Clarke, Modet & C°
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REF EXPEDIENTE No.: 04 067546
PATENTE : APARATO PARA LA LICUEFACCION DE GAS
NATURAL Y METODOS RELACIONDOS CON EL MISMO
SOLICITANTE: BECHTEL BWXT, IDAHO LLC.

ASUNTO: SOLICITUD ESTUDIO DE FONDO

DILIA RODRIGUEZ D ’ALEMAN, en ml condición de apoderada de la Sociedad solicitante, por el presente escrito atentamente solicito a Usted que habiØndose surtido la publicación de la presente solicitud, en la Gaceta de la Propiedad Industrial No.559

de fecha Diciembre 31, 2005 se proceda con el estudlo de Fondo.

Para tal fin me permito anexar la tasa correspondiente.

Agradezco continuar con el presente trÆmite.

SeæorJefe,

DILIA RODRI
T.P.No. 208

P-561 41

D ’ALEMAN

SUPERINTENDENCIA BE INDUSTRIA V COMERCIO

RECIBO OFICIAL BE CAJA 06 - 12,074 FECHA FEBRERO 13 BE 2006

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NIT: 800176089-2

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DEPOSITANTE TIPO P460 BANCO CUENTA No. P460 FECHA P60 yr. P460 --

CLARKE MODET V CO. COLOMBCONSIGNACION BANCO POPULAR 050-00110-6 50534202 13/02/2006 5,315,000.00

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CANT. RENTISTICO CONCEPTO TOTAL CONCEPTO

1 50005-01-01 SOLICITUDES 114 FTC CAP-IT EXAMEN DE FATENTIBILID 194,000.00
TOTAL: $ 194,000.00

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RECIBO BE CAJA APLICADO AL EXPEDIENTE No.

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DIVISION DE NUEVAS CREACIONES

RADICACION EXPEDIENTE No. 04.. 67546

EL EXTRACTO DE LA PRESENTE SOLICITUD DE PATENTE DE INVENCION

- PCT, FUE PUBLICADO EN LA GACETA DE PROPIEDAD INDUSTRIAL No

559, DE FECHA 30 DE DICIEMBRE DE 2005, EL TERMINO HABIL SEIALADO

POR LA LEY EXPIRA EL 28 DE MARZO DE 2006.

soNOTA: Dentro del plazo de los seis (6) meses siguientes a partir de la fecha de publicaciOn en (a gaceta de Propiedad Industrial, deberÆsolicitar y cancelar el examen de patentabilidad so pena de que la solicitud caiga en abandono, de acuerdo con lo establecido en el Articulo 44 de (a Decision 486/2000.

SE PRESENTARON OPOSICIONES POR PARTE DE TERCEROS.

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Cara 13 No. 27-00 Piso 5 V1
Connvtador 33412 21-2-34
FMC 2813125 eniI: in1b90v.c0 Santa Fe de Bogoti D.C. - Colontia

C

Aug. 25, 1959 F. KURATA ET AI.. 2,900,797
SEPARATION OF NORMALLY GASEOUS ACIDIC COMPONENTS AND METHANE

Filed May 25, 1956 3 SheetsSheet 1

FIG.I

Pu vu

400

1200

1000

uS
COO

eOO

4O0

200

$00

P..T DIAGRAM FOR
CH4-0O2 MIXTURE

31 SOLID CO2 LIQUID CO2+ CH4

Sa LIQUID C

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SOLID CO I + I

VAPOR

VAPOR CH, & CO5

TEMPERATURE

FIG. 2

- U.....

0,1 MEWAN

- 170 -ISO -ISO -$10 -00 70 -50 -30 -10 10 30 50 70 TEMPERATURE *F

JAMES PAUL KOeIN

BY FRED KURATA

ATTORNEY

Aug. 25, 1959 F. KURATA ET AL 2,9001797
SEPARATION OF NORMAI.L.Y GASEOUS ACIDIC COMPONENTS AND METHANE
Filed May 25, 1956 3 SheetsSheet 2

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MOLE CO2 IN MIXTURE

FIG.4

’a

THREE PHASE LJ

I-

- 250 -240 -220 -200 iso -iso -140
TEMPERATURE F

I!

- 120 -tOO

INveiTORS
JAMES PAUL POHN
BY

FRED KURATA

.4,

United States Patent Office 2,900,797

Patented Aug. 25, 1959

UO7fl
SEPARATION OF NORMALLY GASEOUS ACIDIC
COMPONE21M AND METHANE

Fed Karate, Lawrence, Kane., and James Paul Kahn, Bo hHL
Application May 24 I956 Serial No. 587,411
6 Claims. (CL 62-12)

This Invention relates to the seParation of normally

gaseous acidic components and I hydro- carbons. lame aspect this invention relates to the purl. ficadon of a mattane stream cntahflg carbon dioxide.

in another aspect this Invention relatCi to the removal

of carbon dioxide from natural ga.. Various normally gaseous hydrocarbon streams that

contain methane as the major component also contain normally acidic components, such as carbon dioxide, In amounts which require the separation of such normally gaseous acidic components from the gas stream. Present methods for removal of these acidic components are in-adequate and Impractical in many lnstanQçs where sub-staatiafly pure streams are desirable. Catbo, dioxide my be removed, for example, by various con$ntionsl ab-sorption methods using an amine solution or an alkali hydroxide. Water-washing also may be used for room-

"I

emov- carbon dioxide..
It Is deisrable to remove carbon dioxide from methane because the presence of that acidic components reduces the fuel value of the methane stream and also results in corrosion of the treating equipment or handling equip-

ment when small amounts of water are present. Carbon dioxide maybe present in the natural gas stream as supplied from the well or may be present as the result

of various treatmets prior to the desired separation of the carbon dioxide from the methane stream.

