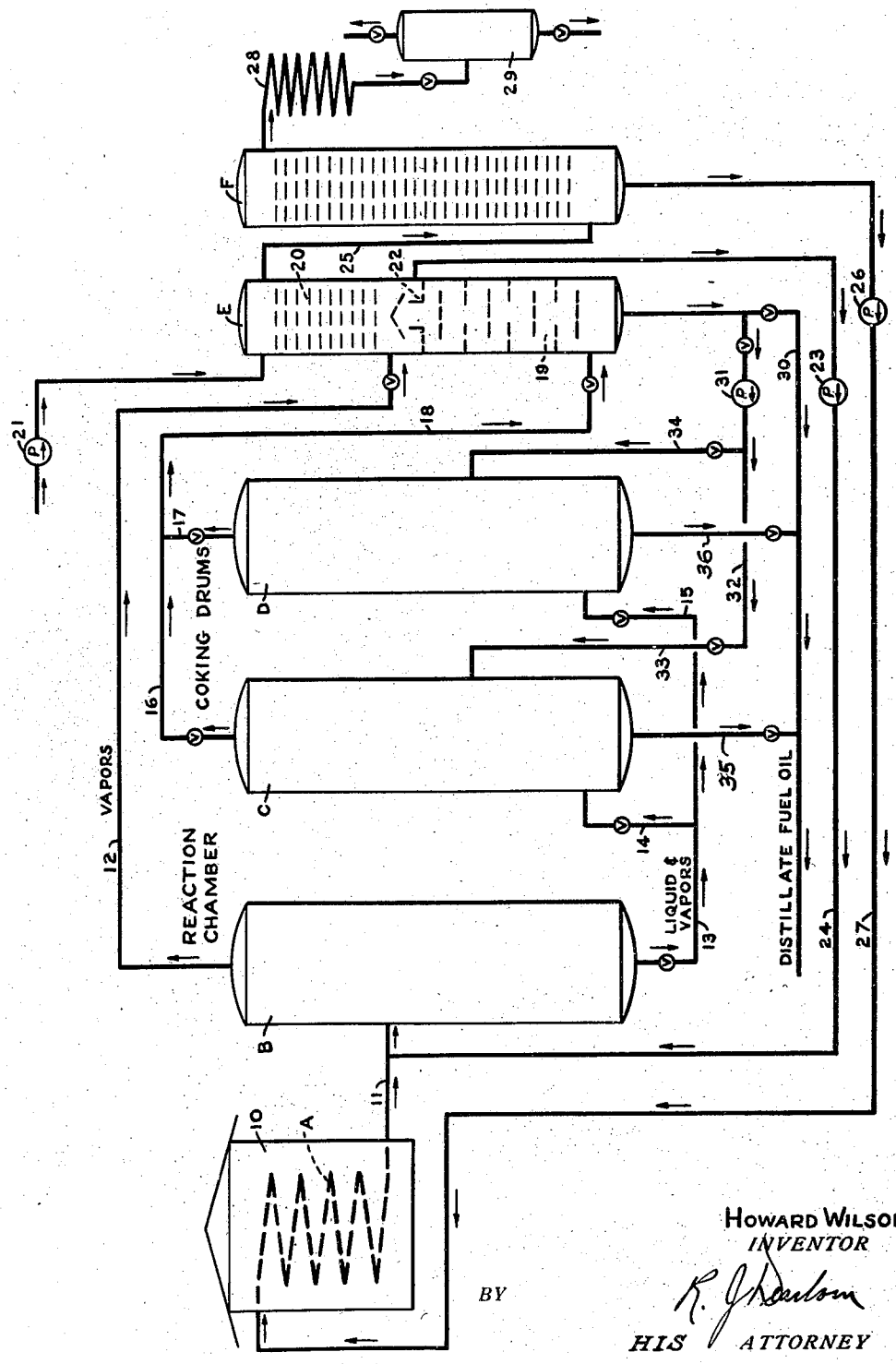
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COKING HYDROCARBON OIL

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COKING HYDROCARBON OILS

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This invention relates to the coking of hydrocarbon oils and involves particularly certain improvements in the preheating of the coking chambers.

