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TREATING HYDROCARBONS

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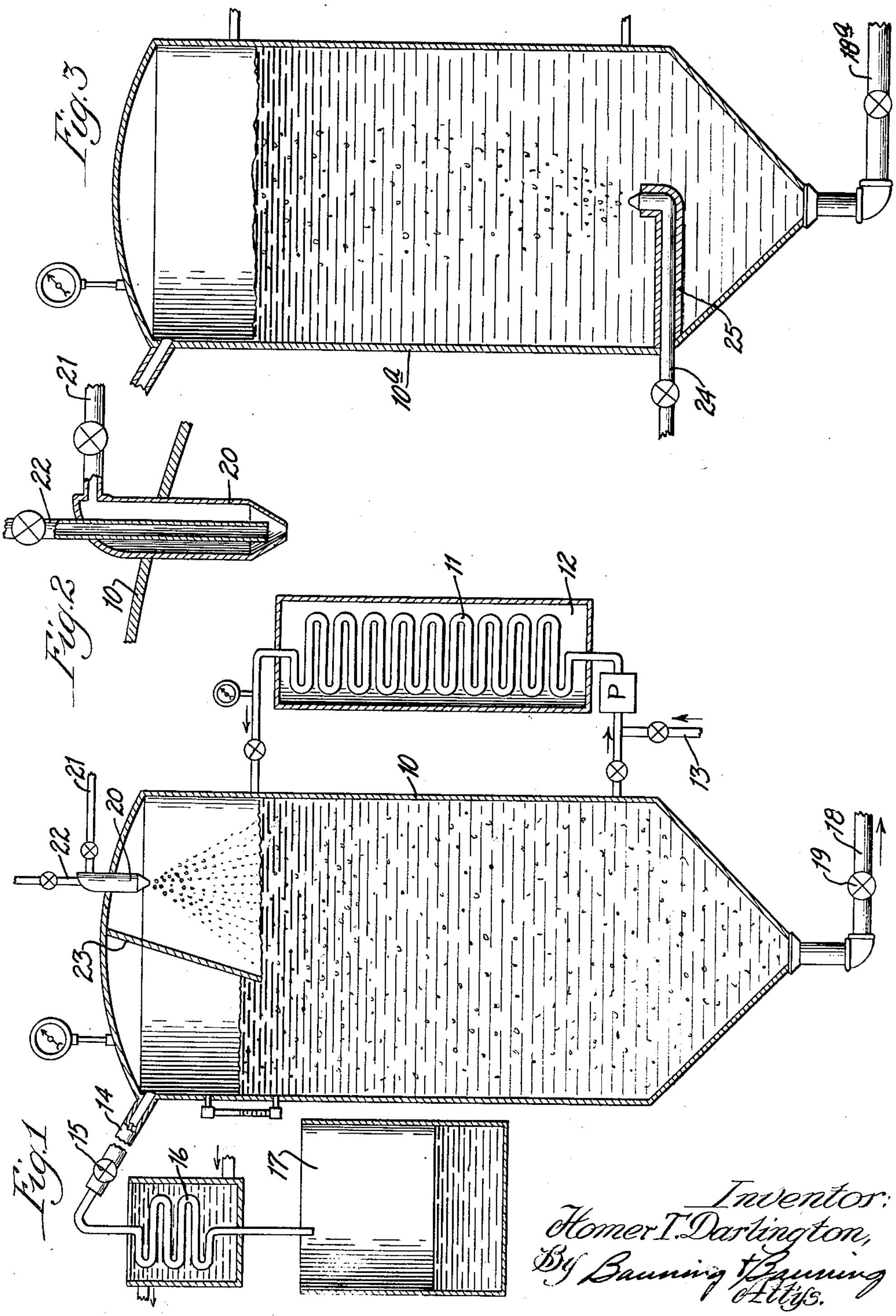

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TREATING HYDROCARBONS

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My invention relates to a method of treating liquid hydrocarbon for the purpose of promoting cracking and the production of the lighter distillates, particularly gasoline, or for the purpose of lightening the quality, and reducing the viscosity of the hydrocarbon, or for otherwise beneficially influencing and promoting the cracking operation in ways which will more fully appear from the following specification.

