

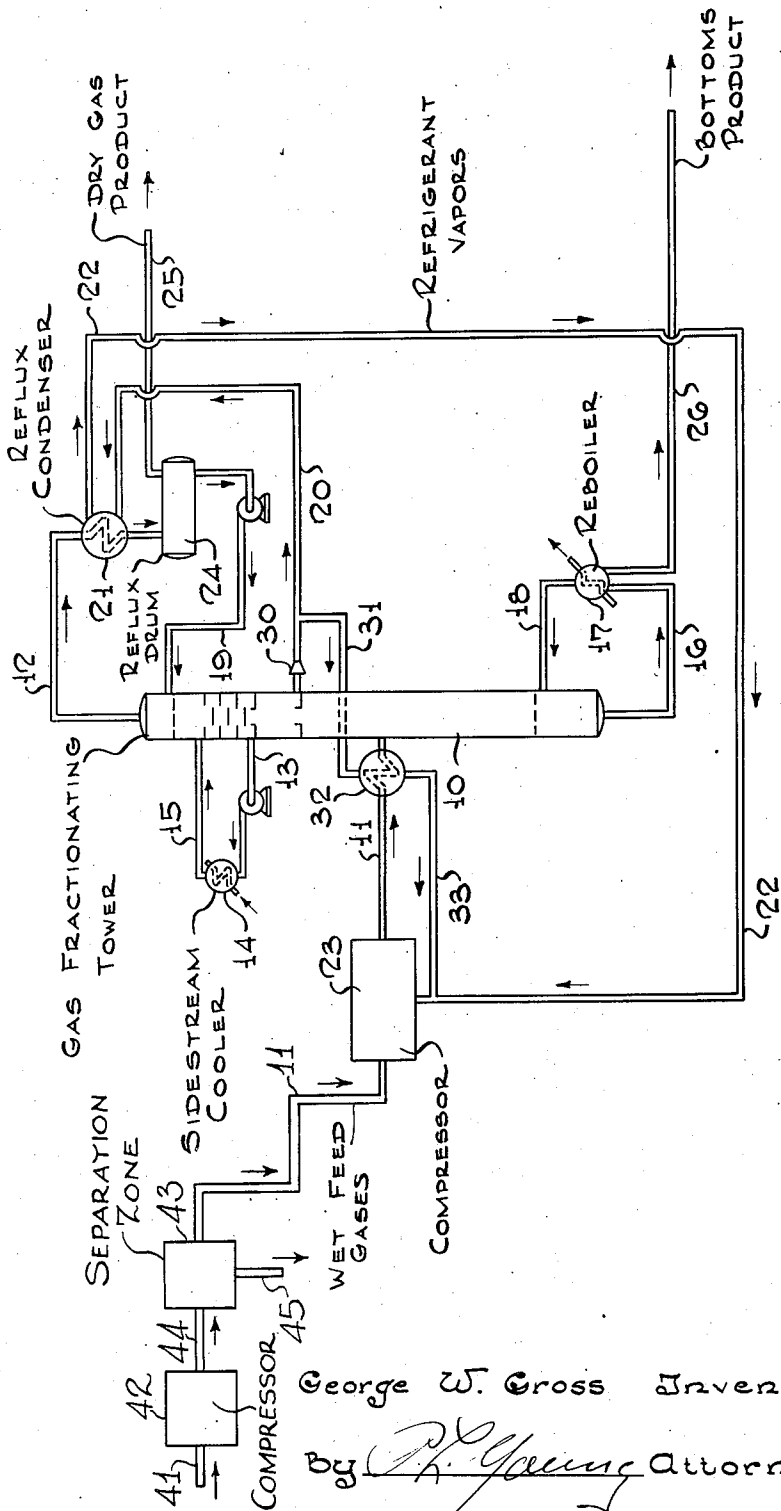
May 10, 1949.

G. W. GROSS

2,469,724

HYDROCARBON FRACTIONATING

Filed Dec. 27, 1946



George W. Cross Inventor

By R. Young Attorney

UNITED STATES PATENT OFFICE

2,469,724

HYDROCARBON FRACTIONATING

George W. Gross, Linden, N. J., assignor to Standard Oil Development Company, a corporation of Delaware

Application December 27, 1946, Serial No. 718,851

1 Claim. (Cl. 183—114.6)

1

This invention relates to the fractionating of hydrocarbon mixtures and in particular to fractionation of normally gaseous hydrocarbons from oil-field and petroleum refinery mixtures.

