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APPARATUS FOR TREATING HYDROCARBON OILS

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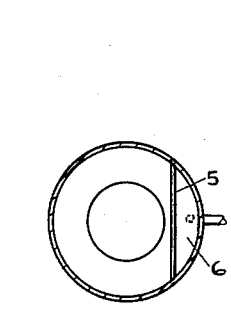


Fig. II

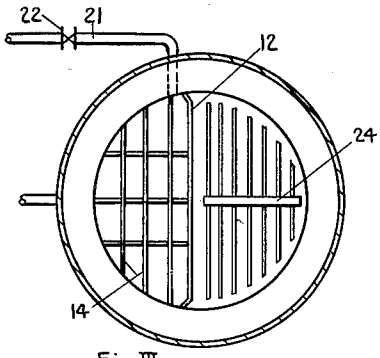


Fig. III

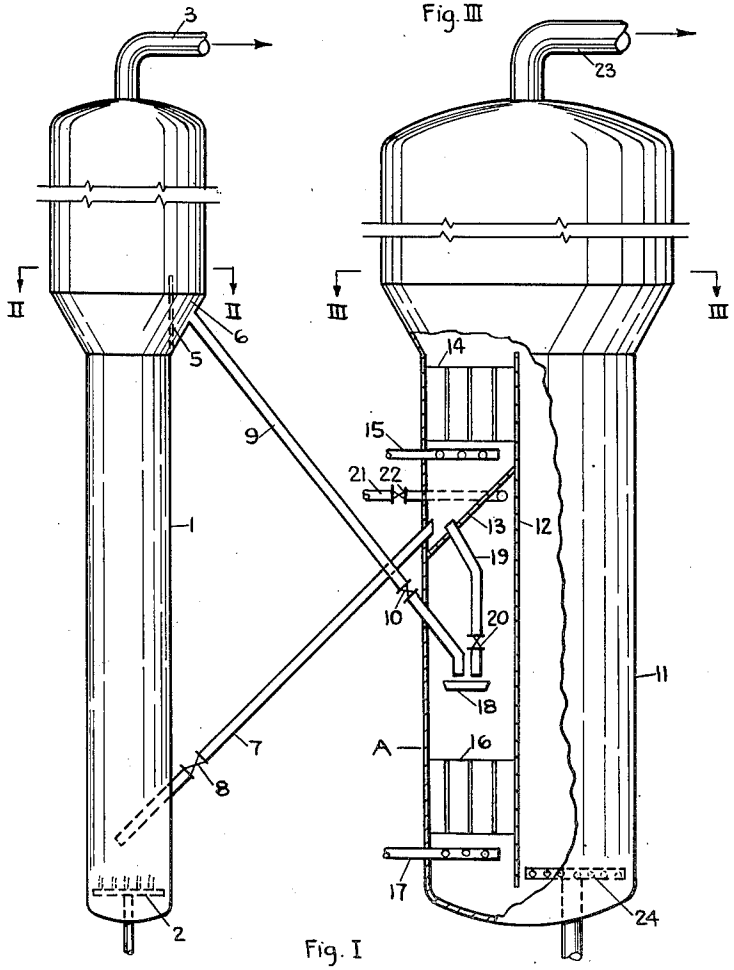


Fig. I

Inventors: Lawson E. Border
Richard P. Trainer

By: C. J. Ott
Their Attorney

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APPARATUS FOR TREATING HYDROCARBON OILS

Richard P. Trainer, Alton, Ill., and Lawson E. Border, Westwood, N. J., assignors to Shell Development Company, Emeryville, Calif., a corporation of Delaware

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2 Claims. (Cl. 23—288)

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In our copending patent applications, Serial No. 124,674, filed October 31, 1949, and Serial No. 146,669, filed February 28, 1950, we have described improved apparatus for the removal of carbonaceous deposits from contaminated finely divided solid contact agents, i. e., regeneration. The apparatuses described in said copending applications are designed to afford more practical, inexpensive and convenient recycle of part of the hot regenerated material into a stripping zone which is located in heat transfer relationship with a burning zone. In the operation of these apparatuses, the stripping takes place while the contact material is in the so-called fluidized or pseudo-liquid dense phase and the static heads in the systems are such that the contaminated solid may be simply flowed into the stripping zone.

