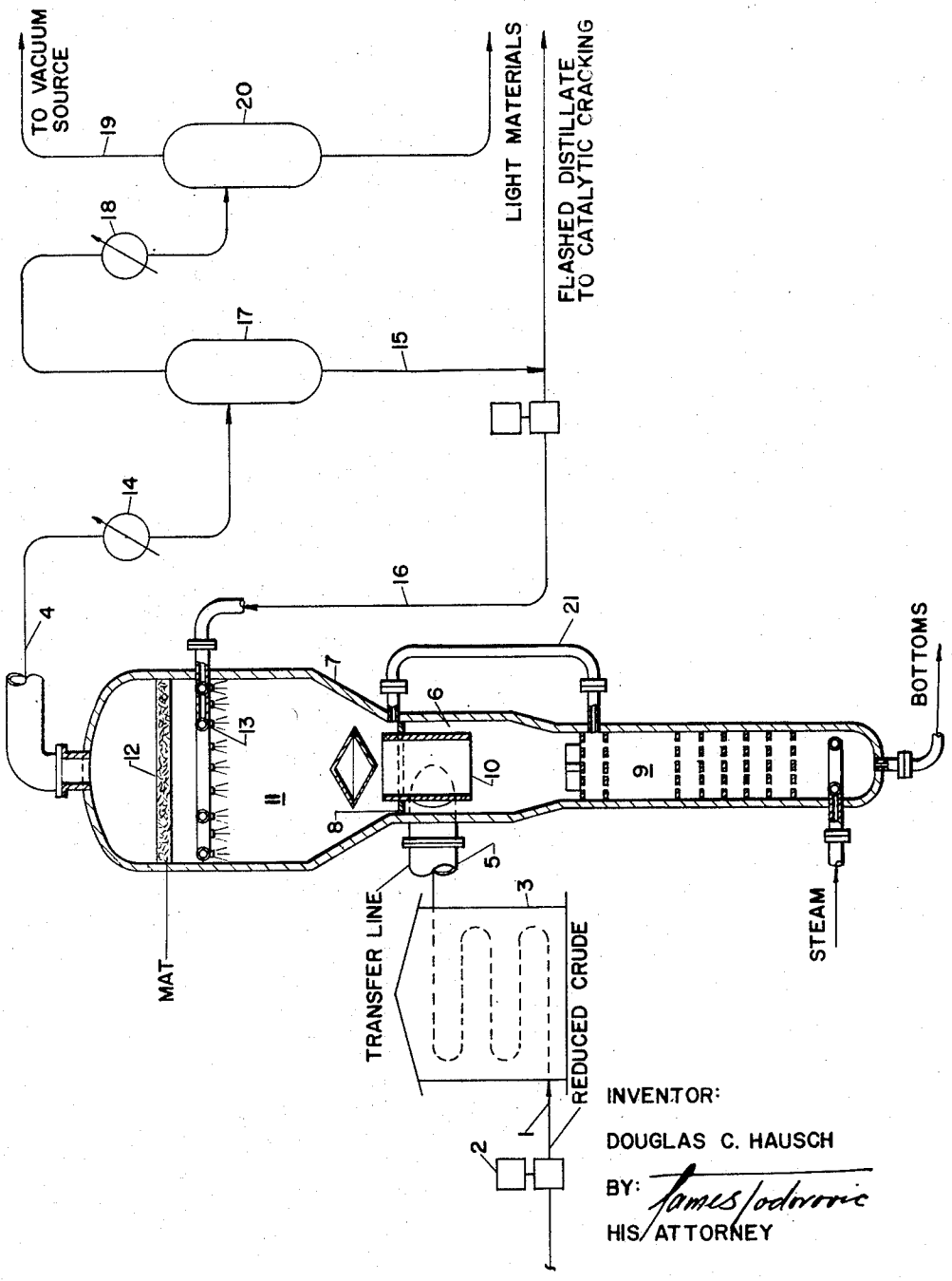
Oct. 15, 1957 D. C. HAUSCH 2,809,923

PRODUCTION OF CATALYTIC CRACKING FEED STOCK FROM PETROLEUM RESIDUES BY VACUUM FLASHING

Filed July 23, 1956



INVENTOR:

