condenser to receive the top mixture having been cooled from the condenser, the flash drum configured for operating at a temperature of -19 ºC to 70 ºC and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the top portion of the flash drum is configured to remove the light component(s) of the top mixture and wherein the bottom portion of the flash drum is configured to remove the medium component(s) of the top mixture, with the proviso that for the separations system there is no distillation column disposed between the source of the multi-component condensate mixture and the flash drum.

[0009a] In one aspect, there is provided a separations system for separating ethylene, 2-methylbutane and at least one unsubstituted C_6-C_{12} hydrocarbon in a multi-component condensate mixture having 2-methylbutane, ethylene, fines and at least one unsubstituted C_6-C_{12} hydrocarbon, the separations system comprising: a feed conduit in fluid communication with a source of the multi-component condensate mixture; a stripper column in fluid communication with the feed conduit, the stripper column having a top portion, a bottom portion distal from the top portion and three to ten theoretical stages, the stripper column configured to receive through the feed conduit the multi-component condensate mixture at a temperature in a range of -13 degrees Celsius (ºC) to -5 ºC and a pressure of 340 kilopascals gauge (kPag) to 420 kPag, wherein the stripper column is further configured for operating at an internal pressure of 200 kPa to 1500 kPa to separate the multi-component condensate mixture into: a heavies component mixture with the at least one unsubstituted C_6-C_{12} hydrocarbon, and a top mixture having a medium component(s) and a light component(s), wherein the medium component(s) include at least the 2-methylbutane and the light component(s) include at least the ethylene, wherein the top portion of the stripper column is configured to remove the top mixture and the bottom portion of the stripper column is configured to remove the heavies component mixture; a reboiler in fluid communication with the stripper column, the reboiler configured for operating at a temperature of 50 ºC to 200 ºC; a condenser in fluid communication with the top portion of the stripper column, wherein the condenser is configured to cool the top mixture coming from the top portion of the stripper column to a temperature of -19 ºC to 42 ºC; and a flash drum having a top portion and a bottom portion distal from the top portion, wherein the flash drum is in fluid communication with the

condenser to receive the top mixture having been cooled from the condenser, the flash drum configured for operating at a temperature of 15 °C to 70 °C and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the top portion of the flash drum is configured to remove the light component(s) of the top mixture and wherein the bottom portion of the flash drum is configured to remove the medium component(s) of the top mixture, with the proviso that there is no distillation column disposed between the source of the multi-component condensate mixture and the flash drum.

[0010] In another aspect, the present disclosure also includes a gas phase polymerization system that includes a gas phase polymerization reactor; a product purge bin in sequential fluid communication with the gas phase polymerization reactor; and the separations system as described herein in sequential fluid communication with the product purge bin and the gas phase polymerization reactor, wherein the light component(s) containing at least the ethylene from the top portion of the flash drum are returned to the gas phase polymerization reactor.

[0011] The present disclosure also includes a method of separating ethylene, 2-methylbutane and at least one unsubstituted (C_6-C_{12}) hydrocarbon in a multi-component condensate mixture having 2-methylbutane, ethylene, fines and at least one unsubstituted (C_6-C_{12}) hydrocarbon, where the method includes feeding the multi-component condensate mixture at a temperature in a range of -13 degrees Celsius (°C) to -5 °C and a pressure of 340 kilopascals (kPag) to 420 kPag into a stripper column having a top portion, a bottom portion distal from the top portion and three to ten theoretical stages, the stripper column operating at an internal pressure of 200 kPa to 1500 kPa; separating the multi-component condensate mixture with the stripper column into a heavies component mixture with the at least one unsubstituted (C_6-C_{12}) hydrocarbon, and a top mixture a having medium component(s) and a light component(s), wherein the medium component(s) include at least the 2-methylbutane and the light component(s) include at least the ethylene, removing the top mixture from the top portion of the stripper column and the heavies component mixture from the bottom portion of the stripper column; cooling the top mixture to a temperature of -19 °C to 42 °C; and separating the top mixture cooled to the temperature of -19 °C to 42 °C into the medium component(s) and the light component(s) in a flash drum having a top portion and a bottom portion distal from the top portion, wherein the

flash drum operates at a temperature of 15 ºC to 70 ºC and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the light component(s) are removed from the top portion of the flash drum and the medium component(s) are removed from the bottom portion of the flash drum with the proviso that the method does not use a distillation column between the source of the multi-component condensate mixture and the flash drum.

