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CONVERSION OF PETROLEUM OILS

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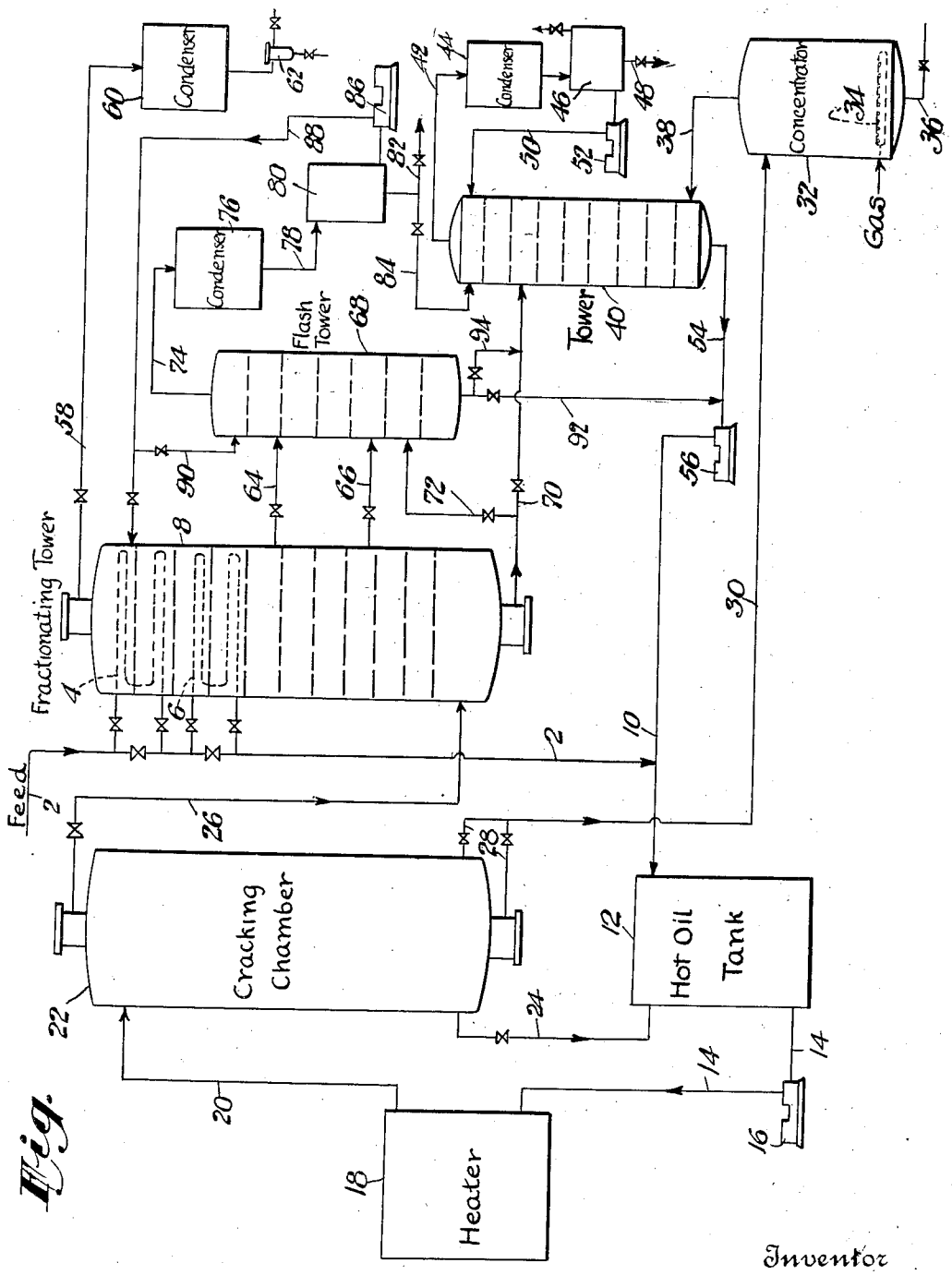


Fig.

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CONVERSION OF PETROLEUM OILS

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4 Claims. (Cl. 196—48)

This invention pertains to the art of pressure distillation of petroleum oils, and particularly to that portion of the art relating to the conversion of higher boiling point oils into oils of lower boiling point by cracking the same at higher temperatures under superatmospheric pressure.

