May 28, 1963 H. LINDE 3,091,095

PROCESS FOR THE DECOMPOSITION OF GASES LOW IN ETHANE, PREFERABLY FOR THE PRODUCTION OF PURE ETHYLENE

Filed Aug. 19, 1960 2 Sheets-Sheet 1

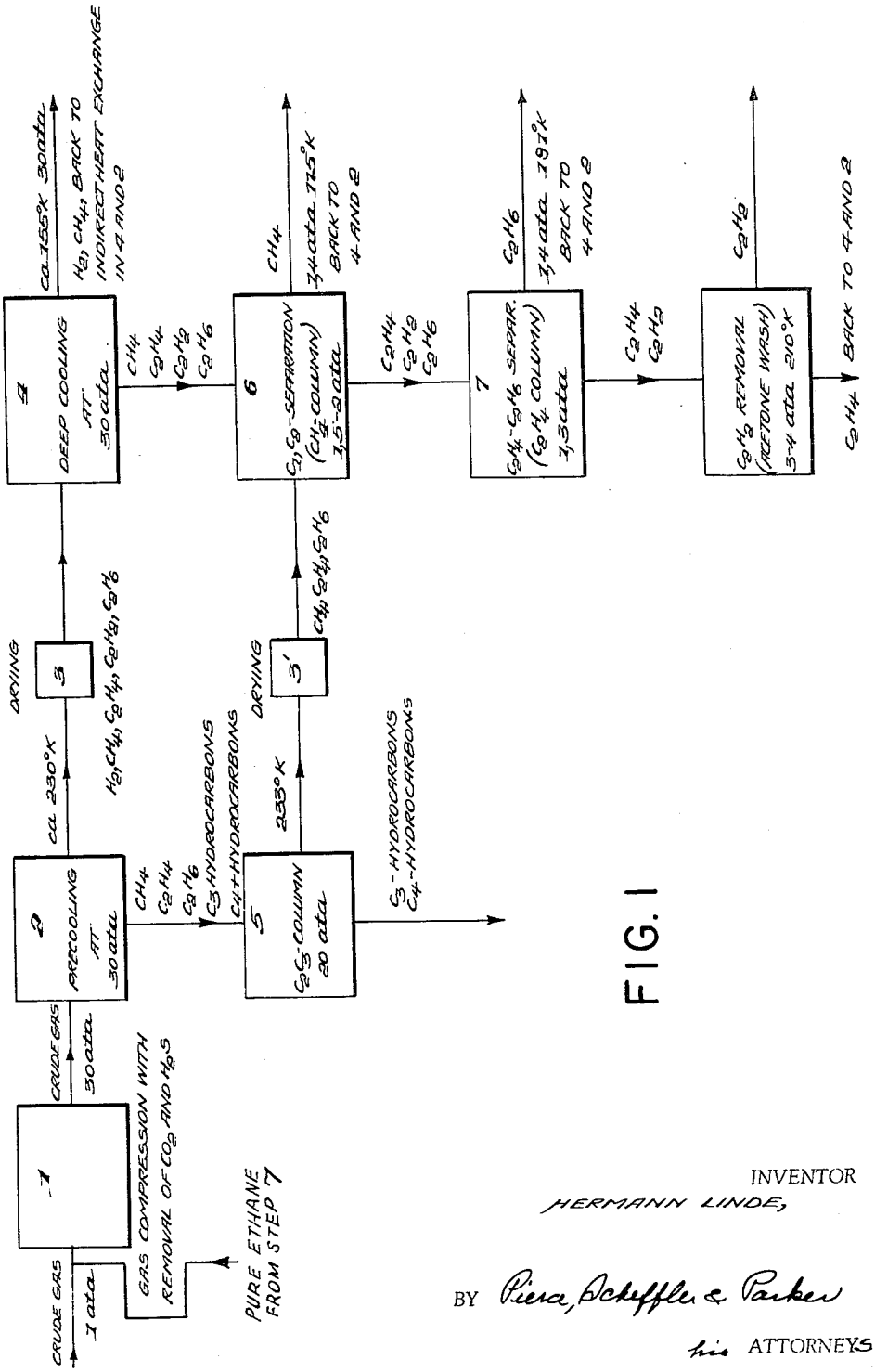


FIG. 1

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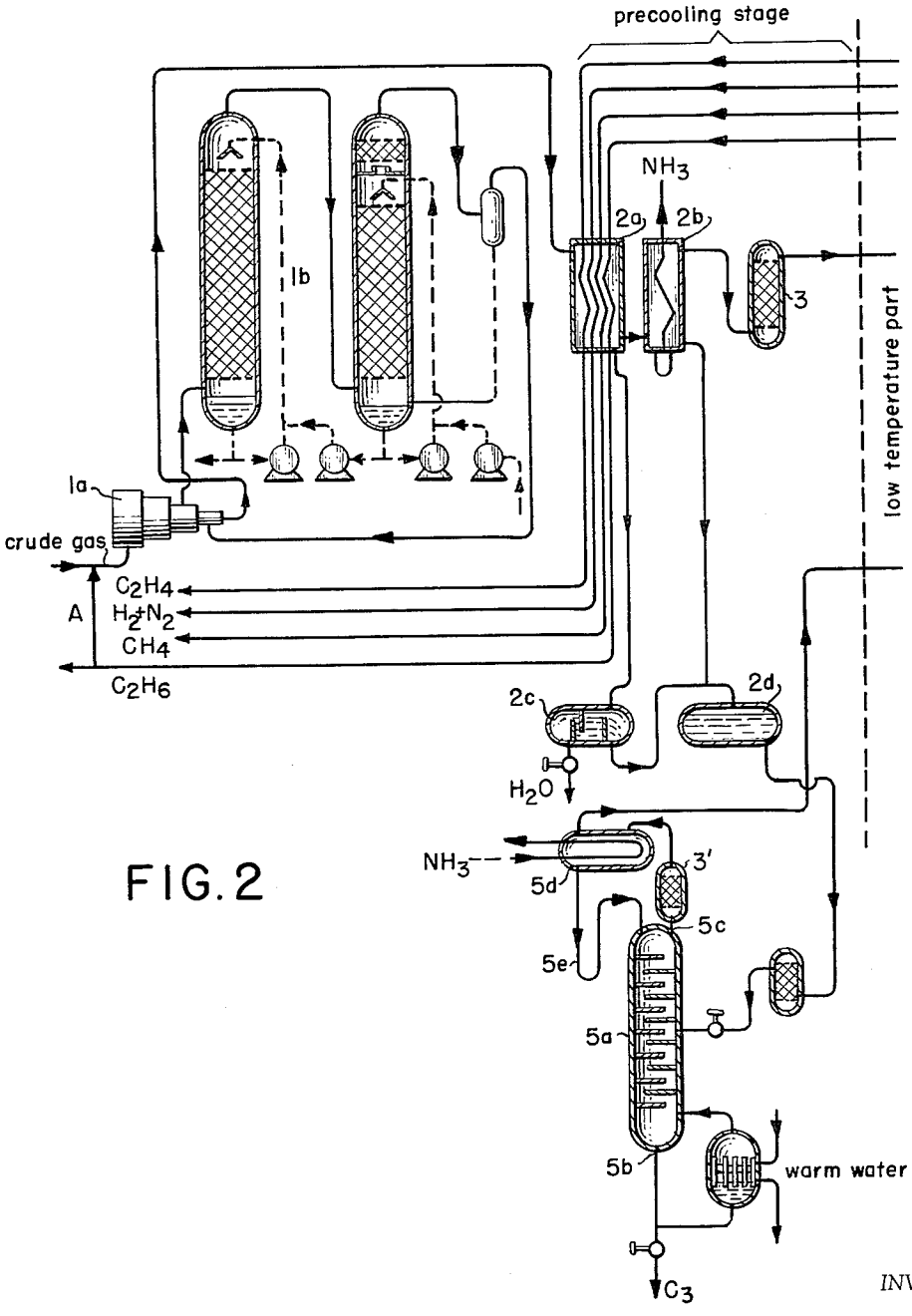


FIG. 2

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3,091,095

PROCESS FOR THE DECOMPOSITION OF GASES LOW IN ETHANE, PREFERABLY FOR THE PRODUCTION OF PURE ETHYLENE

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1 Claim. (Cl. 62—28)

