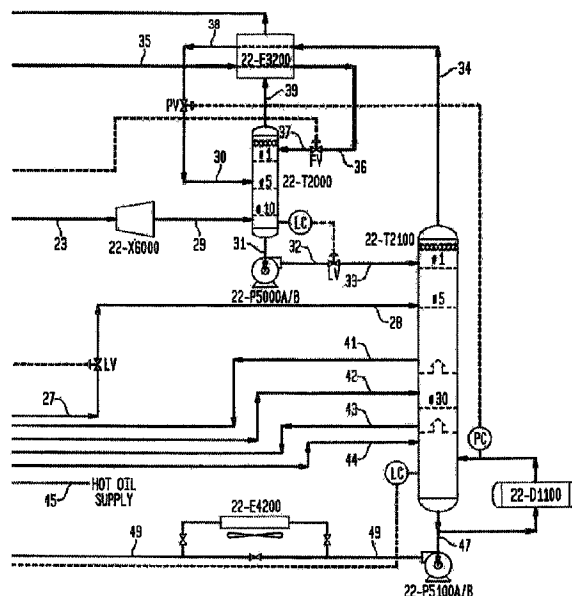




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(54) **Titre : PROCÉDES POUR LA SÉPARATION DE GAZ HYDROCARBONES**
(54) **Title: METHODS FOR SEPARATING HYDROCARBON GASES**



(57) **Abrégé/Abstract:**

A process for separating a hydrocarbon gas into a fraction containing a predominant portion of the methane or ethane and lighter components and a fraction containing a predominant portion of the C2 or C3 and heavier components in which the feed gas is treated in one or more heat exchange and expansion steps; partly condensed feed gas is directed into a separator wherein a first residue vapor is separated from a C2 or C3-containing liquid; and C2 or C3-containing liquids at substantially the pressure of separation are directed into a distillation column wherein the liquid is separated into a second residue to recover a C2 or C3-containing product. A portion of the vapor and/or a portion of the liquid from the first hydrocarbon vapor/liquid separation is further cooled and introduced into a fractionation column to increase the C2 or C3 and heavier hydrocarbons recovery from the natural gas stream.

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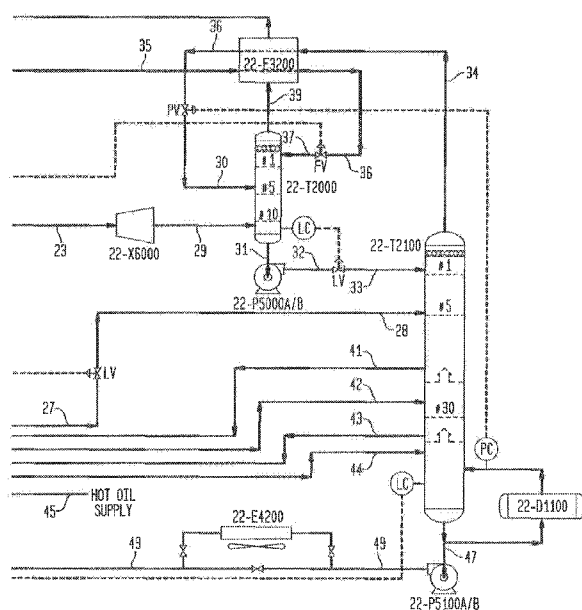
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[Continued on next page]

(54) Title: METHODS FOR SEPARATING HYDROCARBON GASES

FIG. 1B



(57) Abstract: A process for separating a hydrocarbon gas into a fraction containing a predominant portion of the methane or ethane and lighter components and a fraction containing a predominant portion of the C2 or C3 and heavier components in which the feed gas is treated in one or more heat exchange and expansion steps; partly condensed feed gas is directed into a separator wherein a first residue vapor is separated from a C2 or C3-containing liquid; and C2 or C3-containing liquids at substantially the pressure of separation are directed into a distillation column wherein the liquid is separated into a second residue to recover a C2 or C3-containing product. A portion of the vapor and/or a portion of the liquid from the first hydrocarbon vapor/liquid separation is further cooled and introduced into a fractionation column to increase the C2 or C3 and heavier hydrocarbons recovery from the natural gas stream.

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METHODS FOR SEPARATING HYDROCARBON GASES

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method and apparatus for the improved recovery of C2 and/or C3 and heavier components from hydrocarbon gases.

[0002] In conventional processes for extracting propane and C2 and/or C3 bearing gases are treated by a combination of expansion of heavier components from hydrocarbon gases (or compression followed by expansion) heat exchange and refrigeration to obtain a partially condensed stream which is collected in a feed separator having a pressure typically in the order of 50 to 1100 psia and a temperature in the order of -50° to -200° F. These conditions of course can vary substantially, depending on the pressure and temperature conditions necessary to achieve partial condensation for a particular gas, and the pressure and temperature at which the feed is available to the process. The liquid resulting from partial condensation is supplied to a fractionation column called a "heavy ends fractionation column" as a mid-column feed while the vapor from the feed separator is used to generate reflux by partially condensing the overhead vapors from the heavy ends fractionation column through appropriate heat exchange means. In a typical system the heavy ends fractionation column will operate at a pressure less than that of the feed separator (possibly allowing for a small pressure drop as the partially condensed liquid passes from the separator to the heavy ends fractionation column) and the heavy ends fractionation column overhead vapors leave at a temperature in the order of -120° to -160°F for C2 and heavier recovery and - 20° to - 70° F for C3 and heavier recovery. The heat exchange of these overhead vapors against the residue vapors from the light ends fractionation column provides partial condensate which is used as a reflux to the light ends fractionation column.

[0003] Pre-cooling of the gas before it is expanded to the light ends fractionation column pressure will commonly result in formation of a high-pressure condensate. To avoid damage to the expander, the high pressure condensate, if it forms, is usually separated in the feed separator, separately expanded through a Joule-Thomson valve and used as a further feed to the mid-portion of the heavy ends fractionation column.

[0004] Refrigeration in such a process is sometimes entirely generated by work expansion of the vapors remaining after partial condensation of the high pressure gas to the light ends fractionation column operating pressure. Other processes may include external refrigeration of the high pressure gases to provide some of the required cooling.

[0005] When processing natural gas, feed is typically available at line pressure, of 900 to 1100 psia. In such case expansion to a pressure in the order of 150 to 500 psia is common. In an alternate process, facilities may be designed to extract propane or propylene from refinery gases. Refinery gases commonly are available a pressure of 50 psia to 250 psia. In this case, at the convenience of the process designer, the light ends fractionation column may be designed to operate at a pressure below the pressure of the refinery gas which is available, i.e., perhaps 50 to 100 psia, so that work expansion can be used to supply refrigeration to the process. This will result in lower light ends fractionation column temperatures and will increase potential heat leakage and other engineering problems associated with cryogenic temperatures. It is also possible in this case to compress the refinery gas to a higher pressure so that it may be thereafter expanded in a work-expansion machine to afford refrigeration to the overall process.

