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[54] **CRYOGENIC EXTRACTION PROCESS FOR NATURAL GAS LIQUIDS**

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[58] Field of Search 62/17, 20, 23, 24, 27, 62/28, 29, 43, 40; 208/340

[56] **References Cited**

UNITED STATES PATENTS

3,367,122	2/1968	Tutton	62/40
3,236,057	2/1966	Tafreshi	62/40
3,407,613	10/1968	Muller	62/27
3,405,530	10/1968	Denahan	62/28
3,707,066	12/1972	Carne	62/11
3,354,663	11/1967	Hendrix	62/28
2,582,148	1/1952	Nelly	62/23
3,362,175	1/1968	Burns	62/20
2,952,984	9/1960	Marshall	62/27
2,973,834	3/1961	Cicalese	208/340
3,358,461	12/1967	Hendrix	62/17

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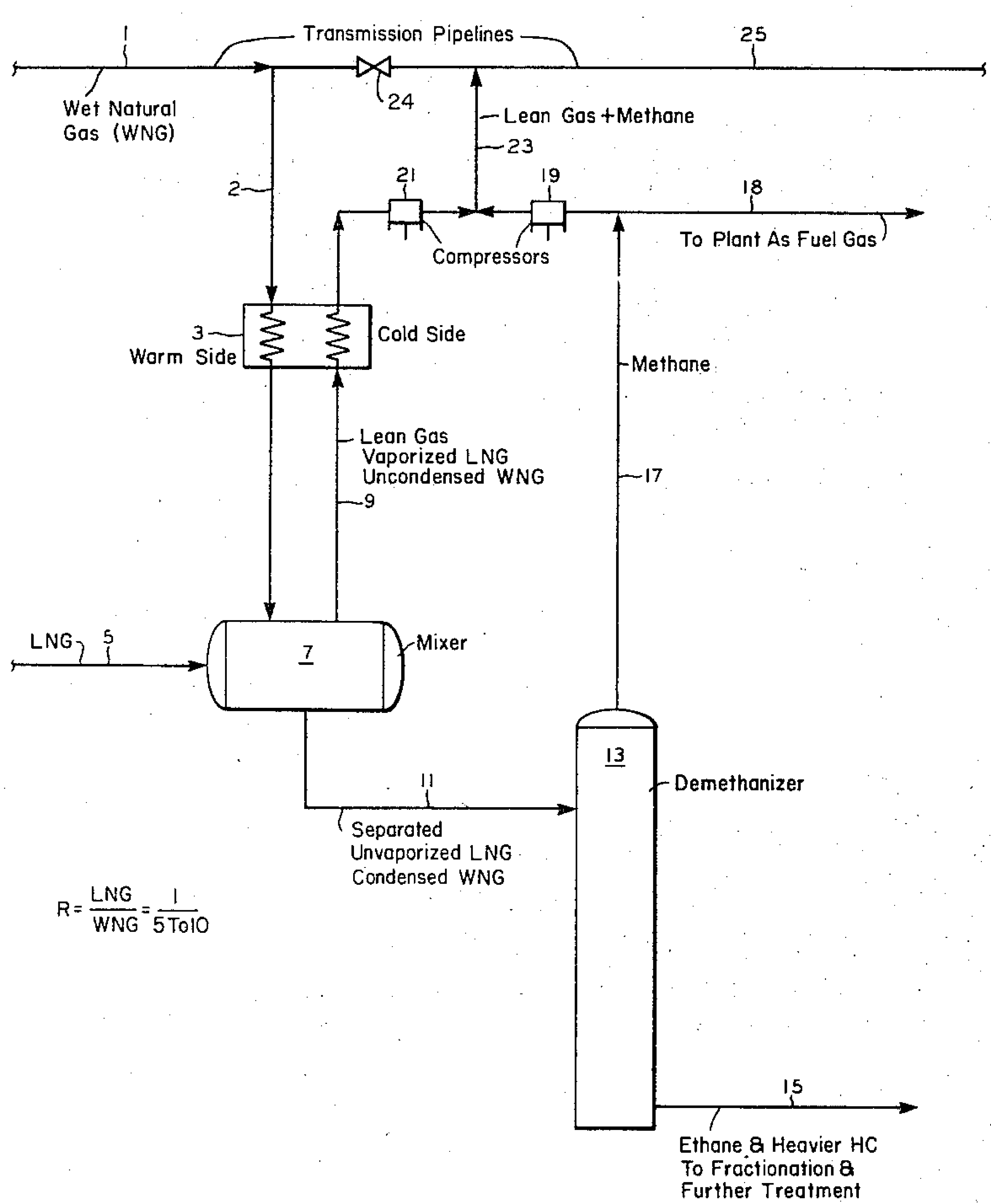
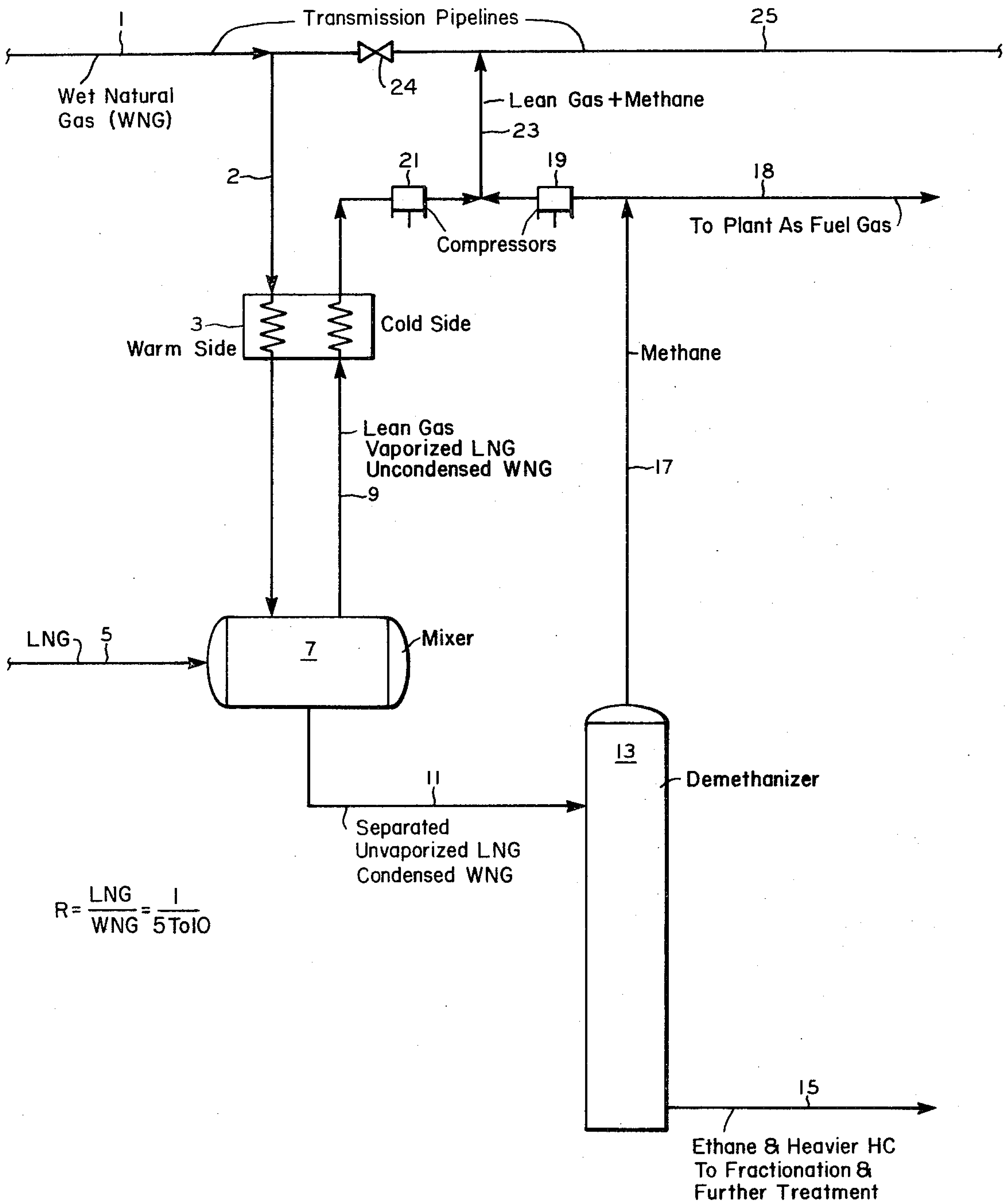
[57] **ABSTRACT**

A process for the cryogenic extraction of natural gas liquids through the vaporization and direct heat exchange of liquefied natural gas with a wet natural gas.