In petroleum refining today, large volumes of hydrocarbon gaseous mixtures are obtained. From these mixtures many valuable gaseous compounds are recovered. Local conditions usually determine the most advantageous means of processing these mixtures to separate desired constituents. The present invention is concerned with the processing of normally gaseous hydrocarbon mixtures for the separation of individual constituents by fractionation under pressure. The particular feature of the invention is the employment of side stream products to provide refrigeration for the liquefaction of the highly volatile overhead gaseous products. This use of constituents of the feed supply to obtain the refrigeration for convenience of processing more volatile constituents overcomes the prior art need of external refrigeration.

In order that the invention may be more fully understood, the following specific description in connection with the accompanying drawing is presented as an embodiment, but not a limitation, of the invention.

For purposes of illustration, treatment of a feed stock obtained from an oil-field plant will be taken. A typical composition of such a feed stock is as follows:

	Mol Percent
C ₁ and lighter-----	52.6
C ₂ -----	18.1
C ₃ -----	19.3
i-C ₄ -----	2.2
n-C ₄ -----	2.9
i-C ₅ -----	1.3
n-C ₅ -----	0.8
C ₆ -----	1.0
C ₇ + -----	1.8

In this illustration, a feed stock of the above composition is introduced through line 41 to a compressor 42 wherein sufficient pressure is applied to condense the easily liquefiable C₅ to C₇ hydrocarbons. The stream of uncondensed gases and liquefied hydrocarbons are removed from compressor 42 through line 44 and are introduced to separation zone 43 wherein the liquefied hydrocarbons are separated from the uncondensed gases. Thus the liquefied hydrocarbons constituting the C₅ to C₇ and higher hydrocarbons are removed from separation zone 43 through line 45 while the remaining uncondensed gases are passed through line 11 to the compression equipment 23. In equipment 23, the gas is compressed to a pressure of about 440 pounds per square inch. The substantially liquefied composition is then

2

cooled in heat exchanger 32 and passed into about the middle of fractionation tower 10. This tower is usually of the bubble plate type. The fractionation tower in this particular illustration contains bubble cap plates of about 30 plates in number. The tower 10 is shown as being equipped with an overhead vapor line 12, an upper liquid side stream exit line 13 connected to a cooler 14 and return line 15, reboiler inlet line 16, reboiler 17, reboiler vapor return line 18, a reflux line 19 and side stream exit line 20, and a condenser 21. Heat is shown as being maintained in the column 10 by means of the reboiler system 16, 17 and 18. Temperature control of about 105° F. in the upper part of the tower is maintained by the cooler system 13, 14 and 15 and the amount of reflux through line 19. The stream admitted through line 15 has a temperature of 90° F. and the reflux stream through line 19 has a temperature of 50° F. A pressure of about 430 pounds per square inch is maintained upon the tower and the directly connected equipment, the condenser 21, cooler 14 and the reboiler 17.

The overhead product passing from the tower at 115° F. through line 12 enters condenser 21. The condenser 21 is cooled to about 35° F. by the vaporization of the side stream material removed from the tower from a plate located near the exit of line 20. To effect this vaporization, the pressure upon the side stream product may be reduced as shown in the device 30, or as in this embodiment, partly in device 31 and partly in condenser 21, to about 20 pounds per square inch.

The composition of this stream is:

	Mol Percent
C ₂ -----	3.0
C ₃ -----	85.2
i-C ₄ -----	11.8
n-C ₄ -----	

After passing through the condenser 21, the side stream material passes through line 22 into the multi-stage compression equipment 23 and thereafter is supplied into line 11 with the feed supply to the tower 10. The overhead material from the tower 10 after passage through the condenser 21 passes into the drum 24. From the drum 24, the liquid product is passed into line 19 as reflux entering the tower at a temperature of about 50° F. The composition of the reflux stream is:

	Mol Percent
C ₁ -----	11.2
C ₂ -----	20.6
C ₃ -----	63.5
i-C ₄ -----	1.6
n-C ₄ -----	3.1

The vapor product from the drum 24 is passed through line 25 for further processing. The com-

3

position of this stream in this particular embodiment is:

	Mol Percent
C ₁ -----	58.4
C ₂ -----	20.0
C ₃ -----	21.1
i-C ₄ -----	0.2
n-C ₄ -----	0.3

The distillation residue is removed through line 16 into the reboiler 17. From the reboiler 17 portion of the liquid material is returned through line 18 to provide the necessary heat for the operation of tower 10. The temperature of the stream admitted through line 18 is about 330° F. The remainder of the liquid is passed through line 26 for further processing. The composition of this stream is:

	Mol Percent
C ₃ -----	1.7
i-C ₄ -----	20.3
n-C ₄ -----	27.3
i-C ₅ -----	13.3
n-C ₅ -----	8.5
C ₆ -----	10.1
C ₇ -----	18.8

The applicant's invention is thus concerned with the processing in a low temperature gas fractionating tower requiring overhead refrigeration. The applicant's invention is in regard to the use of a side stream material for supplying the refrigeration largely through the reflux stream instead of the conventional method involving external circuits for one or more of the streams supplied to the tower. Furthermore, temperature control can be easily effected in the distillation zone, according to the invention, by interadjustment of the volume of the reflux stream and the amount of pressure reduction on the side stream fraction. Also, the vaporized side stream may be used to cool the feed supply after compression as shown in the drawing by the circuit indicated by reference numerals 31, 32 and 33.

Processing according to the applicant's invention provides refrigeration together with the fractionation of the constituents of the hydrocarbons mixture. The integral refrigeration-fractionation system thus consists of withdrawing a liquid side stream from the tower, using the side stream as a refrigerant and recycling the refrigerant vapors after passing through compression equipment to the fractionation tower. The refrigerant vapors may be added to the feed gas at any stage, depending upon the refrigerant pressure and temperature required at the reflux condenser. To minimize compression requirements, the refrigerant vapors should be added to the feed gases at the highest pressure level. Heat removal for condensing the major portion of the reflux is provided by the side stream cooler at a temperature level not requiring refrigeration.

The integral refrigeration-fractionation system of the applicant's invention has many processing advantages. Of these, the main advantages are:

4

1. A substantial investment saving is obtained in comparison with the conventional system of using external refrigeration system.

2. Greater simplicity in the tower operation and space requirements is realized because of the compactness of the fractionating tower and integral refrigeration system, and the relatively few equipment pieces.

3. In the conventional closed-type refrigeration system, trouble is frequently encountered due to the accumulation of light "wild" gases. The integral refrigeration system is relatively free of this difficulty.

What is claimed is:

A process for separating a complex mixture of C₁ to C₈ hydrocarbons which comprises subjecting said mixture to a pressure sufficient to liquefy C₅ to C₈ hydrocarbons, removing the liquefied C₅ to C₈ hydrocarbons leaving a residual mixture of C₁ to C₄ hydrocarbons, subjecting the said mixture of C₁ to C₄ hydrocarbons to a pressure sufficient to substantially liquefy the mixture, passing said liquid mixture into a fractionating zone, operated at about 430 p. s. i., separating from said fractionating zone an overhead gaseous fraction comprising principally C₁ hydrocarbons at a temperature of about 105° F., two liquid side stream fractions comprising principally C₃ hydrocarbons, and a bottoms fraction comprising principally C₄ hydrocarbons, reducing the pressure on one of the said liquid side stream fractions to about 20 p. s. i., to effect substantial vaporization, cooling the overhead gaseous fraction by indirect heat exchange with a part of said vaporized side stream fraction, cooling the incoming feed stock to the fractionating zone with another part of the said vaporized side stream fraction, condensing a portion of the cooled overhead gases providing a gaseous product and a condensed liquid, removing from said cooled overhead fraction the gaseous product, recycling the condensed liquid as reflux into the fractionating zone at a temperature of about 50° F., compressing the vaporized side stream material after said heat exchange and recycling said compressed side stream product into said fractionating zone and cooling the second liquid side stream fraction to a temperature of about 90° F. and passing the cooled second liquid side stream to an upper part of the fractionating zone above the point at which the second liquid side stream was withdrawn.

GEORGE W. GROSS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,074,094	Blau -----	Sept. 23, 1918
1,415,058	Schill -----	May 9, 1922
1,924,196	Miller -----	Aug. 29, 1933
2,000,992	Schlitt -----	May 14, 1935