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Description

The invention relates to a process for separating a multi-component liquid, in particular reduced crude into a plurality of fractions. More specifically the present invention relates to the separation of reduced crude with the objective to maximize the production of valuable distillate fractions and to minimize the production of less valuable residue fraction.

In normal refinery practice crude oil is first topped to remove gasoline therefrom and optionally other low boiling straight run materials. The residue remaining as bottom product is called reduced crude. Topping of the crude oil is normally carried out in multiple stage fractional distillation columns yielding a top-product and a number of side draw product streams. In such a column the crude oil is flashed in a lower flash zone in the column, whereafter the flashed vapours are fractionated in the upper part of the column. From the reduced crude forming the bottom product from such a fractional distillation column, the main feedstock for catalytic cracking is obtained.

The most common method for separating this catalytic cracking feedstock from reduced crude is by vacuum flashing.

Vacuum flashing is a process comprising heating the reduced crude resulting in partial vaporization of the crude to provide a mixture of a liquid phase and a vapour phase, passing the mixture into a lower part of a first column while maintaining a sub-atmospheric pressure within the first column using a steam ejector system, components of the mixture being separated to yield at least one distillate fraction and a bottoms fraction, and withdrawing said fractions from the column. Such a process is disclosed in US—A—3 301 778.

Due to the important demand for lighter hydrocarbons it is often highly desirable to increase the amount of distillate fractions produced in the flash tower from a given reduced crude feed. This requires flashing off more of the heavier distillate fraction in the feed, resulting in less bottom product. The extent to which more of the heavier distillate fraction can be flashed off is among other things dependent on the degree of reduced pressure in the flash zone of the flash tower. The degree of reduced pressure which can be obtained in the flash zone of the flash tower depends in its turn on the applied steam ejector system and the pressure drop over the internals in the flash tower.

An object of the present invention is to improve the above-mentioned known process for separating a multi-component liquid, in order to increase the production of distillate fractions from a given feed whilst consuming less energy compared to the known processes.

To this end the process for separating a multi-component liquid according to the invention is characterized in that it further comprises passing the bottoms fraction to a second column while maintaining a pressure within the second column which is higher than the pressure in the first column, and contacting the bottoms fraction with steam in the second column to obtain at least one heavy-distillate fraction and a residual fraction, wherein driving steam of said steam ejector system is used in the second column for contacting the bottoms fraction.

In the above described process according to the invention the bottoms fraction from the first column, the flash tower, is stripped with steam in a separate column. Owing to the absence of steam injection in the first column, the pressure in the first column can be maintained at a lower level compared to the pressure, prevailing in systems where flashing and steam stripping are carried out in one column. A lower pressure results in an increased yield of distillate. By using the driving steam of the steam ejector system of the flash tower for stripping the bottoms fraction in the second column, the total amount of required steam can be kept relatively low, allowing a reduction of the costs of the process.

The invention will now be described by way of example only, with reference to the accompanying drawing showing a schematic representation of a suitable system for carrying out the process according to the invention.

Reduced crude introduced via line 1 is passed through a plurality of preheaters 2 and a heating furnace 3 where the material is partially vaporized and heated to a transfer temperature of, for example, 425°C. 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. Depending on the composition of the reduced crude this temperature is normally in the range between 400 and 440°C.

The heated and partially vaporized reduced crude is subsequently passed via a transfer line 4 to a first column 5, hereinafter called flash tower. The pressure in the flash tower 5 is maintained at a sub-atmospheric level by a steam ejector system 6, communicating with the flash tower 5 via a line 7. A suitable pressure in the flash zone of the flash tower 5 may be in the order of magnitude of about 2.67 kPa (20 mm Hg absolute). Once arrived in the flash tower 5 the heated and partially vaporized reduced crude is forced to flow through a vane type inlet device with a plurality of downwardly inclined vanes 8, which vanes cause a separation of liquid and vapour. The separated liquid descends to the bottom part 9 and is withdrawn from the flash tower 5 by pump 10 through withdrawal line 11. The separated vapour flows upwardly into the upper section of the flash tower in which a demister mat 12 and a plurality of spray sections 13 are arranged one above the other.