In the fractional distillation of crude petroleum oil or its distillates and residues for the production of definite marketable products, considerable care is taken to maintain the products within certain distilling ranges and to remove from any particular distillate relatively light or heavy ends which may be undesirable in the resulting product or desired in a different product. Commercial cracking processes however are carried on without regard to the recovery, for example, of the light ends such as gasoline contained in the recycle stock, which should be removed and not returned to the heating zone of the cracking unit.

The primary object of the present invention is therefore, to provide an improved process for converting petroleum oils in which the recycle stock or any intermediate distillate withdrawn from the system is stripped of its content of light constituents having the character of pressure distillate or gasoline.

In accordance with this object the invention comprises a pressure cracking process in which the vapors from the cracking zone are rectified and subjected to reflux condensation under relatively high superatmospheric pressure to produce reflux condensates which are withdrawn while hot and partially vaporized by reducing the pressure thereon, thereby to remove the lower boiling constituents as vapors.

Other objects and advantages of the invention will be disclosed by the following detailed description of the invention taken in connection with the accompanying drawing in which:

The figure is a diagrammatic elevational flow sheet of an apparatus embodying features of the improved invention adapted for carrying out the improved process.

Referring to the drawing, the relatively high boiling petroleum oil to be treated which may be a gas oil or other suitable distillate or residue is introduced into the cracking system through a feed pipe 2, which connects through suitable valved connections with preheating coils 4 and 6 mounted in the upper portion of a reflux and rectifying tower 8. In the tower 8 the feed stock may be utilized in the coils 4 and 6 for controlling the cut temperature on the tower and for preheating the feed stock for the system. From the pipe 2 the preheated oil passes by a pipe 10 into a hot oil surge tank 12, from which it is passed through a pipe 14 and pump 16 under a relatively high superatmospheric pressure through a heater 18 of the pipe still furnace type. During the passage of the oil through the heater 18, it is gradually heated to a temperature of from 750° F. to 925° F., or to a point at which the oil will crack. The highly heated products from the heater 18 are conducted through a transfer line 20 into an enlarged cracking chamber 22 in which a body of oil may be maintained at a cracking temperature for a sufficient time to convert substantial quantities of the oil.

In starting up the apparatus the oil from chamber 22 may be conducted through a valved pipe 24 directly back to the surge tank 12 until the cracking unit has been brought to the desired cracking temperature and pressure. The cracked vapors from the chamber 22 are conducted therefrom through a valved vapor line 26 into the lower portion of the reflux tower 8 through which the vapors pass and are subjected to rectifying and reflux conditions. The tower 8 is preferably of the bubble tray type so that as the vapors pass from tray to tray they are brought into an intimate contact with bodies of condensate of gradually decreasing temperature. The tower is preferably also provided with overflow pipes for the trays so that the condensate collecting on each tray will be conducted on to the next lower tray and the condensate from the lowermost tray in the tower will be conducted into the base of the tower.

As the cracking operation proceeds the body of oil in the cracking chamber 22 becomes gradually more saturated with heavy polymerized tars and pitches which must be removed from time to time in order to prevent the formation of excessive deposits of carbon and coke in this chamber. Residuum is therefore withdrawn from the chamber 22 at suitable intervals through valved pipes 28 under sudden reduction of pressure, and conducted through a transfer line 30 into a flash concentrator 32 in which substantial quantities of the residuum are vaporized due to the reduction in pressure upon release of the residuum from the chamber 22. The pressure maintained in the cracking chamber 22 may range from 125 lbs. per square inch to upwards of 500 lbs. depending upon the particular type of oil being treated in the system; while the pressure in the concentrator is preferably maintained at approximately atmospheric or not

more than about 15 pounds per square inch above atmospheric which is sufficient to provide for rapid flow of vapors and other materials from the concentrator 32. In order to facilitate the vaporization in the concentrator, a gas may be introduced into the residuum therein through a distributer 34, while the stripped residuum may be withdrawn through a valved pipe 36.

The vapors produced in the concentrator 32 are conducted through a vapor line 38 into a reflux tower 40 the temperature of which is controlled to condense all constituents of the vapors having boiling points above that of constituents desired in the pressure distillate. The pressure distillate or gasoline vapors, which may comprise as high as 5% of the residuum, are conducted from tower 40 through a vapor line 42 to a condenser 44, and the resulting condensate is recovered in a receiver 46. The condensate (pressure distillate) may be conducted from the receiver 46 to storage through a valved connection 48, or portions of this condensate may be returned to the top of tower 40 through a pipe 50 and pump 52 for the purpose of controlling the cut temperature on the vapors leaving the tower.

