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3,701,723

ELECTRIC TREATMENT OF DISPERSIONS

Original Filed July 25, 1969

2 Sheets-Sheet 1

FIG. 1.

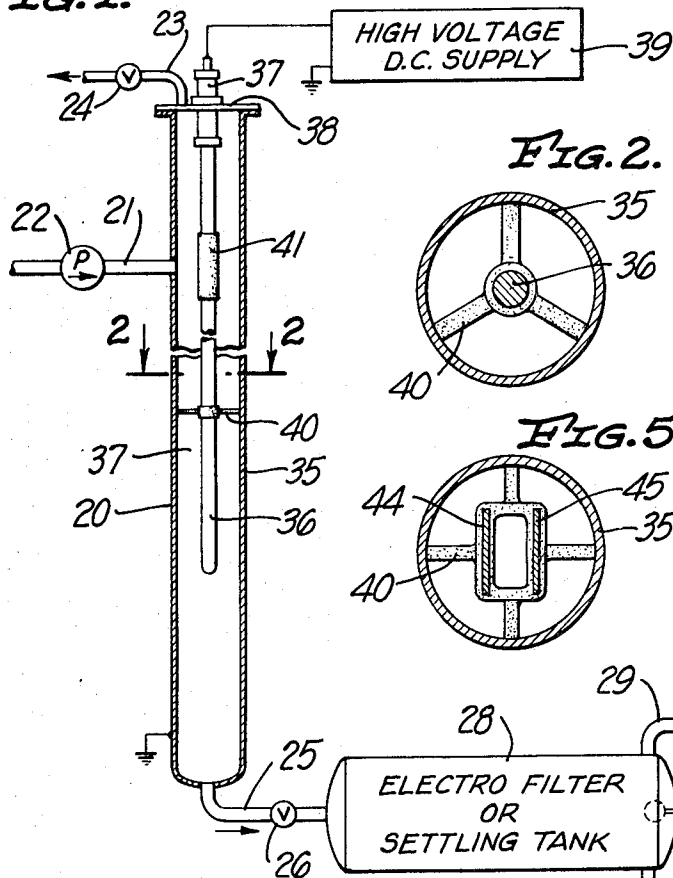


FIG. 2.

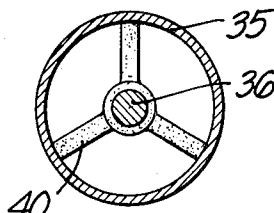


FIG. 3.

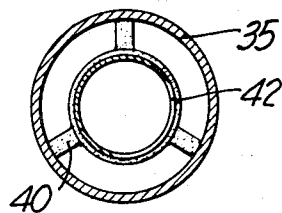


FIG. 5.

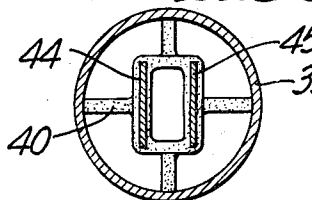


FIG. 4.