Each spray section 13 is composed of a plurality of liquid spray nozzles 14 and a draw-off tray 15, and optionally a layer of packing material arranged between the spray nozzles 14 and the accompanying draw-off tray 15, for intensifying the contact between liquid and rising vapour. The draw-off trays 15 are each provided with openings for the passage of rising vapour and a lower part for collecting descending liquid. The draw-off trays may for example be formed by grid trays or bubble cap trays. The rising vapour after being separated from the liquid upon flowing along the vanes 8, first encounters sprays of liquid from the nozzles 14 of the lowermost spray section 13. Upon contact with the sprays of liquid, liquid remained in the rising vapour is removed therefrom and entrained by the liquid sprays. The nozzles 14 of the lowermost spray section 13 are supplied with liquid from the draw-off tray of the next upper spray section. Thereto the liquid from the next upper spray section is passed through an accumulator 16 and is partially recirculated via pump 17 and a return line 18 to the lower most spray nozzles 14. Upon passing through the demister mat 12 arranged above the lowermost spray section 13, any entrained liquid is separated from the vapour so that substantially liquid-free vapour enters the upper region of the flash tower 5.

The vapour passing upward through the flash tower 5 is gradually condensed in multiple boiling fractions by contact with relatively cool liquid. Thereto, liquid is discharged at several levels from the upper part of the flash tower 5, passed through coolers 19 for cooling and reintroduced into the flash tower 5 via the nozzles 14. The upward flow of vapour is contacted with the relatively cool liquid, so that the vapour cools down and is partly condensed.

It has been found that the required heat transfer between the upward vapour flow and the liquid droplets introduced via the spray nozzles 14 of a spray section 13 takes place within a distance of about 1m. This means that a spray section height of about 1m will be sufficient for the desired heat transfer between vapour and liquid. Up to now it is normal practice to use spray sections having a height far exceeding 1m. Reduction of the spray section height has the advantage that at a given tower height more spray sections can be installed, and therefore a greater variety of side draw product streams can be obtained.

The flash tower 5 shown in the drawing is provided with 4 product side withdrawal lines 20. The higher the side withdrawal lines 20 are arranged in the flash tower 5, the lower the boiling points of the withdrawn product streams are. The remaining vapour if any is withdrawn over the top of the flash tower 5 via line 7 by the action of the steam ejector system 6. The driving steam from the steam ejector system 6 is directly passed together with vapour, if any, from the flash tower 5 via line 21 into a second column 22, hereinafter called stripping tower, which is maintained at a higher sub-atmospheric pressure than the pressure in the flash tower 5.

In the stripping tower 22 the driving steam is used for stripping the bottoms fraction from the flash tower supplied into said stripping tower 22 via line 11. Prior to introducing the bottoms fraction into the stripping tower 22, the bottoms fraction is heated in a furnace 23 to bring the bottoms fraction temperature at or near its initial boiling point at the pressure prevailing in the stripping tower 22. The downward flowing bottoms fraction introduced into an upper region of the stripping tower 22 is contacted with the upward flowing steam introduced into a lower region of the stripping tower 22. To guarantee an intimate contact between steam and bottoms fraction, the stripping tower 22 is provided with a plurality of contact trays 24, causing a redistribution of the liquid and steam over the cross section of the stripping tower. The contact trays may for example be formed by grid trays, sieve trays or bubble cap trays.

For controlling the temperature in the bottom-part of the tower, the stripping tower 22 is suitably provided with a quench system 25 containing heat exchange means, for cooling a part of the residual fraction and reintroducing said cooled liquid into the lower part of the column at a level higher than the level of withdrawal.

The upper part of the stripping tower 22 is provided with a spray section 26 for reintroducing withdrawn cooled liquid into the stripping tower 22 for liquefying the vapour in the top of the column to prevent entrainment of vapour by the steam leaving the stripping tower 22 via line 27 over the top thereof.

The stripping tower 22 as shown in the drawing is further provided with two product withdrawal lines 28 and 29 for withdrawing a residual fraction and a heavy-distillate fraction, respectively.

The steam passed over the top of the stripping tower 22 is introduced into a plurality of condensers 30, one of which is shown in the drawing, for condensing the steam at substantially atmospheric pressure.

