April 16, 1935. G. S. DUNHAM 1,998,122

METHOD AND APPARATUS FOR HANDLING RESIDUAL OILS

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Fig. 1

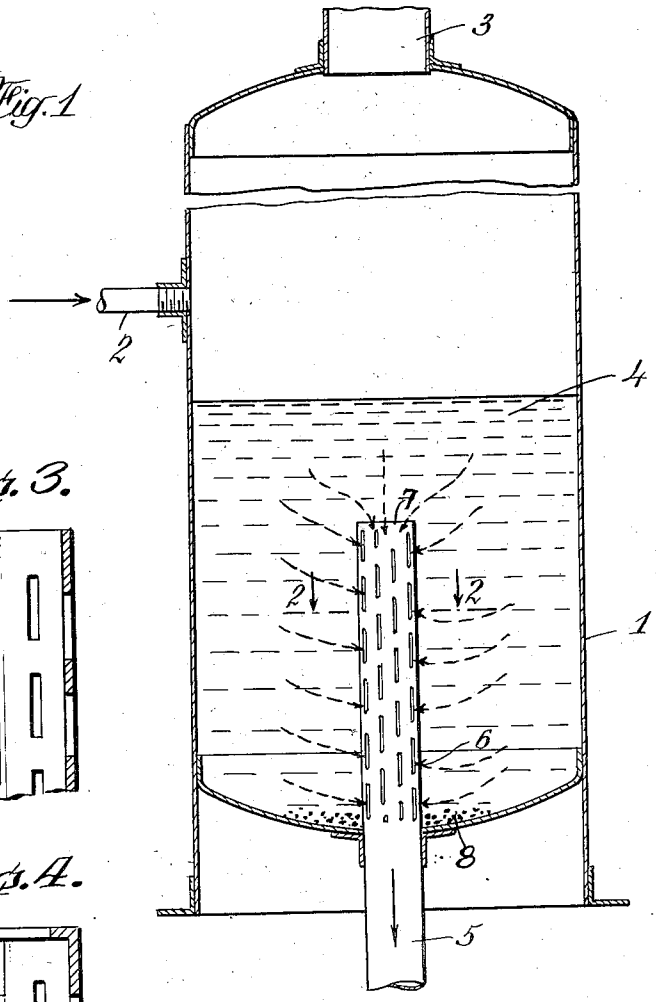


Fig. 3.

Fig. 4.

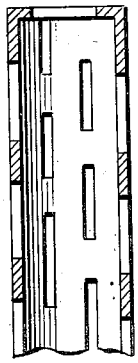
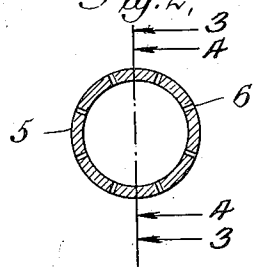


Fig. 2.



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METHOD AND APPARATUS FOR HANDLING RESIDUAL OILS

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4 Claims. (Cl. 196—68)

This invention has to do with method and apparatus for the handling of residual oils, such as those produced in the distillation of petroleum products where lighter products are separated by vaporization, particularly heavy residual oils that contain carbonaceous or other solid matter in suspension, or contain bodies which readily form coke or coky substances, or in general contain any heavy matter which constitutes or tends to form non-fluent clogging masses. The invention relates particularly to a novel method and apparatus for the handling and discharging of residual oil produced in a cracking operation, and also to the cracking operation in which these features are embodied.

In the cracking of petroleum oils, the oil undergoing treatment is subjected to elevated temperatures sufficient to produce cracking and is maintained at such elevated temperatures for a period of time sufficiently long to effect the desired amount of cracking, the cracking reaction frequently being conducted under pressures substantially above atmospheric. In the cracking reaction, chemical changes in the material under treatment occur with resulting formation of light hydrocarbons, for example, gasoline. An attendant reaction is the formation of heavy hydrocarbons and possibly uncombined carbon, the result being that residual oils derived from cracking operations contain coke, carbon or coky material or at least contain substantial amounts of heavy constituents or bodies that readily form coke or coky material. The lighter fractions in the cracked oil are separated from the residual oil by vaporization. The vaporizing operation for the separation of lighter fractions from the cracked oil may be carried to any desired point depending upon how much of the material it is desired to pass overhead as vapors or upon how heavy a residual oil is desired.

