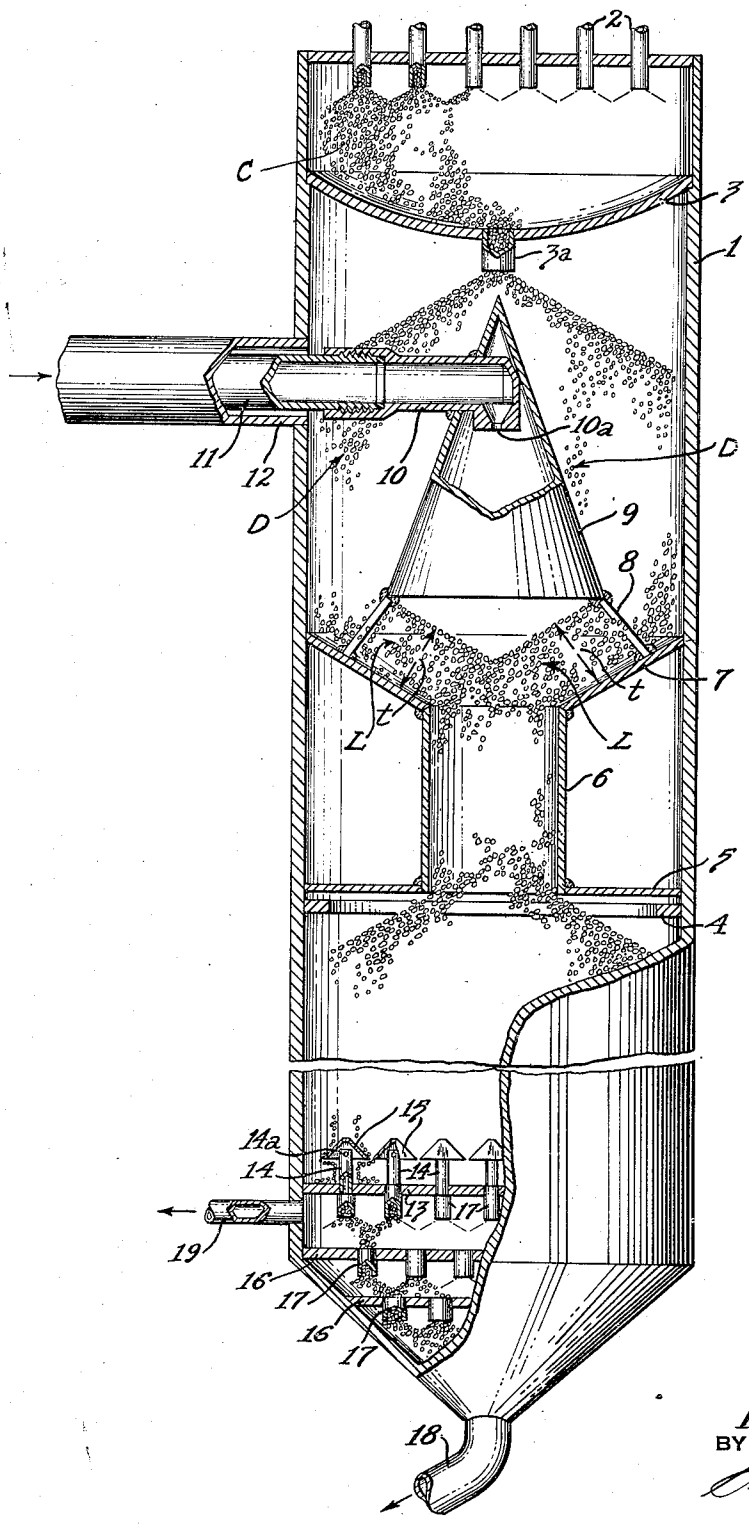
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ART OF APPLYING AN ATOMIZED HYDROCARBON MIXTURE TO CONTACT MATERIAL DURING PASSAGE THEREOF THROUGH A REACTION ZONE

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INVENTOR
Hans G. Shimp
BY Gordon A. Kessler
ATTORNEY

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ART OF APPLYING AN ATOMIZED HYDROCARBON MIXTURE TO CONTACT MATERIAL DURING PASSAGE THEREOF THROUGH A REACTION ZONE

Hans G. Shimp, Moylan, Pa., assignor to Houdry Process Corporation, Wilmington, Del., a corporation of Delaware

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My invention relates to the art of applying an atomized hydrocarbon mixture to contact material as it passes downwardly through a reaction zone under the influence of gravity.