The heat obtained from the products withdrawn from the flash tower 5 and the stripping tower 22 may be applied for preheating the reduced crude to be introduced into the flash tower 5.

Since the steam from the steam ejector system 6 is at a substantially higher pressure than the pressure in the flash tower 5, the pressure in the stripping tower 22 will also be substantially higher than the flash tower pressure. To obtain the highest possible amount of more valuable heavy distillate fraction and the least possible amount of less valuable residual fraction, the pressure in the stripping tower 22 should however be kept at a low sub-atmospheric pressure. The minimum pressure in the stripping tower 22 is determined by the minimum condensation pressure of the steam leaving the stripping tower 22.

By applying a so-called dry fractionating system — i.e. a system without steam injection — in the flash tower, as shown in the drawing, the pressure in the flash tower can be considerably reduced compared with wet fractionating systems wherein steam is introduced into the flash tower. A lower pressure means in general a higher output of valuable products and less bottom product.

The present invention is not restricted to a process wherein the initial separation between liquid and vapour in the flash tower 5 is obtained by causing the reduced crude to flow along a plurality of vanes 8. Instead thereof, the reduced crude may for example be passed through a centrifugal separator positioned in the flash tower 5. Further the invention is not restricted to the particular arrangement of spray sections, packing material and demister mat as shown in the drawing. The packing material and demister mat can for example be suitably replaced by further spray sections. The number of spray sections is chosen in relation to the number of side products which should be yielded at processing reduced crude with a given composition.

Claims

1. Process for separating a multi-component liquid, comprising heating the multi-component liquid to provide a mixture of a liquid phase and a vapour phase, passing the mixture into a lower part of a first column while maintaining a sub-atmospheric pressure within the first column using a steam ejector system, components of the mixture being separated to yield at least one distillate fraction and a bottoms fraction, and withdrawing said fractions from the column, characterized in that the process further comprises passing the bottoms fraction to a second column while maintaining a pressure within the second column which is higher than the pressure in the first column, and contacting the bottoms fraction with steam in the second column to obtain at least one heavy-distillate fraction and a residual fraction, wherein driving steam of the steam ejector system is used in the second column for contacting the bottoms fraction.

2. Process as claimed in claim 1, wherein the steam from the steam ejector systems is passed into a lower region of the second column and the bottoms fraction is passed into an upper region of the second column to cause countercurrent flows of steam and bottoms fraction.

3. Process as claimed in claim 1 or 2, wherein the pressure in the second column is maintained at a sub-atmospheric level.

4. Process as claimed in any one of the claims 1—3, wherein part of the residual fraction from the second column is after cooling reintroduced into said column at a higher level than the level of withdrawal.

5. Process as claimed in any one of the claims 1—4, wherein the bottoms fraction is heated prior to passing this fraction into the second column.

6. Process as claimed in claim 5, wherein the bottoms fraction is heated prior to passing this fraction into the second column to a temperature at or near its initial boiling point.

7. Process as claimed in any one of the claims 1—6, wherein cooled liquid is introduced into the second column for separating formed vapour from the steam, prior to withdrawing the steam from said second column.

Patentansprüche

1. Verfahren zur Auftrennung einer Mehrkomponenten-Flüssigkeit, umfassend das Erhitzen der Mehrkomponenten-Füssigkeit zur Erzeugung einer Mischung aus einer flüssigen Phase und einer dampfförmigen Phase, Einleiten der Mischung in einen unteren Teil einer ersten Kolonne, wobei in der ersten Kolonne ein unteratmosphärischer Druck unter Verwendung eines Dampfejektorsystems aufrechterhalten wird, dadurch Komponenten der Mischung abgetrennt werden unter Bildung mindestens einer Destillatfraktion und einer Bodenfraktion, und das Abziehen besagter Fraktionen aus der Kolonne, dadurch gekennzeichnet, daß das Verfahren weiterhin das Weiterleiten der Bodenfraktion zu einer zweiten Kolonne unter Aufrechterhaltung eines Druckes innerhalb der zweiten Kolonne, welcher höher ist als der Druck der ersten Kolonne, und das Kontaktieren der Bodenfraktion mit Dampf in der zweiten Kolonne zur Erhaltung mindestens einer Schwerdestillatfraktion und einer Rückstandsfraktion umfaßt, wobei der Antriebsdampf des Dampfejektorsystems dazu verwendet wird, um in der zweiten Kolonne die Bodenfraktion damit zu kontaktieren.

