

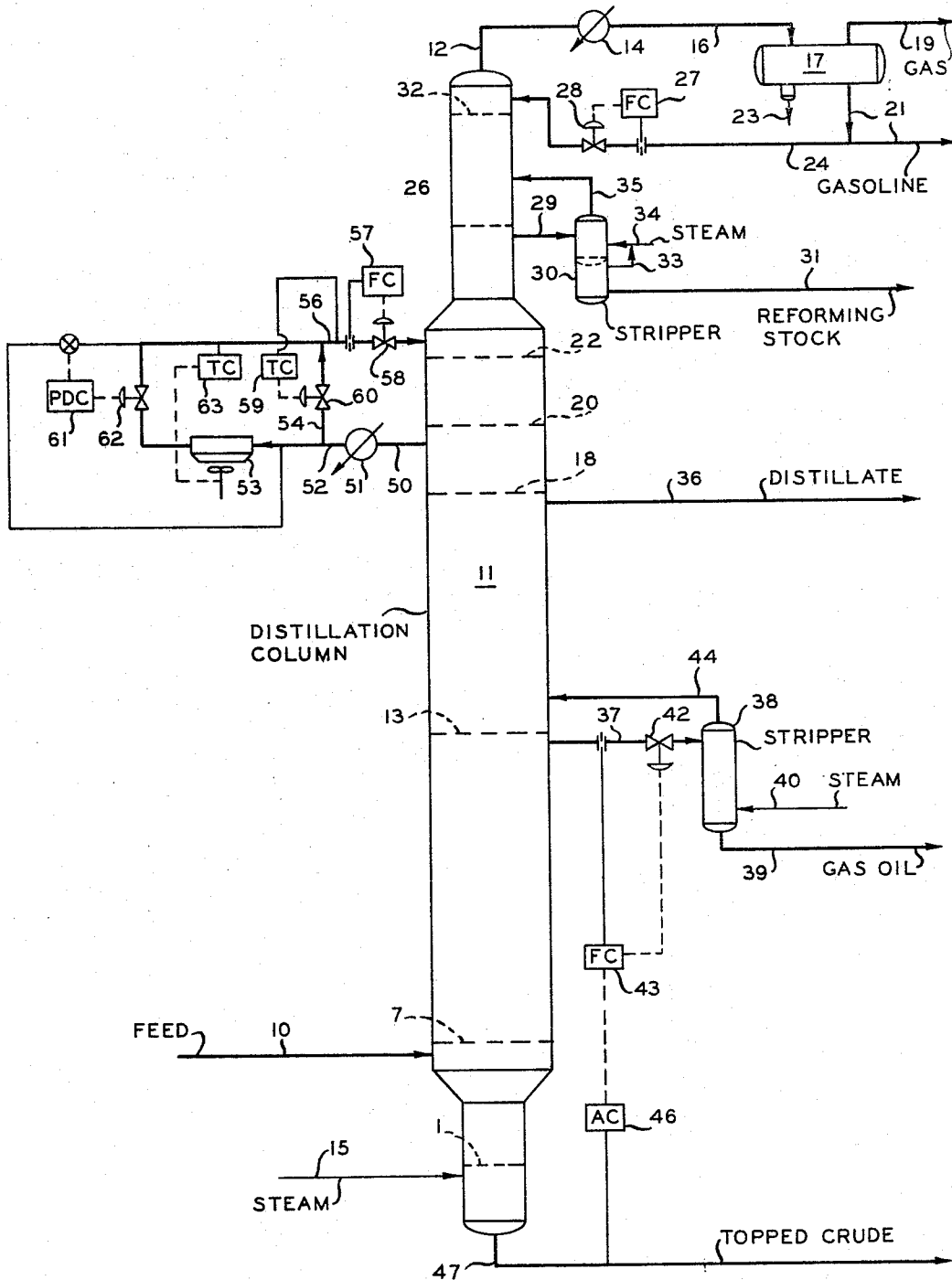
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DISTILLATION CONTROL SYSTEM

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DISTILLATION CONTROL SYSTEM

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This invention relates to an improved distillation control system. In another aspect, this invention relates to an improved distillation control system wherein a side stream is withdrawing from the distillation column, cooled and recycled as reflux to the distillation column. In yet another aspect, this invention relates to a distillation control system wherein the composition of the residual product stream is controlled by the withdrawal of a product fraction from an intermediate region of the distillation column.