When an atomized hydrocarbon mixture is to be engaged with contact material for cracking or other conversion purposes, it has been determined, in accordance with the invention, that at least a substantial part of the contact material should be directed so that it gravitates downwardly through the reaction zone into and through the path taken by the aforesaid hydrocarbon mixture after ejection thereof from a suitable nozzle, or equivalent.

For the purpose stated above, suitable deflecting means such as a conical member or equivalent deflecting structure may be supported within the reaction zone in inverted relation substantially symmetrically with respect to the periphery thereof. The contact material is admitted to the reaction zone above this conical member which causes at least a substantial part thereof, while following a path which is circumferentially complete around said member, to diverge from an axis extending longitudinally through the reaction zone. After divergence of the contact material has ceased, the contact material, in suitable manner, is directed into the path of the atomized hydrocarbon mixture as described above.

Various other objects and features of my invention will become apparent from the following detailed description.

My invention resides in the art of controlling movement of contact material, the novel process steps and mechanical features of the character hereinafter described and claimed.

For an understanding of my invention and for an illustration of one form of apparatus with which it may be practiced, reference is to be had to the accompanying drawing, in which:

The figure is a vertical sectional view, partly in elevation, showing a reaction zone of the invention.

Referring to the drawing, I have shown a vertical housing 1 which, in horizontal cross section, may be of any suitable configuration. The housing 1 defines a reaction zone wherein hydrocarbon material is cracked or otherwise converted in the presence of contact material C which moves downwardly therethrough under the influence of gravity, the contact material C being introduced into said housing 1 in suitable manner, as by a plurality of spaced pipes 2 extending through the top housing wall.

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In the form of the invention herein shown, although not necessarily, the housing 1, below the upper surface of the contact material C, may support a shallow receptacle-like member 3 having a central discharge pipe 3a opening therethrough and extending downwardly therefrom. A substantial distance below the member 3, a ring 4 or other suitable supporting member may be welded or otherwise suitably secured to the interior housing surface. This ring 4 supports a disk 5 which, in turn, supports an upstanding tubular member 6 communicating with that portion of the housing 1 below the ring 4 by way of an opening formed in the central part of said disk 5. The upper end of the tubular member 6 supports a deflecting member 7 having a central opening which communicates with said tubular member 6, the deflecting member 7 being suitably secured at its peripheral surface to the interior surface of the housing 1. The deflecting member 7 may carry a plurality of inclined rods 8 which are disposed in suitable spaced relation so as to support an inverted receptacle-like member 9 having its lower surface suitably spaced from the interior surface of the housing 1 and which may have true right-angle conical, frusto-conical, or equivalent pyramidical or frusto-pyramidical configuration. In the appended claims, the expression "cone-like" shall be understood as generically describing members of the character just referred to. As clearly appears from the drawing, the central longitudinal axis of the member 3, the pipe 3a, conical member 9, deflecting member 7, tubular member 6 and the disk 5 coincide, preferably, with the longitudinal axis of the housing 1. In lieu of the receptacle-like member 9, it shall be understood that any other suitable member having plane or other suitable configuration may be supported in the housing 1 in spaced relation with respect to the interior surface thereof so as to deflect the contact material therearound.

In the form of the invention herein shown, although not necessarily, the conical member 9, near its apex, is apertured for the reception of a pipe 10 which, interiorly of said conical member 9, terminates in a downwardly directed nozzle 10a through which an atomized hydrocarbon mixture passes as hereinafter described. The pipe 10 may be threaded to a supply pipe 11 which extends exteriorly of the housing 1 where it may be supported by a tubular member 12.

Adjacent the lower end of the housing 1, any suitable arrangement may be provided for dis-

engaging cracked or converted vapors from the contact material C. To this end, if desired, a tube sheet 13 may be secured in suitable manner to the interior surface of said housing 1. Upstanding from the tube sheet 13 and opening therethrough are a plurality of tubes 14 communicating with an utilizable for supporting a plurality of suitably arranged channel members 15, or equivalent, which are disposed in inverted relation so that, in known manner, they are utilized for the disengagement of vapors from the contact material.