It is common practice to conduct coking operations in continuous units having a plurality of coking drums by continuously passing a stream of oil through a heating zone thence severally to the coking drums in succession. When the coking operation is completed in one of the drums the heated stream of oil is diverted to a succeeding drum and the former drum is steamed out and cooled, and the coke removed therefrom while coking is being carried on in the succeeding drum. In this way the unit may be kept continuously on stream. Difficulties have, however, been encountered in this type of operation due to the sudden changes in temperature which accompany the coke drum switching which disturb the thermodynamic balance of the unit, and in operation it has been necessary to reduce the charge rate which reduces the capacity of the unit. Efforts have been made to preheat the coke drum prior to diverting the heated stream of oil thereto by directing the vapors from the coke drum in operation, which normally pass to the dephlegmator or fractionator, into the subsequent coke drum to preheat it before diverting the stream of oil to be coked thereinto. One difficulty with this expedient is that considerable condensation of the vapors occurs in the coke drum during the prewarming period and the condensed material distills over into the dephlegmator after the coking operation has been commenced which upsets the balance of the unit and produces a loss in light constituents.

In accordance with my invention the preheating of the coke drum is accomplished by utilizing a source of heat which is available in the coking unit and which is independent of the thermodynamic balance of the unit. In practicing the invention vapors evolved in the coking operation are subjected to reflux condensation to produce a hot condensate which is normally withdrawn as a product of the process and which is periodically diverted to a coking drum to preheat it. In a preferred method of practicing the invention the vapors from the coking operation are subjected to a primary dephlegmation to produce a heavy condensate adapted for fuel oil. During the normal operation this condensate is withdrawn as a product of the process and near the end of the coking operation in a given coking drum the hot fuel oil product is directed to a subsequent coking drum serving to preheat it prior to diverting the stream of oil for coking into such subsequent drum. In this way the coke drum is preheated without disturbing the thermodynamic equilibrium of the unit. This method of preheating the coke drum has the further advantage of removing the very heavy residual constituents which come over into the dephlegmator near the end of the coking cycle and which normally cause coking difficulties. In accordance with the invention these very heavy potential coke forming constituents which are evolved in the final stages of the coking operation and which pass over with the vapors into the dephlegmator are directed into the succeeding coke drum serving to preheat it ready to receive the charge for coking. The disposition of the heavy coke forming materials in this way serves to prevent the formation of coke in the dephlegmator and actually increases the operating time in which the unit may be maintained on-stream.

The invention may be practiced in connection with various types of coking processes. For example, in one type of operation hydrocarbon oil such as a petroleum residual stock is passed through a heating coil wherein it is heated to a cracking temperature and delivered to a coking drum. In another type of operation the vapors from the coking drum are fractionated to obtain a condensate stock which is passed through a recycling cracking coil and the heated products are combined with a residual stock, the resultant mixture being delivered to the coking drum. In some cases the residual stock is utilized in the dephlegmation of vapors and the resultant mixture of reflux condensate and unvaporized residual stock is withdrawn from the dephlegmator and either passed through a heating coil or combined directly with the hot products from the cycle condensate cracking coil for passage to the coking drum. In some cases a reaction chamber is interposed between the heating coil and the coking drum. In any of these various methods of coking and cracking vapors evolved in the coking operation may in accordance with the invention be subjected to dephlegmation to form a hot condensate which may be normally withdrawn as a product of the process and which may be diverted to the coke drum to be preheated near the end of the coking cycle in one of the other drums and such drum thereby preheated so as to be in condition to receive the stock for coking.