It is particularly with the handling of such residual oils from cracking operations that the present invention is concerned. It will be understood, however, that in the distillation of certain crude oils and other petroleum products, even though little or no cracking is effected, residual oils containing heavy or coky solids or heavy bodies which form non-fluent masses may be produced, and the present invention contemplates the handling of such residues as well as residues from cracking reactions.

In the cracking operation, the products from the cracking coil are ordinarily discharged continuously into a vaporizer, in which further cracking may or may not take place, depending upon the nature of the cracking operation. Vaporization of the oil down to a residual oil of desired gravity is ordinarily effected by reason of the heat contained in the reaction stream which enters the vaporizer, but it will be understood that the extent of vaporization which is effected in the vaporizer can be controlled by the addition or subtraction of heat from the vaporizer according to the well-known practices of the art. The separated vapors are ordinarily withdrawn continuously from the vaporizer, and the residual oil also is withdrawn from the vaporizer, continuously or intermittently. For operating reasons, a pool of the residual oil is maintained in the bottom part of the vaporizer. This type of operation is also found in some types of oil distillation processes where little or no cracking is involved. In systems where the vaporizing chamber operates under substantial pressure, residual oil may be discharged and further vaporization effected by flashing upon reduction in pressure. It is understood that the invention is applicable to the handling and discharging of residual oil in all operations of the kind above described, as well as to various other analogous uses.

Much difficulty has been encountered in commercial operation in connection with the discharge of residual oil from cracking and distilling apparatus. The presence in the residual oil of coke or other solid material frequently causes stoppage of the oil discharge opening or line. Ordinarily the residual oil discharge opening is a single opening of generous size in the bottom of the chamber which contains the residual oil. Even large openings of this kind frequently become clogged by coke deposits or the like. Coke and other deposits gradually settle at the bottom of the chamber and may build up until the discharge flow of residual oil becomes stopped. Also, deposits of coke or the like frequently form on the sides of the container and then slide off or fall to the bottom thereby stopping the oil discharge outlet. It is easily possible for enough coke to build up in the reaction chamber or vaporizer of certain forms of cracking operations to necessitate shut down of the entire unit within a relatively few hours. Discharge of residual oil from an opening or openings placed near but not at the bottom of the residual oil container has been proposed and, in general, is open to the same objections as noted above. Various means for over-coming these objections have been proposed, including forced recirculation of residual oil to keep the carbon in suspension, jet devices

for effecting a forced discharge of residual oil, a series of draw-off openings placed at different heights along the sides of the residual oil container so that the higher outlets may be put into operation when the lower ones become stopped, and the like. All of these expedients are open to a number of objections in the matter of installation and operation, and the result is that the single bottom discharge opening described above is by far the most widely used in commercial operation.

It is an object of this invention to provide method and apparatus for handling residual oil in a vapor separating chamber, or other chamber where such residual oil is produced or occurs, to permit maintenance of a pool of residual oil in the chamber but at the same time to inhibit and prevent for long periods of time the formation of objectionable nonfluent deposits in said chamber and to accomplish this result without necessity of providing special power consuming means such as devices for maintaining forced circulation, and the like, notwithstanding the presence in the residual oil of substantial amounts of carbon, coke, other solid material or coke-forming bodies.

It is a particular object of the invention to provide method and apparatus for effecting discharge of residual oil from a vapor separating chamber, or the like, which provide for continuous discharge of residual oil from the chamber with a minimum of difficulties arising out of stoppage of the discharge system, it being an object to provide for reliable operation of the discharge of residual oil from the system for long periods of time at least comparable with the length of time during which the remainder of the system, as for instance a cracking system, can be operated without shut-down. The average length of run on a modern coil type cracking unit to which this invention has been applied is many hundreds of hours of continuous operation without clogging of the residual oil discharge system herein described.