The heavy reflux condensate produced in the tower 40 is passed through a pipe 54 and pump 56 into the pipe 10 and then into the hot oil tank 12, where it forms a portion of the cracking stock passed to the heater 18. The temperature in the lower portion of the tower 40 may be maintained comparatively high so that the oil passed into the tank 12 (which is preferably highly insulated) is at a comparatively high temperature.

The cut temperature on the tower 8 is maintained at a point such that the overhead vapors comprise substantially the desired gasoline or pressure distillate fraction. These vapors are conducted from the tower 8 through a valved vapor line 58 into a final condenser 60, from which the pressure distillate or gasoline is recovered and conducted to storage from a connecting trap 62. The tower 8 is preferably maintained under a substantially high superatmospheric pressure which may be substantially the same pressure as that maintained on the oil in the cracking chamber 22, or a pressure intermediate that and a pressure substantially above atmospheric. The vapors entering the tower 8 from the vapor line 26 will maintain the lower portion of the tower at a comparatively high temperature so that the reflux condensate collected in the base of the tower will be at a temperature closely approximating the boiling point of its lower boiling constituents under the pressure maintained in the tower. Likewise the condensate collecting on each tray will contain constituents heated substantially to their boiling point. Since there is a difference in temperature between the base and top of the tower 8 of several hundred degrees F. it will be practically impossible for certain constituents such as kerosene to gravitate to the bottom of the tower because of the high temperature, or to pass off from the top of the tower because of the relatively low temperature. In accordance with the invention therefore these intermediate reflux condensates which may tend to log the tower are withdrawn through valved pipes 64 and 66, and introduced with sudden reduction of pressure into a low pressure flash tower 68 in which substantial portions of the condensates are vaporized by the reduction of pressure. In a similar manner the relatively heavy reflux condensate which may be comprised of heavy gas oil constituents is withdrawn from the base of the tower 8 through a valved pipe 70 and introduced through a valved branch pipe 72 into the lower portion of the flash tower 68.

The condensates withdrawn from the different levels of tower 8 gradually increase in average boiling point and are therefore introduced into the low pressure tower 68 at varying vertical positions corresponding to their relative boiling points, so that the tower 68 is maintained under substantially the same relative temperature gradient as tower 8. Furthermore the condensate introduced through the pipe 64 will contain a larger proportion of low boiling constituents than the condensate introduced from lower points of the tower 8. The upper part of the tower 68 is maintained at a temperature suitable for the removal of only the gasoline or pressure distillate vapors flashed from the reflux condensate. These vapors are withdrawn through a vapor line 74, condensed in a condenser 76, and passed through a transfer line 78 into a storage receptacle 80. Pressure distillate may be withdrawn from the tank 80 and passed to storage through a valved pipe 82, or portions thereof may be conducted through a valved pipe 84 into the upper portion of reflux tower 40 for the purpose of maintaining the proper cut temperature in this tower. Other portions of the condensate from the receiver 80 may be passed by means of a pump 86 and valved pipe 88 into the upper portion of tower 8, where it may be used to aid in maintaining the desired cut temperature therein. Portions of the condensate conducted through pipe 88 may also be passed through a valved branch pipe 90 into the upper portion of the tower 68 in which it is used as a reflux and cooling medium for the purpose of holding back the relatively high boiling constituents in this tower.

Instead of flashing the heaviest condensate from the tower 8 in the flash tower 68, it may be passed directly through the valved pipe 70 into the upper portion of the tower 40 where it is flashed and used as a temperature control medium in this tower.

The stripped condensate refluxed through the tower 68 and collecting at the base thereof is withdrawn through a valved pipe 92 and passed by means of pump 56 and pipe 10 into the hot oil storage tank 12. A portion of this condensate withdrawn through the pipe 92 may be by-passed through a valve pipe 94 and conducted by means of the pipe 70 into the upper portion of the tower 40 particularly when it is desired to cool the upper portion of this tower.

The pressure maintained in tower 68 may be substantially the same as that maintained in the tower 40 and both of these towers are preferably constructed with bubble overflow trays so that the vapors formed and introduced thereinto may be thoroughly rectified.

The cracking process described above in connection with this invention may be referred to as a liquid phase cracking process, but the invention is not limited to cracking in the liquid phase since the mixture of distillates conducted to the heater 18 may be vaporized therein and the vapors heated to a cracking temperature prior to their introduction into the chamber 22. In this case the chamber 22 may be used as a separator for heavy polymerized constituents which may condense from the vapors, and for carbon and coke formed in the process. The temperature of the

vapors leaving the heater 18 under these conditions is maintained at about 1100° F.