In carrying out the art of my invention, I bring together hydrocarbon and ordinary salt, alum, sodium-sulphate, aluminum-chloride (dissolved in water), or other chemical salts, or any combination of one or more of them, in aqueous or other solution into hydrocarbon oil under conditions of temperature and pressure conducive to cracking oil, in such a manner that on evaporation of the solvent named above the agent is left as favorable colloid nuclei incorporated or dispersed, or both, in the hydrocarbon being treated, bringing about cracking and changes favorable for the elimination of carbon as a suspension in the residue oil. Favorable conditions for the carrying out of the present process are the following, to-wit: a temperature above 450° F., but preferably in practice between 750° F. and 1000° F., and a pressure sufficient to keep the hydrocarbons which are heavier than gasoline liquid at the temperature used, said pressures ordinarily running between 100 pounds and 1500 pounds to the square inch.

I find it favorable to emulsify or homogenize the salt solution in oil and spray the emulsion into the hot chamber; for instance, into a gas space above the oil in a reaction chamber or a cracking still, or spray as above through gas into hot oil, or force it directly into the hot oil, preferably through an insulated nozzle, or to bring together hot oil from the cracking still with the oil emulsion, in which cases the evaporation of the solvent leaves the salts in a dispersed or incorporated form which for practical purposes is equivalent or nearly so to a colloidal dispersion or incorporation, though not necessarily chemically so, where, upon acting as an aid in cracking, the nuclei salts become coated with carbon and can be removed from the still continually or intermittently.

Apparatus for carrying out this process is shown in the accompanying drawings, in which—

Figure 1 is a diagrammatic view showing the apparatus in vertical section;

Fig. 2 is an enlarged partial vertical section of the spray nozzle shown in Fig. 1; and

Fig. 3 is a similar view of a reaction chamber similar to that of Fig. 1 showing a modified form of the spray device.

In the embodiment illustrated, a reaction chamber 10 is heated by means of a pipe coil 11 through which oil is circulated by means of a pump P, the oil 11 being heated in a well known manner by means of a suitable furnace 12. Fresh oil may be introduced into the system through a pipe 13. A suitable dephlegmator or the like 14 connects with the top of the reaction chamber above the normal level of the oil therein, and is controlled by means of a valve 15. Vapors, as gasoline or the like, passing the valve 15 are condensed in suitable condensing coils 16 which are cooled in a well known manner, the liquid as gasoline or the like being stored in a suitable tank 17. Residual oil is withdrawn preferably from the bottom of the reaction chamber 10 through a draw-off pipe 18 which is controlled by means of a valve 19.

The foregoing apparatus is well known in the oil cracking art. To this I have added a spray nozzle, which consists of an outer shell 20, to which is supplied through a pipe 21 a suitable salt solution or the like, as will hereinafter be described. For properly atomizing the liquid passing the nozzle 20, I have provided a steam pipe 22 with steam supplied thereto at a suitable pressure for properly atomizing the liquid which is supplied, also under proper pressure, by the pipe 21. A shield or partition 23 extends across the top of the reaction chamber and below the level of the hydrocarbon oil therein so as to prevent spray particles from the nozzle 20 from passing up into the dephlegmator 14.

Thus it will be seen that the salt solution or liquid mixture emerging from the nozzle 20 is atomized and sprayed in fine particles against the surface of the liquid in the reaction chamber 10. Since this reaction chamber is maintained under conditions of temperature and superatmospheric pressure conducive to cracking, the temperature is sufficiently high to cause the liquid solvent or vehicle to become very quickly vaporized, thereby leaving the salt solid in the form of finely divided particles which enter the oil and go into colloidal dispersion or suspension therein.

The nozzle 20 is so situated as to preclude the possibility of spraying any of the liquid particles containing the salt directly against the walls of the reaction chamber 10. In other words, the stream of the liquid particles is so directed as to cause the liquid to be vaporized before the particles can come in contact with a wall of the vessel. In this way, no deposition of the salt can be made upon the walls of the vessel, inasmuch as the salt or other solid being in colloidal suspension in the oil will not adhere to the walls of the vessel, as would be the case if the liquid solution were to be allowed to come in contact with the walls of the vessel before evaporation of the liquid solvent or carrier took place.

In Fig. 3 is shown a modification of the construction in which the reaction chamber 10*a* is supplied with the same kinds of salts or other solids for solution or suspension in liquid through a spray nozzle 24, which is located beneath the surface of the hydrocarbon oil to be treated and preferably near the bottom. This nozzle is preferably surrounded with a suitable heat insulating covering 25, the effect of which is to prevent evaporation, to a large extent at least, of the liquid solvent or vehicle. If desired, the nozzle 20 of Figs. 1 and 2 may also be provided with an insulating covering for the same reason; namely, to prevent the deposition of solids within the nozzle due to evaporation of the liquid solvent or vehicle.