It is also an object of the invention to provide, in combination, method and apparatus for discharging residual oil and for acting upon the body of residual oil in the vaporizer pool in such manner that the discharge of the oil itself effects an action on the oil in the pool which inhibits and prevents for long periods of time formation of objectionable clogging deposits in the residual oil pool.

It is a still further object of the invention to provide method and apparatus which, while inhibiting and minimizing coke deposits as indicated above, nevertheless is capable of handling such deposits as may occur during long periods of continuous operation so that operation of the vaporizer and discharge of residual oil therefrom proceeds regularly and in normal manner even after a substantial amount of deposited material may have accumulated in the vaporizer.

The present invention overcomes all of the above difficulties to such extent that said difficulties no longer constitute an annoyance in connection with the operation of cracking stills, and the like, but rather the vaporizer and residual oil discharge means are capable of operating and do regularly operate as reliably and long as do the other parts of the system.

The novel results and advantages effected by the present invention as above described are accomplished principally by withdrawing residual oil from the pool of residual oil in the vaporizer over an extended area distributed throughout various parts of the body of the pool in the manner and by the means described more fully below, by maintaining through the medium of the residual oil discharge itself a gentle circulation throughout the vaporizer pool sufficient to inhibit the formation of solid deposits in the oil until the oil can be discharged but insufficient to dislodge deposits which may have formed after long periods of operation, and by so constructing the discharge outlet and localizing said deposits relative thereto that withdrawal of residual oil may proceed without hindrance even with a substantial amount of deposit in the vaporizer pool.

A preferred embodiment of the invention is illustrated in the accompanying drawing, in which Figure 1 is a vertical sectional view of a vapor separating apparatus embodying the invention, and Figure 2 is a detail sectional view taken on the plane indicated by line 2—2 in Figure 1. Figures 3 and 4 are vertical sections of the discharge outlet pipe.

In said drawing, 1 indicates the shell of a vaporizer or vapor separating chamber of a kind commonly used in oil distilling and cracking operations. The hot stream of oil coming from the heating zone, not shown, enters vaporizer 1 through inlet line 2. In the embodiment here shown, vaporization of a portion of the incoming stream of oil entering through line 2 takes place by reason of the heat contained in the incoming stream itself, although it will be understood that further vaporization can be effected by heating the vaporizer or a lesser amount of vaporization can be effected by cooling the vaporizer or the incoming oil as desired according to well-known practices in the art. Vapors rise into the upper part of the vaporizer 1 and leave the vaporizer through the vapor outlet 3 provided at the top of the vaporizer. The vapors then pass along to fractionating equipment, condensers, and the like.

The unvaporized oil in vaporizer 1 gravitates to the bottom part of the vaporizer to form a pool 4 of residual oil. This pool 4 of residual oil is the heavy residual material which may contain carbon, coky or other solid matter, or coke-forming bodies as described at length above. In the drawing, the upper portion of vaporizer 1 which constitutes the vapor chamber, has been broken away so that the proportion of the vaporizer devoted to vapor space and that devoted to the pool of residual liquid 4 is not shown. It will be understood, however, that the major portion of the vaporizer is usually devoted to vapor space.

Residual oil from the vaporizer pool 4 is discharged from the vaporizer through line 5. It will be understood that line 5 is provided at some point along its length with a control valve by means of which the rate of discharge of residual oil from vaporizer 1 can be controlled according to the usual practice in the art. Discharge line 5, as here shown, leaves the vaporizer from a centrally located point at the bottom of the vaporizer, but discharge line 5 extends upwardly a substantial distance into the pool of residual oil 4 in the vaporizer. In the common form of vaporizer operation, the pool of oil 4 is say from five to ten feet deep, in which case discharge line 5 preferably extends up into the vaporizer pool a distance of say three to six feet. The upper end of the discharge line 5 should at all times be below the normal upper operating level of the vaporizer pool 4, but should be a sufficient dis-

tance above the bottom of the vaporizer so that a considerable amount of solid material can deposit in the bottom of the vaporizer without building up to such a height that clogging of the upper end of the discharge line 5 might occur. In preferred operation, the upper end of the discharge line may be from 50% to 75% of the distance from the bottom of the vaporizer to the mean operating level of the vaporizer pool.

