PROCESS FOR THE FRACTIONATION OF NATURAL GAS

Martin Friedrich Wilhelm Reinhold Streich, Nieder Eschbach, Kreis Friedberg, Germany, assignor to Messer, Griesheim GmbH, Frankfurt am Main, Germany, a corporation of Germany

Filed Jan. 17, 1967, Ser. No. 69,854

Claims priority, application Germany, Feb. 5, 1966, M 68,286

U.S. Cl. 48—196

7 Claims

ABSTRACT OF THE DISCLOSURE

A process for the fractionation of a gas mixture comprising high and lower boiling hydrocarbons including rectification in a stripping column wherein a sump fraction and a head fraction are produced in the column and the reflux necessary for performing the rectification is produced by cooling the head fraction by at least partly vaporizing the sump fraction under reduced pressure.

The present invention is concerned with a new and improved process for the fractionation of natural gas. In certain localities, natural gas is available in large quantities. From these localities, it is brought to the consumption centers through pipeline systems, in some cases with the interposition of transport in liquid form. The economic pressure in a long distance pipeline is generally in the range from 30 to 70 atmospheres.

In addition to the main component, namely methane, high grade natural gas contains the heavy paraffin hydrocarbons in more or less high concentrations, the separation of which may be of interest for various reasons. In the first place, the calorific value of natural gas can be adjusted to a desired value by separating the heavy hydrocarbons, the complete separation of ethane frequently not being carried out in order to improve the calorific value. In addition, the heavy hydrocarbons constitute a potential starting material for a petrochemical industry situated near the pipeline or for the liquid gas market. A process is known in which the heavy hydrocarbons are separated by partial condensation or are concentrated by two-stage partial evaporation. In this process, the degree of separation of the higher hydrocarbons is determined by the initial concentrations, the fractionation pressure and the fractionation temperature, so that it is not freely selectable in respect of the individual components. This method is, for example, disadvantageous when low yields of ethane but high yields of propane and all higher boiling hydrocarbons are desired. As compared with this method, processes in which the natural gas is partially condensed in a plurality of stages at different temperatures, afford a certain, although likewise limited, selectivity.

In addition, a process is known in which a liquefied natural gas is introduced into the middle portion of a fractionation column and is separated therein into a high boiling sump liquid and a head gas having a high methane content; the reflux for the top portion of the column being produced by partial liquefaction of the head gas by means of cold natural gas. This process is based on natural gas supplied in liquid form.

Another method of fractionating natural gas likewise makes use of separation by rectification and consists in that the cooling for producing the reflux is supplied by at least partial expansion of the methane-containing head gas in a vortex tube. In this process, the sump of the stripping part of the column is heated. This method is disadvantageous when there is no use, under reduced pressure, for the quantity of methane produced by the expansion and this methane must, for example, again be re-compressed to the pipeline pressure.

According to the present invention, there is provided a process for the separation and concentration of heavy hydrocarbons present, for example, in natural gas, with the use of a rectifying column, while avoiding the above-mentioned limitations and disadvantages wherein at least a part of the cooling required for producing the reflux is produced by partial evaporation of sump liquid which is under reduced pressure.

The evaporation of the sump liquid in the process according to the present invention is advantageously effected only to such an extent that methane can be removed in the following demethanising column without the necessity of incorporating a concentration or intensification part in the head of the demethanising column.

The process according to the present invention affords particular advantages, especially when the natural gas under high pressure, because the degree of separation of heavy hydrocarbons is higher for a given quantity of liquid than in the method using partial condensation. In addition, the expense of producing the reflux is lower, provided that the starting material is gaseous natural gas, and the demethanisation of the heavy hydrocarbons can be effected more easily, because this is carried out under reduced pressure with more favourable relative volatilities.

At extremely high natural gas pressures, it may be convenient, in order to obtain the most favourable separating effect, for the natural gas which is to be fractionated, before it enters the column, to be expanded in such a manner as to perform work or to be expanded isenthalpically. In the case of the present invention, it is immaterial whether this expansion takes place at a high temperature for the purpose of producing energy or at a low temperature for the purpose of producing a given degree of separation.

Considerable concentration of the heavy hydrocarbons can finally be achieved by the isobaric connection of a concentration column downstream of the stripping column.

For the purpose of describing the present invention, it will now be described in more detail with reference to the accompanying drawings, in which:

FIGURE 1 illustrates a flow diagram of an installation for the limited separation, from natural gas, of ethane and for the almost complete separation of all hydrocarbons having higher boiling points than ethane; and

FIGURE 2 illustrates a flow diagram of a portion of the installation according to FIGURE 1 in which, in contradistinction to FIGURE 1, the natural gas is expanded before entering the column and is then fed into the middle of the rectifying column.

The natural gas fractionating plant which is illustrated in FIGURE 1 and which can be used for carrying out the process according to the present invention, comprises a rectifying column 7, a demethanisation column 21, driers 3A and 3B, a countercurrent vessel 5, a reflux condenser 9 and a re-compressor 27. In the plant illustrated in FIGURE 2, in addition to the re-compressor 27, there is provided an additional re-compressor 37. The turbine 38 (FIGURE 2) serves for the partial expansion of the natural gas.