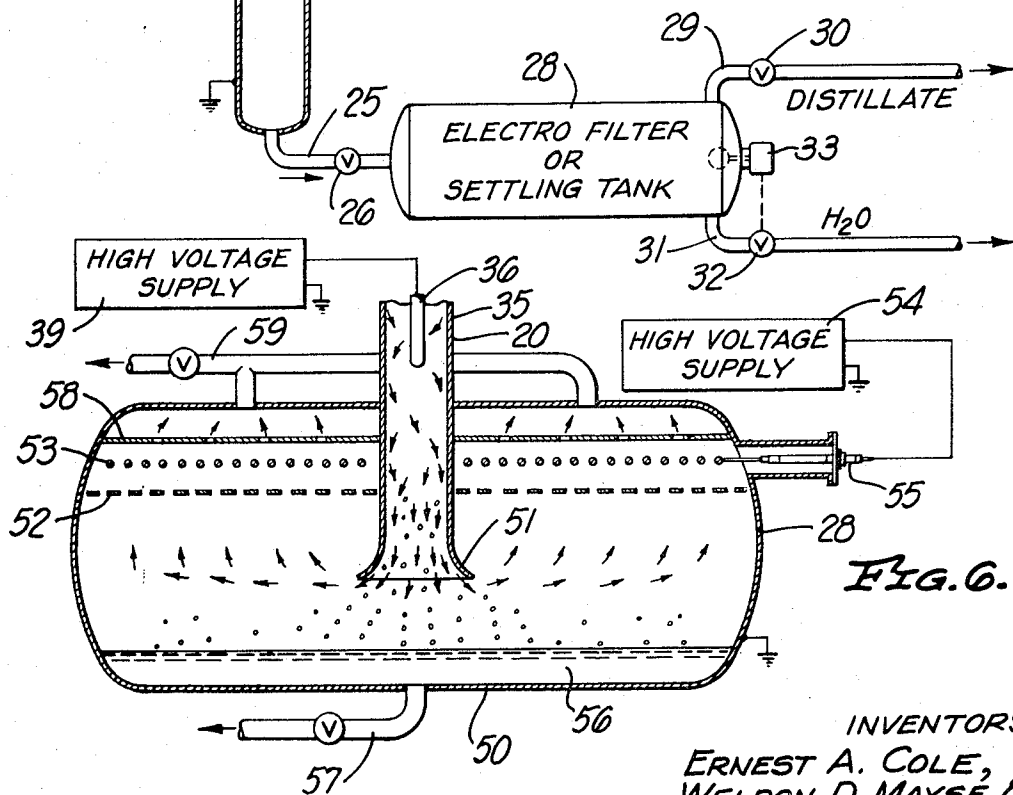
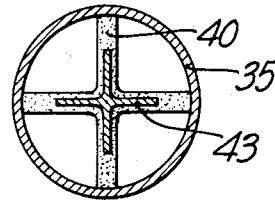


FIG. 6.