[0006] A typical flow plan of a process for separating C3 and heavier hydrocarbons from a gas stream is illustrated in U.S. Pat. No. 4,251,249 to Jerry G. Gulsby.

SUMMARY OF THE INVENTION

[0007] In one embodiment of the invention, there is described a process for separating a hydrocarbon gas containing at least methane, ethane and C3 components into a fraction containing a predominant portion of the ethane and lighter components and a fraction containing a predominant portion of the C3 and heavier components or a predominant portion of the methane and lighter components and a fraction containing a predominant portion of the C1 and / or C2 and heavier components, in which process

(a) the feed gas is treated in one or more heat exchangers, and expansion steps to provide at least one partly condensed hydrocarbon gas, providing thereby at least one first residue vapor and at least one C2 or C3-containing liquid which liquid also contains lighter hydrocarbons; and

(b) at least a portion of the C2 or C3-containing liquids is directed into a distillation column wherein said liquid is separated into a second residue containing lighter hydrocarbons and a C2 or C3-containing product; comprising:

(1) cooling said second residue to partially condense it;

(2) intimately contacting at least part of one of said first residue vapors with at least part of the liquid portion of the partially condensed second residue in at least one contacting stage and thereafter separating the vapors and liquids from said contacting stage;

(3) supplying the liquids thereby recovered to the distillation column as a liquid feed thereto; and

(4) directing the vapors thereby recovered into heat exchange relation with said second residue from the distillation column, thereby to supply the cooling of step (1), and thereafter discharging said residue gases; the improvement comprising:

(5) withdrawing a portion of the first residue vapor;

(6) cooling said portion of the first residue vapor to partially condense it;

(7) intimately contacting at least part of one of said first residue vapors with at least part of the liquid portion of the partially condensed portion of the first residue in at least one contacting stage and thereafter separating the vapors and liquids from said contacting stage;

(8) supplying the liquids thereby recovered to the distillation column as a liquid feed thereto; and

(9) directing the vapors thereby recovered into heat exchange relation with said portion of the first residue from the separator, thereby to supply the cooling of step (6), and thereafter discharging said residue gases;

the improvement further comprising:

(10) withdrawing a portion of the C2 or C3 containing liquid from the separator;

(11) directing said portion of the C2 or C3 containing liquid from the separator into a heat exchange relationship with the liquid product from the contacting device;

- (12) cooling said portion of the C2 or C3 containing liquid from the separator;
- (13) intimately contacting at least part of one of said first residue vapors with at least part of the C2 or C3 containing liquid from the separator in at least one contacting stage and thereafter separating the vapors and liquids from said contacting stage;
- (14) supplying the liquids thereby recovered to the distillation column as a liquid feed thereto;
- (15) directing the vapors thereby recovered into heat exchange relation with said portion of the first residue from the separator, thereby to supply the cooling of step (6), and thereafter discharging said residue gases; and
- (16) directing the liquids thereby recovered into heat exchange relation with said portion of the C2 or C3 containing liquid from the separator, thereby to supply the cooling of step (11), and thereafter discharging said liquids to a heavy ends fractionation column.

[0008] The contacting step (2) is carried out in a feed separator/absorber which includes fractionation means for vapor/liquid counter-current contact and

- (i) wherein said partly condensed second residue is introduced into said separator/absorber above or at an intermediate point in said fractionation means, whereby the liquid portion of it passes downwardly through said fractionation means; and
- (ii) wherein said partly condensed portion of the first residue is introduced into said separator/absorber above or at an intermediate point in said fractionation

means, whereby the liquid portion of it passes downwardly through said fractionation means; and wherein said portion of the cooled C2 or C3 containing liquid from the separator is introduced into said separator/absorber above or at an intermediate point in said fractionation means, whereby the liquid portion of it passes downwardly through said fractionation means; and

(iii) said at least part of one of said first residue vapors is supplied to said separator/absorber below said fractionation means, whereby the first residue vapor rises through said fractionation means in counter-current contact with the liquid portion of the partly condensed second residue.

[0009] The fractionation means in said separator/absorber provide the equivalent of at least one theoretical distillation stage arranged to contact at least part of one of said first residue vapors with the liquid portion of the partly condensed second residue.

[0010] The fractionation means in said separator/absorber provide the equivalent of at least three theoretical distillation stages arranged to contact at least part of one of said first residue vapors with the liquid portion of the partly condensed second residue.

[0011] At least part of one of said first residue vapors are co-mingled with the liquid portion of the partially condensed second residue, liquid portion of the partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

[0012] At least part of one of said first residue vapors are comingled with both the liquid portions and vapor portions of said partially condensed second residue, partially condensed portion of the first residue vapor and portion of the cooled

C2 or C3 containing liquid from the separator.

[0013] Further, there is described an apparatus for separating a hydrocarbon gas containing at least methane, ethane and C3 components into a fraction containing a predominant portion of methane and ethane and lighter components and a fraction containing a predominant portion of the C2 or C3 and heavier components in which apparatus

(a) one or more heat exchange means and one or more expansion means are provided which are cooperatively connected to provide at least one partly condensed hydrocarbon gas, providing thereby at least one first residue vapor and at least one C3-containing liquid which liquid also contains lighter hydrocarbons; and

(b) a distillation column connected to receive at least one of said C2 or C3-containing liquids which is adapted to separate the C2 or C3-containing liquids into a second residue containing lighter hydrocarbons and a C2 or C3-containing product;

the improvement comprising:

(1) heat exchange means connected to said distillation column to receive said second residue and to partially condense it;

(2) heat exchange means connected to said distillation column to receive said a portion of the first residue and to partially condense it;

(3) contacting and separating means connected to receive at least part of one of the first residue vapors and at least part of the liquid portion of the partially condensed second residue and partially condensed first residue vapor and to

comingle said vapor and liquid in at least one contacting stage, which means include separation means for separating the vapor and liquid after contact in said stage;

(4) said means (2) and (3) being further connected to supply the liquids separated therein to the distillation column as a liquid feed thereto;

(5) said means (2) and (3) also being connected to direct the vapors separated therein into heat exchange relation with said second residue and portion of the first residue from the distillation column in said heat exchange means (1); and

(6) heat exchange means connected to said distillation column to receive said liquids and to cool the portion of the C2 or C3 containing liquid from the separator.