From the natural gas arriving in pipeline 1, the quantity wanted for the fractionation is branched off and fed through pipe 2 to one of the two driers 3A, 3B, and possibly to additional purification units (not illustrated). The purified gas is then available in pipe 4, upstream of the low temperature plant, at, for example, a pressure of 50...
3 atmospheres and a temperature of 20°C. A typical composition of such a gas is:

- 90.9 volume percent of CH₄
- 7.2 volume percent of C₂H₆
- 1.6 volume percent of C₃H₈
- 0.2 volume percent of C₄H₁₀
- 0.1 volume percent of C₅H₁₃

In the countercurrent vessel 5, the gas is cooled to about -50°C by heat exchange with two incoming methane fractions and fed through pipe 6 into the bottom part of the rectifying column 7. A mixture of methane and ethane is removed from the head of the column through a pipe 8, whereafter it is further cooled by removal of heat, in the manner explained hereinafter, and partly liquefied. This liquid-vapour mixture flows through pipe 10 to a separator 11, from which the first methane fraction escapes through pipe 12, while through pipe 13 the reflux passes to the column 7.

When starting with a purified gas of the above-given composition, the liquid collecting in the sump of the column 7 has a composition of:

- 70.0 volume percent CH₄
- 20.6 volume percent C₂H₆
- 7.1 volume percent C₃H₈
- 1.0 volume percent C₄H₁₀
- 0.4 volume percent C₅H₁₃

In addition to methane, this fraction contains all hydrocarbons in the desired quantity. A slight excess of ethane is present, because a small proportion of the ethane separated is lost with the second methane fraction. The sump liquid is drawn off through pipe 15, expanded in valve 16 and passed through pipe 17. The cooling effect in the reflux condenser 9 and, therefore, the liquid/vapour ratio at the entry of the column 21, can be adjusted either via the bypass 19 and 20 or by increasing the pressure of the sump liquid in the system 17, 18, 9 by means of valve 32.

In the demethanisation column 21, the heavy hydrocarbon fraction is freed of methane to the desired extent at a pressure of 21 atmospheres and then passed through pipe 24 to the remainder of the fractionating plant. The heat for the upward flow of the vapour is supplied in column 21 via two separate heat exchangers 22 and 23. The use of two heat exchangers permits a more favourable adaptation of the working to the equilibrium curve or the recovery of a certain amount of cooling at a lower temperature level, which is, for example, advantageous for the transformation of the cooling to the level of the reflux condenser 9.

The second methane fraction is drawn off through pipe 25, re-heated to ambient temperature in the heat exchanger 5, passed through pipe 26 to a re-compressor 27, compressed therein to approximately pipeline pressure, re-mixed with the heated first methane fraction drawn off through 12, 5 and 14, and introduced via pipe 29 into the continuation 31 of the pipeline. When the plant is not in operation, the unfractonated natural gas passes from the line section 1, through valve 30, directly to the line section 31.

The cooling required in the reflux condenser 9 additionally to the sump cooling, can be supplied in conventional manner through pipe 33, for example, by using a propane-ethane cascade or by means of cold produced by pre-expansion of the natural gas, as illustrated in FIGURE 2.

According to a modification of the method illustrated in FIGURE 1, the natural gas is expanded before entering the column 7. Before being fed into the pipeline through 29, all the methane must be re-compressed in the compressor 37. A part of this compression energy can be supplied by the turbine 35. Introduction of the natural gas into the middle of the column 7 permits extensive methane separation in column 7 itself. The necessary gas heat is supplied via the heat exchanger 38. The remainder of the cooling for the reflux condenser is supplied by partial expansion of the natural gas in the turbine 35. The first methane fraction is returned via the reflux condenser 9 and gives up sensible cold.

It is to be understood that the present invention is not restricted to the specific embodiments described above and illustrated in the accompanying drawings. On the contrary, many variations are possible in the various steps of the process, without departing from the scope of the present invention.

What we claim is:

1. A process for the fractionation of a gas mixture comprising methane and higher boiling hydrocarbons, preferably natural gas, by means of rectification in a stripping column wherein a sump fraction and a head fraction are produced in the column, and the reflux necessary for performing the rectification is produced by cooling the head fraction by at least partly vaporizing the sump fraction under reduced pressure.

2. A process according to claim 1, wherein the vaporizing of the sump fraction is effected only to such an extent that the methane is later removed from the sump fraction in a following demethanisation column without the necessity for any concentration part being in the demethanisation column.

3. A process according to claim 2, wherein before entering the stripping column, the gas mixture to be fractionated is expanded in such a manner as to perform work.

4. A process according to claim 2, wherein before entering the stripping column, the gas mixture to be fractionated is expanded isentropically.

5. A process according to claim 1, wherein methane is later removed from the sump fraction in a following demethanisation column, the demethanisation column being heated by two separate heat exchangers.

6. A process according to claim 5, wherein the heat exchangers are at different temperature levels.

7. A process according to claim 3, wherein the demethanisation column is heated by two separate heat exchangers.

References Cited

UNITED STATES PATENTS

2,557,171 Bodel, et al. 6/1951 Bodle et al. ------ 48—196 XR
2,658,360 11/1953 Miller 48—190 XR
2,712,730 7/1955 Spangler 48—196 XR
2,771,149 11/1956 Miller et al. ------ 48—196
3,241,933 3/1966 Plout et al. ------ 48—196
3,531,214 7/1970 Proctor et al. ------ 48—196
5,407,052 10/1995 Huntress et al. ------ 48—196

MORRIS O. WOLK, Primary Examiner
R. E. SERWIN, Assistant Examiner

U.S. Cl. X.R.

62—52; 208—350