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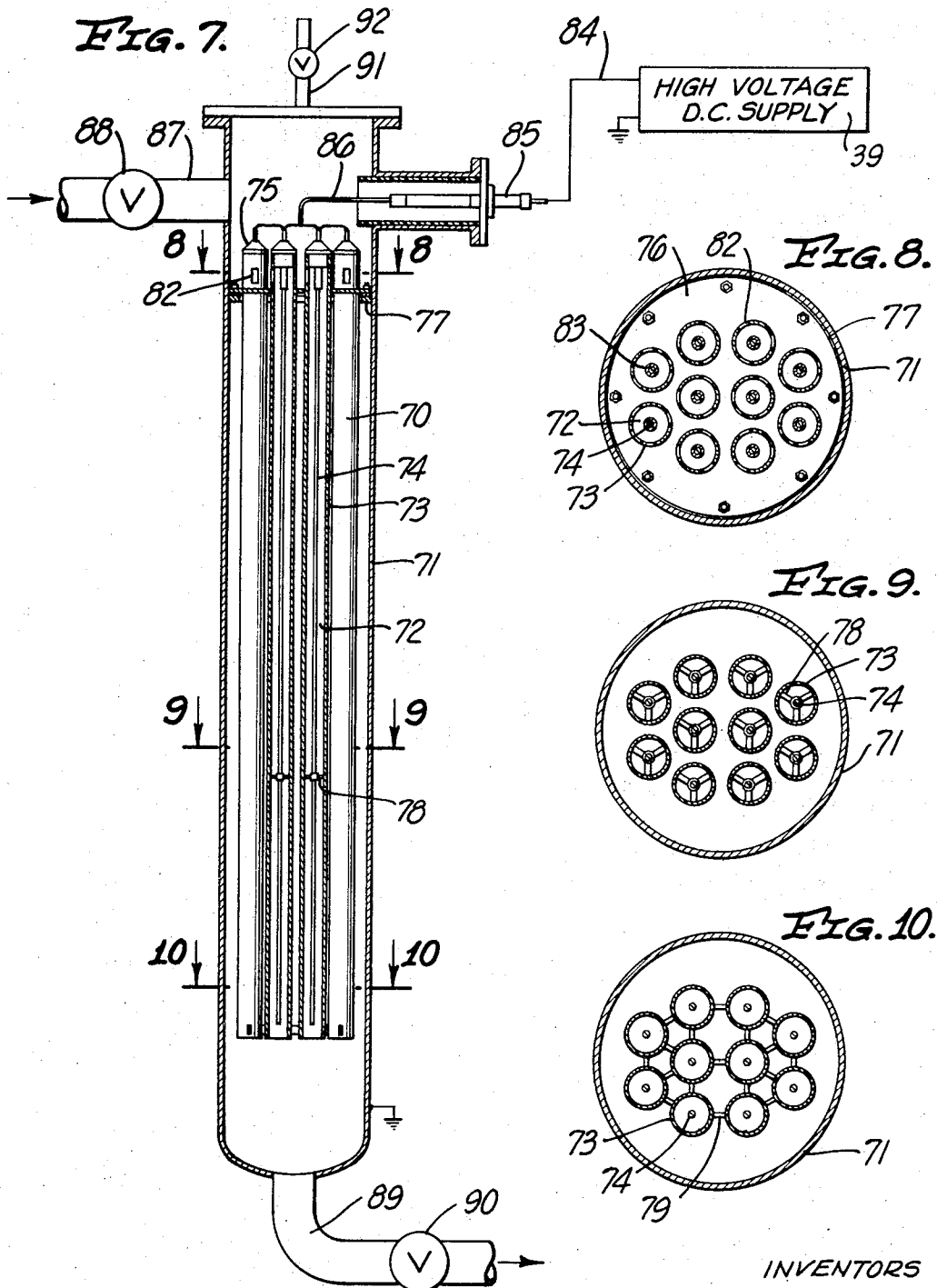
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ELECTRIC TREATMENT OF DISPERSIONS

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Original application July 25, 1969, Ser. No. 844,963.

Divided and this application Feb. 22, 1971, Ser.

No. 117,264

Int. Cl. B03c 5/00; B01d 13/02

U.S. Cl. 204—188

3 Claims 10

ABSTRACT OF THE DISCLOSURE

Process and apparatus for coalescing liquid droplets, such as water, dispersed in an oil distillate, such as gasoline or kerosene. Coalescing process and apparatus utilizing a unidirectional electric field between elongate electrodes with a high voltage gradient and a high rate of flow in the space between the electrodes. Coalescing process and apparatus wherein the coalesced liquid is maintained within the distillate and is separated from the distillate downstream of the coalescing electrodes.

This is a division of application Ser. No. 844,963, filed July 25, 1969 and now abandoned.

This invention relates to the treating of dispersions and more particularly, to the coalescing of a finely dispersed internal phase prior to separation of the internal phase material. The invention is specifically directed to the coalescing of minute liquid droplets, such as water droplets, dispersed in an oil distillate, such as gasoline, kerosene, gas oil, and the like. As used herein, the term "oil distillate" is intended to be limited to petroleum distillates having a maximum boiling point in the order of 700° F.

The invention provides for the treatment of dispersions comprising an external phase of high resistivity liquid, i.e., oil distillate, and a finely dispersed internal phase of more conductive liquid, such as water. The process and apparatus provide for coalescing the internal phase while maintaining the coalesced liquid in the external phase, with the coalesced liquid droplets being separated from the external phase liquid in a separate operation downstream of the coalescing operation.