DOUGLAS C. HAUSCH

BY: James Todaro

HIS ATTORNEY

United States Patent Office 2,809,923
Patented Oct. 15, 1957

2,809,923

PRODUCTION OF CATALYTIC CRACKING FEED STOCK FROM PETROLEUM RESIDUES BY VACUUM FLASHING

Douglas C. Hausch, Anacortes, Wash., assignor to Shell Development Company, New York, N. Y., a corporation of Delaware

Application July 23, 1956, Serial No. 599,481

2 Claims. (Cl. 196—72)

This invention relates to the separation and recovery of flashed distillate suitable as a feed stock for catalytic cracking from petroleum residues by vacuum flashing.

The object of the invention is to provide an improvement in the vacuum flashing of petroleum residues to prepare feed stock for catalytic cracking whereby the severity of the flashing operation may be increased thereby increasing the yield of catalytic cracking feed stock of suitable quality.

In normal refinery practice crude petroleum is first topped to remove gasoline and if desired other low boiling straight-run materials. The residue remaining is called reduced crude. The main feed stock for catalytic cracking is obtained from this reduced crude and the most common method for separating this catalytic cracking feed stock is by vacuum flashing.

In essence, vacuum flashing is a simple operation. The oil is heated with partial vaporization and the mixture of vapors and unvaporized liquid is passed to a flash tower under vacuum. The resulting vapors are condensed to give a so-called flashed distillate. This operation can be carried out without trouble provided that one is satisfied with a relatively mild or shallow flash. However, difficulties arise when one strives for the deepest possible flash to obtain the maximum quantity of catalytic cracking feed stock. The first of these is due to so-called carry-over of residue with the flashed vapors. It is well known that even quite small amounts of residue entrained in the flashed vapors severely degrade the quality of the flashed distillate as a catalytic cracking feed stock. In commercial operation it is the practice to control the depth of flashing such that the carry-over of residue does not exceed more than about 0.1% by weight of the flashed distillate produced.

In order to curtail the carry-over of residue with the distillate, trays above the flash have been used in some cases. Such trays are, however, found to be only partially effective and furthermore have the disadvantage of offering an appreciable pressure drop which limits the vacuum that may be pulled in the flashing zone.

Also, in some cases a foraminous mist coalescer has been used in place of trays. Such mist coalescers are much more effective than trays. Preferred foraminous mist coalescers take the form of a mat of tangled wire several inches thick such for example, as the so-called York mat manufactured by the Otto H. York Incorporated, West Orange, New Jersey, or the so-called Metex mat manufactured by the Metal Textile Corporation, Roselle, New Jersey. These mats have an open volume upward of 85% and a density between about 3 and 15 pounds per cubic foot depending upon how much they are compressed. Such mats offer a very small pressure drop. They are quite effective when clean but in spite of their large open volume they tend to clog when used in severe deep flashing services.

The material which is coalesced in the foraminous mist coalescer must drop back and the coalescer must of necessity be wet. In order to prevent clogging it has been the practice in some cases in the past to spray a part of the condensed flashed distillate product onto the wire mat from the top. This liquid passing down through the mat washes it of clogging material. This operation has been satisfactorily used in some cases. See for example, the Oil and Gas Journal for November 7, 1955, page 103.

As the severity of flashing is increased, however, this operation becomes impossible due to clogging of the mat even with the largest practical volume of liquid spray. Obviously as the amount of liquid spray is increased a point is soon reached where the yield of product recovered becomes less than would be obtained under milder flashing conditions with no or less spray.

This difficulty is encountered in deep flashing under severe conditions. It is encountered when the petroleum residue is heated in a choked heating coil, i. e. where sonic velocity is reached at or near the exit of the heating zone. It is especially encountered in deep flashing operations when the residue is heated in an open coil, i. e. the velocities are below sonic and when the heated flashing residue is passed through a centrifugal separation zone, i. e. cyclone arrangement, to separate the flashed vapors from the unvaporized liquid residue.