[0014] The contacting and separating means includes fractionation means for countercurrent vapor/liquid contact and wherein said means is connected to receive the portion of one of first residue vapors to be treated therein below said fractionation means and to receive the portion of said liquids from the partially condensed second residue, portion of the partially condensed first residue and portion of the cooled C2 or C3 containing liquid from the separator to be treated therein above or at an intermediate point in said fractionation means said fractionation means thereby being adapted so that the first residue vapors rise there-through in countercurrent contact with partially condensed second residue and portion of the partially condensed first residue and being further adapted so that the portion of the C2 or C3 containing liquid from the separator is cooled by the liquids exiting the fractionation means.

[0015] The fractionation means includes vapor/liquid contacting means which are the equivalent of at least one theoretical distillation stage.

[0016] The contacting and separating means (2) comprise means for comingling at least part of one of said first residue vapors with the liquid portion of the partially condensed second residue, liquid portion of the partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

[0017] The contacting and separating means (2) comprise means for comingling at least part of one of said first residue vapors with both the liquid and vapor portion of said partially condensed second residue, said partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Figures 1A and 1B are schematics of a hydrocarbons separation process according to the invention.

[0019] Figures 2A and 2B are schematics of an alternative embodiment of a hydrocarbons separation process according to the invention.

[0020] Figures 3A and 3B are schematics of a preferred embodiment of a hydrocarbons separation process according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] The present invention provides an improved process for recovering C2 and/or C3 and heavier components from hydrocarbon-bearing gases. In the improved process of the present invention the overhead vapor from the heavy ends fractionation column and a portion of the first residue vapor from the separator are partly condensed

and at least a portion of the C2 or C3 containing liquid from the separator into a heat exchange relationship with the liquid product from the contacting device and then at least the respective liquid condensates and cooled liquid are combined with at least the vapor from the partially condensed feed gases described above in the heavy ends fractionation column feed separator which, in the present invention, also acts as an absorber. The feed separator/absorber is designed to afford one or more contacting stages. Usually such stages are assumed for design purposes to be equilibrium stages, but in practice this need not be so. Vapor from the feed separator/absorber passes in heat exchange relation to the overhead from the heavy ends fractionation column, thereby providing partial condensation of the heavy ends fractionation column overhead vapor and portion of the first residue vapor, and liquid from the feed separator/absorber is supplied to the heavy ends fractionation column as an upper or top liquid feed to the column.

[0022] If the separator/absorber contains an absorption section, such as packing, or one or more fractionation trays, these stages will be assumed to correspond to a suitable number of theoretical separation stages. Our calculations have shown benefits with as few as one theoretical stage, and greater benefits as the number of theoretical stages is increased. We believe that benefits can be realized even with the equivalent of a fractional theoretical stage. The partially condensed heavy ends fractionation column overhead, partially condensed portion of the first residue vapor, and at least a portion of the cooled C2 or C3 containing liquid from the separator are supplied above or at an intermediate point of this section, and the liquid portions of these streams pass downward through the absorption section. The partially condensed feed stream is usually supplied below the absorption section, so that the vapor portion of it passes upwardly through it in countercurrent contact with the liquids from the partially condensed heavy ends fractionation column overhead. The rising vapor joins the vapors which separate from partially condensed heavy ends fractionation column overhead above the absorption section, to form a combined residue

stream.

[0023] While described above with respect to a preferred embodiment in which overhead, a portion of the first residue vapors are condensed and, at least a portion of the cooled C2 or C3 containing liquid from the separator are used to absorb valuable ethane, propane, etc. from the expander outlet vapors, we point out that the present invention is not limited to this exact embodiment. Advantages can be realized, for instance, by treating only a part of the expander outlet vapor in this manner, or using only part of the overhead condensate or none of the separator liquid as an absorbent in cases where other design considerations indicate that portions of the expander outlet or overhead condensate should bypass the feed separator-/absorber. We also point out that the feed separator/absorber can be constructed as either a separate vessel, or as a section of the heavy ends fractionation column.

[0024] In the practice of this invention there will necessarily be a pressure difference between the separator/absorber and the heavy ends fractionation column which must be taken into account. If the overhead vapors pass through the condenser and into the separator without any boost in pressure, the feed separator/absorber will assume an operating pressure slightly below the operating pressure of the heavy ends fractionation column. In this case the liquid feed withdrawn from the separator/absorber can be pumped to its feed position in the heavy ends fractionation column. An alternative is to provide a booster blower in the vapor line to raise the operating pressure in the overhead condenser and separator/absorber sufficiently so that the liquid feed can be supplied to the heavy ends fractionation column without pumping. Still another alternate is to mount the feed separator/absorber at a sufficient elevation relative to the feed position of the liquid withdrawn therefrom that the hydrostatic head of the liquid will overcome the pressure difference.

[0025] In still another alternative, all or a part of the partially condensed heavy ends fractionation column overhead and all or part of the partially condensed feed can be combined, such as in the pipe line joining the expander output to the feed separator/absorber and if thoroughly intermingled, the liquids and vapors will mix together and separate in accordance with a relative volatility of the various components of the total combined streams. In this embodiment the vapor-liquid mixture from the overhead condenser can be used without separation, or the liquid powder thereof may be separated. Such co-mingling is considered for purposed of this invention as a contacting stage.

[0026] In still another variation of the foregoing, the partially condensed overhead vapors can be separated, and the all or a part of the separated liquid supplied to the separator/absorber or mixed with the vapors fed thereto.

[0027] The present invention provides improved recovery of propane or propylene per amount of horsepower input required to operate the process. An improvement in operating horsepower required for operating a heavy ends fractionation column process may appear either in the form of reduced power requirements for external refrigeration, reduced power requirements for compression or recompression, or both. Alternatively, if desired, increased C3 recovery can be obtained for a fixed power input.

[0028] Turning to the figures, Figures 1A and 1B are schematics of a hydrocarbon separation process according to the invention. A hydrocarbon bearing gas natural gas is fed through line 20 to a warm gas/gas exchanger 22-E3000 and then to a chiller 22-E3400. Refrigeration is supplied through line 52 and 53 with some refrigerant removed through a valve assembly before entering the chiller. The chiller has a line 54 which will withdraw refrigeration for recompression and liquefaction. The cooled gas stream is fed through line 21

through a cold gas/gas exchanger 22-3100 to a cold separation column 22-D1000.