Any suitable arrangement may be utilized for discharging the contact material from the housing 1. To this end and as diametrically indicated, a plurality of spaced horizontal tube sheets 16 may be secured to the interior surface of the lower end portion of the housing 1 below the aforesaid tube sheet 13, the extreme lower end portion of said housing 1, preferably, being conical as illustrated. A plurality of suitably spaced tubes or pipes 17 open through and depend from each of the tube sheets 13 and 16. As known in the art, the tubes 17 on successively lower tube sheets progressively decrease in number and the diameter thereof progressively increases whereby the contact material passes through the lower conical end portion of the housing 1 and reaches a main discharge pipe or conduit 18 which may be inclined as illustrated.

In operation, contact material C is admitted to the housing 1 by way of the pipes 2 and, ordinarily, the contact material fills said housing 1 to the outlet ends of the respective pipes 2. As the operation proceeds, contact material passes continuously through and from the housing 1 by way of the above described sets of tubes 17 which lead to the discharge pipe 18. Simultaneously, contact material is admitted to said housing 1 by way of the aforesaid pipes 2. Thus, within the housing 1, there is a moving bed of contact material which moves downwardly under the influence of gravity.

After admission to the housing 1, the contact material C, initially moves into the member 3 from which it passes downwardly by way of the discharge pipe 3*a* which, as stated, is centered with respect to the apex of the conical member 9. Accordingly, it results that at least a large or substantial part of the contact material, during continued downward movement, is distributed substantially in uniform manner around the periphery of said conical member 9 at any intersecting horizontal plane including the horizontal plane coinciding with the lower surface thereof.

he contact material while moving downwardly as described immediately above, follows a path which is circumferentially complete around the conical member 9 by which said contact material is deflected as indicated at D so as to diverge with respect to the longitudinal axis thereof, this action continuing until the contact material reaches the lower surface of said conical member 9. Resulting from this action of the conical member 9, there is formed interiorly of the contact material a chamber through which the atomized hydrocarbon mixture is passed as hereinafter described.

Thereafter, in accordance with the invention, at least a large or substantial part of the contact material, while moving under the influence of gravity, is caused to move through the path taken by the atomized hydrocarbon material ejected from the nozzle 10*a*. More particularly, the contact material last named, after passage thereof below the conical member 9, is caused to gravitate as a layer of contact material moving downwardly from the lower surface of the conical member 9 and having configuration which is suitable for the efficient application thereto of the atomized hydrocarbon material. This may be accomplished in any suitable manner. As herein shown, although not necessarily, the deflecting member 7 is thus utilized and, as clearly appears from the drawing, said member 7 causes the contact material, after passage thereof below the conical member 9 to move, under the influence of gravity, as a layer L of contact material which faces the lower open end of the conical member 9. Moreover, as indicated at *t*, the thickness of this layer of contact material, as determined initially by the space between the lower surface of the conical member 9 and the member 7 may be regulated to some extent by the angle of inclination of said member 7. If the inclination of the latter is at or near the angle of repose of the contact material beneath the conical member 9, as is preferred, said layer of contact material has substantially uniform thickness as indicated at *t*.

Thereafter, in the form of the invention herein shown, the contact material passes downwardly through the tubular member 6 and then through the housing proper where the desired reaction continues in the presence of the contact material on which a deposit of carbonaceous material is accumulated as the operation proceeds. Finally, as stated, the contact material passes through the pipes 17 and then leaves the housing 1 by way of the pipe 18. Thereafter, in suitable manner, said contact material is regenerated and then returned to the pipes 2 for re-admission to said housing 1.

When hydrocarbon material is to be cracked in the housing 1, the contact material C hereinbefore referred to should be catalytic in character and the temperature thereof, upon admission to the housing 1, should range between 800° F. and 1000° F. or higher, for example, about 900° F. Any suitable kind of catalytic contact material may thus be utilized such, for example, as activated clay pellets, synthetic silica-alumina pel ets or beads, etc., these pellets or beads having suitable major dimensions such as between 1/8 and 3/4 of an inch.

Hydrocarbon material, while entirely in the liquid phase or in desired proportion of vapor phase and liquid phase material, is supplied to the pipe 10 from any suitable source of supply, not shown, under superatmospheric pressure ranging, for example, from 15 lbs. to 30 lbs. per sq. inch gauge. By the nozzle 10*a*, this liquid phase material is atomized so as to form a fine mist or spray which passes downwardly through the conical member 9, preferably in non-contacting relation with respect to the interior surface thereof, so as to be injected into the aforesaid layer L of contact material during the described movement thereof under the influence of gravity beneath the conical member 9. Some vaporization of the liquid hydrocarbon material may occur immediately after ejection thereof from the nozzle 10*a* and, if so, the extent of such vaporization depends on the temperature of the incoming hydrocarbon material, the character thereof as regards boiling range and the degree of pressure reduction at said nozzle 10*a* considering the temperature of the contact material. In any event, a substantial proportion of the admitted

hydrocarbon material exists as an atomized liquid when it is injected into the layer L of contact material.

