

ADSORPTION/DISTILLATION IN A SINGLE COLUMN DESIGN

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This Application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional
5 Patent Application No. 61/931,440 filed January 24, 2014 which is incorporated herein by
reference in its entirety as if fully set forth herein.

FIELD OF THE INVENTION

[0002] Partial condensers are used in distillation columns when the distillate product is
removed as a vapor stream. This approach is commonly employed when there are very light,
10 i.e., volatile components in the feed to the column that would require a high column pressure
and a low condenser temperature to completely condense these very volatile components.
The use of a partial condenser can avoid the use of costly refrigeration in the condenser.
Many distillation schemes with partial condensers have both liquid and vapor products. In
such cases there is considerable spillover of heavier components in the vapor product and
15 vice versa. It is not possible to maintain a sharp split between liquid and vapor products in
conventional partial condensation schemes. This drawback can be overcome by use of a top
dividing wall column, which uses both absorption and distillation techniques on either side of
dividing wall to provide a sharp split between vapor and liquid components.

BACKGROUND OF THE INVENTION

20 [0003] There are several distillation schemes in aromatics complex that use partial condenser
for separation of lighter components. Typical examples of such columns include a C₅
stabilizer or a deheptanizer column.

[0004] FIG. 1 represents the prior art system of a conventional C₅ stabilizer. This
conventional stabilizer aims at separating C₁-C₄ components as an overhead vapor product,
25 C₅ as an overhead liquid product and C₆₊ components as the bottoms product of the column.
The column operates at 8.5 kg/cm²g with an overhead temperature of 40°C.

[0005] However, the prior art system possesses several disadvantages. It is not possible to
condense the lighter components in the overhead product at 8.5kg/cm²g and use cooling
water as the overhead cooling media. The overhead system has a partial condenser. Lighter

components (used as offgas) are drawn as the vapor product from the partial condenser. C₅ product is the liquid stream from the partial condenser. A considerable amount of C₅ components are lost to the offgas vapor stream. The loss of C₅ components can be prevented by decreasing the overhead temperature (e.g., by using refrigeration) or increasing the column pressure. However, this increases the operating cost of the column. The prior art systems provides a loose split between C₁ to C₄ in vapor and C₅ in liquid product, the recoveries of these components is also low as they are lost in the off gas vapor stream.

[0006] FIG. 2 represents the prior art system of a conventional dehepatnizer column. This conventional dehepatnizer aims at separating lighter components (C₁ to C₅) as an overhead vapor product, C₇ as an overhead liquid product and C₈₊ components as the bottoms product of the column. The column operates at 5.0 kg/cm²g with an overhead temperature of 40°C.

SUMMARY OF THE INVENTION

[0007] An embodiment of the invention is directed to a process wherein two different unit operations (absorption and distillation) take place on either side of a top dividing wall column. One side of the dividing wall column uses absorption to separate non-condensable components from the feed; the other side of the dividing wall uses distillation to separate heavier liquid components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 represents a conventional C₅ stabilizer in accordance with the prior art;

[0009] FIG. 2 represents a conventional dehepatnizer column in accordance with the prior art;

[00010] FIG. 3 represents a process scheme in accordance with an embodiment of the invention for a stabilizer design; and

[00011] FIG. 4 represents process scheme in accordance with an embodiment of the invention for a deheptanizer design.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[00012] An embodiment of the invention is directed to a process wherein two different unit operations (absorption and distillation) take place on either side of a top dividing wall column.

[00013] In an embodiment of the invention shown in FIG. 3, the process scheme of the claimed invention is designed to separate light components (non condensable), C₅ (Top liquid product), and C₆₊ (Heavies) in a single top divided column. The feed stream is first sent to the pre-fractionation side of the top divided column. The vertical dividing wall splits the top portion of the column into two halves. The feed side of the wall is called the pre-fractionation section. The non-condensables (used as off gas) is removed as overhead vapor product from a vent condenser. In certain embodiments of the invention, the column overhead pressure is set at 2.7 kg/cm²g via a pressure controller on the overhead vapor product line. The section above the feed acts as an absorption section that is primarily used to minimize the loss of heavier components. The pre-fractionation side has reflux coming from two sources: A liquid stream condensed from a vent condenser; and a heavy stream from a bottoms pump.

[00014] In an embodiment of the invention, the vapor from the overhead of the main section is condensed and cooled to 40°C in air-cooled exchanger followed by the water-cooled condenser. The condenser outlet is collected in an overhead receiver. The C₅ liquid is pumped out of the drum via reflux pumps. A portion of the light liquid is sent back to the column as reflux and the remainder is withdrawn as C₅ product.