Processes now used for separation of acidic components from normally gaseous hydrocarbons require relatively complicated equipment and the use of relatively expensive
reactants or reagents. It Is much to be desired to provide a process for the removal or recovery of acidic compon-

ents, such as carbon dioxide, from methane containing

gases by a simpler, less expensive process. The object of this invention is to provide a method for

purification of a normally gaseous hydrocarbon stream

containing normally gaseous acidic component.. Another object of this invention isçto provide a new and useful method for removal of car,on dioxide from

natural gas.

It is still another object of this invention to provide a more economical and inexpensive process for the re- moval of carbon dioxide from methane by utilizing the

high pressure available from natural gas from the well. Still another object of this Invention I. to separate small

amounts (1 mole percent or more) of carbon dioxide or other normally gaseous acidic components from methane. Various other objects and advantages of the present invention will become apparent to than skilled In the

art from the accompanying description and disclosure. According to this invention, a mixture of methane and

carbon dioxide is cooled, while maintaining the pressure sufficiently high, sufficient to precipitate solid carbon di-oxide from a liquid phase of methane. The resulting liquid phase of methane contains less carbon dioxide than the original mixture and is, thsrefore, recovered as a product of the process by separating therefrom the solid

carbon dioxide.

2
In one embodiment of this invention, a normally

Vow= mixture containing methane as the principal corn.- ponent and carbon dioxide as an acidic impurity Is cooled under elevated pressure. The cooled stream Is then en- o panded to reduce the pressure such that finely divided Wild carbon dioxide is formed in admixture with liquid methane. The resulting slurry of solid carbon, dioxide

and liquid methane with any gaseous methane which

may be present as a result of the reduction In pressure lo are passed to a suitable separation none wham the solid carbon dioxide is separated from liquid and vaporous methane. Using the preferred operating conditions of

the present invention, the stream of methane and carbon dioxide is cooled at a pressure above fbi three phase locus

15 pressure and a temperature slightly above the three pbasi locus temperature as hereinafter described.’ This mixture is then expanded through an expansion valve, or anexpan- slon engine, to reduce the pressure to about one atnee-

sphere and the temperature to about _2580 F. At this

20 temperature and pressure there are a single liquid phase of methane, a vapor phase of methane, and a solid phase of carbon dioxide. Under these preferred conditions the

carbon dioxide content In the liquid is about 0.2 mole

percent. Any vapor present at these conditions will con- 25 win lees than 0.2 mole percent carbon dioxide, usually only a trace.

Figure 1 of the drawing, Is a diagrammatic illustration’ ofIa pressure-temperature diagram for one particular mix-
ture of methane and carbon dioxide.
so Figure 2 is a pressure-temperature diagram for two

mixtures of methane and carbon and methane, for pure methane and for pure carbon dioxide.

Figure 3 Is a plot of the three phase locus temperature and the three phase locus pressure against mole percent W carbon dioxide In the mixture of methane and carbon

dioxide.

Figure 4 Is a plot of the three phase locus of Figure 2 down to one atmospheric pressure abeolutà.
Figure 5 is a diagrammatic view of the apparatus for
40 carrying out the process.

Curve BCD of Figure i is the typical loop for vapor. liquid equilibria; C being the critical point of the mixture.

As can be seen from this figure, the solid-vapor boundary is defined by the curve BDF. The solid-liquid boundaries are defined by the two vertical lines DR and PG. There-

fore, on the curve BDP, the three phases are in equilib- rium and in coexistence. In accordance with the present invention, the proper conditions of temperature and pres- sure are selected such that the region In which solid exists

60 is avoided until after the mixture passes through the’ ex- pansion valve. In other words, conditions are such that
the mixture to be treated Is always in the liquid and/or vapor phase up to the, expansion valve.’ After the mix-ture Is cooled in a cooler. It is desirable to have the mk-

65 tare as a liquid in the region to the right of DR and above

CD of Figure 1.’ It is advantageous to cool the mixture so that its temperature approaches curve DE from the

right.
The portion of the diagram from Figure 1 represented

so by BCDE for two mixtures of carbon dIirtvI4e and math- am is represented on the plot of Figure 2. For amixture

containing 54.3 mole percent carbon dioxide the tempera-

ture must be higher than BDE In order to avoid the for- motion of solid. if this mixture is completely liquefied

65 at the lowest possible temperature, It is seen that this mixture must be kept under a pressure higher than about 710 p.si.a. and the solid will begin to form at a tempera-ture of about 850 F.
For the mixture contaIning 18 mole pecoeMt carbon dioxide, B"D’E’ Is the ’boundary curve for solid. For this mixture thu pressure must hihigherthen 490p.s.La.inordsrtocasupletely ’Itatth.iniaj.

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2,900,707

3 mum temperature of about 117’ F. The pressure and

temperature where solid forms in the liquid becomes
lower as the carbon dioxide content decreases. In a mix-ture containing about 0.2 mole percent carbon dioxide,
the mxiture can be completely liquefied under atmospheric pressure at 258 F. without the formation of solid. This means that the solubility of carbon dioxide in liquid methane is about 0.2 mole percent under these conditions. In our process we propose to maintain the pressure

higher than point D of Figure 1 or Figure 2 and cool to near the temperature DE to completely liquefy the mix-
ture without the formation of solid. The liquid is then expanded through an expansion valve to precipitate out the solid carbon dioxide. For this reason the pressure and temperature under which the mixture is liquefied de-pends upon its carbon dioxide content. Our own data show that point D for a mixture containing 8.5 mole percent carbon dioxide Is about 450 p.s.i.a. and 128’ F. This point for a mixture containing 3 mole percent

carbon dioxide is 300 p.s.i.a. and 159’ F., and for a mixture containing about 0.2 mole percent carbon dioxide

is I atmosphere absolute and 258’ F.
Figure 3 is the plot of three phase temperature and pressure vs. mole percent carbon dioxide. Figure 4 is the three phase locus down to 1 atmospheric pressure absolute. The three phase locus shown in Figures 3 and 4 will determine the minimum temperature and pressure at which any particular mixture can be liquefied without the formation of solid carbon dioxide.

