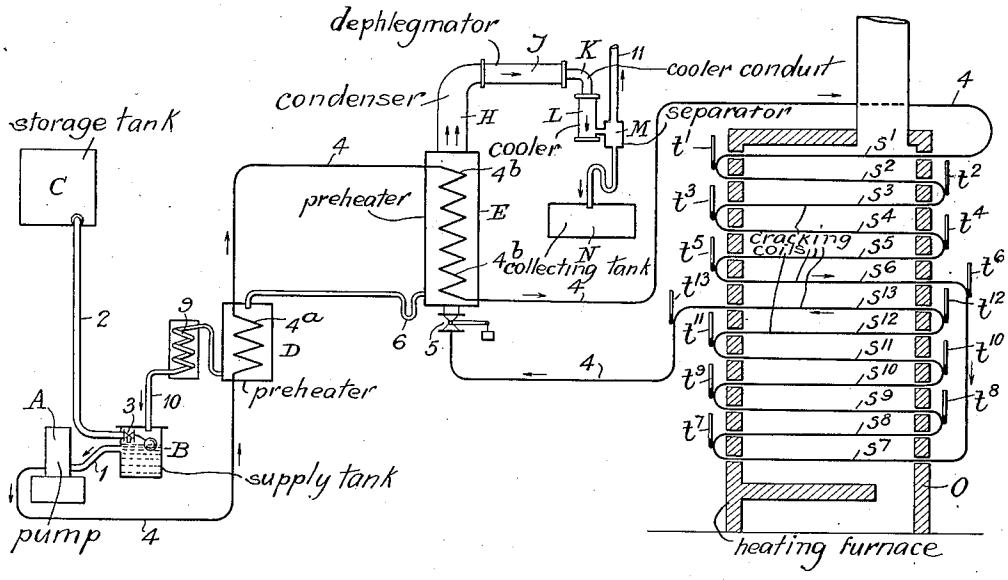
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PROCESS OF CONVERTING HYDROCARBONS AND MINERAL OILS HAVING A HIGH BOILING POINT INTO THOSE HAVING A LOWER BOILING POINT

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PROCESS OF CONVERTING HYDROCARBONS AND MINERAL OILS HAVING A HIGH BOILING POINT INTO THOSE HAVING A LOWER BOILING POINT

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This invention relates to a process of converting hydrocarbons and mineral oils having a high boiling point into those of a lower boiling point by cracking.

With most of the known cracking processes, the oil to be cracked is pumped through a heated system of tubes until it has attained the cracking temperature which lies between 400 and 450° C. The thus preliminarily heated oil is then caused to flow into a well insulated reaction chamber, a kind of autoclave, in which it is left for some time up to two hours either with or without being further heated. Only in this reaction chamber the transformation proper of the heavy hydrocarbons having a high boiling point into those having a lower boiling point is effected, coke and gas being produced at the same time.

In contrasdistinction to most of the known processes in the process of the present invention no reaction vessel is employed.

The invention provides a process for converting hydrocarbons and mineral oils having a high boiling point into hydrocarbons having a lower boiling point by cracking, which consists in pumping the high boiling oil to be cracked through a directly heated steel coil in which the heating is so effected that the temperature of the reaction of 400 to 450° C. required for the cracking is maintained in the oil, for a time limit lying below 100 seconds preferably in the neighbourhood of 50 seconds whilst the pressure of above 20 atmospheres and not exceeding 300 atmospheres is employed and the gases and vapours formed during cracking are caused to separate at a lower pressure immediately after leaving the coil.

The speed of the oil through the tubes of the furnace is preferably maintained at above 1.25 preferably in the neighbourhood of 2.5 metres per second.

Under these conditions the transformation of the heavy hydrocarbons into such of lower boiling point can be smoothly effected, the benzines formed are of a high quality, the formation of gas is small and the danger of rapid incrustation of the heating tubes is reduced to a minimum. Moreover, by the employment of only a tubular system arranged in a furnace any risk of fire or explosion is avoided and moreover with a given tubular system owing to the high speed of the oil and the short reaction time a maximum output per time unit is attained.