It is often desirable to coalesce a finely dispersed internal phase of a dispersion prior to treatment of the dispersion for removal of the internal phase, as by chemical treatment or electrical treatment or thermal treatment or settling or combinations thereof. As in most industrial operations, such coalescing has been achieved by various means in the past. However, the degree of coalescence achieved and the cost of the operation have not always been satisfactory. It is an object of the present invention to provide a new and improved process and apparatus for coalescing water and the like in oil distillates with relatively simple and inexpensive equipment which achieves satisfactory operation.

It has been found that improved coalescing can be obtained by moving the liquid through an interelectrode treating space having a high voltage gradient between the electrodes and having a high rate of flow of fluid through the space. It has been found that the desired coalescing operation is achieved by using rates of flow, an order of magnitude greater than those previously utilized, that is to say, electric treaters with elongate interelectrode spaces have been operated with rates of flow measured in inches per minute, while the present invention utilizes similar electrode structures with operating rates measured in inches per second. It has been found that coalescing can be achieved utilizing high voltage gradient and high rate of flow without separating the coalesced liquid, per-

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mitting continuous operation at high rate in a very simple coalescer, with the separation being performed in a subsequent piece of equipment.

Other objects, advantages, features and results will more fully appear in the course of the following description. The drawings merely show and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

FIG. 1 illustrates a coalescer, partly in vertical section, embodying the invention;

FIG. 2 is an enlarged sectional view taken along the line 2—2 of FIG. 1;

FIGS. 3, 4, and 5 are views similar to that of FIG. 2, showing alternate constructions for the inner electrode;

FIG. 6 is a view similar to that of FIG. 1 showing an alternate embodiment of the invention with the coalescer mounted directly on a subsequent treating vessel;

FIG. 7 is a view similar to FIG. 1 showing a presently preferred embodiment of the invention;

FIG. 8 is an enlarged sectional view taken along the line 8—8 of FIG. 7;

FIG. 9 is an enlarged sectional view taken along the line 9—9 of FIG. 7; and

FIG. 10 is an enlarged sectional view taken along the line 10—10 of FIG. 7.

FIG. 1 illustrates a coalescer 20 having an inlet line 21 with pump 22, a vent line 23 with valve 24 for purging the unit, and an outlet line 25 with valve 26. The outlet line may be connected to a subsequent treating unit 28 such as an electrofilter or a settling tank or a chemical or thermal or electric treater. The main distillate stream leaves the unit 28 via line 29 with valve 30 therein and the separated water leaves via line 31 with valve 32 therein. Valve 26 may be used to build back pressure on the coalescer to assist in the purging of gas. Alternatively this could be accomplished using valves 30 and 32. The level of the distillate-water interface in the unit 28 may be controlled by a level controller 33 coupled to one of the valves 30, 32, here the latter. Alternatively, level control may be accomplished manually. The coalescer is illustrated as an upright unit with downflow, but could also operate with upflow or in a horizontal or intermediate position as desired.

The coalescer 20 comprises a container having an electrode structure with first and second electrodes defining an interelectrode space therebetween. In the embodiment of FIG. 1, a cylindrical tube 35 serves as the container and as the outer electrode. A rod 36 is centrally positioned within the container and serves as the inner electrode, defining an annular space 37 between the two electrodes. The rod 36 may be mounted in an insulating bushing 37 supported on a plate 38 which closes the upper end of the container 35. A high voltage D.C. supply 39 has one output connected to the rod 36 with the other output connected to circuit ground, with the container 35 also being connected to circuit ground. A spider 40 may be carried on the rod 36 adjacent the lower end thereof for maintaining the rod in position relative to the container. A piece of insulating sleeving 41 may be positioned about the rod 36 opposite the inlet line 21 to reduce the likelihood of shorting by the incoming fluid.

The fluid to be treated enters the coalescer through inlet pipe 21, flows generally axially through the interelectrode space 37 and exits through pipe 25. The flow pattern may be helical, as would be produced by a tangential input, or may be generally straight. The input may be tangential or radial or otherwise as desired.