Since natural gas contains certain impurities, such as ethane, hydrogen sulfide, and nitrogen, the presence of
these Impurities will alter the above limits of temperaturu

and pressure to some extent. In the initial of cooling the normally gaseous methane containing stream, the pressure should be above the three phase locus pressure while employing a sufficiently low temperature to cool

the methane containing stream without the formation of solid. The pressure, however, can be lowered with the

temperature as the carbon dioxide content decreases along the three-phase locus. Upon liquefaction of the methane,
only a single phase Is formed with a two-component mix-ture of methane and carbon dioxide. However, it is to be

recognized that if other impurities are present such as hydrogen sulfide, another liquid phase may be formed

such as a liquid hydrogen sulfide rich phase.

Figure 5 of the accompanying drawings illustrates an arrangement of apparatus of the present invention using as a working example specific operating conditions for

the continuous removal of carbon dioxide from natural gas In which the separation Is effected In accordance

with the conditions described. According to the drawing, natural gas containing about S mole percent carbon diox-ide and which has been dehydrated by conventional meam at a pressure of about 3,000 pounds per square Inch

absolute and at a ts.nperature of about 100’ F. or higher, Is passed from the well or from a compressor th,ugh conduit 11 to a cooler 12. In cooler 12 the methana

stream containing about 5 mcie percent carbon dioxide is cooled to a temperature of about 140’ F. by beat PTLbenpe with the purified methane product streams in

conduits 1$ and 13. Additional cooling by external re- frigeration (not shown) may be necessary to achieve this temperature. At this temperature and pressure, a single phase containing methane and carbon dioxide exist.. The pressure may be reduced In cooler 12 to lower the tan- Motors the desired value or to aid the cooling result-ing from the beat exchange. The pressure, however, should be maintained sufficiently high in accordance with

the temperature that the carbon dioxide does not separate as a solid from the liquid methane stream. Tha pressure is maintained above the three phase locus pressure, for

example, 750 pounds per square Inch absolute.

The liquid stream Is passed from cooler 12 through con. dolt 13 to an expansion valve or an expansion engine 14.

4
In expansion valve 14 the Is reduced to atmos-phetic and the temperature falls to about 2SO A. the boiling point of medmne. Dining the expansion ned cool-ing in expansion valve 14, atbon dioxide Iout 5 asfluccrystalsandboarrlsd over bsthepssndlltlild MUM through co*dvlt U to a conesetIceal cyclone arator 17. In cyclone separator 17 solId carbon dlodda is removed or separated from insibane as a slurry and is withdrawn from the cyclone.pavor through coudit 10 21. Liquid methane tv-’-ttl.g lass than 0.2 mole per-cent carbon dioxide Is removed from cyUaue separator 17 through conduit 13 as a product of the process. This liquid methane stream may be beat ’hngi4 with the

incoming feed in cooler 13, as shown. After best en- 15 changIng cooler 12, the methane stream may be further

expanded, if its pressure is above ahzv9heric and passed to storage as a liquid or It may be vaporized, for use as fuel or other uses. When the methane in conduit 13 Is to be stored or transported, it may not be desirable 20 to heat exchange this stream in cooler 12. Vaporous methane is also withdrawn from cyclone separator 17 through conduit 1$. This vaporous stream of methane may be heat exchanged with the inco’Ing feed In cooler 12, as shown. The vaporous stream in conduit 11 may 25 be combined with the liquid methane stream or may be disposed of from the process as fuel without departing from the scope of this Invention.
It may be preferable to use two separators Instead
of a single one shown. In this an out separator will be

30 emptied of solid carbon dioxide while the other one Is on stream. Hot In’esnIng methane can serve to vaporize

the solid carbon dioxide in the separator, limed switch-ing valves can make this alternate operation of separators autonotiL

35 if feed gas contains a large concentration of carbon dioxide, e.g,, 15 or 20 mole percent carbon dioxide, it may be advantageous to fractionate the gas down to about 5 to 10 mole percent carbon dfrwde, before using the described process to freeze out the residual carbon 40 dioxide. Here it will be necessary to operate the frac-tionator above 715 pounds per square inch absolute In order to prevent the formation of solid carbon dioxide in the fractionation equipment.
Various alternations and modifications of the steps
45 and the correlation of temperature and pressure condi-tions with specific compositions of gas will become ap-parent to those skilled In the art without departing from. the scope ofthisinvention.
Weclaim:

60 1. A procom for the separation of carbon dioxide and methane which comprises n.1MhIing a mixture of methane and carbon dioxide at a sufficiently high pressure

and a sufficiently low temperature to letely liquefy methane In which all the carbon compIn dissolved,
56 -

thereafter-

reducing the temperature on said liquid
low such that carbon doxide precip-

itates from liquid methane as a solid, and separating solid carbon dioxide fjmethane.
2. A process for the separation of carbon dioxide and
60 methane which comprises cooling a stream of methane

containing carbon dioxidewhile nt.Iuflaing a pressure such that the methane is completely liquefied and all of

the carbon dioxide Is dissolved In the liquefied methane, thereafter reducing the temperature of the completely 65 liquefied methane sufficiently low such that finely divided

solid carbon dioxide precipitates from liquid methane and separating finely divided solid carbon dioxide from methane.