[0029] The hydrocarbon gas stream will be separated into two streams with the tops leaving through line 22 and the bottoms through line 25 to line 16. The bottoms will pass through a valve in line 26 for flow control and will rejoin line 26 to line 35 where they will enter subcooler 22-E3200. These cooled hydrocarbon gases leave the subcooler through line 36 and enter light ends fractionation column 22-T2000. The hydrocarbon gas stream that is not diverted will continue through line 37 to the light ends fractionation column 22-T2000 at the top of the column.

[0030] The tops from the cold separation column 22-D1000 will leave through line 22 and reach a junction with line 24. Line 24 will also contain a valve assembly PV which is used to control the flow of the stream in Line 24. The remainder of the tops from the cold separation column flow through line 23 through an expander/compressor 22-X6000. This expanded hydrocarbon gas stream will be fed through line 29 into the light ends fractionation column 22-T2000.

[0031] The tops from the light ends fractionation column 22-T2000 will leave through line 39 and pass through line 40 where they will pass through cold gas/gas exchanger 22-E3100 and warm gas/gas exchanger before passing through line 55 to an expander/compressor 22-C6000 where the compressed gas stream will enter and expander/compressor discharge cooler 22-E4100 through line 59. The discharged gas stream will exit through line 58 and for sales or further processing as required.

[0032] Line 56 contacts line 55 and some of the hydrocarbon gas will be

drawn off before entering the expander/compressor 22-C6000 and recovered for use as fuel gas. A valve assembly is present in line 56 for controlling the quantity of the material to be used as fuel gas.

[0033] The bottoms from the light ends fractionation column 22-T2000 will exit through line 31. These bottoms comprise an intermediate liquid stream that required further fractionation. Line 31 is in fluid communication with a transfer pump 22-P5000A/B which directs the bottoms from the light ends fractionating column to line 33 and into the top of a heavy ends fractionation column 22-T2100.

[0034] Part of the bottoms from the cold separator column 22-D1000 are diverted through line 27 where they will pass through a level control valve that flows through line 28 into the heavy ends fractionating column.

[0035] A stream comprising a cooler, intermediate product liquid is withdrawn from the heavy ends fractionation column 22-T2100 through line 41 which is fed to a side heater 22-E3800 which will heat the stream and return it through line 42 to a point lower in the heavy ends fractionation column from which it was withdrawn. Another side stream is withdrawn from the heavy ends fractionation column 22-T2100 through line 43 which is fed to a heavy ends fractionation column reboiler 22-E3700 which will heat the side stream. This stream is fed to a trim reboiler 22-E4000 where it will be further heated before being returned through line 44 to a point lower in the heavy ends fractionation column from which it was withdrawn. Line 45 will supply hot oil from a hot oil supply (not shown) to the trim reboiler 22-E4000 while line 46 will return hot oil from the trim reboiler.

[0036] A line at the bottom of the heavy ends fractionating column will remove

some of the hydrocarbon comprising mainly of C2s and less volatile hydrocarbons or C3s and less volatile hydrocarbon and direct it to a valve in line 51. Line 51 receives bottoms from the heavy ends fractionating column 22-T2100. Line 47 feeds the bottoms from the heavy ends fractionating column and feeds them to a heavy ends fractionating column bottoms pump 22-P5100A/B which feeds the bottoms through line 49 to a product exchanger 22-E3600 which feeds the bottoms through line 50 to the product pump 22-P5200A/B. This pump directs the bottoms through line 51 where they can be directly fed to a pipeline.

[0037] A valve in line 49 will allow bypass of the product exchanger 22-E3600 and divert the flow to an air or water cooled heat exchanger when the plant is operated in the C3 and heavier recovery mode. After cooling, these bottoms can be fed back into line 49 for feeding to the product exchanger 22-E3600.

[0038] The tops from the heavy ends fractionation column 22-T2100 will exit through line 34 and pass through a subcooler 22-E3200. Line 38 exits the subcooler 22-E3200 and connects to a valve PV. The tops from the heavy ends fractionation column will be fed through line 30 into the light ends fractionation column 22-T2000 where they will be further fractionated for reentry back into the heavy ends fractionation column as a reflux stream.

[0039] Figures 2A and 2B represent an alternative embodiment of the present invention. In this alternative description all the designations as employed in describing Figures 1A and 1B are re-employed and mean the same for the description of the unit operations taking place. In Figures 2A and 2B, a liquid/liquid exchanger is present between the heavy ends fractionation column and the light ends fractionation column.

[0040] The bottoms from the cold separator column 22-D1000 will be fed

through line 25 to a junction connecting to a valve LV and line 28 for entry into the heavy ends fractionation column. The feed through line 26 will connect with a liquid/liquid exchanger 22-E3900 and pass through into the light ends fractionation column 22-T2000.

[0041] Figures 3A and 3B represent another alternative embodiment of the present invention. In this alternative description all the designations as employed in describing Figures 1A and 1B are re-employed and mean the same for the description of the unit operations taking place. In Figures 3A and 3B, the bottoms from the light ends fractionation column 22-T2000 are fed through line 31 to the light ends fractionation column bottoms pump 22-P5000A/B which feeds the bottoms through line 32 and valve LVI to subcooler 22-E3200. Valve LVI may be opened and closed to divert some of the bottoms back to the bottom of the light ends fraction column.

[0042] The bottoms fed to the subcooler 22-E3200 are now lower in temperature and are fed through line 33 into heavy ends fractionation column 22-T2100 where they will be further fractionated.

[0043] While this invention has been described with respect to particular embodiments thereof, it is apparent that numerous other forms and modifications of the invention will be obvious to those skilled in the art. The appended claims in this invention generally should be construed to cover all such obvious forms and modifications which are within the true spirit and scope of the invention.

CLAIMS

1. A process for separating a hydrocarbon gas containing at least methane, ethane and C3 components into a fraction containing a predominant portion of the ethane and lighter components and a fraction containing a predominant portion of the C3 and heavier components or a predominant portion of the methane and lighter components and a fraction containing a predominant portion of the C2 and heavier components, in which process

(a) a feed gas (20) is treated in one or more heat exchangers (22-E3600, 22-E3700, 22-E3800), and expansion steps to provide at least one partly condensed hydrocarbon gas, which is sent to a separator (22-D1000) providing thereby at least one first residue vapor (22) and at least one C2 or C3-containing liquid (25) which liquid also contains lighter hydrocarbons; and

(b) at least one of the C2 or C3-containing liquid (25, 27, 28) is directed into a distillation column (22-T2100) wherein said at least one of the C2 or C3-containing liquid is separated into a second residue (34) containing lighter hydrocarbons and a C2 or C3-containing product;
comprising:

(1) cooling said second residue (34) to partially condense said second residue (34);