In certain cracking operations in which substantially no logging of the tower 8 is experienced, the whole of the reflux produced therein may be flashed under reduced pressure in the tower 40, and concentrator 32 together with the towers 40 and 68 (or 40 alone) may be employed to treat the reflux condensates and residuum from a plurality of cracking units such as the one shown and described in the drawing.

The superatmospheric pressure maintained on the chamber 22 may be controlled by the valved outlets from the trap 62 or the valves in pipes 26 or 58. The pressure maintained on the tower 8 may be likewise controlled by the valve in pipe 58 to maintain a pressure greater than that maintained in condenser 60, and less than that in chamber 22. The tower 8 is always maintained under a substantially higher pressure than that maintained in towers 68 or 40, and the back pressure held on the tower 68 may be used to control the degree of vaporization therein. The pressure in tower 8 should be at least about 25 lbs. per square inch above that in tower 68, but for ease of operation a difference of 50 lbs. is preferably maintained.

The various elements of the apparatus shown in the drawing are diagrammatic, and in actual commerical practice the cracking chambers, towers and hot oil and vapor lines will be heavily insulated.

Having described the preferred form of the invention, what is claimed as new is:

1. The process of converting petroleum oils, which comprises passing oil under a relatively high superatmospheric pressure through a heating zone in which the oil is heated to a conversion temperature, discharging the resulting highly heated products into an enlarged chamber, passing vapors from said chamber into a rectifying tower maintained under a relatively high superatmospheric pressure in which the vapors are passed through a series of zones maintained at gradually decreasing temperature and in each of which a body of condensate is maintained, withdrawing substantially only pressure distillate vapors from said tower for final condensation and collection, withdrawing a relatively low boiling reflux condensate from a zone in the mid-portion of said tower into the mid-portion of a rectifying zone of relatively lower pressure than that maintained in said tower, and withdrawing reflux condensate from the lower portion of said tower into the lower part of said rectifying zone, distilling substantial portions of the condensates introduced into said rectifying zone by suddenly reducing the pressure thereon, removing and condensing pressure distillate vapors from said rectifying zone and passing unvaporized condensate collecting in said rectifying zone into said heating zone.

2. In the art of cracking petroleum oils, in which oil is cracked under superatmospheric pressure at a high temperature in a cracking zone, and vapors therefrom are subjected to reflux condensation under a relatively high pressure in a refluxing zone, the improvement which comprises withdrawing residuum from said cracking zone and distilling it under a reduced pressure, passing the vapors from said residuum into a reflux tower, withdrawing reflux condensate from said refluxing zone into a separating zone and vaporizing portions thereof by suddenly reducing the pressure thereon, removing and condensing the relatively low boiling vapors evolved from said reflux condensate, passing portions of the resulting distillate into said reflux tower to control the refluxing of said residuum vapors, and passing unvaporized reflux condensate collecting in said reflux tower and said separating zone into said cracking zone.

3. The process of converting petroleum oils, which comprises cracking a relatively high boiling point oil under high pressure and temperature in a cracking zone, passing vapors therefrom into a rectifying zone maintained under a relatively high superatmospheric pressure, withdrawing residuum from said cracking zone, and vaporizing portions thereof by flashing the same under reduced pressure, passing the residuum vapors into a refluxing zone in a tower, withdrawing condensate under sudden reduction of pressure from said rectifying zone into a refluxing zone, in a separate tower, wherein substantial portions of said condensate are vaporized, passing unvaporized portions of said condensate into said first mentioned refluxing zone in contact with the vapors produced from said withdrawn residuum, and subjecting the combined condensate collecting in said first mentioned refluxing zone to cracking conditions of temperature and pressure.

4. In the art of cracking petroleum oils in which oil is cracked under superatmospheric pressure at a high temperature in a cracking zone and vapors therefrom are subjected to reflux condensation under a relatively high pressure in a rectifying tower through which the vapors pass in intimate contact with a series of bodies of condensate of progressively decreasing temperature and boiling point, the improvement which comprises withdrawing substantially only pressure distillate vapors from the upper portion of said tower for final condensation and collection, withdrawing a relatively light reflux condensate from the mid-portion of said tower and a relatively heavy reflux condensate from the lower portion of said tower, introducing said withdrawn condensates into separate distilling zones maintained at a substantially lower pressure than the pressure maintained in said tower, separately distilling said condensates in said zones by the heat made available on reducing the pressure thereon, separately fractionating the vapors evolved from said condensates to remove hydrocarbons suitable as pressure distillate and produce a relatively low boiling and a relatively high boiling cracking stock.

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