A distillation process wherein a multi-component fluid mixture is introduced into a vertical distillation column is conventionally employed to separate a multi-component fluid feed mixture into multiple product fractions. Temperatures, pressures, and reflux ratios within the distillation column must be closely controlled to obtain product fractions of high purity. Temperature control throughout a distillation or fractionation column is normally difficult to maintain. Where product fractions are withdrawn from intermediate regions of the distillation column, temperature control of the distillation column becomes even more difficult. Not only, under these circumstances, must the top and bottom temperatures be closely controlled but it becomes necessary to control the distillation column temperatures throughout the distillation column.

Accordingly, an object of my invention is to provide an improved distillation control system.

Another object of my invention is to provide an improved distillation control system wherein the temperature of a distillation column reflux stream is controlled.

Another object of my invention is to provide an improved distillation reflux stream temperature control system.

Another object of my invention is to provide an improved system for controlling the composition of a residual product fraction withdrawn from a distillation column.

Other objects, advantages and features of my invention will be readily apparent to those skilled in the art from the following description, the drawing and appended claims.

By my invention I have provided an improved distillation control system wherein a liquid side stream is withdrawn from a distillation column and passed to a first cooling zone; a portion of the cooled side stream effluent is passed to a second cooling zone; the effluent from the second cooling zone is combined with the remainder of the effluent from the first cooling zone not passed to the second cooling zone, and the combined mixture recycled to the fractionation column as a reflux stream. I have further provided an improved fractionation control system wherein a process variable of a residual fraction withdrawn from the fractionation zone representative of the composition is measured and a rate of flow of a product side stream fraction withdrawn from an intermediate region of the fractionation column is manipulated responsive thereto.

My invention in providing for the two stage cooling of a reflux side stream provides improved temperature control of the recycled stream and thus substantially better temperature control within the fractionation column. By cooling only a portion of the reflux liquid in a second cooling zone and combining the effluent from the second cooling zone with the remainder of the effluent from the

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first cooling zone, reflux stream temperature fluctuations are eliminated or reduced to a minimum. By my invention, a recycle stream at a controlled temperature is passed to a fractionation column at a constant rate of flow.

The drawing is a schematic representation of one embodiment of my invention.

Referring to the drawing, the invention will hereinafter be described as applied to a particular fractionation process. It is not intended, however, that the invention should be limited to the specific embodiments presented therein. A lube crude oil at the rate of 25,000 barrels per stream day (BPSD) and having an API gravity of 44.0 is passed via conduit means 10 to distillation column 11. The crude oil feed to distillation column 11 comprises a vapor-liquid mixture wherein the vaporous fraction comprises 77 liquid volume percent. The temperature of the feed passed to distillation column 11 is 655° F.

As illustrated, distillation column 11 can comprise a three section distillation column wherein the lower section comprises a four feet, 6 inches diameter section containing six perforated trays, the middle section comprises a twelve feet diameter section containing 16 perforated trays, and the upper section comprises an eight feet diameter section containing 10 perforated trays. As illustrated, the feed is introduced into distillation column 11 below the seventh tray. 250 p.s.i.g. steam is introduced into distillation column 11 below the first tray at the rate of 3820 pounds per hour. A top temperature of 178° F., a top pressure of 8 p.s.i.g., a bottom temperature of 625° F. and a bottom pressure of 10 p.s.i.g. are maintained within distillation column 11.

A vaporous fraction is withdrawn from the top of distillation column 11 via conduit means 12 and passed to a heat exchange means 14 such as a U-tube heat exchanger wherein the vaporous fraction is partially condensed. A vapor-liquid mixture is passed from heat exchange means 14 via conduit means 16 to an accumulator 17. A vaporous residual gaseous fraction is withdrawn from the top of accumulator 17 via conduit means 19. A product gasoline fraction is withdrawn from accumulator 17 via conduit means 21 at the rate of 1898 BPSD, said gasoline product fraction having an API gravity of 77.6. Water is withdrawn from the water leg of accumulator 17 via conduit means 23 at the rate of 510 barrels per day. The temperature and pressure within accumulator 17 is maintained at 100° F. and 3 p.s.i.g., respectively. A portion of the liquid contained within accumulator 17 is recycled via conduit means 21 and 24 to the top of distillation column 11 as a top reflux stream, at 8400 B/D.

A liquid side stream is withdrawn from the 26th tray and passed via conduit means 29 to a stripping column 30. The temperature of the liquid stream passed to stripper 30 is 260° F. Within the upper section of stripper 30, the liquid feed is contacted with 250 p.s.i.g. stripping steam passed to stripper 30 via conduit means 34 at the rate of 1780 pounds per hour. A vaporous fraction comprising 1810 pounds per hour of water and 1800 pounds per hour of hydrocarbon vapors is withdrawn from the top of stripper 30 via conduit means 35 and recycled to distillation column 11. A reforming stock product fraction is withdrawn from the bottom of stripper 30 via conduit means 31 at the rate of 3382 BPSD, said reforming stock product fraction having an API gravity of 60.5. A bottom temperature of 245° F. and a bottom pressure of 12 p.s.i.g. is maintained within stripper 30.