(2) intimately contacting at least part of one of said first residue vapor (22, 23, 29) with at least part of a liquid portion (30) of a partially condensed second residue in at least one contacting stage (#1, #5, #10) and thereafter separating vapors (39) and liquids (31) from said contacting stage;

(3) supplying the liquids (31) thereby recovered to the distillation column (22-T2100) as a liquid feed (33) thereto; and

(4) directing the vapors (39) thereby recovered into heat exchange relation with said second residue (34) from the distillation column, thereby to supply (40) the cooling of step (1), and thereafter discharging residue gases;

the improvement comprising:

(5) withdrawing a portion (24) of the first residue vapor;

(6) cooling said portion of the first residue vapor (24) to partially condense said portion of the first residue vapor (35);

(7) intimately contacting the at least part of one of said first residue vapor (22, 23, 29) with at least part of a liquid portion of the partially condensed portion of the first residue vapor (36) in the at least one contacting stage and thereafter separating the vapors (39) and the liquids (31) from said contacting stage;

(8) supplying the liquids (31) thereby recovered to the distillation column as the liquid feed (33) thereto; and

(9) directing the vapors (39) thereby recovered into heat exchange relation with said portion of the first residue vapor (35) from the separator (22-D1000), thereby to supply (35) the cooling of step (6), and thereafter discharging said residue gases; the improvement further comprising:

(10) withdrawing a portion of the C2 or C3 containing liquid (25) from the separator (22-D1000);

(11) directing (25, 26, 35) said portion of the C2 or C3 containing liquid (35) from the separator (22-D1000) into a heat exchange relationship with liquid product from the contacting stage;

(12) cooling (22-E3200) said portion of the C2 or C3 containing liquid from the separator (22-D1000);

(13) intimately contacting the at least part of one of said first residue vapor (22, 23, 29) with the portion of the C2 or C3 containing liquid from the separator (22-D1000) in the at least one contacting stage and thereafter separating the vapors and liquids from said contacting stage;

(14) supplying the liquids (31) thereby recovered to the distillation column as the liquid feed thereto;

(15) directing the vapors (39) thereby recovered into heat exchange relation with said portion of the first residue vapor from the separator, thereby to supply the cooling of step (6), and thereafter discharging said residue gases; and

(16) directing the liquids thereby recovered into heat exchange relation with said portion of the C2 or C3 containing liquid from the separator, thereby to supply the cooling of step (1), and thereafter discharging said liquids to said distillation column.

2. The process according to claim 1 wherein said contacting step (2) is carried

out in a feed separator/absorber which includes fractionation means for vapor/liquid counter-current contact and

(i) wherein said partly condensed second residue is introduced into said separator/absorber above or at an intermediate point in said fractionation means, whereby the liquid portion of it passes downwardly through said fractionation means; and

(ii) wherein said partly condensed portion of the first residue is introduced into said separator/absorber above or at an intermediate point in said fractionation means, whereby the liquid portion of it passes downwardly through said fractionation means; and wherein said portion of the cooled C2 or C3 containing liquid from the separator is introduced into said separator/absorber above or at an intermediate point in said fractionation means, whereby the liquid portion of it passes downwardly through said fractionation means; and

(iii) said at least part of one of said first residue vapors is supplied to said separator/absorber below said fractionation means, whereby the first residue vapor rises through said fractionation means in counter-current contact with the liquid portion of the partly condensed second residue.

3. The process according to claim 2 wherein the fractionation means in said separator/absorber provide the equivalent of at least one theoretical distillation stage arranged to contact at least part of one of said first residue vapors with the liquid portion of the partly condensed second residue.

4. The process according to claim 1 wherein at least part of one of said first residue vapors are co-mingled with the liquid portion of the partially condensed second residue, liquid portion of the partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

5. The process according to claim 1 wherein at least part of one of said first residue vapors are comingled with both the liquid portions and vapor portions of said partially condensed second residue, partially condensed portion of the first residue vapor and portion of the cooled C2 and C3 containing liquid from the separator.

6. An apparatus for separating a hydrocarbon gas containing at least methane, ethane and C3 components into a fraction containing a predominant portion of methane or ethane and lighter components and a fraction containing a predominant portion of the C2 or C3 and heavier components in which apparatus

(a) one or more heat exchange means and one or more expansion means are provided which are cooperatively connected to provide at least one partly condensed hydrocarbon gas which is sent to a separator, providing thereby at least one first residue vapor and at least one C2 or C3-containing liquid which liquid also contains lighter hydrocarbons; and

(b) a distillation column connected to receive at least one of said C2 or C3-containing liquids which is adapted to separate the C2 or C3-containing liquids into a second residue containing lighter hydrocarbons and a C2 or C3-containing product; the improvement comprising:

(1) heat exchange means connected to said distillation column to receive said second residue and to partially condense it;

(2) heat exchange means connected to said distillation column to receive said a portion of the first residue and to partially condense it;

(3) contacting and separating means connected to receive at least part of one of the first residue vapors and at least part of a liquid portion of the partially condensed second residue and partially condensed first residue vapor and to comingle said vapor and liquid in at least one contacting stage, which means include separation means for separating the vapor and liquid after contact in said stage;

(4) said means (2) and (3) being further connected to supply the liquids separated therein to the distillation column as a liquid feed thereto;

(5) said means (2) and (3) also being connected to direct the vapors separated therein into heat exchange relation with said second residue and portion of the first residue from the distillation column in said heat exchange means (1); and

(6) heat exchange means connected to said distillation column to receive said liquids and to cool the portion of the C2 or C3 containing liquid from the separator.

7. The apparatus according to claim 6 wherein said contacting and separating means includes fractionation means for countercurrent vapor/liquid contact and wherein said means is connected to receive the portion of one of first residue vapors to be treated therein below said fractionation means and to receive the portion of said liquids from the partially condensed second residue, portion of the partially condensed first residue and portion of the cooled C2 or C3 containing liquid from the separator to be treated therein above or at an intermediate point in said fractionation means said fractionation means thereby being adapted so that the first residue vapors rise there-through in countercurrent contact with partially condensed second residue and portion of the partially condensed first residue and being further adapted so that the portion of the C2 or C3 containing liquid from the separator is cooled by the liquids exiting the fractionation means.

8. The apparatus according to claim 7 wherein said fractionation means includes vapor/liquid contacting means which are the equivalent of at least one theoretical distillation stage.

9. The apparatus according to claim 6 wherein said contacting and separating means (2) comprise means for comingling at least part of one of said first residue vapors with the liquid portion of the partially condensed second residue, liquid portion of the partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

10. The apparatus according to claim 6 wherein said contacting and separating means (2) comprise means for comingling at least part of one of said first residue vapors with both the liquid and vapor portion of said partially condensed second residue, said partially condensed portion of the first residue and portion of the cooled C2 or C3 containing liquid from the separator.

