PROCESS OF AND APPARATUS FOR DISTILLING AND CRACKING HYDROCARBON OILS

Filed Aug. 21, 1922

Fig. 2.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Inventor

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By

Attorney
To all whom it may concern:

Be it known that I, ALFONCE H. HELLER, a citizen of the United States, residing at Berkeley, in the county of Alameda and State of California, have invented certain new and useful Improvements in Processes of and Apparatus for Distilling and Cracking Hydrocarbon Oils, of which the following is a specification.

This invention relates to a process and apparatus for heat treating hydrocarbon oils and pertains particularly to the distillation and cracking of heavy petroleum oils in such a way that carbon incrustations within the apparatus may be avoided.

One particular feature is included in the process and apparatus in which a plurality of parallel arranged pipes are so connected to each other and to a central hollow shaft about which they are grouped and with which they rotate, that oil may be introduced through the shaft and passed progressively through each of the pipes and finally discharged from an axially located discharge connection. During this operation heat is applied to the pipe arrangement in such a way that the pipes farthest from the center are subjected to the highest degree of heat, the temperature of which is sufficient to effect cracking of the oil in the pipes.

Another outstanding feature of the process and apparatus of this invention includes the use of the rotatable pipe still described combined with a freely movable abrading rod positioned within each of the pipes which rotate with the center shaft and revolve about it.

Other features and advantages are described and claimed in the following specification and claims, and illustrated in the accompanying drawings, in which:

Figure 1 represents a side elevation of a partial section taken substantially centrally and on the line 1—1 of Figure 2 through the length of the apparatus, illustrating the furnace and central pipe in section;

Figure 2 is an end view of the structure shown in Figure 1 taken on the line 2—2 of Figure 1, looking in the direction of the arrow;

Figure 3 is a sectional view taken on the line 3—3 of Figure 1, looking in the direction of the arrow;

Figure 4 is an enlarged sectional view showing a modification of the form of stuffing box connection for the axial intake and outlet for oil;

Figure 5 represents a sectional view, partly broken away, showing the position of a hollow rod within one of the pipes;

Figure 6 represents a cross sectional view taken on the line 6—6 of Figure 5;

Figure 7 shows a modified arrangement in which a plurality of round, solid rods are used;

Figure 8 represents a cross sectional view showing how a square rod may be used; and

Figure 9 represents a portion of a twisted solid rod used within the treatment pipes.

Referring in detail to the figures of the drawings, like numerals refer to like parts in the different figures. The furnace structure of suitable concrete, brick, or other building material is indicated at 1. A fire box 2 having an opening 3 is shown in the lower part of the furnace 1, and a stack, not shown, may lead from the upper portion of the furnace at one end thereof.

Extended lengthwise through the furnace are a plurality of pipes connected together to form a rotatable pipe still the details of which will now be described. A centrally located horizontal pipe or tube 4 is journalled at opposite ends of the furnace in the supporting bearings 5 which are cooled or lubricated by cooling liquid or oil in a channel 5" formed in the upper portion of the bearing 5. The bearing is mounted at the upper end of supporting legs or braces 6, which in turn have a base portion 7 mounted at one end on a masonry support 8 and secured thereto by fastening screws or bolts 9, and at the opposite end adjacent the furnace door opening the bearing 5 is supported on girders 10 which bridge the space opposite the furnace opening 3. The bearing is provided with a suitable bushing or cast iron encircling the pipe 4 as indicated at 11, and the bushing is preferably keyed to the pipe 4.

In the particular arrangement of still illustrated, twenty-nine pipes are grouped about the central pipe 4. These pipes are numbered consecutively from 12 to 40, and the particular sequence of their connection may be understood from an inspection of Figures 2 and 3. These pipes 12—40, inclusive, are positioned and fixed in parallel relative and are grouped around the central pipe 4 and have their ends connected.
by return bend portions 41 in such a manner that the pipes are connected in series, the hollow central pipe 4 being in ported communication with one of the more centrally located pipes, and the other pipes being progressively connected to those toward the outside of the group, from which latter a return connection is made to the hollow central extension 49 as will be explained.