2. Ein Verfahren, wie in Anspruch 1 beansprucht, in welchem der Dampf aus dem Dampfejektorsystem in einen niedriger gelegenen Abschnitt der zweiten Kolonne und die Bodenfraktion in einen höher gelegenen Abschnitt der zweiten Kolonne eingespeist wird, um dadurch in entgegengesetzter Richtung verlaufende Ströme von Dampf und Bodenfraktion zu erzeugen.

3. Ein Verfahren, wie in Anspruch 1 oder 2 beansprucht, in welchem der Druck in der zweiten Kolonne auf einem unteratmosphärischen Wert gehalten wird.

4. Verfahren, wie in irgendeinem der Ansprüche 1 bis 3 beansprucht, in welchem ein Teil der Rückstandsfraktion der zweiten Kolonne nach Abkühlen in besagte Kolonne an einem höher gelegenen Abschnitt wieder eingeführt wird als dem Abschnitt entspricht, von dem sie abgezogen wurde.

5. Verfahren, wie in irgendeinem der Ansprüche 1 bis 4 beansprucht, in welchem die Bodenfraktion vor Einspeisen dieser Fraktion in die zweite Kolonne erhitzt wird.

6. Verfahren, wie in Anspruch 5 beansprucht, in welchem die Bodenfraktion vor Einleiten in die zweite Kolonne bis auf eine Temperatur erhitzt wird, welche bei oder nahe bei ihrem Anfangssiedepunkt liegt.

7. Ein Verfahren, wie in irgendeinem der Ansprüche 1 bis 6 beansprucht, in welchem abgekühlte Flüssigkeit in die zweite Kolonne eingeführt wird, um darin eventuell gebildete Dämpfe von dem Wasserdampf abzutrennen, bevor dieser aus der zweiten Kolonne abgezogen wird.

Revendications

1. Procédé pour la séparation d'un liquide à plusieurs composants, comprenant le chauffage

du liquide à plusieurs composants de façon qu'on obtienne un mélange d'une phase liquide et d'une phase vapeur, le passage du mélange dans une partie inférieure d'une première colonne tandis qu'on maintient dans la première colonne une pression inférieure à la pression atmosphérique en utilisant un système d'éjecteur à vapeur d'eau, les composants du mélange étant séparés pour donner au moins une fraction de distillat et une fraction de queue et l'évacuation de ces fractions de la colonne, caractérisé en ce que le procédé comprend en outre le passage de la fraction de queue à une seconde colonne tandis qu'on maintient dans la seconde colonne une pression supérieure à la pression régnant dans la première colonne, et la mise en contact de la fraction de queue avec de la vapeur d'eau dans la seconde colonne de façon qu'on obtienne au moins une fraction de distillat lourd et une fraction résiduelle, où la vapeur d'eau d'entraînement du système d'éjecteur à vapeur d'eau est utilisée dans la seconde colonne pour mise en contact avec la fraction de queue.

2. Procédé selon la revendication 1, dans lequel la vapeur d'eau provenant du système d'éjecteur à vapeur d'eau est passée dans une région inférieure de la seconde colonne et la fraction de queue est passée dans une région supérieure de la seconde colonne de manière à causer des écoulements à contre-courant de la vapeur d'eau et de la fraction de queue.