It has been found under these conditions of deep flashing where clogging of the foraminous mist coalescer would be encountered in the usual operation, satisfactory operation may be obtained if, instead of spraying liquid condensate down through the foraminous mist coalescer, it is sprayed downward counter to the rising flashed vapors at a point just below the mist coalescer. In this operation wherein the mist coalescer is not washed with the returned liquid the severity of the flashing operation may be increased beyond that possible according to the previous practice.

Example I

A reduced crude was vacuum flashed under severe conditions to produce catalytic cracking feed stock. The flashing was carried out in a commercial vacuum flashing system in which system a wire mat was employed with the conventional overhead spray. The figure, as will be discussed below, illustrates the same apparatus modified to operate according to the invention.

With a York mat six inches thick the operation was started on the fifth of a month and was satisfactory. However, by the thirteenth of the same month the entrainment had increased and it was necessary to reduce the feed rate, and on the eighteenth of the same month it was necessary to shut the plant down. It was found that the mat was clogged over most of the area with from about 0.9 to 2.2 pounds of deposit per square foot of mat area. The mat was therefore removed and operation continued at a reduced rate while holding the entrainment at a maximum of 0.1%.

Subsequently, a new mat was installed and the sprays were removed from above the mat and placed below the mat as indicated in Figure 1. With this arrangement continuous operation without clogging was achieved under the same severity conditions which caused clogging in the conventional operation. In addition it was found possible to still operate continuously and satisfactorily under increased severity conditions, i. e. the operating pressure was decreased from 140 mm. Hg. to 88 mm. Hg. and the transfer temperature was increased 15° F. This resulted in an increase of over-head yield of flashed distillate of 2.5–3.0% volume while moreover the entrainment rate was about 0.01% weight.

Example II

In another case a commercial vacuum flasher with

spherical flashing chamber housing a centrifugal separation zone and equipped with a six inch wire mat sprayed from above was used to flash a reduced crude petroleum described above. In this case the severity of flashing was somewhat less and operation over a period of about six months was possible although the pressure drop through the mat gradually increased from about ½ inch water to about 7 inches water during that time. This vacuum flasher was also modified according to the invention by removing the sprays from above the mat and placing them so that the spray was downward counter to the rising vapors from a point just below the mat. With this arrangement continuous operation was possible with no measurable increase in the pressure drop.

An attempt has been made to explain the unexpected result. After operating the unit described in Example II in the conventional manner and before modifying the unit as explained, this unit was studied while using only the spray without the mist coalescing mat and while maintaining the carry-over at a maximum of 0.1%. It was found that as the spray was increased from 0 to about 15% of the flasher distillate the allowable feed rate could be increased while still holding the carry-over at the stated maximum value. For example, increasing the spray from 3040 B./D. to 3760 B./D. (about 13% to about 15%) allowed the feed rate to be increased by 1350 B./D. (i. e. from 33,000 to 34,350 B./D.). A further increase in the spray resulted in a loss in the percent by volume of flashed distillate recovered. It is evident from this that the downward rain of spray droplets through the ascending vapors tends to reduce the carry-over of liquid residue. It appears therefore that when operating according to the invention the amount of material coalesced in the mat is reduced. Considering the great difference between the carry-over with and without the mat (0.10% and 0.01%), however, it is evident that the mist coalescer still coalesces a large amount of material and without the spray oil washing the mat it would be expected to clog. A further discovery, however, appears to explain why under the conditions of this invention the clogging is not made worse but less. As previously explained the mist coalescer must be operated wet. This condition would normally be expected due to the mist which is continuously coalesced in the mat and drains therefrom. However, it is found that under deep flashing conditions the rising vapors are not at equilibrium with the liquid but are above their dew point. This is due at least in part to the centrifugal separation. The vapors therefore are capable of vaporizing further amounts of oil. They therefore tend to vaporize liquid in the mat and this leads to the concentration in the mat of viscous relatively non-volatile matter which clogs the mat. When the "wash oil" is injected downward through the rising vapors below the mat instead of above it, the vaporization of part of the spray droplets brings the vapor to its dew point, and thereby reduces or eliminates the distillation, so to speak, of liquid in the mat. The mat therefore remains properly wet and the fluid coalesced material is able to drain from the mat thereby avoiding clogging.