At the opposite ends of the furnace, and near the ends of the pipes, are spacing plates 42 which have a circular periphery and through which the individual pipes project and have a relatively tight connection. The purpose of these spacing plates 42 is also to prevent the escape of heat and heating gases from the furnace and to confine the heat and the heating gases to the space immediately about the group of pipes 12—40. To further provide for a tight fit at the periphery of the plates 42 a complementary stationary annular plate 49 is made at each end of the furnace and in close, but spaced relation to the plates 42.

The plates 49 have an intimately projecting flange 49a which is adapted to move in a channel shaped extension 49b continued from the plate 49. Thus in the rotary movement of the group of pipes and the plates 42, the tortuous passage provided between the parts 49a and 49b limits the escape of the heating gases from the furnace. The plates 42 are preferably welded to the exterior of the pipe 4 or otherwise braced so as to move with the pipe 4 during the rotation of the pipes with and about the pipe 4 as an axis. The pipes 12—40, inclusive, are illustrated as having flanges 44 at their ends to which may be secured by bolts, not illustrated, the corresponding flanges of the end bent portions 41. In order to make possible a compact assembly, and also provide space for the flanges 44, the pipes 12—40 are positioned in staggered end-wise relation so that next adjacent pipes project alternately further from the plates 42 on the opposite ends of the rotatable assembly.

The particular apparatus and the manner of introducing and leading off the oil treated will now be described. An intake pipe for fresh oil is indicated at 45, and it will be noted that this pipe is slightly off center with respect to the center of the pipe 4. An outlet pipe for oil which has been treated in indicated at 46, and this pipe is illustrated as in alignment with the center of the pipe 4. Both of these pipes 45 and 46 are illustrated as screw threaded in a stuffing box structure having a stationary block member 47, which in turn has cylindrical sleeves 47a and 47b providing an annular space therefrom. The purpose of this arrangement is to provide an oil tight fit against the movable portion of the still, as will be shown. The pipe 4, at one side of the bearing 5, has a plate 48, having a cylindrical flange 48a projecting therefrom which is adapted to fit in the space between the sleeves 47a and 47b. A spring-held annular clamping flange 49 fits over the outer end edge portion of the plate 48 and has a central opening 49a through which an oil tight seal. Packing material 54 is provided between 47a and 47b at the inner end of the space to assist in preventing the leakage of oil, and oil vents are indicated at 54 as will be shown. The pipe 49 to yieldingly hold the plate 48 and the block member 47 in engagement. The position of the flange 49a between the sleeves 47a and 47b serves to assist in the rotation of the blocks and to provide an oil tight seal. Packing material 54 is provided between 47a and 47b at the inner end of the space to assist in preventing the leakage of oil, and oil vents are indicated at 54 as will be shown. The oil outlet pipe 46 terminates at the center of the block 47. An inner oil outlet pipe 55 is positioned centrally within and spaced from the pipe 4, and extends theretofrom from a point on the lower side of one bearing and terminates near the inner end of the pipe 46 and in alignment therewith. The opposite and still end of the pipe 55 is connected to the pipes of the still, as will be described hereinafter. The block 47 has a second set of concentric flanges corresponding to the flanges 47a and 47b, and indicated at 47c for the inner flange and 47d for the outer flange, and both of them serving to provide an annular space therebetween. Fitted into this space is a cylindrical flange 56 which closely encircles the pipe 55 and is fixed to it by clamping screws 57. The extreme outer end of the pipe 55 is closely rotatably fitted into the central opening within the flange 47c. The inner end of the part 56 has a plurality of spaced fingers 58 projecting along the pipe 55 and serving to space the inner end of the flange 56 from the next adjacent face of the part 48 so that fresh oil may pass between the fingers 58 from the pipe 48 inwardly and along the exterior of the outlet pipe 55. The space between the flanges 47c and 47d is also provided with packing material 54 and similar construction. The outer side through the block 47 are indicated at 54c. This description applies to the stuffing box end of the apparatus.
The end of the apparatus opposite to the stuffing box is used for access to the fire box through the doorway 3. The end of the central pipe 4, farthest removed from the stuffing box, is provided with a cover plate or cap 4a, to tightly close that end of the pipe and prevent oil from leaking. The cap 4a serves also for inspection and cleaning of the interior of the pipe 4.4. Between the plate 42 and the end bearing near the cap 4a is a lead off pipe 4b extending from the central pipe 4 to the pipe 12, the first of the series of the pipes 12—40, inclusive.