For the purpose of more fully explaining the invention reference is had to the accompanying drawing which is a diagrammatical elevation il-

lustrating apparatus adapted for practicing a particular embodiment of the invention.

The apparatus illustrated includes a heating coil A, a reaction chamber B, coking chambers C and D and fractionating towers E and F. The heating coil A is mounted in a furnace 10 adapted to heat the oil therein to a cracking temperature. The heated oil is directed through a transfer line 11 to the reaction chamber B, the heated stream of oil being combined with additional oil as is hereinafter explained. The reaction chamber B is insulated against heat loss and is adapted to maintain the oil therein at a cracking temperature. Separation of vapors from liquid components takes place in the reaction chamber B, separated vapors being passed through a vapor line 12 to the fractionating tower E and liquid residue, together with a sufficient portion of the vapors to accomplish autogenous coking, is withdrawn through a manifold line 13 having a branch 14 extending to the coking drum C and a branch 15 extending to the coking drum D.

The coking drums are insulated against heat loss and are adapted to retain the hot oil received from the reaction chamber so that it may be converted to coke autogenously. Vapors from the coking drums C and D pass through lines 16 and 17, respectively, to a manifold vapor line 18 thence to the fractionating tower E.

The fractionating tower E is formed with a section 19, which receives the vapors from the coking operation through line 18, providing a primary dephlegmating zone for the coke still vapors, and with a section 20 which receives the separated vapors from the reaction chamber B through the line 12 as well as the dephlegmated coke still vapors from the primary dephlegmating zone 19.

Charging stock, such as crude petroleum or topped or reduced crude, is introduced by a pump 21 to the dephlegmating section 20. The vapors therein are dephlegmated with the charging stock to form a resultant mixture of reflux condensate and unvaporized charging stock which is collected on a tray 22. This mixture is withdrawn by a pump 23 and directed through a line 24 to the transfer line 11 so as to commingle the mixture with the hot products passing from the heating coil A to the reaction chamber B. The vapors uncondensed in the fractionating zone 20 pass through a vapor line 25 to the fractionating tower F wherein the vapors are subjected to fractionation. Reflux condensate is withdrawn from the tower F by a pump 26 and directed through a line 27 to the heating coil A. The overhead vapors from the tower F pass to a condenser 28 thence to a distillate accumulator or gas separator 29.

In the dephlegmator 19 the vapors from the coking operation are subjected to a primary dephlegmation prior to being commingled with the vapors from the reaction chamber B for further fractionation in fractionating zones 20 and F. This dephlegmation produces a tarry condensate product which is of relatively high specific gravity in relation to its viscosity and is particularly adapted for fuel oil. During the operation of the process this tarry condensate is normally withdrawn through a line 30 and passed either through a cooler to storage, or to a tar flasher in case it is desired to distill off any contained constituents of lower boiling point than desired in the fuel product. Periodically when it is desired to preheat a coke drum, the tarry condensate passing through the line 30 is diverted to a pump 31 by which the condensate is directed through a manifold line 32 thence either through branch line 33 to the coke drum C or through branch line 34 to the coke drum D. The coke drums C and D may be provided with drawoff lines 35 and 36, respectively, so that a portion or all of the hot condensate introduced to a coke drum for preheating it may be withdrawn from the system. It is not necessary, however, to withdraw the oil used in the preheating and in fact such oil is preferably permitted to remain in the coke drum for coking.