The working up of hydrocarbon gases low in ethane but possibly high in C_3 hydrocarbons in ethylene systems encounters certain difficulties. In fact, due to the low ethane content there is usually a shortage of C_2-containing reflux liquid in the precooler to eliminate the C_3 hydrocarbons as completely as possible. Such gas mixtures having a low ethane content as mainly those resulting from cracking oil and light gasoline, are prepared for the production of ethylene and propylene. The consequence of this shortage is that the C_3 hydrocarbons are entrained into the low-temperature part of the separating plant, and that they appear there in the sump of the ethylene column and collect in impermissibly high amounts in the ethane fraction. Moreover, due to the elevated content of C_3 hydrocarbons in the ethane fraction, the sump temperature of the ethylene-ethane separating column rises, which is extremely annoying for the operation of the system. This refers to concentrations of at least 4 or 5% by volume to about 15 or 20% by volume of C_3 hydrocarbons.

It is the object of the present invention to prevent entrainment of C_3 hydrocarbons from the precooler into the low-temperature part of the separating plant because of too low an ethane content in the crude gases. Therefore, in the separation of C_3 hydrocarbons from the C_1 and C_2 hydrocarbons, effected by precooling, the yield of C_3 hydrocarbons is to be increased in such cases and the ethane purity improved.

According to the process of the invention this object is achieved in that a portion of the ethane returning as pure decomposition product from the system is introduced into the crude gas line ahead of the crude gas compressor. An optimum effect is obtained when the portion of pure decomposition product recycled is such that in the stationary state the ethane concentration of the crude gas going to the decomposition apparatus is about 5 to 10% by volume.

The process of the invention will now be further explained, with reference to the accompanying drawing, in which:

FIG. 1 is a block diagram or flow sheet illustrating a procedure falling within the scope of the present invention; and

FIG. 2 is a diagrammatic representation of apparatus operable for use in carrying out the process of the application, including a scrubbing step as described herein.

First, as shown in FIG. 1, the crude gas is compressed to about 30 atmospheres with removal of CO_2 and H_2S (step 1), and then is precooled to about 230° K. (step 2). This causes the C_3, and higher, hydrocarbons as well as the amounts of C_1 and C_2 hydrocarbons corresponding to the equilibrium conditions to separate out. The resulting precooling condensate enters a C_2/C_3 fractionating column operated at 20 atmospheres (step 5), from which the C_3, and higher, hydrocarbons are withdrawn as sump liquid. The reflux liquid of this column consists mainly of ethane. If the amount thereof in the crude gas or in the precooling condensate is too small, then the C_3 hydrocarbons cannot be washed out of the head product of the C_2/C_3 column completely enough and they pass together with the draining methane, ethane, and ethylene into the methane column (step 6), into which is fed also the bulk of CH_4, C_2H_4, C_2H_6 and C_2H_2 separated from the C_3-free

crude gas stream by deep cooling to 155° K. (step 4). After the separation of the methane, the C_2 hydrocarbons flow together with any C_3 hydrocarbon impurities into the ethylene column (step 7), where the ethane is separated as liquid. In the processing of gases low in ethane there concentrate here in the sump of the ethylene column all C_3 hydrocarbons which due to the shortage of C_2-containing reflux liquid in the C_2/C_3 column have been entrained into the low-temperature portion. Thereby the yield of C_3 hydrocarbons is reduced, and, moreover, the purity of the resulting ethane is greatly impaired.

According to the invention it is now proposed, in the decomposition of hydrocarbon gas mixtures low in ethane, to return a portion of the pure ethane recovered from the system to the crude gas compressor together with the entering crude gas (step 1). By this measure the ethane content of the crude gas supplied to the precooler is increased. In this way it is then possible to form highly concentrated C_2-hydrocarbons-containing condensate at the head of the C_2/C_3 column, whereby the washing out of C_3 hydrocarbons is promoted. For this reason, and also because now the ethane fraction drawn from the sump of the ethylene column is increased by the recycling of the ethane, the C_3-hydrocarbons-content in the sump of the ethylene column decreases. The resulting reduction of the sump temperature again involves a considerable relief for the operation of the system.

The process of the invention may be further explained by reference to FIG. 2 as basis.