3. A process for the separation of carbon dioxide and methane which comprises cooling a stream of methane containing carbon dioxide while maintaildng a pressure such that the methane is completely liquefied and all of the carbon dioxide Is dissolved In the liquefied methane, thereafter expanding the completely liquefied methane to 75 lower the temperature thereof such that finely divided

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solid carbon dioxide precipitates from liquid methane and recovering the purified liquid medlens U ft product.
and separating finely divided solid carbon dioxide from ofthe process.
liquid methane. 6. A process for the separation of carbon d t and
4. A process for the separation of carbon dioxide and methane which comprises mintkh1flg the mixture of
methane which comprises cooling a stream of methane g methane and carbon dioxide at a sufficiently high pressure
containing between about I and about 20 mole percent and a sufficiently low temperature to completely liquefy
carbon dioxide while maintaining a pressure such that the methane in which all of the carbon dioxide is dis-
the methane is completely liquefied and all of carbon solved, thereafter expanding liquefied methane to reduce
dioxide is dissolved in the liquefied methane, thereafter the temperature sufficiently low such that solid carbon
expanding the completely liquefied methane to reduce 10 dioxide is formed and separating the solid carbon dioxide
the pressure to about atmospheric and the temperature thus formed from expanded methane.
to about 258° F. to precipitate solid carbon dioxide
from liquid methane, and separating solid carbon dioxide References Cited In the file of this patent
from expanded methane. UNITED STATES PATENTS
5. A process for the separation of carbon dioxide and 15
methane which comprises cooling a stream of methane 668,197 La Sueur ---------------Feb. 19, 1901
containing about S mole percent carbon dioxide to a 981,860 Jackson ----------------Jan. 17, 1911
temperature of about 140° F. while maintaining the 1,546,682 Slate -------------------July 21, 1925
pressure above 750 pounds per square inch absolute and 1,893,852 Sullivan ----------------Jan. 10, 1933
sufficiently high to completely liquefy methane in which 20 1,912,443 Goosmaun --------------June 6, 1933
all of the carbon dioxide is dissolved, thereafter expand- 1,971,106 Hasche ---------------- Aug. 21, 1934
ing the completely liquefied methane to about atmospheric 1,992,486 Hunt ------Feb. 26, 1935
pressure and to a temperature of about 258° F. to 2,070,098 Twomey ---------------Feb. 9, 1937
form a slurry of liquid methane and finely divided solid 2,548,499 Rupp --------------.----- Apr. 10, 1951
carbon dioxide, passing said slurry to a cyclone separa- 2,585,288 Van Nuys --------------Feb. 12, 1952
fInn zone, In said cyclone separation zone separating 2,641,450 Garbo ----------------- June 9, 1953
liquid methane containing not more than about 0.2
mole from finely divided carbon dioxide,

2,687,950 Kalbach ---------------Aug.31, 1954
percent solid 2,769,852 Paulson----------------- Nov. 6, 1956

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bdO

Feb. 22, 1966 HADI HASHEMI-TAFRESHI 3,236,057 REMOVAL OF CARBON DIOXIDE AND/OR HYDROGEN

SULPHIDE FROM METHANE

Filed May 28, 1962

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INVENTOR

Wadi
BY

United States Patent Office 3.,236v057

Patented Feb. 22, 1966

3,236,057
REMOVAL OF CARBON DIOXIDE AND/OR
HYDROGEN SULPHIDE FROM METHANE

Hadi Hashemi-Tafresbi, Norman, Okia., assignor to
Conch International Methane Limited, Nassau, Baha-mas, a corporation of the Bahamas
Filed May 28, 1962, Ser. No. 198,036
2 Claims. (Cl. 62-12)

This invention relates to a process for the removal of those constituents in natural gas which solidify at low temperatures, such as carbon dioxide, hydrogen sulphide, neopentane, etc.

In the copending application Ser. No. 13,857, filed on Mar. 9, 1960, now Patent Number 3,132,016, descrip-
tion is made of a process for the removal of a component from a fluid stream containing at least two components

in which the process comprises the steps of removing one of the components as a solid by cooling the feed
stream in a temperature reduction step, separating the solids from the fluids present after the cooling step, ad-mixing the removed solids with a carrier medium and passing said solid and carrier medium to the cooling step of the process in heat exchange relation with the fluid

stream, and causing a phase change of the solid wtih a corresponding absorption of heat from the feed stream.
The heat exchange according to the process of said ap-plication Ser. No. 13,857, produced by passing the mix-

ture of solid and carrier medium to the cooling step, can be very efficient, and the cooling step will not plug if a suitable carrier medium and a suitable velocity for the

mixture of solid and carrier medium are chosen.
It has been found, however, that the efficiency of the heat exchange is reduced when the carrier medium in the mixture is subject to evaporation before the change in phase of the solid takes place. For example, if the mix-ture passed into the cooling step comprises a slurry of solid carbon dioxide and/or solid hydrogen sulphide In liquid methane, the liquid methane can evaporate before a change in phase occurs in the solid carbon dioxide and/or solid hydrogen sulphide thereby producing ac-cumulation of solid carbon dioxide and/or solid hydro-gen sulphide without carrier medium in the cooling step. Such occurrence would lead to blockage of said step.
It is an object of this invention to provide in a proc-ess for the removal of carbon dioxide or hydrogen sul-phide from liquefied natural gas or methane in which the carbon dioxide or hydrogen sulphide is precipitated as a solid from the liquid hydrocarbon, a novel step that overcomes the said obstacle which might occur in the process of the application Ser. No. 13,857. As used herein, the term liquefied natural gas is meant to in-clude liquefied methane, liquefied natural gas and liquefied lower hydrocarbons.
These and other objects and advantages of this inven-tion will hereinafter appear and for purposes of illus-tration, but not of limitation, embodiments of the inven-tion are shown in the accompanying drawing In which: FIG. 1 is a flow diagram illustrating the practice of this invention, and
FIG. 2 is a flow diagram adapted to be inserted into the process of FIG. 1 for modification thereof.
In accordance with the practice of this invention there is provided a process for the removal of carbon dioxide or hydrogen sulphide from natural gas in which carbon dioxide or hydrogen sulphide is precipitated as a solid from liquefied natural gas and which comprises the step

of passing a slurry of solid carbon dioxide or solid hydro-gen sulphide in the liquefied natural gas into a bath of a carrier liquid maintained under such conditions of pres-sure and temperature that the carbon dioxide or hydrogen
5 sulphide boils off therefrom.
A suitable liquid for use in the bath as a carrier liquid

