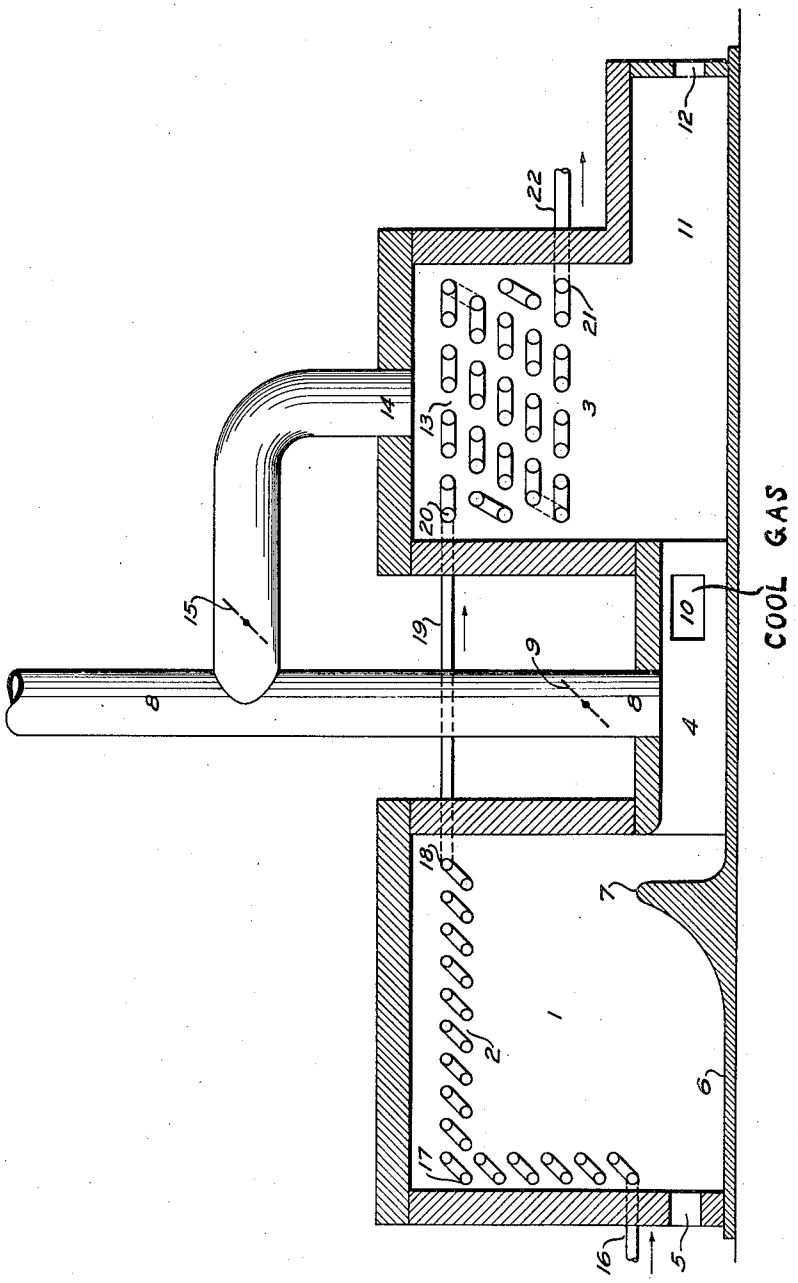
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THERMAL DECOMPOSITION OF HYDROCARBONS

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THERMAL DECOMPOSITION OF HYDROCARBONS

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This invention relates to the thermal decomposition of hydrocarbons by cracking, and more specifically provides an improved method for heating the hydrocarbons during the process of conversion.

The usual method of heating hydrocarbon oil to conversion temperature as commonly heretofore practiced in the oil industry comprises introducing the hydrocarbon oil into a continuous tubular heating coil at the coolest point in the heating zone and gradually bringing the oil up to the desired conversion temperature as it passes through the coil, finally ejecting it therefrom at the hottest point, or at least at a zone in the heating element higher in temperature than the point of introduction.