The upper end 7 of residual oil discharge line 5 is open for free entry of residual oil from pool 4; that is, discharge line 5 is ordinarily an open ended pipe with its open end located within vaporizer pool 4 as shown. If desired, however, the flow of residual oil into the end 7 of discharge line 5 may be restricted by partially closing the opening 7 by means of a closure having perforations or slots, thereby permitting entrance into the end of the discharge line of a limited amount of residual oil.

Along the length of discharge pipe 5 intermediate the vaporizer bottom and the upper end 7 of the pipe, a series of openings are provided which may assume any desired form but are here shown as vertically disposed slots 6 spaced up and down the length of that portion of the discharge line 5 which is within the pool of residual oil and also spaced around the periphery of the pipe. The arrangement of slots 6 in discharge line 5 is further illustrated in the detail cross-sectional view shown in Figure 2. The preferred arrangement is the provision of vertical slots spaced helically around pipe 5 from its point of entry into the vaporizer to its upper extremity, as shown, but it will be understood that the size, shape, arrangement and spacing of these openings 6 may be varied somewhat without departing from the spirit of the invention or sacrificing the advantages secured therefrom. In the present preferred form, slots 6 are shown as rectangular in section and have parallel walls, but it will be noted that slots 6 may, if desired, be made with walls diverging toward the interior of the pipe, this being an additional precaution against clogging of the slots by particles of solid material which might become wedged into the slots. The arrangement shown in the drawing has the effect of withdrawing oil from a plurality of points well distributed at different heights in the vaporizer pool and also distributed to a considerable extent laterally of the body of oil in the pool. Thus, there is no localized point of discharge for the residual oil which may become clogged by deposits forming therein or by deposits on the bottom or sides of the vaporizer sliding down and thus stopping the discharge opening. Residual oil enters all of the slots 6 and the opening at the upper end 7 of discharge line 5 simultaneously.

Figure 3 is a vertical section through the discharge pipe 5 at a point near the top, showing the open end 7 and the slots 6. Figure 4 shows how the open end 7 may be slightly constricted, if desired.

It has been found that a quiescent liquid body or space in the bottom of the vaporizer promotes accumulation of deposits of coky matter. Due to the natural contraction of the residual oil stream entering the open end of discharge pipe 5, or due to any restriction which may be imposed by partially covering open end 7, there is created a slight difference of pressure between the inside of the pipe below its open end and the oil in the vaporizer pool 4 outside of the pipe, which action establishes a positive flow of oil from the main body of the pool through slots 6 into the pipe 5. This not only insures a positive discharge flow but effects a self-cleaning action of the discharge openings 6. Also, this positively induced flow of residual oil through openings 6 serves to maintain a continuous but gentle circulation or agitation throughout vaporizer pool 4 which is not of sufficient violence to loosen or dislodge coke deposits that may form after long periods of operation on the sides or bottom of the vaporizer but which is sufficient to maintain solid materials in suspension so that practically all such materials are removed from the vaporizer pool before they find opportunity to settle and form solid masses. Further, this circulation or agitation in the vaporizer pool inhibits the formation of solid deposits from heavy bodies which would quickly degrade into such deposits if permitted to remain in quiescent condition in the vaporizer for any substantial length of time.