should be characterized by a viscosity which is low and a vapor pressure which is low at the working tempera-
ture of the bath. The temperature of the bath should, 10 in turn, be so controlled as to make it possible for the solid carbon dioxide or hydrogen sniphide-liquefied natu-ral gas mixture in the bath to evaporate. For example, if the process is addressed to the separation of carbon dioxide and if the bath is maintained at atmospheric 15 pressure, a suitable temperature would be about 100’ F., and a suitable liquid for the bath could be a hydrocarbon heavier than ethane or mixtures of such hydrocarbons, for example, propane, butane or a mixture of C, hydro-carbons and C4 hydrocarbons, such as pentane and 20 butane.
The temperature of the liquid in the bath is preferably

maintained at the desired level by heating the bath with a feed stream of natural gas subsequently to be treated
according to this invention. The gas or gases boiled off 25 from the bath are also preferably passed in heat exchange relationship with the feed stream of natural gas to be treated In accordance with this invention. It is especially

preferred that the natural gas used to operate the heat ex- changer also be used afterwards to heat the bath.
30 When applying this invention to a preferred method

for the removal of carbon dioxide from natural gas, a stream of natural gas containing carbon dioxide is cooled
while maintaining pressure such that the natural gas will

be completely liquefied and all of the carbon dioxide is 35 dissolved in the liquefied natural gas, for example, as shown in U.S. Patent No. 2,900,797. The pressure on the resultant liquid is then reduced by passing the feed stream through an expansion valve or an expansion en- gine, thereby further to reduce the temperature of the 40 feed stream with corresponding precipitation of finely

divided solid carbon dioxide from the liquid.
This invention can be employed also for the removal
of hydrogen sulphide from natural gas, as in the system described in U.S. Patent No. 2,901,326.
45 This invention will be described with reference to the removal of carbon dioxide present in a concentration of 0.23 mol percent in a feed stream of liquefied natural gas at a temperature of 212 F. and 750 p.s.i.a. with

about 5.44 mol percent of nitrogen also present in the 50 feed stream.
With reference now to FIG. I of the drawings, the

feed stream is advanced through conduit 1 to an ex- pansion turbine 2 wherein the pressure of the feed stream
56 is let down from 750 p.s.i.a. to 130 p.s.i.a. with work but without vaporization. From the expansion turbine, the feed stream at 130 p.s.ia. is advanced through line 3 through an expansion valve 4 wherein the pressure is let down to 50 p.s.i.a, while some of the liquefied nitrogen 60 gas is flashed off as a gas and with a corresponding drop in temperature to 243’ F. at which temperature carbon dioxide solidifies to form a mixture of solid particles of carbon dioxide, liquefied natural gas, gaseous nitrogen and gaseous hydrocarbon. The mixture is advanced

65 through an ejector 49 and through line 3’ to a vessel 5 which operates as a separator.
The gaseous components including the gaseous natural
gas and nitrogen are removed from the vessel 5 through

71’

3
the conduit 6 through which they are advanced by the blower 6° to the condenser 7 for passage in indirect heat exchange relation with liquefied natural gas whereby the gaseous components bled off from the vessel S are partially condensed and advanced through conduit S from the heat exchanger 7 into the low pressure side of the ejector 4° at corresponding pressure. If desired, nitrogen rich gases in conduit 8 can be bypassed through conduit 9 into a separator 10 for. removal of nitrogen gas from separator 10 into the passage 11 and through the valve 12 into the conduit 21 while liquid natural gas or other hydrocarbon drains from the separator 10 into conduit 13 for return to conduit S. The liquefied methane or liquefied natural gas which is employed as the coolant in the partial condenser 71s fed in the con-denser through line 14 at a temperature of 255 F. and it departs from the condenser through line 15. Liquefied natural gas or liquefied hydrocarbon can be made available for this purpose from the main liquefac-tion plant.
The 8lurry of solid particles of carbon dioxide and liquefied natural gas are removed from the vessel 5 through the conduit 16 for passage through an expansion valve 17 whereby the pressure is reduced to atmospheric pressure of about 14.7 p.s.i.a. with a corresponding flash-ing of some of the liquefied gas and further reduction in temperature to 266° F. whereby additional amounts of carbon dioxide are precipitated. The mixture of solid particles of carbon dioxide, natural gas in a gaseous state and natural gas in a liquefied state are advanced through conduit 16° to the vessel 18 which functions as a separator. The gaseous hydrocarbons are removed from the vessel 18 via conduit 19 and the gases are dis-placed by the blower 20 for joinder with the nitrogen rich gas in conduit 21 to provide a gaseous mixture which can be burned as a fuel after first recovering the cold contained in the gas by passage of the gas in beat ex-change relationship with the feed stream (not shown). In the vessel 18, the liquid hydrocarbon is thrown off as a product via conduit 22 while a slurry containing a higher concentration of carbon dioxide in liquefied hy-drocarbon is removed via conduit 23 for passage to an evaporator 24. The evaporator is partially filled with a bath of propane liquid 20 maintained, at a temper-ature of 105° F. At the temperature of 105° F., the solid carbon dioxide undergoes a phase change from a solid to a gas while the liquefied natural gas is also converted by phase change from a liquid phase to a gaseous phase, both of which are accompanied with the absorption of heat.
The gaseous carbon dioxide and natural gas in a gas-eous phase pass from the evaporator 24 into conduit 25 to a heat exchanger 26 having an outlet conduit 27. In the heat exchanger 26 the gaseous materials are passed in heat exchange relation with natural gas advanced through the heat exchanger from the line 28 to the con dull 289 which leads through the evaporator 24 for pas-sage of the natural gas in beat exchange relation with the carbon dioxide and liquefied gas during phase change, as previously pointed out.
Heat is absorbed from the natural gas in the -evapora-tor 24 and heat exchanger 26 in’ the following manner: Gaseous natural gas containing 0.23 mol percent of car-bon dioxide and 5.44 mol percent of nitrogen enters the system via conduit 28 under a pressure of 750 p.sA.a. and at a temperature of 100° F. The natural gas passes through heat exchanger 26 wherein it gives up beat by indirect heat exchange to the gaseous carbon dioxide and gaseous hydrocarbons passing therethrough from conduit
25. It subsequently passes through the evaporator 24 wherein it gives up heat by indirect beat exchange to the slurry of solid carbon dioxide in liquid hydrocarbon via
the propane bath 20 and the natural gas is then directed
to a liquefaction plant 28b at a temperature of 1000

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F. at which it issues frofft the evaporator 24 and it Is subsequently liquefied to provide the feed stream flow into
conduit L

PIG. 2 illustrates a preferred practice of this invention
5 by way of modification of the process illustrated In PIG. 1 from the point where the slurry of solid carbon di-oxide in liquefied natural gas issues as a concentrate from the base of the vessel 18 into conduit 23.
In accordance with the modification illustrated in FIG.