In the form shown in Fig. 3 steam may be added, if desired, but the device will operate quite effectually if the nozzle is supplied only with a salt solution or with a solid in suspension in a liquid under sufficient pressure to cause it to be forced into the reaction chamber against the pressure therein, and also sufficient to prevent clogging of the nozzle due to the deposition of the solute or other solid which is carried thereby.

This liquid solvent or carrier preferably has a boiling point lower than the temperature at which the hydrocarbon oil in the reaction chamber is treated, so that when this liquid material is injected into the reaction chamber through either the nozzle 20 or the nozzle 24, the liquid solvent or vehicle will rapidly be evaporated leaving the solid behind in the hydrocarbon oil. When this liquid material is injected through the nozzle 24 the steam or vapor thus formed in the hot oil causes the solid particles, which are simultaneously formed, to be separated from each other in a finely divided state of colloidal dispersion in the hot oil. At the same time the steam or vepor of the liquid thus generated assists greatly in removing the vapors of gasoline and other light hydrocarbons from the oil through which they rise.

The discrete solid particles thus dispersed throughout the body of oil under treatment act as nuclei for the deposition of carbon, and at the same time provide surfaces where cracking of the oil can readily occur, the deposition of carbon being an incident to the cracking of the oil. As this carbon continues to be deposited upon these solid particles, it will no longer remain in suspension, unless agitated, but sinks and is drawn off from the body of the oil, either continuously or intermittently through the pipe 18, fresh cracking stock being supplied through the pipe 13 and fresh solid particles are supplied to the oil through the nozzles 20 or 24, so as to maintain the level of the oil substantially constant.

I have found that when salts are favorable to the production of cracking, deposition of carbon, decolorizing, or other purposes, I am enabled to get the maximum amount of efficiency by bringing them to the smallest size possible, and that by putting them in solution and treating them in the manner described, these particles do not again coalesce, but are held separate from each other and expose the largest possible surface for effective use to the desired end.

Attention is called to the fact that in the past, particularly in distilling oils containing salt water have brought about expensive operating conditions, as the salt has crystallized on the sides of the stills, forming an objectionable coating. I obviate this trouble by bringing such oils containing natural salt or chemical salts in suspension or dispersion, directly into the presence of hot oil, and commingling and incorporating them therewith, at a temperature and pressure sufficient to almost immediately evaporate the water or other solvent, thus leaving the salt or salts in a dispersed or incorporated form, accomplishing by means of my discovery a favorable way of influencing the treatment of oils under conditions of heat and pressure conducive to cracking. The solution should be added sufficiently far from the sides of the apparatus and commingled with the hydrocarbon there-the sprinklers 28, by means of a pump (not shown) which is disposed between the pipes 33 and 34 which are respectively connected to the trough and the sprinklers. The water passes from the sprinklers down through the screens 29, being cooled in its downward path, as in usual practice by the passage of air through the tower. The cooling water falls over the perforated distributing pan 31 and is distributed over the tubes of heat exchanger tube unit 30, passing on to the collecting trough 32, whereupon the cycle is repeated. In the cooling tower illustrated, four heat exchanger tube units are employed, the fluid to be cooled being circulated through the units and the bowing of the tubes for the purpose of removing deposits therefrom being effected when desired, as described with reference to Figs. 1 to 5.

In Fig. 8 there is illustrated an application of the heat exchanger tube unit of this invention to a standard type of evaporator. The evaporator comprises an outer shell indicated generally by the numeral 40, which shell is provided with inlet ports 41 and outlet port 42. The heat exchanger tube unit is horizontally disposed within the shell 40, an opening 43 being provided in one end of the shell through which the tube unit is inserted and removed. A flanged collar 44 is provided around the periphery of the opening 43. The periphery of the tube sheet 45 at the outer end of the tube unit, is adjacent the flanged collar 44. In this construction of the tube unit, modified forms of heads are employed. The head 46 comprises a dome shaped casting having a transverse wall 47 formed therein, dividing the head into relatively large and small respective upper and lower compartments. An inlet port 48 is provided in the upper compartment and an outlet port 49 is provided in the lower compartment. The head 46, tube sheet 45 and collar 44 are secured together by bolts not shown. At the opposite end of the tube unit a dome shaped head 50 is provided. The head 50 is formed with a peripheral flange 51 and is secured to the tube sheet 52 by bolts not shown. A compartment is thus provided at this end of the unit into which all of the tubes open. This end of the unit is free for longitudinal motion as the tubes expand or contract. Transverse beams 53 and 54 are provided for supporting the unit while permitting the same to slide longitudinally thereon. A port 55 having a suitable removable cover 56 is provided in the lower portion of the tank, as in usual practice, for removing deposits and affording access to the interior of the shell.