In the cracking industry the present trend is toward relatively high conversion temperatures and relatively short-time exposure to these temperatures. With the heating method commonly in use, however, the time factor required to bring the oil to the desired high conversion temperature is necessarily long and in subjecting the oil to this gradual heating, transitory cracking, that is, cracking within the heating element, is quite likely to occur and is usually accompanied by over-decomposition of the heavier constituents in the charging stock with a resultant deposition of coke in the tubes and the formation of an excessive amount of fixed gas.

Moreover, I have found, especially with reference to some of the recently developed cracking processes wherein relatively high temperatures are employed, that fairly definite conditions of temperature, pressure and time are required to produce the desired final products from any given charging stock and the results achieved will be in proportion to the accuracy with which these three conditions are controlled. This is especially true in processes developed for the production of highly anti-knock motor fuels wherein I have found it desirable, for best results, to arrive at a definite maximum temperature in a minimum period of time and to hold the oil at or slightly below this maximum temperature for a definite period of time.

My invention provides a method of subjecting the oil undergoing treatment to a high rate of heat in-put by passing it, preferably at high velocity, through an element heated by radiant energy resulting from the combustion in the furnace and thus bringing the oil quickly to the desired maximum temperature.

The invention further provides a method of holding the heated oil at a pre-determined temperature for a definite period of time. This may be accomplished by passing the oil from the radiant heat zone of the furnace into a convection heat zone, which may be located in the same or in a separate furnace and deriving its heat wholly or in part by convection from the products of combustion leaving the radiant heat zone. The pre-determined temperature of the oil in the convection heat zone may be substantially the same or a slightly lower temperature than that temperature at which it leaves the outlet of the radiant heat zone. In some instances it may be necessary to supply a certain amount of additional heat to the convection heat zone and provision is therefore made for direct firing in this zone when and if required. On the other hand, the heated combustion gases from the radiant heat zone may be higher in temperature or greater in quantity, or both, than is required for holding the oil in the convection heat zone at the desired temperature. In this case portions of the combustion gases may by-pass the convection zone and/or those gases which enter the convection zone may be first cooled by introducing air or steam or any other suitable cooling or thinning medium into the stream.

It is evident that in the manner described, I am able to control the time and temperature conditions and the time-temperature relation in both heating zones to a high degree of accuracy and yet, by the use of the two zones, allow a greater flexibility of operation than is attainable in the ordinary furnace where a more or less fixed relationship must prevail between the conditions in the radiant heat section and in the convection heat section.

The attached drawing is a diagrammatic cross sectional elevation of one specific type of heating means suitable for carrying out my improved method of heating, but it should not be construed as limiting the invention to this or to any other specific design or type of furnace or heating element.

Referring in detail to the drawing, 1 indicates a radiant heat zone, in which is disposed a continuous tubular coil 2 of radiant heat tubes. The convection heat zone 3 may be connected to the radiant heat zone 1 by a tunnel or gas passageway 4. Fuel for combustion may be supplied by any suitable type of burner (not shown) to the radiant heat section 1 through port 5, energy being radiated to the tube bank 2 from the flames and from the refractory floor 6 as well as from the top and side walls of this section of the furnace. Fuel for the heating of the oil through the con-

vection coil 13 is obtained by means of a suitable burner (not shown) in the combustion tunnel 11 through port 12. By this means the amount of heat imparted to the oil through the convection coil 13 may be regulated entirely independently from the amount of heat imparted to the radiant coil 2.

On the other hand, if it is desired to add heat to or increase the quantity of the combustion gases passing from the convection coil 13, all or a portion of the products of combustion from the radiant heat section 1 may pass over a bridge wall 7 and through the tunnel 4 to the convection heat zone 3. Regulated portions of the combustion gases from the radiant furnace 1 may, when so desired, pass from the tunnel 4 up to stack 8 in quantities regulated by the damper 9. All of the gases from the radiant furnace 1 may pass up the stack 8 as above indicated. If desired, a cooling medium, such as air, steam or the like, may be introduced into the tunnel 4 through the port 10, to mix with the combustion gases passing through said tunnel on their way from the radiant furnace 1 to the convection furnace 3, if such operation is carried out. Thus, the products of combustion from the radiant heat zone 1, all or in part, with or without the addition of a cooling medium and with or without additional combustion products, may pass upwardly around the tubes in the convection heat bank 13 and finally through the flue 14, past the regulating damper 15 and up the stack 8. Or, as heretofore described, the two coils 2 and 13 may be heated entirely independently from each other.