10 2, the slurry of liquefied. natural gas and solid carbon dioxide particles Is procesed through the pump 30 for passage into a first cyclone separator. 32 wherein a major separation Is effected between, the liquefied natural gas and solid carbon dioxide whereby liquefied natural gas 15 free from solid’ carbon dioxide is removed from the out-flow into conduit 34 while a thickened.elutty of liquefied natural gas containing solid carbon dioxidb in much higher concentration is temoved at the ilnderflow of the cyclone Into the conduit, 36.
20 The thickened underfiow from the first cyclone is dis-placed by the pump 38 through conduit 40 to a second cyclone separator 42 where further separation is effected to remove liquefied natural gas through the conduit 44 for joinder with the product from the cyclone separator 25 32 in conduit 34 while the still further -thickened slurry is removed from the underfiow through. conduit 46 for displacement by pump 48 into cyclone separators 50 and
52. In cyclone 50, the thickened slurry is separated into
an ’underfiow containing a still higher concentration of 30 solid carbon dioxide in liquefied natural gas while the liquid component is cycled through line 54 to the cyclone separator 52 where further separation takes place to pro-vide a liquefied natural gas component which passes out of the cyclone 52 through line 56 into line 34 for joinder .35 with the liquefied natural gas product from separators 32 and 42. The slurry from the underfiow of separator 52 and the underfiow from separator SO is advanced through lines 58 and 60 respectively into a line 23° which leads to

40 the evaporator 24 for further processing in accordance

with the process described with reference to FIG, 1. The slurry fed through line 23° to the evaporator 24 from the cyclones 50 and 52 will contain about 40 percent by vol-ume solid carbon dicoxide with the remainder liquefied

hydrocarbon.45 -
It will be understood that numerous changes may be made in the details of conditions and steps as well as materials without departing from the spirit of the inven-tion, especially as defined in the following claims.

50 I claim:

1. In a process for the removal of components in natural gas which are solidifiable in liquefied natural gas when reduced to low temperature, the steps of
(a) liquefying the natural gas under such conditions
of temperature and pressure that the said compo-
nents are dissolved in the liquefied natural gas,
(b) reducing the temperature of said liquefied natural
gas with corresponding precipitation of said com-ponents to form a slurry of the solidified components
60 In liquefied natural gas,
(c) separating said slurry from the major portion of said liquefied natural gas and withdrawing said major portion as product free of said components,
(d) passing said slurry into a bath’ of liquid having a
65 -higher boiling point than natural gas which remains
in a liquefied state at temperature and pressure con-ditions at which the solidified component in the natur-
al gas undergoes a phase change from the solid state
to a gaseous state, and separating the gaseous corn-
70 ponent.
2. The invention according to claim 1 in which said component comprises a compound selected from the group consisting of carbon dioxide, hydrogen sulphide and neo-pentane.
75 (References on following page)

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aDS

Oct. 24, 1967 C. F. CROWNOVER ETAL 3349,020

LOW TEMPERATURE ELECTROPHORETIC LIQUIPIED GAS SEPARATION
Filed Jan. 8, 1964

Methane -t-

Liquefaction 3

Slurry 9’ap
Slurry 91 Ij 23

vaw

FIG. 2.

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United States Patent OfficeSt3,349,020.,

Oct. 24, 1967

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LOW TEMPERATURE IILECTROPHORETIC
LIQUIFIED GAS SEPARATION
Carl F. Crownover and Richard L. Every, Ponca City,
Okla., assignors to Conch International Methane Lim-

ited, Nassau, Bahamas, a Bahamian company Filed Ian 8, 1964, Ser. No. 336,590
12 Claims. (Cl. 204-180)

This invention relates to the separation of the constitu-ents of a normally gaseous mixture of such constituents, and more particularly a normally gaseous mixture which has been converted into the form of a liquid mixture un-der considerable pressure, A major aspect of the inven-tion relates particularly to the separation of impurities such as CO2, H5S, and so forth from natural methane gas in which such constituents exist as relatively minor impurities.
The prior art discloses a method of separating such constituents, and particularly CO2 from methane gas, which includes the steps of reducing the constituent gases to a totally liquid phase under high pressure, e.g., 750 psi., and at a temperature sufficiently low so that both constituents are in totally liquid form; the pressure is then reduced by means of an expansion valve or expansion engine to a point where the mixture exists as a solid phase of CO2. a liquid phase of methane and the vapor phase of methane. This last mixture is then passed through a cyclone separator and the solid CO2 removed as a slurry of CO2 in liquid methane, the other components being suitably separated also. In practical applications, a disad-vantage of the above method has appeared in that it is difficult to handle and remove the slurry of solid CO2 and liquid methane, due to a tendency of the CO2 par-ticles in the slurry to agglomerate and clog up, which makes the handling of this material rather difficult. The

present invention not only obviates the above difficulty as will be explained in more detail below, but also pro-
vides for the separation of the solid constituents from such a liquid-solid mixture in the manner which tends inher-ently to reduce the clogging effect and to make the mix-ture more manageable up to the point where the actual separation occurs, at which point the solid constituent is removed substantially completely from the liquid con-stituent.