[0011a] In another aspect, there is provided a method of separating ethylene, 2-methylbutane and at least one unsubstituted C_6-C_{12} hydrocarbon in a multi-component condensate mixture having 2-methylbutane, ethylene, fines and at least one unsubstituted C_6-C_{12} hydrocarbon, the method comprising: feeding the multi-component condensate mixture at a temperature in a range of -13 degrees Celsius (ºC) to -5 ºC and a pressure of 340 kilopascals (kPag) to 420 kPag into a stripper column having a top portion, a bottom portion distal from the top portion and three to ten theoretical stages, the stripper column operating at an internal pressure of 200 kPa to 1500 kPa; separating the multi-component condensate mixture with the stripper column into a heavies component mixture with the at least one unsubstituted C_6-C_{12} hydrocarbon, and a top mixture having a medium component(s) and a light component(s), wherein the medium component(s) include at least the 2-methylbutane and the light component(s) include at least the ethylene, removing the top mixture from the top portion of the stripper column and the heavies component mixture from the bottom portion of the stripper column; cooling the top mixture to a temperature of -19 ºC to 42 ºC; and separating the top mixture cooled to the temperature of -19 ºC to 42 ºC into the medium component(s) and the light component(s) in a flash drum having a top portion and a bottom portion distal from the top portion, wherein the flash drum operates at a temperature of 15 ºC to 70 ºC and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the light component(s) are removed from the top portion of the flash drum and the medium component(s) are removed from the bottom portion of the flash drum with the proviso that the method does not use a distillation column between the source of the multi-component condensate mixture and the flash drum.

Brief Description of Drawings

[0012] Fig. 1 illustrates an embodiment of a separations system according to the present disclosure.

[0013] Fig. 2 illustrates an embodiment of a gas-phase polymerization system with the separations system according to the present disclosure.

Detailed Description

[0014] The present disclosure provides for a separation system and a method for separating olefin monomers from inert condensing agents in vent gases recovered from a product purge bin of a gas phase polymerization system. The separation system and the method of the present disclosure can separate the olefin monomers from the inert condensing agents without the use of a distillation column. Instead, the separation system and the method of the present disclosure utilize both a stripper column and flash drum in conjunction with compression stages that help to further extract and separate olefin monomers from inert condensing agents in vent gases recovered from the product purge bin of the gas phase polymerization system.

[0015] Unless defined otherwise herein, chemical engineering terms are based on *Perry's Chemical Engineer's Handbook* (6th ed.) and *Separation Process Principles* by Seader, Henley, and Roper (3rd ed.). Stripper column, a vessel that encloses a stripping mass transfer process. The stripper column of the present disclosure performs reboiled stripping, as opposed to gas stripping or refluxed stripping, which is gas stripping but with reflux. Stripping, the selective removal of components by mass transfer from the liquid phase to the gas phase without the use of external reflux. Reboiler, a heat exchanger used to generate vapor by heating the liquid at the bottom of a column and returning the generated vapor back to the column. Reboiling, the act of generating stripping vapor by heating the liquid at the bottom of a column and returning the generated vapor back to the column. Flash drum, a vessel designed to

What is Claimed is:

1. A separations system for separating ethylene, 2-methylbutane and at least one unsubstituted C_6-C_{12} hydrocarbon in a multi-component condensate mixture having 2-methylbutane, ethylene, fines and at least one unsubstituted C_6-C_{12} hydrocarbon, the separations system comprising:

a feed conduit in fluid communication with a source of the multi-component condensate mixture;

a stripper column in fluid communication with the feed conduit, the stripper column having a top portion, a bottom portion distal from the top portion and three to ten theoretical stages, the stripper column configured to receive through the feed conduit the multi-component condensate mixture at a temperature in a range of -13 degrees Celsius (ºC) to -5 ºC and a pressure of 340 kilopascals gauge (kPag) to 420 kPag, wherein the stripper column is further configured for operating at an internal pressure of 200 kPa to 1500 kPa to separate the multi-component condensate mixture into:

a heavies component mixture with the at least one unsubstituted C_6-C_{12} hydrocarbon, and

a top mixture having a medium component(s) and a light component(s), wherein the medium component(s) include at least the 2-methylbutane and the light component(s) include at least the ethylene, wherein the top portion of the stripper column is configured to remove the top mixture and the bottom portion of the stripper column is configured to remove the heavies component mixture;

a reboiler in fluid communication with the stripper column, the reboiler configured for operating at a temperature of 50 ºC to 200 ºC;

a condenser in fluid communication with the top portion of the stripper column, wherein the condenser is configured to cool the top mixture coming from the top portion of the stripper column to a temperature of -19 ºC to 42 ºC; and

a flash drum having a top portion and a bottom portion distal from the top portion, wherein the flash drum is in fluid communication with the condenser to receive the top mixture

having been cooled from the condenser, the flash drum configured for operating at a temperature of 15 ºC to 70 ºC and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the top portion of the flash drum is configured to remove the light component(s) of the top mixture and wherein the bottom portion of the flash drum is configured to remove the medium component(s) of the top mixture, with the proviso that there is no distillation column disposed between the source of the multi-component condensate mixture and the flash drum.

2. The separations system of claim 1, further including a multi-stage compressor having a first compression stage and a second compression stage, wherein

the first compression stage has a gas phase inlet and a gas phase outlet, the gas phase inlet in fluid communication with a first accumulator, wherein the first accumulator is in fluid communication with a first condenser system and a product purge bin of a gas phase polymerization system, and wherein the gas phase outlet is in fluid communication with a second condenser system; and

the second compression stage has a gas phase inlet and a gas phase outlet, the gas phase inlet in fluid communication with a second accumulator, wherein the second accumulator is in fluid communication with the second condenser system, and wherein the gas phase outlet is in fluid communication with a third condenser system that is in fluid communication with a third accumulator;

wherein the first condenser system is configured to receive and cool vent gases from polymer granules in the product purge bin of the gas phase polymerization system to a temperature of -10 to 60 ºC at a pressure of 110 kPag to 150 kPag to produce a first gas mixture, wherein the first gas mixture passes through the first accumulator into the gas phase inlet of the first compression stage, the first compression stage configured to compress the first gas mixture to a pressure of 375 kPag to 404 kPag and a temperature of 100 °C to 150 ºC;

wherein the second condenser system is configured to receive and cool the first gas mixture from the gas phase outlet of the first compression stage to a temperature of -10 to 60 ºC at a pressure of 375 kPag to 404 kPag and configured to produce a second gas mixture and a first condensate in the second accumulator;

wherein the second gas mixture passes through the second accumulator to the gas phase inlet of the second compression stage, wherein the second compression stage is configured to compress the second gas mixture to a pressure of 1300 kPag to 10300 kPag;

wherein the third condenser system is configured to receive and cool the second gas mixture from the gas phase outlet of the second compression stage to a temperature of -10 to 60 ^{o}C at a pressure of 1300 kPag to 10300 kPag and configured to produce a recycle gas mixture and a second condensate in the third accumulator.

3. The separations system of claim 2, wherein the third accumulator is in fluid communication with the gas phase polymerization system to allow the recycle gas mixture to help convey the polymer granules from the gas phase polymerization system to the product purge bin.

