will be interposed between the bottom of the clarifier compartment 15 and the top of the heater compartment 16. The insulator partitions 38 extend part of the way across the area of the tank, a plurality of such baffles being provided in staggered relation to allow upward flow of oil around the same whereas the upper steel partition 37 is shown as being imperforate except for the connections of the pipes 21 and 32. Between the heater and knockout compartments 16, 17 additional baffle type partition means 39 will be installed, desirably in inclined positions to facilitate the running off of all demulsified water and precipitated sediment.

The clarification chamber 15, interposed between the upper and lower partition means 37, 38, may be subdivided into a lower filtration section, formed by a charge of excelsior or hay between woven wire trays 40 and an upper sedimentation section between the uppermost wire tray 40 and the partition 37.

In operation a raw petroleum liquid or other product, identified as oil throughout this specification, enters the tank at 23 and fills the gas separator chamber 14 under

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the control of the oil inlet valve 35. While the liquid level of the incoming fluid will vary slightly from time to time, the approximate level can be shown by dotted line 23a. This oil received in the tank is relatively cold although it may have been preheated to a slight extent by heat exchange with the pipe 25, the latter being hot as will appear presently. Undesirable gases which may be present mainly in certain crude products are released from the liquid level in the gas separator chamber, said liquid level occupying the entire area of the tank.

While flowing in and through the gas separator chamber 14 the oil receives some further preheating across the heat-transmitting partition 37, the other side of said partition being in contact with the clarified and treated oil which as mentioned is hot. A still further heat exchange occurs as the oil flows from the bottom of the gas separator compartment 14 through the pipe 21 into the bottom compartment 17. Thus it will be seen that the treated oil in compartment 15 is cooled by contact with partition 37, which reduces the tendency of the light fractions of oil to evaporate.

The preheating described has the effect that relatively large and coarse droplets of water which frequently occur in the oil are readily knocked out of the product in the knockout compartment 17, even prior to the heat treatment. This preliminary knocking out of easily removable water is desirable by itself in that it reduces the volume and flow velocity of the ensuing upward flow of the oil through the heating and clarifying compartment. Another and at least equally important advantage of the preheating across the partition 37 is that it results in a cooling of the treated and clarified oil and a corresponding reduction of vapor losses therefrom.

For the moment the flow of the oil will be traced further from the water knockout compartment 17. It is upward into and through the heater compartment 16 where for the first time intensive heating is applied by the heater 18. This intensive heating, applied as mentioned to a volume of oil with finely emulsified water therein and unencumbered by any easily separable water, results in a highly efficient demulsification, caused by the basically known phenomena of differential expansion, accelerated Brownian movement and resulting agglomeration and build-up of previously minute inseparable water particles into larger, easily settleable droplets. This agglomeration is further promoted by the zigzag flow of the product about the baffles 38; also, optionally, by the ensuing irregular flow through the finer openings of the woven wire trays 40 and the filtering materials between the same. As a result very efficient sedimentation of water particles occurs when the so treated mass emerges into the upper, completely unobstructed portion of the clarifying compartment 15.

Liquid temperatures in the tank 10 are at a maximum between the heater 18 and the insulating baffles 38. Above said baffles the temperature of the oil even in the clarification chamber 15 is somewhat lower due to heat exchange across the metallic partition 37, but said partition is still exposed to a very substantial gradient or differential of heat. Thus the partition 37 acts as a chilling medium whereon condensable vapors, previously released in form of bubbles by the intense heat, are recondensed and thus protected from escape and loss. As a result only minor amounts of gaseous matter, substantially formed by uncondensable gases will pass through the equalizer pipe 32.