The extent of penetration of the contact material forming the described layer L of contact material is dependent upon the thickness of said layer and the velocity of the atomized mixture ejected from the nozzle 10*a*. Ordinarily, the atomized mixture should penetrate through or nearly through said layer of contact material. To some extent, uniformity of distribution of the atomized mixture on the contact material decreases as the lower surface of the layer is approached.

After the atomized hydrocarbon material has been applied to the contact material in the manner described above, the latter moves downwardly through the tubular member 6 and thence through the reaction zone proper. As this operation proceeds, the applied hydrocarbon material is cracked in the presence of the contact material, the resulting cracked vapors moving concurrently with the descending contact material and being disengaged therefrom at the channel members 15. Thereafter, in the form of the invention herein shown, these vapors enter the tubes 14 by way of passages 14*a* formed respectively therein, pass downwardly therethrough, then pass through the tube sheet 13 whereupon they pass to any suitable destination by way of a conduit 19 opening into the space below said tube sheet 13.

It is a feature of the invention that some means such, for example, as the inclined member 7 is utilized for directing the contact material so that it gravitates in layer formation through a zone wherein the atomized hydrocarbon material is applied thereto. This zone is above the zone wherein the reaction largely occurs which, in the disclosed form of the invention, is below the disk 5. Accordingly, it follows that, in the upper zone, the contact material usually moves more or less transversely through the path taken by the atomized material issuing from the nozzle 10*a* and, in so doing, assumes layer formation having thickness suitable for obtaining satisfactory penetration of the applied liquid phase material. Preferably, the amount of contact material which passes along the inclined member 7, or equivalent is sufficient to absorb all of the liquid hydrocarbon material ejected from the nozzle 10*a*. As the operation proceeds, contact material moves downwardly along the upper surface of said deflecting member 7, or equivalent and, in so doing, maintains this surface substantially free from liquid hydrocarbon material and/or carbonaceous material. Thereafter, the contact material gravitates downwardly through the tubular member 6, if utilized, and then into the reaction zone proper. As it enters the last named zone, some transverse movement of the contact material occurs with resultant attainment of a substantially uniformly mixed condition of the pieces of contact material which may have been coated with the hydrocarbon mixture to different extent.

The hydrocarbon material traversing the conduit 11 and any preceding heating equipment should be maintained under temperature, pressure and contact time conditions such that, prior to introduction thereof into the reaction zone, there is no substantial formation of cracked products such as carbonaceous material and gasoline. Under the conditions referred to immediately above, the temperature of the hydrocarbon material admitted to the reaction zone may be such as is suitable or desirable. If not free-flowing at ordinary room temperature, such hydrocarbon material should be heated at least to such extent that it is free-flowing. Ordinarily, however, it is desirable for the temperature of the admitted hydrocarbon material to approach rather closely the temperature of reaction in the reaction zone.

The hydrocarbon material traversing the conduit 11 may be of any suitable character whether vaporizable or not. Heavy or even the heaviest types of charge stocks without restriction to boiling range may be utilized and, preferably, prior to the atomizing operation herein described, these stocks are treated to remove salts and asphaltic compounds. It is characteristic of the described cracking operation that, from such heavy charge stocks including topped crudes, reduced crudes, heavy vacuum distillates and the like, large yields of high quality motor gasoline and distillate fuel oils are obtained. If the cracking operation were confined to vapor phase hydrocarbon material, the use of the entire heavy stocks last named as charging material would be undesirable, if not impossible, by reason of the fact that such stocks cannot be completely vaporized in conventional equipment without production of non-vapor phase material such as tar and/or coke. Moreover, the conventional equipment tends to produce, if maximum or near maximum vaporization is obtained, low grade thermal gasolines which are undesirable components of the cracking charge.