The crude gas is compressed in compressor 1*a*, freed from H_2S and CO_2 in the alkaline purification towers 1*b*, and then—after additional compression in the compressor output stage—is subjected to precooling. For this purpose the compressed crude gas is led into heat-exchanger 2*a* in counterflow to the cold separation products leaving the low temperature part of the plant, and subsequently is cooled in cooler 2*b* by the use of ammonia. This cooler 2*b*, which forms part of the precooling stage, acts as reflux condenser its function being the complete separation of the C_3 and higher valence hydrocarbons from the gas mixture. The separation is accomplished by condensation of the C_3 and higher valence hydrocarbons and by the simultaneous washing out of any C_3 hydrocarbons which are still in gaseous state under vapor pressure at precooling temperature (230° K.) by means of a C_2-containing fluid. Therefore, the crude gas must contain a sufficiently large amount of C_2 hydrocarbons to insure efficient operation of the installation.

The condensation product from heat-exchanger 2 is then separated from water in a separator 2*c* and thereupon is combined with the condensation product from cooler 2*b*. This fluid is then led into, and rectified within, the C_2/C_3 tower 5*a*. The C_3 (and higher valence) hydrocarbons collect in the sump of tower 5*a* at point 5*b*, and the C_2 hydrocarbons are removed at point 5*c*, at the top of the tower. This top product is dried in drying vessel 3' and from the product there is condensed, in the condenser, by use of vaporizing NH_3, a reflux which consists mainly of ethane. This reflux is fed into the tower 5*a* by way of pipe 5*e*. The dry gaseous C_2 mixture, when leaving the cooler 5*d*, and the gas mixture dried in drying vessel 3, when leaving the cooler 2*b*, are then conducted to the low-temperature part of the plant where they are separated into their components (see steps 4, 6, 7 and 8 illustrated in FIG. 1).

If the crude gas has a comparatively low ethane content with respect to the content of C_3 (and higher valence) hydrocarbons, the amount of C_2 hydrocarbon—especially the amount condensed by the precooler 2*b*—will not suffice to completely wash out the C_3 component which remains in gaseous state after the condensation of the C_3 (and higher valence) hydrocarbons at the precool-

ing temperature: in this event, the disadvantages, explained in paragraph 1 of the specification, will be encountered.

Furthermore, the low content of C_2 hydrocarbons in the precooling condensation product will adversely affect the operation of the C_2/C_3 tower because there again the C_2 content of the reflux will be too low to permit a rectifying separation for the purpose of obtaining a head, or top, product which contains C_2 hydrocarbons exclusively and a sump product which contains C_3 (and higher valence) hydrocarbons exclusively. The result will be that the head product of the C_2/C_3 tower, conducted to the low-temperature part of the plant, will also contain C_3 hydrocarbons, thereby compounding the disadvantageous conditions described in the first paragraph.

The invention avoids these disadvantages by adding to, and mixing with the crude gas, a large amount of the ethane gained in the form of a separation product prior to the compression of the crude gas as shown in FIG. 2 at point A; the ethane content of the crude gas will therefore amount to approximately 5 to 10 vol. percent.

The separation products withdrawn from the deep cooling stage (step 4), the methane column (step 6), the ethylene column (step 7) and the acetone wash, are warmed by indirect heat-exchange with the gases to be separted in the precooling stage (step 2) and deep cooling stage (step 4) thereby cooling said gases to be separated.

I claim:

In the process of obtaining substantially pure ethylene from crude hydrocarbon gas mixtures, containing ethylene and having a low ethane content and a C_3 hydrocarbons content which is high relative to the ethane content, in a decomposition system in which the crude gaseous mixture is compressed whereby to separate out any CO_2 and H_2S contained in the crude hydrocarbon gas mixture, precooled whereby to liquefy the C_3 and higher hydrocarbons as well as amounts of C_1 and C_2 hydrocarbons corresponding to equilibrium conditions, and then the resulting condensate is fractionated using a refluxing liquid consisting mainly of C_2 hydrocarbons, the improvement which consists in increasing the yield of C_3 hydrocarbons and simultaneously improving the purity of the ethane fraction by returning to the crude gaseous mixture, prior to compression thereof, such an amount of the substantially pure ethane fraction produced in the decomposition system that in the stationary state the ethane concentration of the gas mixture supplied to the decomposition system is from about 5 to about 10% by volume thereby increasing, in the precooling stage, the amount of C_2 hydrocarbons-containing liquid necessary for completely liquefying by scrubbing the C_3, and higher, hydrocarbons.

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