In a typical operation in accordance with the invention the cycle condensate is subjected to cracking in the coil A at temperatures such as 1000° F.–1050° F. under a superatmospheric pressure such as 400–800 lbs. and the effluent from the heating coil is combined with a mixture of reflux condensate and residual stock for reaction in the reaction and separating chamber B wherein cracking is carried on at temperatures in excess of 900° F. under superatmospheric pressure such as 300–600 lbs. Liquid is prevented from accumulating in the reaction chamber by the rapid withdrawal of the liquid residue together with a sufficient portion of the vapors to effect autogenous coking in one of the coking drums C or D. A temperature of 910° F. in the stream of vapors and liquid passing from the reaction chamber B to the coking drum is adequate to accomplish autogenous coking. The pressure in the coking drum is about 50–100 lbs. or higher; for example, with pressures of 350–400 lbs. in the reaction chamber B an advantageous pressure in the coke drum is 150–175 lbs. Temperatures of 840° F.–885° F. are effective coking temperatures. The vapors from the coking drum are subjected to a primary dephlegmation in the dephlegmating zone 19, a relatively small amount of cooling being supplied thereto so that only the heavier components are condensed to form a heavy tarry condensate which may be withdrawn from the dephlegmating zone at temperatures of the order of 790° F–815° F. It is advantageous to recycle a portion of this tarry condensate through the dephlegmating zone 19 in order to increase the liquid flow therein and prevent coking. The tarry condensate is normally withdrawn as a fuel oil product of the process. The dephlegmated vapors from the dephlegmating zone 19 are combined with the vapors which are separately withdrawn from the reaction chamber B and the combined vapors are subjected to dephlegmation in the dephlegmating zone 20 into which charging stock such as topped or reduced crude is introduced. The resultant mixture of reflux condensate and unvaporized crude residuum is withdrawn at temperatures such as 790° F.–815° F. and combined with the heated effluent from the cracking coil A for cracking in the reaction chamber B. The overhead vapors from the dephlegmator 20 pass to the fractionator F at a temperature of for example 710° F.–730° F. and the vapors are fractionated to obtain an overhead distillate, such as a 400° F. end point gasoline product, and a higher boiling reflux condensate which is withdrawn at temperatures, for example, of 660° F.–680° F. and directed to the heating coil A.

Assuming that the coking operation is being carried on in the coke drum C it will be desired to preheat the coke drum D near the end of the coking operation in coke drum C at which time extremely heavy potential coke forming constituents are evolved from the coking drum and passed through the vapor line to the primary dephlegmating zone. The hot tarry distillate

which normally is being withdrawn from the system is then diverted to the coke drum D. In this way the heavy coke forming constituents are flushed out of the primary dephlegmator and utilized to preheat the coke drum D. It is generally preferable to completely drain the liquid in the bottom of the dephlegmator so as to insure the removal of the heavy potential coke forming constituents. The delivery of the condensate to the coke drum at temperatures above 750° F., and preferably approximating 800° F. serves to preheat it sufficiently that when the stream from the reaction chamber B is directed thereto there will be no material condensation and the drum may be rapidly brought to the desired coking temperature.

The coke drums are conveniently provided with vapor connections to the usual steaming out tank (not shown). The introduction of the hot condensate from the dephlegmator 19 into the coke drum D will cause the building up of pressure therein which may be relieved through the vapor line to the steaming out tank. When the pressure begins to drop the valve to the steaming out tank is closed and the valve in line 17 opened to permit the passage of the vapors to the dephlegmator 19. In the meantime the coking in drum C will have been completed and the hot products from reaction chamber B are diverted from the coke drum C to the coke drum D and the valve in the vapor line 16 is closed. The coke drum C is then steamed out and cooled and the coke removed while the coking operation is carried on in the coke drum D, with the resumption of the continuous withdrawal from the system of the tarry condensate from the primary dephlegmator.

Coking operations are commonly conducted in cycles approximating 12 hours; that is, by switching coke drums at time intervals of about 12 hours, and with such a cycle of operations it is found that by diverting the tarry condensate to the preheating operation for about one hour before the end of the coking cycle the desired preheating of the coke drum is accomplished and the removal of the coke forming constituents from the primary dephlegmator, so as to materially increase the length of time that the unit can be maintained on stream, is likewise accomplished.