In accordance wtih the invention, the gaseous compo-nents are produced, as before, at high pressure and low temperature, and the temperature then further reduced by reducing the pressure, to produce a solid phase of the minor constituent mixed with a liquid phase of the major constituent, and treated in such a manner as to electrical-ly charge the particles of the solid constituent with a charge of suitable polarity (usually negative), which has two effects: (1) the particles now tend to repel each other, which reduces the clogging tendency and (2), the particles can now be suitably treated to electrically sepa-rate them out of the liquid. Therefore, up to the point of electrical separation, the mixtpre of solid particles and liquid does not tend to clog as previously, and remains manageable and free-flowing.
The specific nature of the invention as well as other objects and advantages thereof will clearly appear from a preferred embodiment as shown in the accompanying drawing, in which:
FIG. 1 is a diagrammatic view of an apparatus for performing the invention;
FIG. 2 is a sectional diagrammatic view of an alterna-tive means for charging the solid particles;
FIG. 3 is a side elevational view showing the principle of an apparatus for continuously separating the solid constituent from the liquid constituent; and
FIG. 4 is an end view of the apparatus shown in FIG. 3.

The invention will be described particularly with re-spect to the separation of CO2 from natural methane gas as obtained from the well; however, it will be understood that the invention is also applicable to the separation of other gas impurities from other main gaseous materials, for example, H2S-LNG slurries, 002-liquid air, CO2-liquid nitrogen, and so forth. The invention is of par-ticular interest in connection with the production of liquid natural gas (LNG), the major constituent of which is 10 methane, from which it is often desired to remove natur-ally occurring CO2 as an impurity. In a typical application, the gas mixture is produced in a liquifaction plant indi-cated at 2, and is available in pipeline 3 at a pressure above 700 p.s.La., and at a temperature in the order of

 130 degrees F. At this pressure and temperature, as- suming approximately 5% CO2 and substantially all of
the rest to be methane gas, a mixture will be in a com-pletely liquid phase in pipeline 3. The mixture is then passed through a throttle or expansion engine 4 in such 20 manner as to reduce its temperature to - 258 degrees F. at a pressure of I atmosphere. Under these conditions, there will exist in pipeline 6 a single liquid phase of methane, a vapor phase of methane, and a solid phase of CO2. comprising substantially all of the CO2 in the mix-25 ture. A small amount of CO2 will remain dissolved in the liquid and vapor, but this is so small as to be negligible. The effect of the throttling or expansion step in convert-ing the material from the totally liquid phase in pipeline
3 to the above conditions in pipeline 6 is to produce a 30 high degree of turbulence, and one resultant effect of this is to charge electrically a high percentage of the solid CO2 particles with a charge of negative polaiity. This

effect is enhanced by grounding the pipeline 3 and 6 as shown at 5, so that the frictional effect of the liquid flow
35 along the pipelines also tends to produce a static charge

in the liquid, which charge becomes associated with the CO2 particles as soon as they are formed. In many cases,
this charge is sufficient for the purpose of the electrical separation step to be described, but it is also possible to 40 enhance the effect by deliberately increasing the ground-jag effect as will be described below.
The slurry in line 6 now has less tendency to coagulate than an uncharged slurry, due to the individual particles having a like charge and tending to repel each other. 45 This slurry is now passed into a vapor separator 7, and the vapor constituent removed on pipeline 8, while the slurry is removed on line 9, and immediately conducted to electrostatic separator 11, shown in more detail in FIGS.
3 and 4. It will be noted that no effort is made to draw off

50 clear liquid as was done in the prior art, and to separately remove a thickened slurry from the separator, in conse- quence of which the very thin slurry containing the

charged particles of solid CO2 readily passes down pipe-line 9 to the electric separator.
55 One form of continuous separator is shown in FIGS.

3 and 4, where the above slurry passes the pipe 9 to a cylindrical chamber 12 lined with a conducting material,
e.g., copper screen, as shown at 13, this conductive lining being charged to a high negative polarity from D.-r-60 generator 14.via line 16. As an upper limit, the electric field strength between the conductive linings is maintained at a value not exceeding the breakdown potential of the slurry being processed (e.g., LNG=.’30,000 volts per cm.). A drum 17 is located centrally within the cylindrical

65 chamber 13, and is continuously revolved by means of a drive shaft 18, driven from any suitable motor. The sur- face of the drum is also electrically conducting, and may

be in fact a cylindrical sheet of copper firmly fixed to the surface. The positive side of D.-C. generator 14 is alec-70 tncaliy connected to this surface near line 19. The drum rotating in the direction indicated by arrow 21, is engaged by the sharp knife-edge of a scraper 22, which is station-

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ary. It will be apparent that, the high electric voltage will produce a field causing the, negatively charged particles of solid CO2 to migrate toward and become attached to the conductive surface of drum 17, and to be carried

thereby until the material is scraped off by scraper.22, s after which it can be continuously removed from this point
by any suitable conveying means. This action very rapidly, and very completely removes.the solid CO2 particles from

the liquid methane, leaving clear liquid methane, which: can be removed via overflow 23. ’The CO2 thus produced 10

may be used as a commercial product, or many be further employed in heat exchange relationshi, with incoming LNG at any, suitable stage of the fiowline, in order to im-prove the thermal efficiency ’of the process. It will, of course, not be in the form of dry CO2 since it is removed 16 from’ the liquid (but will contain a. certain amount of acompanying liquid, and therefore will be in the form of a thick, slurry having ’a considerable constituent’ of liquid methane, which. may also be suitably employed for heat transfer purposes, and ’the resulting gaseous, methane’ g component may then be employed, as a fuel at a suitable stage of the liquefaction or any other process. The liquid emerging from pipe 23 is quite clear liquid methane, with only a negligible percentage.of dissolved CO2.
Referring to FIG. 2, instead of expanding the totally 25 liquid phase in line 3 to the above-described multiple phase in line 6, it can also ’be changed, as by cooling it down from an, external, refrigeration source, to a phase. consisting of liquid methane gas, and solid CO2 particles, with no vapor phase present.: It will be understood that 30,r thei degree of cooling required for this will vary with the percentage Of CO2. and the initial conditions of the ma-terial: in line 3, but can be easily determined, from the. pressure-temperature diagram for the materials. Since the resulting liquid-Solid mixture in: line.6 does, not in- 35. chide the vapor phase, it is, not subject to the same degree
of turbulence, and it is therefore desirable, to enhance: the frictional charging effect.’ An apparatus for doing this is shown in FIG. 2, and consists of two ’screen sections 31 and 32, which are supported within pipeline.6, and are 40 carefully grounded, as. indicated at 33,, to insure intimate,’ contact and more effective charging. In practice, a suffi-cient number of charge screens will be included to. ade-quately charge the solid: CO2 particles. In this case, it is not necessary to use the separator 7, and the liquid solid 45

mixture in line 6 is.pasted directly, and, by A& short a con- nection as possible, to electric separator. 11, for treatment’ as above described.