5 Claims, 1 Drawing Figure





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CRYOGENIC EXTRACTION PROCESS FOR NATURAL GAS LIQUIDS

This invention relates to a process for the removal of natural gas liquids through cryogenic extraction. In another aspect, this invention relates to a process for vaporizing liquefied natural gas by direct heat exchange with a wet natural gas stream. Particularly, this invention relates to a process for the utilization of liquefied natural gas as a heat sink for cryogenic extraction purposes.

It is increasingly the practice to liquefy natural gas for convenient transport to places where it can be utilized. On arrival, liquefied natural gas is vaporized and used as fuel or for other purposes. At the same time, the considerable expense of liquefying the natural gas in the first instance can be partially recovered by utilizing the liquefied natural gas as a heat sink, namely by utilizing the cold inherent in the liquefied natural gas which is made available for use in the course of the vaporization process.

Various methods for liquefying gases such as natural gases, principally methane, and the like, have either been proposed or used. Vaporizing liquefied natural gases after transporting or storing them at atmospheric pressure is not a simple matter. If part of the liquefied gas is burned to supply all of the heat required to vaporize the gas, up to 2 percent by volume of the gas can be required as fuel. Further, it is impractical to heat the liquefied gas with air by means of air fin heat exchangers because of the heavy frost formed during the heating steps. Thus, it can be seen that there is a distinct need for a practical and economical process for vaporizing the liquefied gas at the place of utilization and also to recover and utilize the refrigeration obtainable during the vaporization process.

It is an object of this invention to provide an economical and efficient process for the separation of natural gas liquids from pipeline natural gas and liquefied natural gas sources. It is another object of this invention to provide a process for the efficient vaporization of liquefied natural gas utilizing the liquefied natural gas as a heat sink for the above cryogenic extraction.

Other aspects and objects of this invention will hereinafter appear in the examples and claims included hereinbelow. Accordingly, the problems discussed above, associated with the prior art methods of vaporizing liquefied gases, are resolved by the practice of the present invention.

The process of this invention also involves a cryogenic extraction method for separating components of natural gas streams and more particularly, a method of separating: (1) methane and varying amounts of ethane, (2) ethane and/or propane and higher boiling point hydrocarbon constituents, and (3) heavier hydrocarbons found in natural gas pipeline streams. Many processes have been developed and numerous plants constructed to accomplish the separation set forth above. These processes principally involve external refrigeration, cooling by expansion of natural gas, and/or solvent absorption. The aforementioned separation processes known to the art have failed to utilize or recognize the possibility of separating natural gas liquids through cryogenic extraction by the blending of liquefied natural gas with pipeline natural gas.

In accordance with the present invention, there is provided an improved process for the cryogenic extraction of natural gas liquids and for the vaporization of liquefied natural gas. In practicing my invention, a wet natural gas source, for example, from a pipeline stream is chilled by direct heat exchange with liquefied natural gas within a suitable vessel which not only vaporizes the liquefied natural gas but performs a cryogenic extraction of natural gas liquids. The resulting lean natural gas stream is taken from the mixing tank and returned to the natural gas transmission pipeline. The natural gas liquids resulting from the cryogenic extraction process are removed to a demethanizer wherein separated methane is either used for plant fuel or returned to the natural gas transmission pipeline. The natural gas liquids are removed from the demethanizer equipment for further fractionation separation and storage.

The present invention will now be illustrated by the following calculated example, wherein reference is made to the accompanying drawing which is a flow diagram for practicing the invention.