FIG. 1A

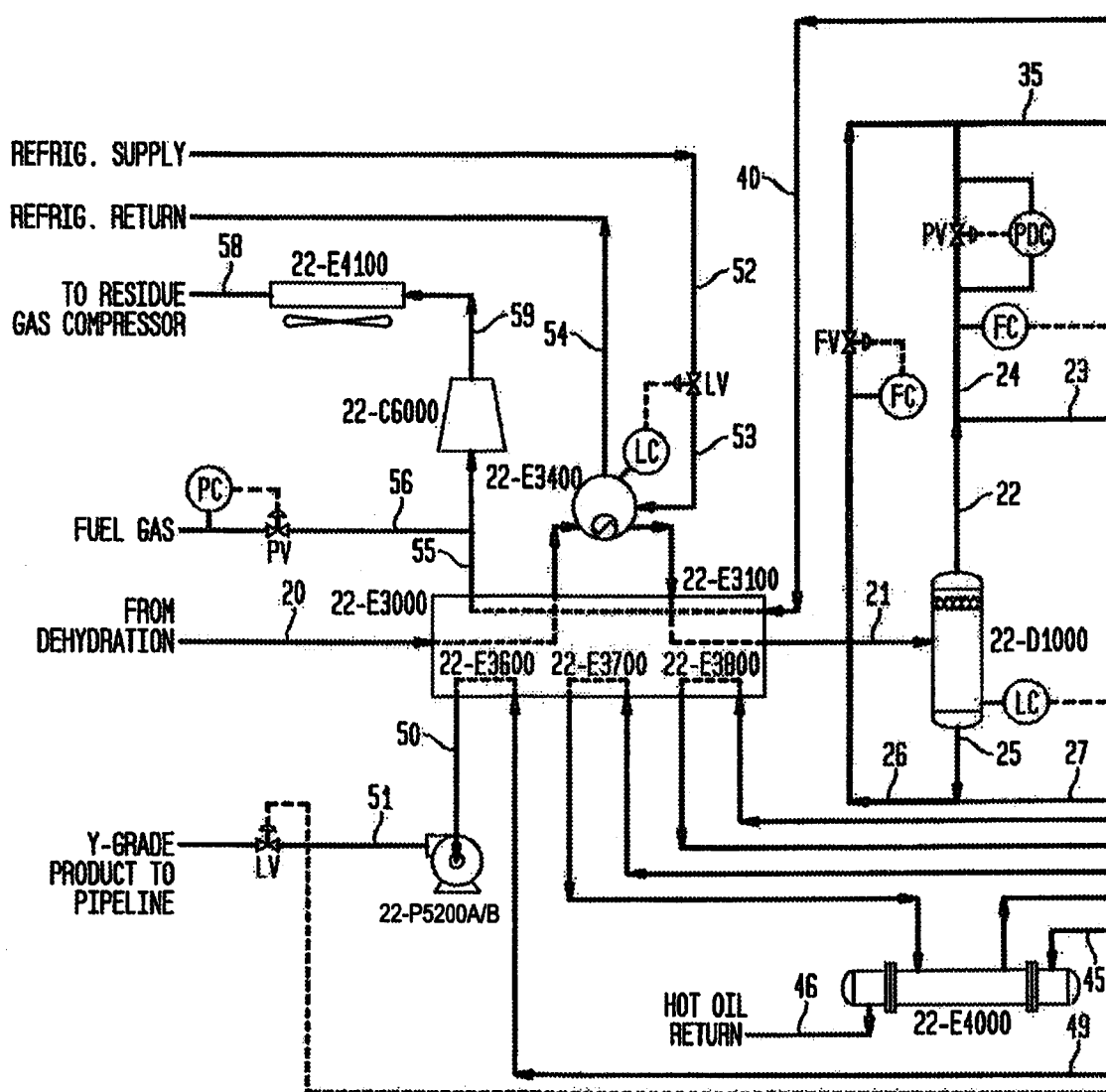


FIG. 1B

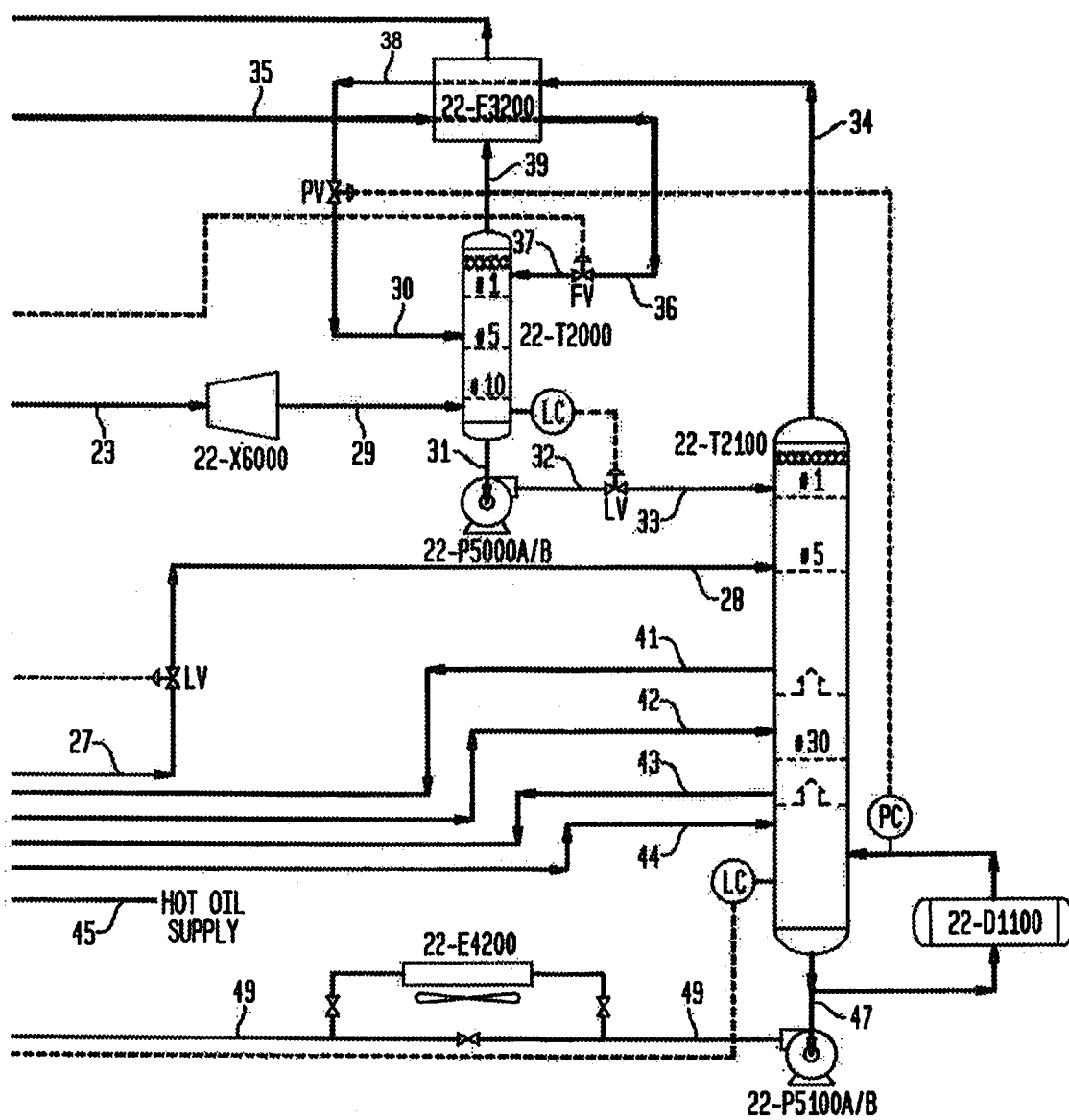


FIG. 2A