A distillate product fraction is withdrawn from the 18th tray of distillation column 11 via conduit means 36 at the rate of 8024 BPSD, said distillate product fraction having an API gravity of 46.0. The temperature of the distillate product fraction withdrawn from distillation column 11 is 385° F.

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A liquid side stream is withdrawn from the 13th tray of distillation column 11 via conduit means 37 and passed to a stripper 38. Within stripper 38, the liquid feed is contacted with 250 p.s.i.g. stripping steam passed to stripper 38 via conduit means 40 at the rate of 1150 pounds per hour. A vaporous fraction comprising 1150 pounds per hour of water and 1350 pounds per hour of hydrocarbon vapors is withdrawn from the top of stripper 38 via conduit means 44 and recycled to distillation column 11. A product gas oil fraction at a temperature of 590° F. is withdrawn from the bottom of stripper 38 via conduit means 39 at the rate of 2642 BPSD, said gas oil fraction having an API gravity of 36.2.

A residual top crude fraction is withdrawn from the bottom of distillation column 11 via conduit means 47 at the rate of 7283 BPSD, said top crude fraction having an API gravity of 24.9.

Having described the process flow, the inventive distillation control system will now be described.

A liquid side stream is withdrawn from the 20th tray of distillation column 11 via conduit means 50 and passed to a conventional heat exchange means 51, such as a U-tube heat exchanger, wherein the liquid side stream is cooled from a temperature of 365° F. to a temperature of 244° F. The liquid side stream is withdrawn from tray 20 at the rate of 32,745 BPSD, said liquid side stream having an API gravity of 46.5.

A portion of the effluent from heat exchange means 51 is passed via conduit means 52 to a second heat exchange means, such as an air fin cooler 53, wherein that portion of the liquid side stream passed to said second heat exchange means is further cooled. The remainder of the effluent from heat exchange means 51 is passed via conduit means 54 to conduit means 56 wherein said remainder of the effluent from heat exchange means 51 is combined with the cooled effluent from heat exchange means 53 and the combined mixture recycled to the 22nd tray of distillation column 11.

The rate of flow of the combined cooled effluent mixture to distillation column 11 via conduit means 56 is controlled by a conventional flow controller 57 opening and closing valve 58 responsive to a rate of flow measurement in conduit 56 and a set point representative of a desired reflux flow rate to distillation column 11. The rate of flow of effluent from heat exchange means 51 via conduit means 52 and conduit means 54 to conduit means 56 is controlled by a conventional temperature controller 59 opening and closing valve 60 responsive to the temperature of the combined cooled effluent side stream and a set point representative of a desired side stream reflux temperature.

The rate of flow through heat exchange means 53 is controlled by a conventional pressure differential controller 61 opening and closing valve 62 responsive to a difference in pressure measurements in conduit 52 and conduit 56, as illustrated, and a set point representative of a desired pressure differential. The flow through valve means 60 and 62 is correlated to produce a desired combined effluent flow rate in conduit 56 downstream of the communication of conduit 54 with conduit 56.

The cooling within heat exchange means 53 is controlled by a conventional temperature controller 63 responsive to a temperature measurement of the effluent from heat exchange means 53 in conduit 56 and a set point representative of a desired temperature of the cooled effluent flowing from heat exchange means 53.

A process variable representative of the composition of the top crude flowing through conduit 47 such as viscosity is measured by a conventional analyzer controller 46. Responsive to this analysis measurement and a set point representative of the desired top crude composition, a signal is transmitted by analyzer controller 46 as a set point to a conventional flow controller 43. Flow controller 43 opens and closes valve 57 responsive to a rate of flow measurement in conduit 37 and the set point transmitted

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from analyzer controller 46, thereby manipulating the rate of flow through conduit 37 responsive to the composition measurement of the fluid flowing through conduit 47.

It is also within the scope of this invention to recycle a portion of the product gas oil fraction from stripper 38 to the distillation responsive to the composition measurement of the fluid flowing through conduit 47 so as to maintain the composition of said fluid substantially constant. In this embodiment, recycle of gas oil to the distillation zone is controlled and not the rate of flow of liquid to stripper 38.

As will be evident to those skilled in the art, various modifications of this invention can be made, or followed, in the light of the foregoing disclosure, without departing from the spirit or scope thereof.