The oil traversing the two heating elements may flow in any of a variety of paths, for example as follows:

The oil to be heated and converted may be introduced into the radiant heat tubes, in substantially liquid state, or in substantially a vaporized state, or in a mixed vapor and liquid state, through line 16 and the path of the fluid may criss-cross back and forth between adjacent tubes of the inner and outer rows of the vertical portion of the bank to a point 17. At this point 17 the direction of flow may be changed from a substantially vertical to a substantially horizontal plane and the fluid may flow in a staggered path from each tube in the upper row of the horizontal section to the adjacent tube in the lower row, back to the next adjacent tube in the upper row and so on to a point 18. The fluid may then pass through line 19 to an inlet point 20 in the top row of the convection tube bank 13, thence flowing from left to right through successive adjacent tubes in the top row, transferring to the next lower row, there flowing from right to left through successive adjacent tubes and so on in a general downwardly direction throughout the convection bank to the outlet point 21, from the last tube. From this point the oil may be discharged through line 22 to other cracking process equipment (not shown).

A number of other paths of flow may be more advantageous with some charging stocks, and hence the invention is not to be limited to a specific design or type of heating element and furnace or to a specific course or path of flow through the heating element and heating zone, inasmuch as the invention comprises broadly a method of heating hydrocarbons in a substantially radiant heat zone and in a substantially convection heat zone; the time and temperature on each zone being independently controlled.

As an example of one of the many operations which may be greatly improved by the application of the principles of my invention: A 26° A. P. I. Baumé gravity topped crude, may be treated in a cracking process wherein reflux condensate from the dephlegmator of the system is recycled to the heating element for re-cracking with the charging stock. The combined feed, at a temperature of about 700° F., owing to the addition of about four parts of hot reflux condensate to one part of raw oil, may be heated to an outlet temperature from the heating element of approximately 915° F., more or less. The heating element may consist of a convection-heat tube bank and a radiant-heat tube bank both located in a single furnace. The oil is fed first through a convection bank of tubes where it is gradually heated to a temperature of about 800° F., and then continues through a radiant bank where it attains a final temperature of about 915° F. The heated fluid then discharges into a reaction chamber, the vapors ffom which are subjected to fractionation and their desired light portions condensed, cooled and collected as pressure distillate. An operation of this character may yield approximately 67% of pressure distillate which in turn may contain approximately 85% of material suitable for motor fuel. This operation being what is known as the non-residuum type the remaining 33% of the charging stock is coke, gas and loss.

Substituting my method and means of heating in the process above described: The combined feed may be fed at such a velocity through a radiant-heat tube bank maintained under such temperature conditions that the oil is rapidly raised to a temperature of approximately 925° F. at which temperature it may be discharged into the convection-heat tube bank in a separate furnace which may be heated by the products of combustion from the radiant-heat furnace. The temperature of the combustion products leaving the radiant-heat zone may be of the order of 2000° F., more or less, and these products, before they pass into the convection section may be cooled by the introduction of air thereto, to a temperature of about 1600° F. With this controlled temperature in the convection zone the oil passing through the convection-heat tube bank may be held at a substantially uniform temperature of approximately 900° F. for any predetermined period of time which is controllable not only by the design of the heating element with regard to the diameter and length of tube, but also by the charging capacity or rate of feed through the heating element. With the rate of feed maintained the same as in the first mentioned case, where my invention is not employed, and with other conditions, except as noted, remaining substantially the same, the yield of pressure distillate may be increased to approximately 75%, based on the raw oil, and this distillate, while containing substantially the same percentage of motor fuel as heretofore mentioned, may yield a motor fuel of higher anti-knock rating. On this basis the coke, gas and loss figure may thus be reduced by the use of my process to the extent of 8%, more or less, that is, to about 25%.