4. The separations system of any one of claims 2 or 3, wherein the first condensate is at least part of the source of the multi-component condensate mixture.

5. The separations system of claim 4, wherein the first condensate and the second condensate are at least part of the source of the multi-component condensate mixture.

6. The separations system of claim 2, wherein the third condenser system includes a water-cooled condenser in sequential fluid communication with a refrigerated condenser.

7. The separations system of any one of claims 1 to 6, wherein packing inside the stripper column forms the three to ten theoretical stages of the stripper column.

8. A gas phase polymerization system, comprising:

a gas phase polymerization reactor;

a product purge bin in sequential fluid communication with the gas phase polymerization reactor; and

the separations system of any one of claims 1 to 7 in sequential fluid communication with the product purge bin and the gas phase polymerization reactor, wherein the light component(s) containing at least the ethylene from the top portion of the flash drum are returned to the gas phase polymerization reactor.

9. A method of separating ethylene, 2-methylbutane and at least one unsubstituted C_6-C_{12} hydrocarbon in a multi-component condensate mixture having 2-methylbutane, ethylene, fines and at least one unsubstituted C_6-C_{12} hydrocarbon, the method comprising:

feeding the multi-component condensate mixture at a temperature in a range of -13 degrees Celsius (ºC) to -5 ºC and a pressure of 340 kilopascals (kPag) to 420 kPag into a stripper column having a top portion, a bottom portion distal from the top portion and three to ten theoretical stages, the stripper column operating at an internal pressure of 200 kPa to 1500 kPa;

separating the multi-component condensate mixture with the stripper column into a heavies component mixture with the at least one unsubstituted C_6-C_{12} hydrocarbon, and a top mixture having a medium component(s) and a light component(s), wherein the medium component(s) include at least the 2-methylbutane and the light component(s) include at least the ethylene,

removing the top mixture from the top portion of the stripper column and the heavies component mixture from the bottom portion of the stripper column;

cooling the top mixture to a temperature of -19 ºC to 42 ºC; and

separating the top mixture cooled to the temperature of -19 ºC to 42 ºC into the medium component(s) and the light component(s) in a flash drum having a top portion and a bottom portion distal from the top portion, wherein the flash drum operates at a temperature of 15 ºC to 70 ºC and a pressure of 240 kPa to 405 kPa to separate the top mixture into the medium component(s) and the light component(s), wherein the light component(s) are removed from the top portion of the flash drum and the medium component(s) are removed from the bottom portion of the flash drum with the proviso that the method does not use a distillation column between the source of the multi-component condensate mixture and the flash drum.

10. The method of claim 9, further comprising at least one of item (i), (ii), (iii) and/or (iv):

(i) feeding the medium component(s) exiting from the bottom portion of the flash drum into a gas phase polymerization reactor;

(ii) feeding the light component(s) exiting from the top portion of the flash drum into the gas phase polymerization reactor;

(iii) operating the stripper column with no external reflux

(iv) operating the flash drum at a temperature of -19 ºC to 70 ºC,

item (i), (ii) and/or (iii):

(i) producing with the separations system of any one of claims 2-6 the multi-component condensate mixture at least partially from vent gases from polymer granules in the product purge bin of the gas phase polymerization system;

(ii) conveying polymer granules from a gas phase polymerization reactor to a product purge bin using the recycle gas mixture produced in the separation system of claim 2;

(iii) filtering the multi-component condensate mixture to remove the fines from the multi-component condensate mixture; or

item (i), (ii), (iii) and/or (iv):

(i) feeding the light component(s) removed from the top portion of the flash drum into a compressor configured and operative for compressing ethylene;

(ii) flashing the light component(s) from the top portion of the flash drum in a second flash drum;

(iii) compressing the top mixture from the top portion of the stripper column prior to cooling the top mixture to the temperature of -19 ºC to 42 ºC;

(iv) compressing the light component(s) from the top stream prior to flashing the light component(s) from the top stream of the flash drum in a second flash drum.