As described in copending application, Serial No. 197,958, filed November 28, 1950, the efficiency of the process may be materially improved by controlling the manner of mixing the contaminated powder with the recycled hot powder and the manner of contacting the mixture with the stripping gas. Thus, in the apparatus described in this latter application the contaminated powder and the hot recycled powder are mixed in a mixing pot and the effluent therefrom falls freely for a short distance countercurrent to the uprising stripping gases before entering the pseudo-liquid phase where the main stripping is carried out. While this manner of operation is efficient, it requires a relatively costly separate stripping vessel. Also since both the contaminated powder and the recycled powder must flow into the stripping vessel, this vessel must be placed at a relatively low position and must be operated under a low pressure. This then requires that the effluent powder mixture be pumped back into the burning zone against a positive pressure.

The apparatus of the present invention incorporates the good features and avoids the less desirable features of the apparatuses of the said copending applications and is, consequently, an improvement thereover. In the apparatus of the present invention, the stripping and burning are carried out in contiguous zones in a single vessel. Hot powder from the burning zone is cycled to the stripping zone without any pumping. The stripped powder is transferred to the burning zone without any pumping. At the same time the preferred method of contacting the powder and stripping gas is utilized. In the present apparatus the stripping is carried out under a positive pressure. This requires a special arrangement of the various vessels, lines, etc., when using the apparatus as a part of a fluidized catalyst reaction system, e. g., a catalytic cracking plant. Certain of the more important features of the resulting system are the following:

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No so-called risers are required. Risers are not only costly to build and quite costly to maintain in view of the serious erosion to which they are subjected, but their use requires an expenditure of large amounts of energy. In the system of the invention, both the reactor and the regenerator are at essentially the same level. This level is essentially ground level. This allows a unit of low height. This is not only advantageous from the standpoint of avoiding excessive piping, large heat losses, etc., but results in a system which can be built with considerably less capital expenditure since little supporting steel work is required. In order to obtain the static heads necessary for operation of the apparatus, it is necessary that a long, narrow reaction vessel be applied and that the velocities therein be higher than heretofore considered normal. The high ratio of length to diameter and the high velocity, it is found, each materially increase the efficiency in the reaction vessel. As previously mentioned, the stripping is effected efficiently due first to the manner of contacting the powder with the stripping gas and, second, to the higher temperatures obtained by the indirect heat transfer from the burning zone and the recirculation of hot regenerated powder. In the system to be described, it is also possible to strip the spent powder in a small primary zone immediately following the reactor prior to the main stripping operation. This operation may be performed in the small drawoff well located within the reactor at the upper end of the drawoff pipe. When used in a catalytic cracking plant, this feature, which is optional, allows substantial yields of highly concentrated polynuclear aromatics to be separately recovered from the main stripping zone. In the system to be described, the hot regenerated powder may be flushed of inert combustion gases in a very simple manner by injecting steam into the bottom of the sump provided. This materially reduces the load in the hydrocarbon gas recovery section of the plant by the elimination of these inert gases.

The invention will be described in more detail as applied in the catalytic conversion of a hydrocarbon oil. To aid in the description reference will be had to the drawings in which Figure I is an elevational view partly in section of the major parts of a catalytic cracking plant and

Figures II and III are sectional plan views of the two major vessels taken at the indicated planes II—II and III—III, respectively.