I claim:

1. A distillation process which comprises passing a feed mixture to a distillation zone, withdrawing a vaporous stream from the upper region of said distillation zone, withdrawing a liquid stream from the lower region of said distillation zone, passing a liquid side stream from an intermediate region of said distillation zone to a first cooling zone, passing at least a portion of the resultant cooled side stream from said first cooling zone to a second cooling zone, combining the remainder of the effluent stream from said first cooling zone with the effluent stream withdrawn from said second cooling zone, passing at a substantially constant flow rate the resultant combined cooled mixture of said distillation zone above the point of withdrawal of said side stream from said distillation zone, manipulating the rate of flow of effluent from said first cooling zone to said distillation zone responsive to a temperature measurement of said combined cooled mixture, and manipulating the rate of flow through said second cooling zone responsive to a differential pressure measurement, said differential pressure measurement comprising the difference in measurements representative of the pressure of the effluent withdrawn from said second cooling zone and the feed to said second cooling zone.

2. The process of claim 1 further including measuring a process variable of the effluent withdrawn from said second cooling zone representative of the temperature of said effluent, and manipulating the cooling within said second cooling zone responsive thereto.

3. The process of claim 2 wherein said feed mixture is a crude oil, said vaporous stream comprises residue gas and gasoline, and said liquid withdrawn from said lower region is a topped crude.

4. The process of claim 1 further comprising passing a liquid side stream from an intermediate region of said distillation zone to a stripping zone, passing a vaporous stream from said stripping zone to said distillation zone, withdrawing a liquid stream from the lower region of said stripping zone, measuring a process variable of said liquid stream withdrawn from the lower region of said distillation zone representative of the composition thereof, and manipulating the rate of flow of said liquid side stream to said stripping zone responsive to such composition measurement.

5. The process of claim 4 wherein said feed mixture is a crude oil, said liquid stream withdrawn from said lower region is a topped crude fraction, and said measurement representative of said composition comprises a measurement representative of the viscosity of said liquid stream withdrawn from the lower region of said distillation zone.

6. Apparatus comprising a distillation column, first conduit means in communication with the top of said distillation column, second conduit means in communication with the bottom of said distillation column, third conduit means in communication with an intermediate region of said distillation column, a first heat exchange means, a second heat exchange means, fourth conduit means communicating between an intermediate region of said distillation column and said first heat exchange means, fifth conduit means communicating between said first heat ex-

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change means and said second heat exchange means, sixth conduit means communicating between said second heat exchange means and said distillation column, the point of communication between said sixth conduit means and said distillation column being above the point of communication between said fourth conduit means and said distillation column, seventh conduit means communicating between said fifth conduit means and said sixth conduit means, means for maintaining a rate of fluid flow through said sixth conduit means downstream of the communication between said seventh and said sixth conduit means substantially constant, means for manipulating a rate of fluid flow through said seventh conduit means responsive to a temperature measurement in said sixth conduit means downstream of the communication between said sixth and said seventh conduit means, and means for maintaining a rate of flow through said second heat exchange means responsive to a pressure differential between a pressure measurement in said fifth and said sixth conduit means.

7. Apparatus comprising a distillation column, first conduit means in communication with the top of said distillation column, second conduit means in communication with the bottom of said distillation column, third conduit means in communication with an intermediate region of said distillation column, a first heat exchange means, a second heat exchange means, fourth conduit means communicating between an intermediate region of said distillation column and said first heat exchange means, fifth conduit means communicating between said first heat exchange means and said second heat exchange means, sixth conduit means communicating between said second heat exchange means and said distillation column, the point of communication between said sixth conduit means and said distillation column being above the point of communication between said fourth conduit means and said distillation column, seventh conduit means communicating between said fifth conduit means and said sixth conduit means, means for maintaining a rate of fluid flow through said sixth conduit means downstream of the com-

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munication between said seventh and said sixth conduit means substantially constant, means for manipulating a rate of fluid flow through said seventh conduit means responsive to a temperature measurement in said sixth conduit means downstream of the communication between said sixth and seventh conduit means, means for maintaining a rate of flow through said second heat exchange means responsive to a pressure differential between a pressure measurement in said fifth and said sixth conduit means, means for measuring a temperature in said sixth conduit means upstream of the communication between said sixth and said seventh conduit means, and means for manipulating the cooling within said second heat exchange means responsive to said temperature measurement in said sixth conduit means upstream of the communication between said sixth and seventh conduit means.

8. Apparatus in accordance with claim 6 further comprising a stripping column, eighth conduit means communicating between an intermediate region of said distillation column and said stripping column, means for measuring a process variable of a fluid flowing through said second conduit means representative of the composition of said fluid flowing through said second conduit means, and means for controlling the rate of flow through said eighth conduit means responsive to such composition measurement.

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