Referring to the figure, reduced crude introduced by line **1** and pump **2** is passed through the open coils of the heating furnace **3** wherein the material is partially vaporized and heated to a transfer temperature of, for example, 800° F. The transfer temperature is preferably the highest temperature to which the residue can be heated without any appreciable cracking, i. e. the incipient cracking temperature. This temperature is generally between about 750 and 820° F. A vacuum is pulled on line **4** by means of steam jets (not shown). The heated and partially vaporized reduced crude is then passed by the transfer line **5** to the centrifugal separator **6** built in the flash tower **7**. Thus, the mixture enters the tower tangentially below the plate **8**. The separated liquid descends to the bottom section **9** where it is lightly stripped with steam. The vapors pass up through the center over-flow pipe **10** into the upper section **11** containing the six inch York mat **12** and the sprays **13**. The liquid is sprayed downward with nozzles giving a solid cone spray pattern and the nozzles are so arranged over the cross section of the tower that the entire cross section of rising vapors is covered by the spray. The pressure in the region above the mat may be from a few mm. Hg up to about 200 mm. Hg and in a typical case is around 80 mm. Hg. Liquid coalesced in the mat and from the spray collects on the plate **8** and is withdrawn by line **21**. In this particular case this liquid is combined with the unvaporized product in the bottom section **9**. It may, however, be recycled to the heater if desired.

The vapors after passing through the mat **12** are withdrawn by line **4** to a condenser **14** wherein the major part of the product is condensed as flashed distillate. The condensate is removed by line **15**. Part of it is passed by line **16** to feed the sprays. The vapors still remaining after passing through the condenser **14** and separator **17** are further cooled by a condenser **18** and are then exhausted by line **19**. The material collected in separator **20** is essentially light gas oil.

The foraminous mist coalescer should have a large free volume and exert a low pressure drop as, for example, is the case in the mats mentioned above. It is, however, not essential that the packing be of metal wire as other materials such as glass wool and the like may be used. The coalescer is placed across the total area of vapor flow and may be of any thickness consistent with a suitably low pressure drop.

The amount of liquid sprayed counter to the ascending vapors will vary depending upon the severity of the flashing conditions and upon the percentage of the residual petroleum which is flashed but in any case should be enough to bring the vapor to its dew point, and usually will be between about 3% and about 15%. Larger amounts can be used in some cases but larger amounts normally result in decreasing the yield of flashed distillate product.

Since the amount of flashed distillate which can be sprayed back into the flashed vapors without a substantial loss in yield of flashed distillate is quite limited and since the improvement according to the invention increases as the amount of spray is increased, the most advantageous results are obtained when all of the flashed distillate which is recontacted with the flashed vapors is introduced by the sprays just below the coalescer as described.

I claim as my invention:

1. In the method for the continuous recovery of catalytic cracking feed stock from petroleum residue which comprises passing petroleum residue through a heating zone the exit of which is maintained under sub-atmospheric pressure, heating the petroleum residue to incipient cracking temperature in said zone whereby the residue is largely but incompletely vaporized, passing the mixture of vapors and unvaporized liquid residue at sub-atmospheric pressure into a centrifugal separation zone wherein the vapors are separated from the unvaporized liquid residue, passing the vapors upward from the center of said centrifugal separation zone and through a foraminous mist coalescing zone, condensing the vapors after passing through said foraminous mist coalescing zone and spraying a portion of the resulting condensate in a downward direction through the rising vapors the improvement in which said condensate is sprayed at a point just below said formanious mist coalescing zone.

2. In the recovery of catalytic cracking feed stock from petroleum residue by vacuum flashing comprising the steps of heating petroleum residue to incipient cracking temperature with partial vaporization under vacuum, centrifugally separating the vapors from the unvaporized residue in a centrifugal separation zone, passing the sepa-

rated vapors through a foraminous mist coalescing zone and then condensing them, and spraying part of the condensate back into said vapors, the improvement which comprises spraying said part of condensate in a downward direction counter to the vapors at a point just below said foraminous mist coalescing zone rather than above said foraminous mist coalescing zone.

References Cited in the file of this patent

UNITED STATES PATENTS

1,962,153 Peterkin ..... June 12, 1934