The invention is preferably carried out in the following manner: By means of a pressure pump the oil to be cracked is continuously pumped through a tubular system which preferably consists in individual superimposed coil planes arranged in a furnace. Each coil plane is continuously connected with the adjacent one so that the oil can pass through the whole tubular system from the top to bottom in opposite direction to the heating gases. In this arrangement on the countercurrent principle however the oil would be heated progressively in such a way, that it would reach the reaction temperature of between 400 and 450° C., only just at its exit from the furnace or only a short distance before issuing. In order to prevent the consequential incomplete splitting of the oil and to assure that the oil will take up the reaction temperature of 400 and 450° C., for a certain time i. e., below 100 seconds but preferably in the neighbourhood of 50 seconds, the arrangement in the tubular system in the furnace is preferably such that the oil in the upper parts of the tubular system passes in countercurrent to the flue gases, whilst in the lower part the oil flows through the furnace coil concurrent to the flue gases. Any other kind of heat transference may be employed for the purpose of heating the oil on a certain path corresponding to the speed of the oil to the reaction temperature of 400 to 450° C., and to maintain it at that temperature during the required reaction period

below 100 seconds but preferably in the neighbourhood of 50 seconds. For example, the oil after having been heated to 400° C., in a furnace in countercurrent to the flue gases could be led to a tubular system heated in a suitable molten fluid, for example molten lead, or this tubular system may be heated by electro-thermic means.

In order to control the temperatures and time of reaction in the individual coil planes, each coil plane at the exit point of the oil, that is to say at the inlet of the oil to the next coil plane, is provided with a suitable temperature indicating device which may be a thermometer or a thermo-couple so that it is possible to follow the rise in temperature of the oil from one coil plane to the next one. If for example twenty coil planes each of 30 metres length are superimposed in the furnace and if the oil is pumped through the tubes at a speed of two metres per second, and if the oil at the exit of four adjacent coil planes has taken up the reaction temperature of 400 and 450° C., the oil would have been subjected for 4×30 or 120 metres to the reaction temperature. Inasmuch as the oil speed is 2 metres per second the reaction time would in this case be $\frac{120}{2} = 60$ seconds. By varying the oil speed and the intensity of the fire the reaction time may be varied without it being necessary to make any alteration in the tubular system.

On leaving the coil the gases and vapours formed are passed through a safety valve adjustable to between 20 and 300 atmospheres and issue under reduced pressure into one or more distillation columns, wherein the heat interchange between the hot gases and vapours and the oil to be cracked is directly or indirectly effected; this can also be effected if desired under a moderate over pressure in a well known manner. The entire distillation is preferably followed by fractional condensation in such a manner that the heaviest components are permanently separated to be employed as fuel oil, that the middle components are returned to the oil pump to be introduced again with fresh oil into the cracking process and finally the light components and gases after passing a dephlegmator cooled by water are liquefied in a benzine cooler and then separated from the gases formed.

With the above described arrangement of the cracking apparatus it has been found that a prolongation of the reaction time beyond 80 seconds, for example by reducing the oil speed in the tubular system, not only shows no advantages, but on the contrary the absolute yield in benzine corresponding to the reduced amount of oil, is lowered per time unit, whilst the amount of gases split off which is equivalent to loss, is relatively and absolutely increased. Moreover, the benzines formed are reduced in quality with increased reaction time. Neither is it advantageous, to shorten the reaction time too much, because on the one hand the frictional pressure and thus the power consumption becomes too high and on the other hand the cracking is not intensive enough, so that not sufficient light constituents are formed. The following three working figures are given to explain matters.

The first test forms an example carried out in accordance with the present invention.

	1	2	3
Quantity in litres of oil pumped per hour	115	56	34
Yield in benzine up to 150° C.:			
(a) In volume %	28.7	25.0	26.5
(b) In litres	33	14	9
Unsaturated hydrocarbons in the benzine	4%	7%	7.5%
Gas splitting in litres per hour	300	1800	3000
Oil speed in the coil system in metre seconds	2.5	1.25	.75
Reaction temperature	430°	430°	430°
Cracking pressure in atmospheres	300	300	300
Time of reaction in seconds	50	100	167

In these three examples a crude oil free from benzine of specific gravity 0.835 was employed. It can be seen from these examples that the percentage of the benzine yield remains practically constant, but that the absolute yield in benzine is highest in Example 1, which is carried out in accordance with the invention. The benzine formed under the conditions of Example 1 is qualitatively much better than the benzine obtained in accordance with Examples 2 and 3, where a longer reaction time was employed, and finally the amount of gas split off in Example 1 shows also the best figures.

The accompanying drawing illustrates by way of example one embodiment of an apparatus suitable for carrying out the invention.

In said drawing, A indicates the pressure pump which is supplied with the oil to be cracked through the conduit 1 from the tank B. The tank B is automatically supplied from the storage tank C through the conduit 2, the opening and closing of which is controlled by the float 3.

The pressure pump A delivers the oil through the conduit 4 and through two heat-interchanging coils 4_a and 4_b provided in the tanks D and E. The oil passing through said coils 4_a and 4_b is preheated and enters the tubes arranged in the furnace O. These tubes are indicated by single thick lines S_1 to S_{18} in the drawing. It is of course possible for each system to be composed of a number of tubes arranged in series and situated within the same plane. In the embodiment illustrated each tube unit is 30 metres in length, so that the total length of the tubes in the furnace O, is 13×30, i. e., 390 metres.