Referring to the drawings, the system comprises a reaction vessel 1. The bottom of this vessel is at essentially ground level. The vessel itself is tall and narrow and should provide a fluidized bed having a minimum ratio of height to diameter of at least 6. A preferred ratio is between about 7 and 13. In a typical case, this vessel is about 7½ feet in diameter in the bottom section and is about 60 feet up to the swage line. It is also important that the vessel be larger near the top for a distance of at least about 15 feet. In the typical case the upper swaged section is about 15 feet in diameter and about 15 feet in length. The high ratio is employed to obtain the high velocity required for the difference in static heads necessary for the operation of the apparatus. The swaging is necessary to provide the lower velocity required for control and to allow settling of suspended catalyst. The approximately 15 feet minimum length of the swaged section is the minimum effective disengaging height with conventional cracking catalyst at a superficial gas velocity of about 1.1 foot per second.

The oil to be converted is injected directly into the catalyst bed at the bottom by means of the distributor 2. After passing through conventional cyclone-type separators (not illustrated), the vapors of the converted oil are withdrawn from the top by outlet line 3.

At the swage line a short partition 5 is arranged to form a draw-off well 6 in the swaged section, as illustrated.

Hot regenerated catalyst is fed directly to the bottom of the reactor by gravity flow through the standpipe 7 provided with control valve 8. Spent catalyst is withdrawn from the draw-off well by gravity through standpipe 9 provided with control valve 10.

The regenerator 11 is positioned at the side of the reactor and the bottom is likewise at substantially grade level. This relationship between the positions of the vessels is necessary to provide the static heads required for the desired flow of the powder. The regeneration vessel, like the reactor, is swaged to a larger diameter at the top for a minimum distance of about 15 feet to reduce the velocity and provide a disengaging space.

The regeneration vessel is provided with a vertical partition 12 which extends as a chord from wall to wall as indicated and divides the horizontal cross-section of the vessel into a smaller stripping section on the left and a larger burning section on the right. The burning section of the regeneration vessel should, like the reactor, have a high ratio of height to effective diameter. Thus, in the case illustrated the cross-sectional area of the burning zone below the swage section is about 180 square feet and the height is about 55 feet. The partition 12 extends from a point near the swage line to a point near the bottom of the vessel but sufficiently short of the bottom to provide a passageway for the flow of fluidized powder from the stripping section under the bottom of the partition into the burning section.

A sealing partition 13 is provided in the upper section of the left hand zone below the swage line and is arranged to divide that zone into an upper stripping zone and a separate lower stripping zone. The upper zone is preferably

provided with vertical baffles 14 which divide the zone into a number of long, narrow passages with open ends. Stripping gas is introduced into the upper zone by a pipe distributor 15. Line 7, previously referred to, connects with the lower part of this upper stripping zone as illustrated.

The lower stripping zone is likewise preferably provided with vertical baffles 16, similar to baffles 14, and is also provided with means 17 for introducing a gaseous stripping medium. Line 9, previously mentioned, passes through the wall of the vessel and is arranged to discharge in the mid-section of the lower stripping zone above the said vertical baffle 16 and below the partition 13. A mixing pan or splash baffle 18 is provided and is located a short distance below the end of line 9. Another line 19 provided with control valve 20 is provided to interconnect the lower and upper stripping zones. This line which passes through the sealed partition 13 is arranged as illustrated to afford the desired controlled flow of fluidized powder from the bottom of the upper zone into the mixing pan 17.

The regeneration vessel is also provided with a discharge line 21 having a back pressure control valve 22. This line is connected as high as possible in the lower stripping zone just below partition 13. The vessel is also provided with a discharge line 23 at the top, and with a suitable distributor 24 for the injection of air at the bottom to the right of partition 12.

When the apparatus is arranged as described and the necessary gas rates are applied, the system operates as follows:

At the high velocities afforded by the narrow reaction zone and burning zone, a low density of fluidized powder is maintained in these zones. This low density, coupled with the considerable height, provides a sufficient difference between the static heads of these beds and of the denser powder in the transfer lines 7, 9 and 19 to cause the desired flow. In a typical case, the pressure in the reaction vessel varies from 23 p. s. i. at the bottom to 13 p. s. i. in the disengaging space. In the regeneration vessel the pressure ranges from 23 p. s. i. at the bottom to 14 p. s. i. in the disengaging space. Under these conditions, there is a 2 p. s. i. pressure drop across the valves 8, 10 and 20, and valve 22 is adjusted to hold a back pressure of 18 p. s. i.