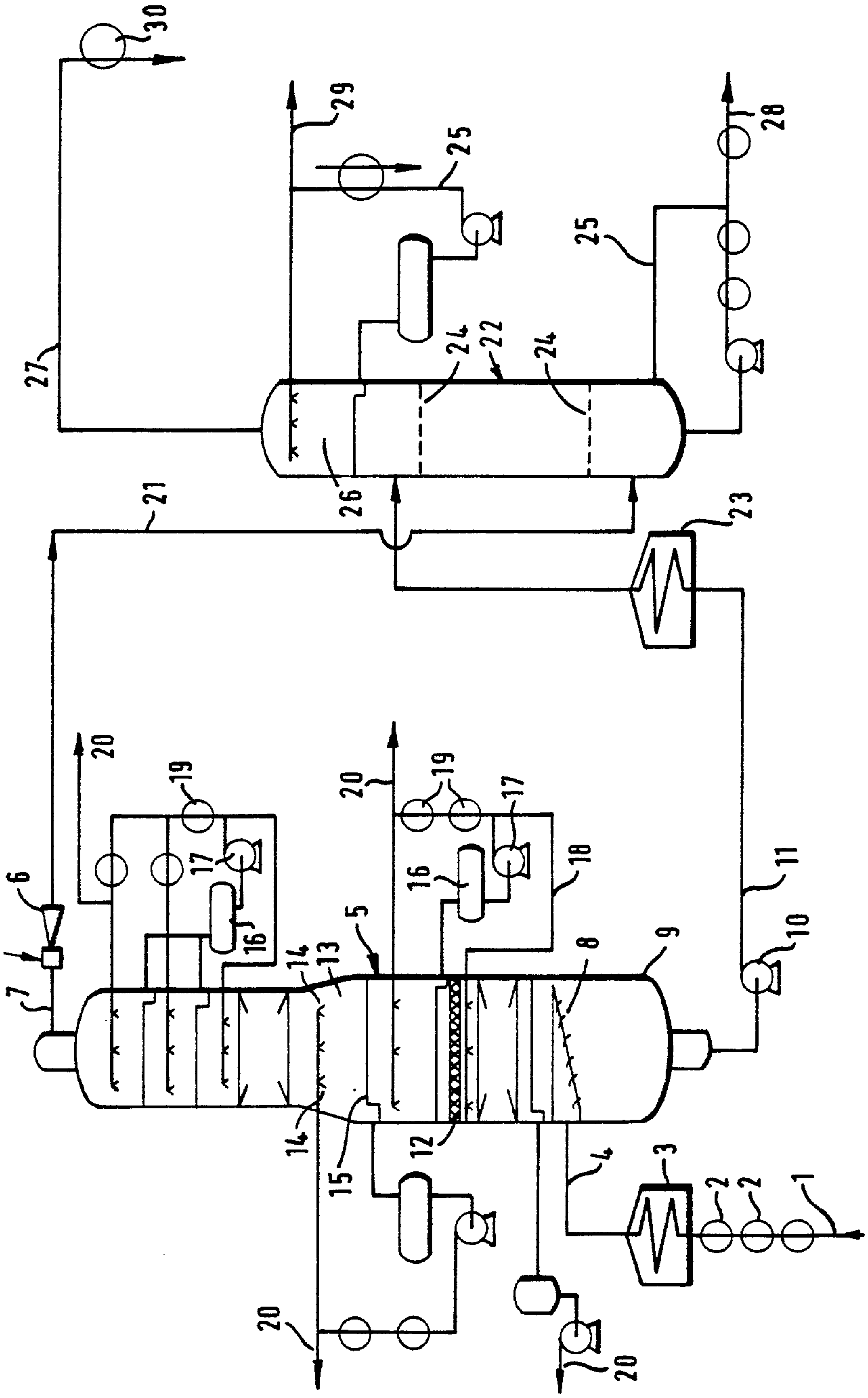
3. Procédé selon la revendication 1 ou 2, dans lequel la pression dans la seconde colonne est maintenue au-dessous de la pression atmosphérique.

4. Procédé selon l'une quelconque des revendications 1—3, dans lequel une partie de la fraction résiduelle provenant de la seconde colonne est après refroidissement réintroduite dans ladite colonne à un niveau plus élevé que le niveau de soutirage.

5. Procédé selon l'une quelconque des revendications 1—4, dans lequel la fraction de queue est chauffée avant le passage de cette fraction dans la seconde colonne.

6. Procédé selon la revendication 5, dans lequel la fraction de queue est chauffée avant le passage de cette fraction dans la seconde colonne à une température égale à son point initial d'ébullition ou proche de ce point.

7. Procédé selon l'une quelconque des revendications 1—6, dans lequel du liquide refroidi est introduit dans la seconde colonne pour séparer la vapeur formée de la vapeur d'eau, avant l'évacuation de la vapeur d'eau de la seconde colonne.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