In the passage from one tubular system to the next one, are arranged thermometers

or thermo-couplings T_1 to T_{13} which exactly measure the rise in temperature in the oil in the individual tubes of the system.

The apparatus operates in the following manner:—

The oil is passed through the tubes as mentioned above in the direction of the arrow, passing from S_1 to S_6, from thence to S_7 and leaving at S_{13}. The furnace O is heated for example by flue gases. Assuming the oil passing through the tubes S_1 to S_9 to be heated to such an extent that on its issuing from the pipe S_9, it has reached a temperature of for example 400° C., which will be indicated by the thermometer T_9, then during its further passage through the pipes S_{10}, S_{11}, S_{12} the temperature increases slightly. This temperature increase can be regulated by the heating means so that the oil leaves the pipe S_{13} at a temperature of 440° C. as indicated by the thermometer T_{13}. Thus the oil in its passage through the four pipes S_9 to S_{13} is submitted to the conditions necessary for cracking.

If each pipe has for instance a length of 30 metres and if the oil is passed through said pipes at the rate of 2 metres per second, the reaction period will be $4 \times 30 = \frac{120}{2}$ or 60 seconds.

After leaving the furnace O, the oil is passed through the expansion valve 5, which is adjustable according to the oil to be treated, for pressures between a minimum of 20 atmospheres and a maximum of 300 atmospheres. It passes in contact with the coils 4_b where the hot vapours and gases are partly condensed.

The condensate passes through the syphon 6 into the heat interchanger D where the greater part of its heat is given off to the cold oil passing through the coil 4_a. From thence the oil passes through the water cooler 9 and the tube 10 into the tank B from whence it is returned admixed with fresh oil for further cracking.

The uncondensed vapours pass from the tank E through a condenser H where they are freed from any fog or cloud particles which they have taken with them, and thereupon enter the dephlegmator J in which the vapours and gases are cooled with water or in any other suitable manner to the required temperature, according to the boiling point the finished gasoline is intended to have.

The vapours and gases are then passed through the conduit K into the cooler L where the gasoline is completely condensed. Finally the separation into gasoline and gas is effected in the separator M. The gas is passed through the tube 11 for use whilst the gasoline passes through the syphon 12 into the collecting tank N.

The above example is only intended to be illustrative of the progress of the process. The length of the tubes in the furnace can be altered according to the size of the plant because the surface of the tube only alters in proportion to the diameter of the tube whilst the amount of oil passing therethrough at the same speed increases as the square of the diameter. Consequently in relation to the increase of the plant, the tubes must always be longer to offer the surface required for the heat transference. This increase in length however need only be considered for the preheating of the oil until it attains the cracking temperature, that is to say, the pipe S_9 in the embodiment illustrated. The cracking tubes S_{10} to S_{13} need not be made longer because the sole factor there, is the reaction period.

I claim:—

1. The process for converting hydrocarbons having a high boiling point into hydrocarbons having a low boiling point by cracking, which consists in carrying out the entire cracking operation solely in directly heated cracking coils in such a manner that the high boiling hydrocarbons to be cracked are passed through the upper parts of said heated cracking coils in counter-current to the heating current thereby heating said hydrocarbons to progressively increasing temperatures up to the most favourable cracking temperature lying between 400 and 450° C., said heated hydrocarbons being thereupon passed through the lower parts of said heated cracking coils concurrent to the heating current for a period lying below 100 seconds preferably in the neighbourhood of 50 seconds, whereby said hydrocarbons are maintained for said period of time at said most favourable temperature attained in the upper part of said heated coils, the whole operation being carried out at a pressure lying between 20 to 300 atmospheres and at a speed of the hydrocarbons lying above 1.25 preferably in the neighbourhood of 2.5 metres per second, and expanding the cracked products immediately after leaving the heating zone.

2. The process for converting hydrocarbons having a high boiling point into hydrocarbons having a low boiling point by cracking, which consists in carrying out the entire cracking operation solely in directly heated cracking coils in such a manner that the high boiling hydrocarbons to be cracked are passed through the upper parts of said heated cracking coils in counter-current to the heating current thereby heating said hydrocarbons to progressively increasing temperatures up to the most favourable cracking temperatures lying between 400 to 450° C., said heated hydrocarbons being thereupon passed through the lower parts of said heated cracking coils concurrent to the heating current for a period lying in the neighbourhood of 50 seconds, whereby said hydrocarbons are main-

tained for said period of time at said most favourable temperature attained in the upper part of said heated coils, the whole operation being carried out at a pressure lying between 20 to 300 atmospheres and at a speed of the hydrocarbons lying in the neighbourhood of 2.5 metres per second, expanding the cracked products immediately after leaving the heating zone and separating out the constituents therefrom.

In testimony whereof I affix my signature.

HERMANN WOLF.