It will be noted that the raw oil preheating, clear oil cooling, vapor condensing partition 37 is one of the most important elements of the present tank. It will be understood by persons skilled in the art that such a partition should have large surface extension while at the same time avoiding a surface configuration which obstructs the flow and interferes with quiescent conditions therein. It is therefore preferred that the partition 37 should be formed in the manner as illustrated wherein it comprises

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a substantially flat upper portion 41 of annular shape, inwardly projecting from the inside of the shell of the tank 10; a portion 42 downwardly depending from the inner edge of the ring 41 and shown as being cylindrical; and a flat substantially horizontal inner and lower portion 43 closing the bottom end of the cylinder 42, said partition 43 may be arranged to slope (not shown) toward the intake of the transfer pipe 21. The oil outlet 24 is disposed in the upper part of the chamber 15 between the partition 42 and the shell of the tank, while the gas transfer and equalizer pipe 32 extends upwards from the flat plate 41. The usual liquid level in compartment 15 can therefore be illustrated by line 15a. The upper part 44 of the clarifying compartment 15 occupies a major part such as about fifty per cent of the horizontal tank area in order to safeguard the quiescent flow which favors the processes described. At the same time it is preferred that a substantial part of the horizontal tank area, up to but not exceeding fifty per cent thereof, should also be given to the lower part 45 of the gas separator compartment 14, surrounded by the partition 42. This arrangement guarantees a sufficient surface area for said partition 42. At the same time it provides safe and adequate oil storage below the liquid level in the gas separator compartment, avoiding undesirable fluctuations of said level even in the event that relatively simple valve means are used for the control of the oil inlet and outlet pipes. Thus the gas in chamber 14 is kept cool and free from vapor.

Each of the compartments 14, 15, 16 and 17 can be made accessible by a simple manway and closure 46, 47, 48, 49, thereby facilitating the required maintenance of the apparatus. Conventional gauges and sight glasses 50, 51, 52, 53 will show the condition of the product in each of the oil carrying compartments 14, 15, 16 and mainly the gradual change of such condition across the baffles 38, and the connection of such sight glasses is simplified by the feature that the use of concentric compartments, typical for earlier demulsifiers, has been avoided.

Further refinements can be added; for instance it may be desirable to insulate the tank and particularly the hot section thereof extending along the heating compartment 16 and a certain distance above the same. At the top and bottom of the tank inherent insulation is provided by the storage of relatively cold oil in the compartments 14 and 17.

What is claimed is:

In a demulsifying apparatus, a generally cylindrical tank having its long axis vertically arranged; a gas separator compartment at the upper end of the tank, a gas outlet at the uppermost part of the tank and communicating with the compartment, a mist extractor screen surrounding the gas outlet, a clarifier compartment immediately below the gas compartment, metallic partition means separating the compartments and comprising an inwardly directed horizontal flange secured to the inner periphery of the tank, and upwardly open ended cylinder secured to the inner edge of the flange and extending downwardly and partially telescoped into the clarifier compartment, a horizontal plate sealing the lower end of the cylinder, the horizontal cross sectional area of said cylinder being less than fifty percent of the cross sectional area of the clarifier compartment, a product inlet port above the horizontal flange communicating with the gas compartment, an outlet port below the flange and above the horizontal plate communicating with the clarifier compartment, an upstanding pipe in the flange establishing communication between the compartments and extending above the inlet port, a filter in the clarifier compartment and extending completely across the tank, a pair of vertically spaced baffles below the filter and in spaced relation thereto, said baffles being composed of non-metallic heat insulating material and connected to the inner periphery of the tank, one of said baffles providing a passageway therethrough

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adjacent one side of the tank and the other baffle providing a passageway therethrough on the side of the tank opposite the first mentioned side thereby providing an irregular flow of product from below the baffles to above the baffles, a heating compartment below the baffles and having relatively narrow elongated tubes extending diametrically and horizontally across the tank and intersecting said long axis, another pair of baffles below the tubes and secured to the inner periphery of the tank and in angular relation to each other, said other baffles each defining an opening between itself and the inner periphery of the tank, said other baffles defining an elongated opening therebetween extending across the tank immediately below and generally paralleling the tubes, a water compartment below said other baffles at the lower end of the tank, an outlet pipe communicating with the water com-

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partment, and a downwardly extending pipe having its upper end connected to the horizontal plate and communicating with said cylinder, said downwardly extending pipe passing through the filter, the first mentioned baffles and one of said other baffles, and a horizontally directed lower opening on said last mentioned pipe extending into said water compartment below said baffles.

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