In a typical unit, the tube 35 may be 2½" inside diameter and the rod 36 ½" outside diameter, resulting in a 1" gap between the electrodes. In one such unit, the interelectrode space is 30" long and in another unit

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it is 60" long. In another typical unit, the tube 35 is 4" inside diameter with the rod 36½" outside diameter, providing a gap of 1¾". The interelectrode space may be 30" in length and 60" in length. The particular dimensions of the components are not critical, however, the rate of flow of fluid through the interelectrode space and the voltage gradient in the space are important in the present invention.

The coalescer provides for the treatment of dispersions comprising an external phase of oil distillate having relatively high resistivity and a finely dispersed internal phase of more conductive liquid such as water. A high voltage gradient is maintained in the gap between the electrodes and the dispersion is moved through the gap at a high rate of flow. As the dispersion moves through the interelectrode space, the minute liquid droplets of the internal phase are coalesced into large drops which are retained in the dispersion as it leaves the coalescer.

The high rate of flow of course provides a high capacity unit in a relatively small and inexpensive physical structure. The maximum voltage applied to the coalescer is dependent upon the rate the distillate is passing through the electric field. With very high rates of flow, very high voltage can be maintained without arcing. It is felt that this high voltage is beneficial to the coalescence even though the rate is high, because coalescence is achieved at very low retention times in the electric field. These high voltages cannot be maintained at low rates of flow. The high rate of flow also prevents gravitational separation of the coalesced drops of the more conductive internal phase liquid.

In the coalescer of the present invention, the unidirectional voltage gradient should be maintained in excess of about 20 kilovolts per inch and the axial rate of flow through the interelectrode space should be maintained in excess of about 1" per second. No upper limit has thus far been noted for the rate of flow. The preferred range for rate of flow of fluid through the interelectrode space is about 4 to 100 inches per second. The maximum voltage gradient is limited by a number of factors including the power supplies available, the quality of the insulation in the structure, and the resistivity of the material being treated. The preferred range for voltage gradient is about 35 to 60 kilovolts per inch.

The interelectrode space is relatively long and narrow and should be at least about 30" in length. Preferably a unit will have a length-to-gap ratio of at least about 15 to 1, but this is not critical.

While the presently preferred electrode configuration is illustrated in FIGS. 1 and 2, it should be noted that other electrode configurations can be utilized and some examples are illustrated in FIGS. 3, 4, and 5. In the structure of FIG. 3, the inner electrode is a tubular cylinder 42 and would be more suitable for use with larger diameter coalescers for having higher volume capability while maintaining a relatively small gap between the electrodes. In the structure of FIG. 4, the inner electrode 43 is of cruciform shape. The electrode structure of FIG. 5 includes parallel plates 44, 45. In one mode of operation, the plates 44, 45 may serve as the two electrodes with the voltage gradient therebetween and with the major portion of the flow directed therebetween. In another mode of operation, the plates may be operated at the same potential and function as a single electrode, with the container 35 functioning as the other electrode.

FIG. 6 illustrates an alternative arrangement for the coalescer 20 and subsequent treating unit 28, with the coalescer mounted directly on the treating unit. In FIG. 6, the treating unit 28 is illustrated as a conventional electric treater with a horizontally disposed cylindrical vessel or container 50 having the coalescer container 35 positioned in an opening in the upper surface of the vessel 50, with the lower end 51 of the container 35 flared outwardly for discharging the dispersion with the coalesced droplets into the interior of the vessel 50.

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The treater of FIG. 6 includes a foraminous ground electrode 52, and a plurality of horizontally disposed rods 53 forming the high voltage electrode which is energized from a supply 54 via a feed-through bushing 55. The separated water collects in the lower portion 56 of the vessel and is removed via drain line 57. The treated oil distillate rises through openings in a meter plate 58 and is withdrawn through an outlet line 59. Of course, the arrangement of coalescer and treater of FIG. 6 is equally suitable for use with chemical treaters, thermal treaters, electrofilters, settling tanks and other such units. In the arrangement of FIG. 6, the coalesced phase is not subject to dispersion in a pipe and valve as it is in the system of FIG. 1.