Example

A wet natural gas stream **1** under a pressure of about 850–1000 psia and an ambient temperature consisting of methane, 95 mole percent; ethane, 3 mole percent; propane, 0.65 mole percent; hydrocarbons of at least 4 carbon atoms per molecule representing in total 0.15 mole percent; carbon dioxide, 0.80 mole percent; and nitrogen, 0.40 mole percent; enters the system at a constant rate of one million cubic feet per day (mcfd). The pipeline gas flows through a gas line **2** and passes into the warm side of heat exchanger **3**. The pipeline gas possesses an approximate combustion energy level of 1,035 BTU per cubic foot. The thus cooled, wet pipeline natural gas stream flows into a mixing and natural gas liquids collector apparatus **7** wherein it is contacted directly with a liquefied natural gas stream **5**. The liquefied natural gas stream **5** is under an equivalent pressure as that of the pipeline gas, at a temperature of about −258°F and consists of methane, 88 mole percent; ethane, 11 mole percent; and propane, 1 mole percent. The liquefied natural gas stream **5** as described above enters the mixing apparatus **7** at a rate of 142,128 mcfd with the gas possessing an approximate combustion energy level of 1,108 BTU per cubic foot. The liquefied natural gas is mixed with the wet pipeline natural gas in apparatus **7** wherein direct heat exchange and cryogenic extraction occurs. In the mixing and natural gas liquids collector apparatus **7**, the liquefied natural gas is vaporized at least in part and the wet natural gas is condensed at least in part, resulting in a cryogenic extraction of the natural gas liquids comprising from about 3 to about 35 mole percent of both the wet and the liquefied natural gas streams. The resulting lean gas leaves the mixing and natural gas liquids collector apparatus **7** through line **9**, and separated natural gas liquids leave the mixing and natural gas liquids collector apparatus **7** through line **11**. The lean natural gas flows through line **9** to the heat exchanger **3** wherein it passes into the cold side of the heat exchanger **3**. The lean natural gas is compressed in compressor **21** and is returned through line **23** to the natural gas transmission pipeline **25**.

The natural gas liquids resulting from the cryogenic extraction are transferred through line **11** to a demethanizer **13** wherein methane is removed through line **17** with ethane and heavier hydrocarbons being removed through line **15** to fractionation treatment and storage.

The methane resulting from the demethanizer **13** flows through line **17** and is either fed through a plant fuel outlet **18** for plant consumption or continues to compressor **19** before being returned to the natural gas transmission pipeline **25.** The natural gas transmission pipeline **1** has a valve means **24** for regulating pipeline flow as offset by plant requirements.

Exemplary of the above system would include a calculated example having a liquefied natural gas (LNG) volume of 142,128 mcfd compared to one million mcfd of wet natural gas. The ratio by volume of LNG to wet natural gas would be 142,128 as compared to one million; therefore, the LNG represents 14.2 percent by volume of the total feed. Altering the ratio of LNG to wet natural gas feed will alter the percentage of the various hydrocarbons actually recovered. This ratio could vary over a fairly wide range from about 10 to about 20 percent by volume.

The following extractions would be possible with the conditions as described hereinabove and are established for exemplary purposes: ethane, 75 percent; propane 95 percent; butane 98 percent; pentanes +99 percent; wherein the percentages are based on percent by volume. Economics and other needs will allow some reduction in the percentages of ethane and propane recovered. The invention permits the recovery of natural gas liquids not only in the feed gas but also in the LNG stream. The calculated figures, based on conditions disclosed and with extraction levels as shown above, are: total extraction shrink from feed gas stream and LNG stream = 46,836 mcfd; total feedgas + LNG = 1,142,128 mcfd; volume percent NGL recovered to feedgas = LNG = 4.1 percent.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in the construction and arrangement of this disclosure within the scope of my invention as defined by the appended claims.

What I claim is:

1. A process for the extraction of ethane and heavier hydrocarbons from a wet natural gas containing methane, ethane and propane and the vaporization of a portion of a liquefied natural gas containing methane, ethane and propane, comprising:

passing a first stream of the liquefied natural gas and a second stream of the wet natural gas into a mixing zone so as to vaporize a portion of the liquefied natural gas and condense a portion of the wet natural gas;

removing from the mixing zone a third stream comprising the vaporized liquefied natural gas and the wet natural gas which is not condensed;

removing from the mixing zone a fourth stream comprising the condensed wet natural gas and the liquefied natural gas which is not vaporized;

passing the fourth stream to a demethanizer;

removing a fifth stream comprising methane from the demethanizer; and

removing a sixth stream from the demethanizer comprising hydrocarbons in the fourth stream heavier than methane.

2. The process of claim **1** wherein the third stream is passed in indirect heat exchange relationship with the second stream.

3. The process of claim **2** wherein the second stream is removed from a pipeline, and at least a portion of the third stream and at least a portion of the fifth stream are returned to the pipeline.

4. The process of claim **3** wherein said wet natural gas comprises about **95** percent methane.

5. The process of claim **1** wherein the ratio of liquefied natural gas to the wet natural gas is in the range of about 10 to about 20 percent by volume.

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