In the operation of the vaporizer, heating fluid is introduced to the exchanger tube unit through the port 48 and passes through the tubes in substantially the same manner as described with reference to the former structure, passing out through the outlet port 49. By reason of the upper compartment being larger than the lower one in the head 46, the heating fluid while at its highest temperature will be passing through the tubes toward the head 50, and while at its lowest temperature will be passing back toward the head 46, and thus the fluid while at a high temperature will be passing through a greater number of tubes than while at a lowered one, thereby effecting the greatest possible heat exchange. Liquid to be vaporized is introduced into the shell through the inlet ports 41 where it circulates around the tubes 3, and vapor which is formed by the exchange of heat, passes out through the outlet port 42. Bowing of the tubes for the purpose of removing deposit formed thereon may be effected either by introducing steam into the tubes, through the opening 48 or by simply varying the temperature of the heating fluid passed therethrough. When desired a separate port, similar to port 21, may be formed in the head 46 for separately introducing steam.

While there has been hereinbefore described specific embodiments of the instant invention it will be understood that many and various changes and modifications in form, procedure, details of construction and applications of the invention may be made without departing from the spirit of the invention, and it will be understood that all and any such changes and modifications as fall within the scope of the appended claims are contemplated and are to be considered as a part of the instant invention.

What we claim as new and desire to secure by Letters Patent is:

1. In a heat exchanger, the combination of a straight tube, adapted for the circulation of fluid therethrough; and means for automatically effecting curvature of said tube when the same is elongated by the application of heat thereto.

2. In a heat exchanger, the combination of a plurality of straight, parallel, spaced tubes, adapted for the circulation of fluid therethrough; and means operatively connected to said tubes for automatically effecting curvature of the same when said tubes are elongated by the application of heat thereto.

3. In a heat exchanger, the combination of a normally straight tube adapted for the circulation of fluid therethrough; bending means adjacent said tube normally held in an angular position; means connecting said tubes and said bending means at the respective ends thereof; and means operatively connecting said tube with said bending means between said respective ends, whereby said bending means will be moved from angular position to straight line position and will effect a curvature of said tubes when the same

is elongated by the application of heat thereto.

4. In a heat exchanger, the combination of a plurality of normally straight tubes arranged in spaced parallel relation and adapted for the circulation of a fluid therethrough; bending means adjacent said tubes normally held in an angular position; connecting means between said tubes and said bending means at the respective ends thereof; and means operatively connecting said tubes with said bending means between the said respective ends, whereby said bending means will be moved from angular to straight line position and will effect a curvature of said tubes when elongation of said tubes is caused by the application of heat thereto.

5. In a heat exchanger, the combination of a plurality of normally, straight tubes, adapted for the circulation of fluid therethrough; a tube plate at each of the opposite ends of said tubes securing the same in their relative positions; tie members secured to said tube plates said tie members being normally held in angular positions; and means disposed between the said tube plates, operatively connecting said tubes and said tie members, whereby upon elongation of said tubes caused by the application of heat thereto, said tube plates will be moved outwardly effecting a straightening of said tie members and causing curvature of said tubes, and whereby said tube plates will be held in fixed spaced relation when said tie members have reached straight line positions and further elongation of said tubes will effect further curvature of the same while their ends are held in fixed spaced relation.

6. In a heat exchanger, the combination of a plurality of spaced, parallel, normally straight tubes; compartments disposed at the opposite ends of said tubes, adapting the same for the circulation of fluid therethrough, each of said compartments comprising a tube plate on its inner end in which the ends of said tubes are secured, a substantially box shaped body portion, and a cover disposed over its outer end, tie members having ends secured in said compartments and normally held in angular positions; and means, disposed between the tube plates, operatively connecting the tubes and tie members, whereby upon elongation of said tubes, caused by the application of heat thereto, said tube plates will be moved outwardly to effect the straightening of said tie members from their angular positions and curvature of said tubes will be effected.