[00015] In an embodiment of the invention, the temperature in top section of the main column is controlled in cascade with the reflux flow control loop. This allows control over the quality of the C₅ product by suppressing the tendency of the heavier components from going to the top of the column.

[00016] In an embodiment of the invention, the reboiler connected to the main section is a thermosyphon steam reboiler that uses steam as heating medium. The heat input to the reboiler is regulated by controlling the steam flow cascaded to the column bottom tray temperature controller.

[00017] The C₅ bottom product is controlled by a level control loop in cascade with the bottom product flow rate.

[00018] Table 1 presents a comparison of operational parameters between the conventional stabilizer design and the TDWC stabilizer design of the claimed invention.

Table 1

Operational Parameters	Units	Conventional Design	Stabilizer design of the invention
C ₅ in product	Kg/hr	367	659
Operating Pressure	Kg/cm ² g	8.3	2.7
RVP	Psia	107	27
Overhead temperature	°C	40	40
Duty	MMkcal/hr	4.7	4.7 (integrated with HAC Overhead)
C ₅ recovery	Wt%	52.3%	96.8%
C ₅ purity	Wt%	59.1%	90.4%
Benzene in C ₅ product	Wt%	0.1%	0.1%
Bottoms temperature	°C	229	183

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[00019] FIG. 4 represents a process scheme in accordance with an embodiment of the invention for a deheptanizer design. The column pressure is reduced to 1.8 kg/cm²g. GT-Low pressure deheptanizer reduces the energy consumption by 19%.

[00020] Table 2 presents a comparison between the conventional deheptanizer design and the TDWC stabilizer design of the claimed invention.

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Table 2

Operational Parameters	Units	Conventional Design	Stabilizer design of the invention
Operating Pressure	Kg/cm ² g	5	1.8
Overhead temperature	°C	40	40
Duty	Mmkcal/hr	23.3	18.9
Bottoms temperature	°C	227	193

[00021] Overall aspects of the invention relate to methods for increasing the energy efficiency or better product purities in a distillation process using a top divided column.

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Those having skill in the art, with the knowledge gained from the present disclosure, will recognize that various changes could be made to the methods disclosed herein without departing from the scope of the present invention. Mechanisms used to explain theoretical or observed phenomena or results, shall be interpreted as illustrative only and not limiting in any way the scope of the appended claims.

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CLAIMS

1. A distillation column comprising:

a column comprises a top section and a bottom section, wherein the top section has a vertical dividing wall that divides the top section into a first section and a second section, wherein the first section comprises an absorption unit, and the second section comprises a distillation unit, wherein top section of the column is configured to be operating at a pressure of $1.8 \text{ kg/cm}^2 \text{ g}$ or of $2.7 \text{ kg/cm}^2 \text{ g}$ and at a temperature of 40°C ;

a partial condenser in fluid communication the absorption unit of the first section;

a total condenser in fluid communication with the distillation unit of the second section;

an overhead receiver in fluid communication with the total condenser;

wherein the first section is a feed side that is configured to receive a feed stream and to separate the feed stream into light, non-condensable components and heavier components, wherein light, non-condensable components are removed from the column through the partial condenser as an overhead vapor product;

wherein the second section is configured to recover condensable components from the heavier components resulted from a pre-fractionation side of the first section through the total condenser;

wherein the bottom section is configured to recover heavy components from the feed stream.

2. The distillation column of claim 1, wherein the column is adapted for use as a stabilizer that removes non-condensables lighter components, $\text{C}_1\text{-C}_4$, from mix aromatics feed, when the top section of the column is configured to be operating at a pressure of $2.7 \text{ kg/cm}^2\text{g}$, and at a temperature of 40°C .

3. The distillation column of claim 1, wherein the column is adapted for use as a deheptanizer that removes non-condensable lighter components, $\text{C}_1\text{-C}_6$, from mix aromatics feed, when the top section of the column is configured to be operating at a pressure of $1.8 \text{ kg/cm}^2\text{g}$, and at a temperature of 40°C .

4 The distillation column of claim 1, wherein the distillation unit of the second section generates a bottom product that is sent back to the first section as an absorption medium for removal of lighter non-condensable components.

5. The distillation column of claim 1, wherein the reflux of the bottom product reduces loss of C_5/C_6 to vapor.