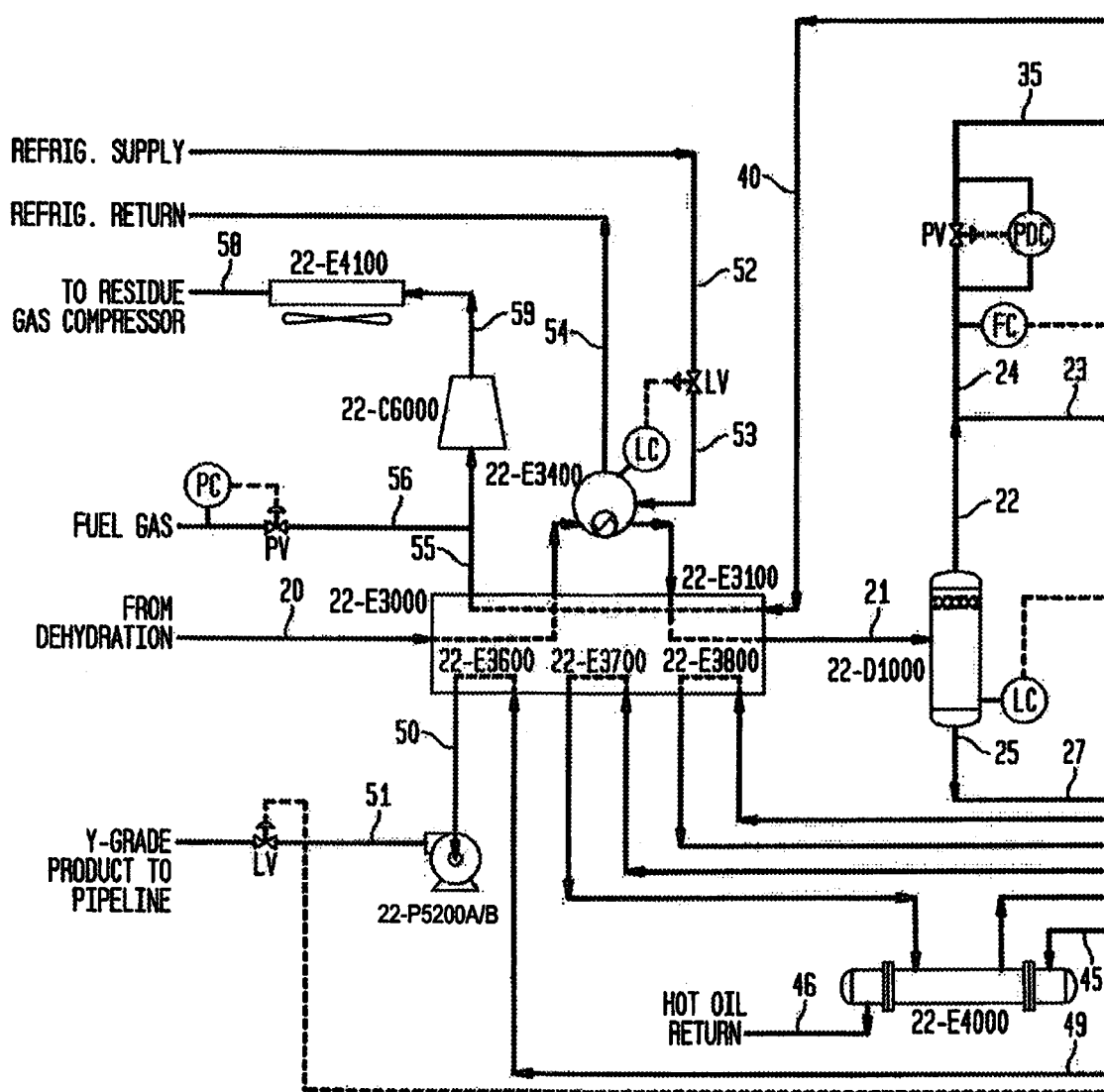
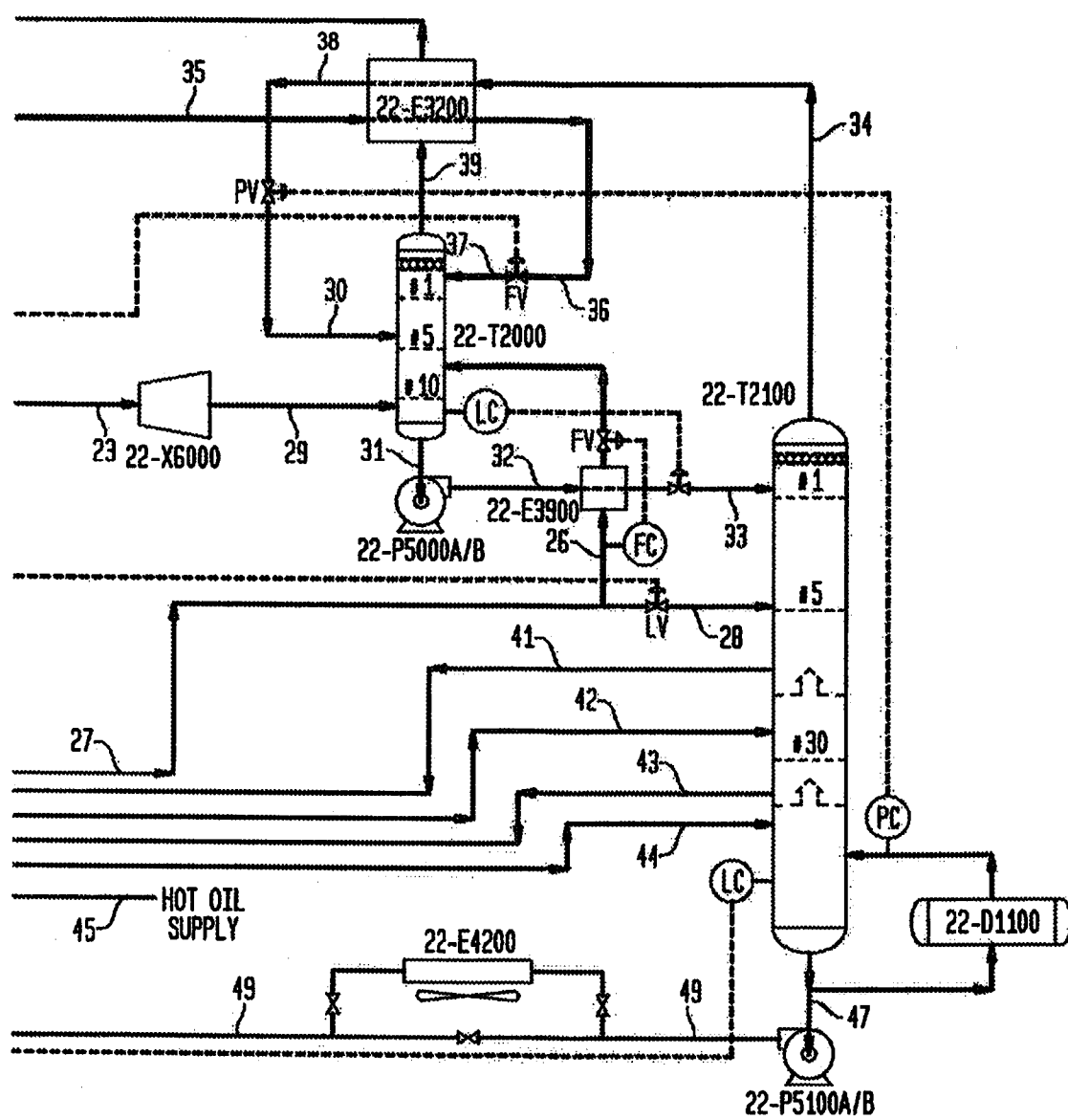
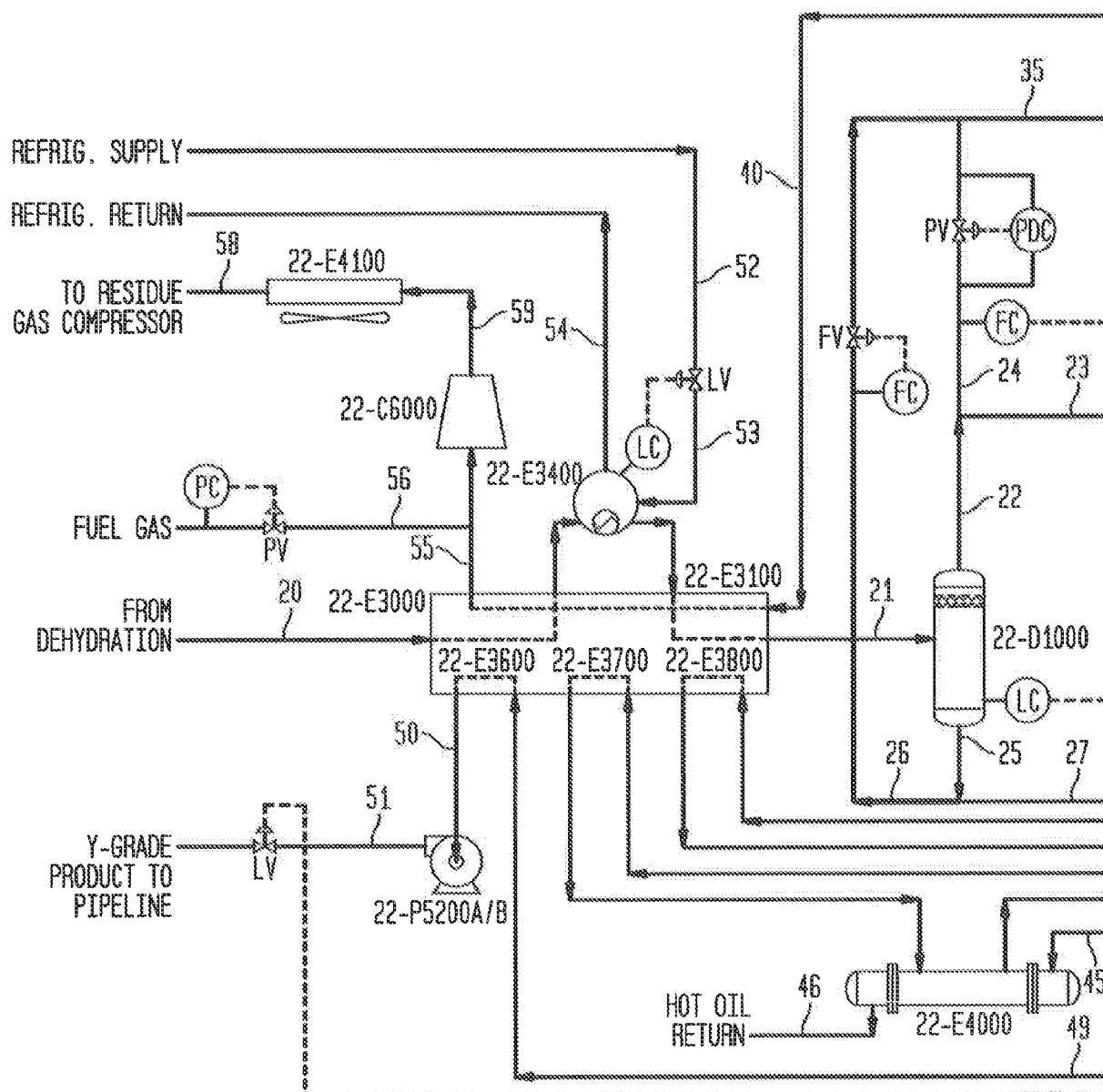


FIG. 2B



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FIG. 3A



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FIG. 3B