While I have described a particular embodiment of my invention for purposes of illustration, it should be understood that various modifications and adaptations thereof which will be obvious to one skilled in the art, may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. In a process wherein hydrocarbon oil is subjected to coking by the delivery of heated oil to a plurality of coking chambers successively, the process that comprises delivering a stream of heated oil to a given coking chamber and subjecting the contents thereof to coking, passing the resultant evolved vapors from said coking chamber to a dephlegmating zone wherein the vapors are subjected to a separate primary dephlegmation at high temperatures and in the absence of residual charging stock to produce a pool of tarry condensate adapted for fuel oil, normally withdrawing tarry condensate from said pool as a product of the process, diverting said tarry condensate near the end of the coking cycle in said coking chamber to another of the coking chambers to thereby preheat such coking chamber, substantially completely draining the pool of tarry condensate from the dephlegmating zone during such period of diversion to effect removal therefrom of heavy coke-forming constituents, then diverting said stream of heated oil to the preheated coking chamber and subjecting the contents thereof to coking, passing the resultant evolved vapors to the dephlegmating zone and resuming the normal withdrawal of tarry condensate from the system.

2. In a process wherein hydrocarbon oil is subjected to coking by the delivery of heated oil to a plurality of coking chambers successively, the process that comprises delivering a stream of heated oil to a given coking chamber wherein the contents are subjected to autogenous coking, passing the resultant evolved vapors from said coking chamber to a dephlegmating zone wherein the vapors are subjected to a separate primary dephlegmation at high temperatures and in the absence of residual charging stock to produce a tarry condensate collecting at temperatures approximating 800° F. and adapted for fuel oil, normally withdrawing the tarry condensate as a product of the process, diverting said tarry condensate near the end of the coking cycle in said coking chamber to another of the coking chambers to thereby preheat such coking chamber, substantially completely draining the pool of tarry condensate from the dephlegmating zone during such period of diversion to effect removal therefrom of heavy coke-forming constituents, then diverting said stream of heated oil to the preheated coking chamber and subjecting the contents thereof to coking, passing the resultant evolved vapors to the dephlegmating zone and resuming the normal withdrawal of tarry condensate from the system.

3. In a cracking and coking process wherein hydrocarbon oil is subjected to coking by the delivery of heated oil to a plurality of coking chambers successively, the process that comprises passing condensate oil through a heating zone wherein it is subjected to cracking temperature, combining the resultant heated products with oil as hereinafter specified for cracking in a reaction chamber, maintaining cracking temperature under superatmospheric pressure in said reaction chamber and separating vapors from liquid residue therein, directing residual constituents from the reaction chamber to a given coking chamber wherein the contents are subjected to coking, passing the resultant evolved vapors from said coking chamber to a primary dephlegmating zone wherein said vapors are subjected to a separate primary dephlegmation at high temperatures and in the absence of residual charging stock to produce a tarry condensate constituting a synthetic fuel oil, normally withdrawing the synthetic fuel oil as a product of the process, passing the resultant dephlegmated vapors and the separated vapors from said reaction chamber to a second dephlegmating zone wherein the vapors are dephlegmated with charging stock, utilizing the resultant mixture of reflux condensate and unvaporized charging stock as the oil being combined with the heated products from said heating zone, subjecting the vapors from the second dephlegmating zone to further fractionation to separate a reflux condensate from lighter products, recycling said reflux condensate to the heating zone, near the end of the coking cycle in said coking chamber diverting the synthetic fuel oil being withdrawn from said primary dephlegmating zone to another of the coking chambers to

thereby preheat such coking chamber, substantially completely draining the pool of synthetic fuel oil from the dephlegmating zone during such period of diversion to effect removal therefrom of heavy coke-forming constituents, then diverting said residual constituents being withdrawn from the reaction chamber to the preheated coking chamber and subjecting the contents thereof to coking, passing the resultant evolved vapors to the dephlegmating zone and resuming the normal withdrawal of tarry condensate from the system.

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