It shall be understood that the invention is not to be limited to utilization of the hereinbefore described receptacle-like member 3 and its centrally disposed pipe 3*a*. This member may be omitted if desired. However, as regards the form of the invention herein disclosed and in order to obtain proper distribution of the contact material while moving below the conical member 9, the upper level of contact material in the housing 1 should be continuously maintained to some extent above the lower surface of said conical member 9.

The ring 4, disk 5 and tubular member 6 may be omitted if desired. However, in a preferred form of the invention, these members are utilized, this being desirable by reason of the fact that the tubular member 6 serves as a draw-off passage which assists in maintaining the contact material in desired layer formation as it passes downwardly along said member 7.

While a preferred application of the invention relates to a cracking operation performed on hydrocarbon material as hereinbefore described, it shall be understood that the invention is not to be thus limited. Thus, for example, the contact material C may be substantially inert catalytically such, for example, as fused alumina, heat resistant quartz and quartz pebbles, fused silica and alumina, etc. If so, the hydrocarbon material traversing the conduit 11 and nozzle 10*a* may be at least partly liquid phase crude bottoms, residual or heavy bottoms, topped crudes or other heavy hydrocarbons containing heavy, difficultly vaporizable fractions or components such as tar, asphalt or the like. The inert catalytic material referred to above should have temperature such, for example, as between 800° F. and 1250° F. and, if so, application thereto from the nozzle 10*a* of an atomized mixture formed from difficultly vaporizable hydrocarbon material causes the latter to be vaporized and viscosity-broken with resultant production, if the contact time is sufficiently short, of distillate hydrocarbon material which is principally higher boiling than gasoline.

While the invention has been described with respect to a certain particular preferred example which gives satisfactory results, it will be understood by those skilled in the art, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended, therefore, in the appended claims to cover all such changes and modifications.

I claim:

1. In a process wherein hydrocarbon material undergoes reaction in the presence of contact material, the steps which comprise admitting contact material at reaction temperature to a reaction zone for downward passage therethrough under the influence of gravity, causing at least a substantial part of the contact material, while following a circumferentially complete path, to diverge from the longitudinal axis of said reaction zone, causing the last named contact material, after divergence thereof has ceased, to gravitate toward said longitudinal axis of the reaction zone as a layer of contact material, and injecting an atomized hydrocarbon mixture into said layer of contact material.

2. In apparatus of the character described, a vertical housing defining a reaction zone, a member supported in said housing in spaced relation with respect to the interior surface thereof, means for passing contact material into said housing for subsequent downward passage around said member throughout the entire periphery thereof at any horizontal plane, means comprising an inclined deflecting member having a central passage and supported below said first named member for causing the contact material, after passage thereof below said first named member, to gravitate as a layer of contact material, means for injecting atomized hydrocarbon mixture into said layer of contact material, and a tubular member disposed in passage-forming relation with respect to the passage in said inclined deflecting member, the contact material, after application of the hydrocarbon mixture thereto, passing through said passage and then through said tubular member.

3. In apparatus of the character described, a vertical housing, means for passing contact material into said housing for subsequent downward passage therethrough under the influence of gravity, means for causing the contact material to gravitate toward the vertical axis of said housing as a layer of contact material, said last named means comprising an inclined deflecting member having a central passage, means for injecting an atomized hydrocarbon mixture into said layer of contact material, and a tubular member disposed in passage-forming relation with respect to the passage in said inclined deflecting member, the contact material, after application of the hydrocarbon mixture thereto, passing through said passage and then through said tubular member.

4. In a process for conversion of a charge of high-boiling liquid hydrocarbons in the presence of a compact mass of granular contact material gravitating through an elongated confined zone, the method which comprises passing said contact material downwardly as an annular stream contiguous to the periphery of said confine zone in the upper region thereof, directing the flow of said annular stream of contact material inwardly toward the axis thereof to form a solid confined stream of substantially smaller flow area than the area circumscribed by the lower end of said annular stream, said contact material during transition from annular to solid stream formation having an exposed surface entirely within said compact mass, injecting an atomized stream containing said liquid hydrocarbons into said contact material throughout said exposed surface, and passing said solid confined stream directly onto an expanded compact moving bed of said contact material for passage through the remaining portion of said elongated confined zone.

5. The method of claim 4 characterized in that said contact material during said transition from an annular to a solid confined stream flows as a layer of substantially uniform thickness.

6. The method of claim 5 characterized in that said atomized hydrocarbon mixture is injected into said moving layer in sufficient quantity to effect substantially complete penetration of the same.

HANS G. SHIMP.

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