Such deposits of solid material as may occur after the system has been in operation for substantial lengths of time ordinarily accumulate in the bottom of the vaporizer as indicated at 8. Even if the deposit 8 eventually builds up to a substantial height in the vaporizer, the discharge area available for passage of the residual oil from pool 4 into line 5 is not substantially reduced. A deposit, as indicated at 8, instead of clogging the entire discharge opening, merely shuts off such portions of slots 6 as are located at the bottom of the vaporizer, which is only a small percentage of the total discharge area available to the residual oil. Formation of a deposit 8 does not affect the operation of the open end 7 of the discharge line 5 nor does it affect the operation of openings 6 which lie above the deposited material, and therefore the discharge of residual oil from a plurality of points throughout the vaporizer pool and the deposit-inhibiting circulating action proceeds exactly as it did before accumulation of any deposit.

The present invention therefore provides method and apparatus for handling residual oil of the class described in vaporizers, vapor separators, and similar equipment of the character described, in such manner that difficulties from coke stoppage and clogging of residual oil discharge are eliminated as a practical operating problem in such equipment as oil cracking units, and the like. As a specific example, the invention described herein has been applied to a coil type cracking operation producing about 2000 barrels of gasoline per day and has been operated regularly on commercial runs averaging about 1500 hours without encountering difficulties due to stoppage of the residual oil discharge. In this operation, the vaporizer embodying the present invention is in continuous use during the entire length of run, no alternate vaporizer being provided. Important features of the invention are its simplicity, freedom from moving parts, no power requirement such as steam for recirculating pumps or the like, no complex control system and no necessity of attention by the operator. The invention is defined in the following claims in terms of those features and combinations of method and apparatus which appear to be responsible for the aforesaid novel results and advantages attained by the invention.

I claim:

1. The method of handling and discharging residual oil from a pool thereof to which additional residual oil is added, from which vapors are separated, and from which residual oil is with-

drawn, all substantially continuously, which comprises withdrawing residual oil from said body in a plurality of small streams at a plurality of points extending from near the bottom of said pool a substantial proportion of the distance upward toward the normal operating level of said pool and located substantially centrally thereof, and uniting such streams, said points of discharge being so arranged as to maintain a gentle circulation in said body of residual oil which inhibits formation of solid deposits, permitting such deposits as may form after the vaporizing process has been in operation for a considerable length of time to form at the bottom of said pool of residual oil, whereby the accumulation of such deposits does not produce stoppage of any substantial percentage of the total residual oil discharge area and does not adversely affect the discharge of residual oil from said body or the maintenance of the aforesaid circulation therein to inhibit the formation of the deposits.

2. Oil vaporizing apparatus which comprises a vapor separator tank, means for introducing unseparated oil products into said vapor separator, means for discharging separated vapors from said vapor separator, discharge means for withdrawing residual oil from said vapor separator which comprises a discharge pipe substantially centrally located extending up through the bottom of the vapor separator to a substantial height within the pool of residual oil in the vapor separator and having an opening at its upper end and a plurality of openings along its length for entry of the residual oil to be discharged.

3. Oil vaporizing apparatus which comprises a vapor separator, means for introducing unseparated oil products into said vapor separator, means for discharging separated vapors from said vapor separator, discharge means for withdrawing residual oil from said vapor separator which comprises a discharge pipe extending up through the bottom of the vapor separator to a substantial height within the pool of residual oil in the vapor separator and having openings at its upper end and along its length for entry of the residual oil to be discharged, the openings along the length of said discharge line consisting of slots spaced vertically along said pipe and also spaced peripherally around said pipe and being of at least as great width at the inside of the pipe as at the outside, and a single outlet pipe communicating with said discharge pipe.

4. The process of withdrawing residual oil from a pool wherein such oil is collected which comprises withdrawing a portion of such oil through numerous orifices vertically distributed from near the bottom of said pool through a substantial portion of the height thereof, said orifices being located substantially centrally therein, and discharging into a common eduction pipe, withdrawing a further portion through a larger orifice, also discharging into said eduction pipe, and so proportioning the stream through said larger orifice as to cause a reduction of pressure upon the discharge side of said first orifices, whereby mild circulation is promoted throughout the body of said pool.

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