The last pipe of this series, 40, is illustrated as one of the outer group of pipes, and is positioned farther from the center than the pipe 12. The end of the pipe 40 next adjacent the stuffing box is connected to the outlet pipe 55 by a pipe 55a which extends centrally toward the central pipe 4 between the plate 42 and the bearing, projects through the pipe 4, and is continued within the pipe 4 as the pipe 55.

A sprocket wheel for applying power to revolve the still is indicated at 59 on the central pipe 4 and is located between the stuffing box and the adjacent bearing.

Scraping means or scouring means is provided for the interior of each of the pipes 12—40, inclusive, and also, if desirable, for the interior of the central pipe 4, by rods 60 which extend lengthwise of the pipes and which are inserted from the ends of the pipes when the bends 41 are removed. These rods 60 occupy a substantial portion of the cross sectional area of the bore of the pipes. The rods normally rest on the inner lower surface of the pipes and are adapted to slide and roll around the inner surface of the pipes as the latter are revolved about the pipe 4 as an axis. In this movement the rods serve as abrading elements and grind away any carbon which may be deposited on the inner surfaces of the pipes. The rods serve also to increase the speed of the oil as it flows through the pipes, it having been found that a given cross section of oil flows much more swiftly through the portion of the pipe containing the rod than through a portion of the pipe, such as the end portions or a similar section without a rod, in which no spacing member is positioned. The rod, in addition to increasing the speed of the oil, serves to reduce the thickness of the body of oil to be heated in any given cross section of oil in the part of the pipe not containing the rod. This relatively thin body of oil is accordingly more readily and quickly heated, and because of its increased speed, reduces to a minimum the formation of carbon on the inner surface of the pipes, the speed serving to wash away carbon before it has opportunity to be deposited. In Figure 5 a typical pipe is shown in section illustrating also in section a hollow rod 60 having the ends thereof plugged at 61, and having an opening 62 through the wall of the hollow rod for the equalization of pressure on the inside and outside of the rod. If the rod were hollow and sealed extremes of temperature might cause it to burst. This form of rod provides a light structure which serves efficiently for the removal of carbon and provides sufficient cross sectional area to reduce the volume of oil within the large pipe without adding the undesirable weight which would be provided by a solid metal rod. The structure of Figure 5 is shown in cross section in Figure 6. Figure 7 shows a modified arrangement in which a plurality of rods, three in this view, are used. A plurality of rods may serve particularly efficiently in certain instances because the tumbling action of the rods is multiplied and the removal of carbon is thus made more positive. Figure 8 shows a form of square rod, and Figure 9 shows a fragmentary view of a twisted arrangement of solid rod, which, because of its cutting edges, has been found particularly efficient for scouring out carbon formations.

In Figure 4, a modification of the stuffing box is illustrated. In this arrangement, the hot oil flows the full length of the central pipe and out past the bearing and through a central pipe within the cold oil pipe which is in immediate contact with the bearing. This arrangement is in contrast with the structure illustrated in Figure 1 in which the cold oil extends through the full length of the central pipe. In Figure 4 the cold oil enters the stuffing box and flows around the central hot oil outlet pipe and is led off through a branch pipe towards the series of revolvable pipes of the still. In this modification a somewhat similar stuffing box is shown as is illustrated in Figure 1. Complementary projecting annular flanges are provided between the fixed parts and the movable parts to prevent leakage of oil from the outer portion to the atmosphere, and from the hot and cold portions. An annular space is provided as an oil seal.