7. In a heat exchanger, the combination of a plurality of spaced, parallel, normally straight tubes adapted for the circulation of fluid therethrough; a tube plate disposed at each of the opposite ends of said tubes securing the same in their relative positions; a guide plate disposed between said tube plates holding the central portions of said tubes in their respective positions, the said tubes passing through orifices formed in said guide plate; tie members secured to said tube plates and normally held in angular position; and means on said guide plate operatively connecting the same with said tie members, whereby upon elongation of said tubes caused by the application of heat thereto, said tube plates will be moved outwardly to effect the straightening of said tie members from their angular positions and curvature of said tubes will be effected.

8. In a heat exchanger, the combination of a normally straight tube adapted for the circulation of fluid therethrough; tying means adjacent said tube normally held in an angular position; a second normally straight tube adapted for the circulation of fluid therethrough, parallel to the first mentioned tube; tying means adjacent said second tube normally held in an angular position; means at the respective ends of said tubes and said tying means securing the same together; and means between said ends operatively connecting said tubes and their said adjacent tying means, whereby upon elongation of said tubes by the application of heat thereto said end connecting means will be moved apart and said angular tying means will be moved to a straight line position effecting a curvature of said tubes.

9. In a heat exchanger, the combination of a plurality of spaced, parallel, normally straight tubes; tube plates disposed at the opposite ends of said tubes holding the same in their relative positions; a plurality of tie members connected to said tube plates and normally held in angular positions; and means disposed between said tube plates connecting said tie members with said tubes whereby upon elongation of said tubes by the application of heat thereto, said tube plates will be moved outwardly to effect the straightening of said tie members from their angular positions and a curvature of said tubes will be effected.

10. In a heat exchanger, the combination of a plurality of groups of spaced, parallel, normally straight tubes; tube plates disposed at the opposite ends of said tubes, holding the same in their spaced relation; a guide member for each group of tubes disposed between said tube plates holding the same in their relative spaced positions; tie members for each group of tubes connected to the tube plates and normally held in angular positions; and means for each group of tubes operatively connecting its said guide member and said tie member, whereby upon elongation of said tubes by the application of heat thereto said tube plates will be moved apart and said tie members will be moved to

straight line positions and curvature of said tubes will be effected thereby.

11. In a heat exchanger, the combination of a plurality of groups of parallel, spaced, normally straight tubes; a tube plate disposed at each of the opposite ends of said tubes, securing the same in their relative positions; a guide plate for the tubes of each of said groups, said guide plate having a plurality of orifices formed therein through which said tubes are passed; tie members for each group of tubes connected with said tube plates, said tie members having hinged connections adjacent said guide plates and being normally held in angular positions; and means on said guide plates operatively connecting the same to the tie members of their respective groups, whereby upon elongation of said tubes by the application of heat thereto, said tube plates will be outwardly moved and said tie members will be moved to straight line positions, effecting the curvature of said tubes.

12. In a heat exchanger, the combination of a plurality of spaced, parallel, normally straight tubes; substantially box shaped head members disposed at the opposite ends of said tubes having tube plates on their inner sides, said tube plates holding the ends of said tubes in their relative positions, and said head members having cover plates disposed on their outer sides, one of said head members having a transverse wall formed therein dividing the interior of same into two sections, and an inlet port formed in one section of said head member and an outlet port formed in the other section, whereby a fluid may be circulated through said head members and tubes; and tie members secured to said tube plates normally held in an angular position and operatively connected to the central portions of said tubes, whereby upon elongation of said tubes by the application of heat thereto, said head members will be moved apart and said tie members will be moved to straight line position effecting the curvature of said tubes.

13. In a heat exchanger, the combination of a plurality of spaced, parallel, normally straight tubes; substantially box shaped head members disposed at the opposite ends of said tubes, having tube plates secured on their inner sides, said tube plates holding the ends of the tubes in their relative positions, and said head members having cover plates disposed on their outer sides, one of said head members having a transverse wall formed therein dividing the interior of same into two sections, and an inlet port formed in one section of said head member and an outlet port formed in the other section, whereby fluid may be circulated through said head members and tubes; and tie members secured to said tube plates normally held in an angular position and operatively connected to the central portions of said tubes, whereby upon elongation of said tubes, by the application of heat thereto, said head members will be moved apart and said tie members will be moved to straight line position effecting the curvature of said tubes, and said divided head member having a steam port formed therein for the introduction of steam into the same.

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