It will thus be evident that by employing my method of heating in a certain type of cracking process operating on a certain charging stock at the usual capacity, the yield and quality of motor fuel may be substantially augmented and the coke, gas and loss figure greatly reduced.

I claim as my invention:

1. A process for the conversion of hydrocarbon fluids, comprising flowing hydrocarbon fluid

through an elongated passageway of restricted cross sectional area, heating a portion of said passageway in one zone with hot gases of combustion, then dividing said gases of combustion into two streams and discharging one of the streams from the process, subsequently mixing a comparatively cool medium with the remaining stream of gases of combustion leaving said zone, and contacting the resultant gaseous mixture with another substantially posterior portion of said passageway in a second zone.

2. A process for the conversion of hydrocarbon fluids, comprising flowing hydrocarbon fluid through an elongated passageway of restricted cross sectional area, heating a portion of said passageway with hot gases of combustion, then diverting a portion of said gases of combustion from contact with a further portion of said passageway, mixing a comparatively cool medium with a remaining portion of said gases of combustion, and contacting the resultant gaseous mixture with a further portion of said passageway.

3. A process for the conversion of hydrocarbon fluids, comprising flowing a hydrocarbon fluid through a tube having a portion arranged in a heating chamber and heating said fluid in said portion to conversion temperatures, subsequently passing the heated fluid through a conversion portion of said tube arranged in a conversion chamber while maintaining said fluid at but not above said conversion temperatures, generating hot gases of combustion and contacting said gases with the first mentioned portion of the tube for heating the fluid in the first portion of the tube to said conversion temperatures, passing only a regulated portion of said hot gases of combustion through the conversion chamber, and diluting the last mentioned gases as they pass into the conversion chamber with cooler diluent gases for maintaining the fluid in the conversion tube at but not above said conversion temperatures.

4. A process for the conversion of hydrocarbon fluids, comprising passing a hydrocarbon fluid through a portion of a tube in a heating zone, generating hot gases of combustion and passing the same in contact with said portion of the tube to heat the fluid to conversion temperatures, subsequently passing the heated fluid while at conversion temperatures into and through a conversion portion of the tube in a conversion zone, discharging a portion of the gases of combustion from the heating zone and preventing the same from entering the conversion zone while diverting another portion of said gases of combustion after discharge from the heating zone into and through the conversion zone, introducing cooler diluent gases into the gases of combustion entering the conversion zone before the gases of combustion contact with the conversion portion of the tube, and causing the mixture of diluent gases and combustion gases to pass through the conversion zone for maintaining the fluid in the conversion portion of the tube at but not above conversion temperatures.

5. A process for the conversion of hydrocarbon fluids comprising flowing a hydrocarbon fluid through a tube, heating a portion of said tube in one zone by gases of combustion and thereby cooling said gases of combustion, afterwards dividing said cooled gases of combustion into two streams and passing one stream of said cooled gases of combustion in contact with another substantially posterior portion of said tube in a second zone, discharging the second stream of gases of combustion and preventing it from re-entering either of said zones, and tempering the first stream of gases of combustion after it has contacted with the first mentioned portion of said tube and before it has contacted with the second mentioned portion of said tube, by introducing relatively cool diluent gases into the first stream of gases of combustion as it enters the second zone.

6. In the heating of hydrocarbon oils to cracking temperatures in furnaces of the type having a combustion zone and a convection heating zone, the method which comprises generating hot combustion products in the combustion zone, passing the oil through the combustion zone and heating the same therein preponderantly by radiant heat to the desired maximum cracking temperature, then passing the oil through the convection zone, removing the combustion products from the combustion zone and dividing the same into two streams, discharging one of the streams from the process and commingling a relatively cool medium with the other of said streams, and passing the resultant mixture through the convection zone in heat exchange relation with the oil flowing therethrough, the quantity of the combustion products discharged from the process and the quantity of cool medium commingled with said other stream being regulated so that said resultant mixture contains such an amount of heat units as to maintain the oil at cracking temperature in the convection zone without increase above said desired maximum cracking temperature attained by the oil in the combustion zone.

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