A presently preferred form of the coalescer is illustrated in FIGS. 7-10 and includes a plurality of electrode structures 70 disposed in a container 71, with each of the electrode structures providing an interelectrode space 72 between a tubular outer member 73 and an inner rod 74. The tubes 73 are mounted in a header plate 76 which in turn is mounted on an inner annular shoulder 77 of the container 71. The rods 74 are supported in insulating bushings 75 at the upper ends of the tubes 73 and are centered by insulating spiders 78 disposed further down along the electrode structures. The lower ends of the tubes 73 are stabilized by interconnecting bars 79, as best seen in FIG. 10.

One or more inlet openings 82 are provided in each of the tubes 73 adjacent the upper ends thereof. An insulating sleeve 83 may be applied to each of the rods 74 opposite the inlet openings if desired. One terminal of the high voltage supply 39 is connected to each of the rods 74 via a line 84, a feed-through bushing 85, and a line 86 and the other terminal is connected to circuit ground along with the container 71 and members 73. The dispersion to be treated enters through an inlet pipe 87 with a valve 88 and the dispersion with the coalesced droplets leaves via line 89 having valve 90 therein. A line 91 with a valve 92 serves as a vent for the coalescer.

The coalescer of FIG. 7 is operated in the same manner as the coalescer of FIG. 1 and the discussion regarding the operating characteristics and the variations in construction are equally applicable to the coalescer of FIG. 7. The unit of FIG. 7 with the plurality of electrode structures provides a much higher volume capacity while retaining the simple structure of FIG. 1 with the long and narrow interelectrode space and the high voltage gradient and high rate of flow of fluid through the space.

We claim:

1. A process for the treatment of dispersions comprising an external phase of high-resistivity oil distillate and a finely-dispersed internal phase of more conductive liquid by use of spaced electrodes bounding an elongate interelectrode treating space, said process including the steps of:

establishing in such interelectrode treating space a unidirectional electric field of high voltage gradient in excess of about 20 kilovolts per inch;

flowing a stream of the dispersion downwardly through said interelectrode treating space at a high rate of flow in excess of about one inch per second to produce turbulent flow and to substantially eliminate short-circuiting during normal continuous operation of the process and to prevent gravitational separation of the coalesced liquid from the external-phase liquid while in the electric field so that the content of dispersed-phase liquid entering and leaving the field is the same; and

separating such coalesced dispersed-phase liquid droplets from the external-phase liquid in a laminar flow zone at a position downstream of said interelectrode treating space and removed from the effect of the electric field in said interelectrode treating space.

2. A process as defined in claim 1 wherein the voltage gradient is maintained in the range of about 35 to 60

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kilovolts per inch and the rate of flow is maintained in the range of about 4 to 100 inches per second.

3. In a process for coalescing minute liquid droplets dispersed in an oil distillate, the steps of:

continuously delivering a stream of oil distillate containing dispersed liquid droplets to the entrance end of an elongate interelectrode space;

continuously withdrawing from the exit end of the interelectrode space a stream of treated oil distillate containing the same amount of the dispersed liquid as was contained in the entering stream of oil and delivering such stream to a laminar flow zone;

maintaining a turbulent flow in the interelectrode space at an axial rate of a magnitude to avoid arcing and in excess of about one inch per second;

establishing in the interelectrode space a high voltage unidirectional electric field with a gradient in excess of about 20 kilovolts per inch for electrically coalesc-

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ing the liquid droplets during the turbulent flow through the interelectrode space; and in the laminar flow zone beyond the effect of the electric field, separating the coalesced liquid droplets from the oil distillate stream.

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U.S. Cl. X.R.

204—302