The operation of the process and the apparatus will now be described. Oil is introduced through the pipe 45, through the stuffing box, and through the length of the central pipe 4 which is thus kept full of cold oil. The oil is then led through the pipe 4b from which it passes into the pipe 12 from which latter it is conducted into the next adjacent pipe 13, and so on through each of the pipes of the series 12—40, inclusive, being introduced into one end of the pipe and discharged from the opposite end, and being reintroduced in a similar manner into an adjacent pipe. In this manner the oil is moved progressively through each of the pipes in series, first in one direction through...
the length of the still and then in the opposite direction in the next adjacent pipe. In the arrangement shown the oil is passed through the group of pipes most closely grouped about the center pipe 4 and then through the next adjacent row of pipes. The particular manner of connecting the pipes forms no part of this present invention, but the invention does include the idea of heating the outer group of pipes more intensely by having the outer group closest to the source of heat in the lower part of the furnace. This idea includes the preliminary heating of the oil as it is freshly introduced by passing it through the central group of pipes first, where it is relatively removed from the direct force of the heat, and then subjecting it to an increased temperature as it reaches the outer group of pipes. After the oil has been subjected in the outer group of pipes to temperature conditions which are at least sufficient to effect cracking conditions within the pipes, the oil is led back from the pipe 40 into the discharge pipe 55 located within pipe 4 and discharged through the pipe 46. In the passage through the pipe 55, within the pipe 4, the oil serves to slightly preheat the incoming oil in the annular space immediately surrounding the pipe 55. The apparatus which thus provides for a flow of cold oil through the length of the center pipe 4 is particularly efficient because the oil serves to keep the material of the pipe fairly cool and to prevent it from overheating and weakening. There is considerable weight on the pipe 4 due to the structure of the pipe assembly carried by it, and the long extent of the pipe 4 within the furnace structure makes it particularly desirable to have the pipe filled with cold oil rather than previously heated oil such as might be the product from a structure such as that shown in Figure 4.

No claim is made by me to the inventions described herein relating to the particular sequence of the path of travel of the oil through the various pipes of the rotatable assembly or to the high speed passage of oil through the pipes which contain the rods.

I claim:

1. The process of producing low boiling hydrocarbon oils from high boiling hydrocarbon oils which comprises passing liquid oil to be treated progressively through a plurality of pipes connected in series and mounted for rotation, and subjecting the oil while in the pipes to a heat treatment sufficient to effect cracking within at least some of the pipes.

2. The process of producing low boiling hydrocarbon oils from high boiling hydrocarbon oils which comprises passing liquid oil to be treated progressively through a plurality of pipes connected in series and mounted for rotation, and subjecting the oil to a heat treatment applied directly to the exterior of the pipes sufficient to effect cracking conditions within at least some of the pipes.

3. The process of producing low boiling hydrocarbon oils from high boiling hydrocarbon oils which comprises passing liquid oil to be treated progressively through a plurality of pipes connected in series and mounted for rotation and having a freely movable rod positioned in each pipe whereby carbon formed within the pipes is kept free from the pipes and may be carried along with the flow of the oil, and subjecting the oil to a heat treatment applied directly to the exterior of the pipes sufficient to effect cracking conditions within at least some of the pipes.

4. Apparatus for cracking hydrocarbon oil material comprising a plurality of pipes connected in series and mounted to rotate about a fixed axis, and a freely movable rod in each of said pipes extending lengthwise thereof.

5. Apparatus for cracking hydrocarbon oil material comprising a plurality of pipes connected in series and mounted to rotate about a fixed axis, a freely movable rod in each of said pipes extending lengthwise thereof, and pipe means located at the axis and through which pipe means materials to be treated may be introduced into said pipes and materials which have been treated may be led off from said pipes.

6. Apparatus for cracking hydrocarbon oil material comprising a rotatable axle, tubular throughout its length, a pipe extending parallel to said axle and in communication with the interior of said axle and revoluble about it, a freely movable rod within said pipe and extending lengthwise thereof, and means for introducing material to said pipe through said axle.

In testimony whereof I affix my signature.

ALFONCE H. HELLER.