It will be noted that the stripping of the spent catalyst discharged from the reactor by line 9 is effected under a positive controlled back pressure. This back pressure is regulated to maintain the level of pseudo-liquid powder in the lower stripping zone at a point above the baffle 16 and below the mixing pan 18 at about the height indicated a "A." Hot regenerated catalyst overflows the top of the baffle 12 into the upper stripping zone. Part of the catalyst is withdrawn by line 7 and passed to the reactor and a second part, controlled by valve 20, is passed by gravity flow against the positive back pressure into the lower stripping zone where it is mixed with the spent catalyst in the mixing pan 17. The hot mixture then falls freely for a short distance countercurrent to the uprising stripping vapors and is then finally stripped in a fluidized bed in the bottom part of the lower stripping zone. The stripping gas with the stripped products is discharged from the system by line 21 and valve 22.

Valve 20 is an automatically controlled slide valve. In the system illustrated this valve is located within the lower stripping section. If

desired, line 19 may be arranged so that valve 20 is in a more accessible outside location.

We claim:

1. An apparatus for continuously removing combustible deposits from finely divided solids which comprises in combination a vertically disposed cylindrical vessel swaged to a larger diameter near the top and provided with top and bottom closures, a vertical partition dividing the horizontal cross-section of said vessel into a smaller stripping area and a separate larger burning area, said partition extending from a point short of the top and at about the swage line to a point near but short of the bottom closure, a second partition extending from the said first partition to the wall of the vessel and cutting the said smaller stripping area into separate upper and lower stripping zones respectively, vertical baffles in the lower part of each of said upper and lower stripping zones, said vertical baffles dividing the said zones into long narrow passages, a mixing pan in said lower stripping zone above the said vertical baffles therein, a conduit means with control valve arranged to pass a controlled amount of powder from the said upper stripping zone into said mixing pan, a conduit means for withdrawing powder from the lower part of said upper stripping zone, a conduit entering through the wall of the vessel and arranged to introduce contaminated powder into said mixing pan, means for injecting stripping gas at a plurality of points into the lower and upper stripping zones at about the lower levels of the vertical baffles therein, conduit means arranged to withdraw stripping gas from said lower stripping zone below said second partition, valve means for controlling the back pressure in said latter conduit whereby a level of powder in the burning zone may be maintained above the first said baffle while the level of fluidized powder in the lower stripping zone may be maintained below the level of said mixing pan, means for injecting air at a plurality of points over the cross-section of said burning zone near the bottom thereof, and means for withdrawing combustion gases together with stripping gas effluent of said upper stripping zone from a point near the top of the vessel.

2. An apparatus for continuously removing combustible deposits from finely divided non-combustible contact agents which comprises in combination a vertically disposed vessel with top and bottom closures and having a larger horizontal cross-section near the top, an outlet for spent combustion gas at the top, a vertical partition extending from wall to wall dividing the horizontal cross-section of the vessel into a smaller stripping section and a larger burning section, said partition extending throughout the greater part of the height of the vessel and terminating short of the top and bottom closures, a second partition extending from the wall of the vessel to the first said partition, said second partition dividing the said stripping section into an upper stripping section and a separate lower stripping section, a small open-topped mixing vessel centrally located within said lower stripping section, a standpipe provided with flow control valve communicating between said upper stripping section through said second partition to the said mixing vessel in said lower stripping section, a separate conduit means arranged to discharge contaminated contact agent to be treated into said mixing vessel, a conduit means for withdrawing treated contact agent from said upper stripping section, an outlet conduit provided with a back pressure control valve arranged to withdraw treating gases from the lower stripping section just below said second partition and separate means for distributing gases over the cross-sectional area of the said upper and lower stripping sections and said burning section near the bottoms of each.

RICHARD P. TRAINER.
LAWSON E. BORDER.

No references cited.