It will be apparent that the embodiments shown are only, exemplary and that various modifications can be made in 50 construction and arrangement within the scope ofi our in-vention as defined in the appended claims.
Weclaim:
1. A process for the separation of mixtures including. two different’ gases, one of Which solidifies: at a higher 55

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temperature- than, the other, which comprises the step’ of’ cooling the mixture until a slurry is produced wherein one, of said two constituents. is in a liquid phase and the.. other is in a solid phase,. charging, the solid phase par-ticles of said slurry with a.charge of.a single polarity, and separating said charged, particles from the ’liquid by attracting them: to: an electrode, of opposite polarity, to that of the charged particles in a high voltage D.Cb field.. 2.’ The invention according to claim’ 1, both the, liquid and the solid. constituents of said slurry being non-con-ductors..

3.’ The invention acording to claim:Z: the said two con-stituents being liquid methane and CO2,
4.. The invention ’according to claim 3, said two con-stituents being initially under high pressure and at a low temperature,: said cooling step being accompljelsed by re-ducing said high. pressure.
S.’ The invention according to claim 4,. said reduction, in pressure being such as to turbulently produce a liquid. and a vapor phase of the methane and a solid phase ofthe CO2, said turbulence tending to produce a ’negative alec-. trio charge on the CO2 particles of the slurry..
6 The invention according to claim. 5, ’including the. further step of separating the vapor phase of methane from the mixture leaving, a flowable slurry. of liquid., methane and CO2.

7. The invention according to. claim 6,. including the step of grounding positive charges produced in the’slurry.
8. The invention according to claim 1, said separation step comprising the step of passing the charged slurry into a cylindrical chamber containing a drum concentric there-with and insulatingly spaced therefrom, ’applying a high.: D.-C. voltage between said drum and said chamber of. such polarity as to: cause the charged particles of the. slurry to.migrate to the surface of: the: drum ’rotating said drum and scraping the adhered solid material from the drum.

9. The invention according to claim 3, said two con-stituents being methane and.H2S..
10. The, invention according to claim 3, said two con, stituents being LNG and 113S.’
11. The invention according to ’claim ’3, said two con-stituents being COt and liquid air.
12. The invention, according to claim 3, said two con-stituents’ being. CO2 and liquid nitrogen.

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JOHN ’H. MACK, Primary Eaminer.’.

:A.:PREScOTT, Assistant Examiner.

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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO DIVISION DE NUEVAS CREACIONES

2020
Bogota, D.C., 23 de noviembre de 2007

Abogada
DILIA MARIA RODRIGUEZ D’ALEMAN
Apoderada

ASUNTO RadicaciOn 04-67546
. TrÆmite 002
Evento 001
Actuación 430

Oficio - 15383
Folios 021

Patente de Invención Patente de Modelo de Utilidad El

Via Nacional ED

Via PCT (fase nacional) Cap.l El Cap. II

No. Sol. I nternacional PCT/US02/20924
Fecha de PresentacjOn Internal. I de julio de 2002

Como resultado del examen de fondo, realizado con fundamento en el artIculo 45 de la Decision 486 de la Comisión de la Comunidad Andina, se le comunica:

1. Documentos estudiados

1.1. DescripciOn: Folios: 48 a 87

1.2. Reivindicaciones: Folios: 88 a 100 (originalmente radicadas)
Folios: 143 a 155 (modificadas)

1.3. Dibulos: Folios: 190 a 206

1.4. Prioridad: Folio: 5
27 de febrero de 2002, Estados Unidos No. 10/086,066

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2. Objeto de la invenciôn

El TItulo de la solicitud es: "APARATO PARA LA LICUEFACCION DE GAS NATURAL Y METODOS RELACIONADOS CON EL MISMO" (Folio 1)

La presente invenciOn se relaciona de manera general con la compresión y Iicuefacción de gases, y mÆs particularmentecon la IicuefacciOn parcial de gases,
tal como el gas natural, a pequena escala, mediante el uso de Un proceso combinado de refrigeración y expansion.

En la reivindicac,ón independiente I se plantea un mØtodo para retirar diOxido de carbono a partir de una masa de gas natural, caracterizado porque dicho mØtodo comprende:

Enfriar al menos una porción del gas natural para formar una suspensiOn que incluye al menos gas natural liquido y dióxido de carbono sOlido;

Hacer fluir la suspension a travØs de un hidrociclOn;

Retirar el diOxido de carbono sOlido y una porciOn del gas natural liquido a travØs de una salida inferior del hidrociclOn.

En la reivindicaciOn independiente 14 se plantea un sistema para retirar dióxido de carbono a partir de una masa de gas natural que incluye al menos Un componente adicional, caracterizado porque comprende:

Un compresor configurado para producir una corriente comprimida de gas natural a partir de al menos una porciOn de gas natural;

Al menos un intercambiador de calor posicionado y configurado para recibir y enfriar la corriente comprimida;

Medios posicionados para recibir y expandir (a corriente enfriada comprimida que forma una suspensiOn conteniendo gas natural liquido y diOxido de carbono sólido;

Un hidrociclón posicionado y configurado para recibir la suspension y separar (a suspension en una primera porciOn de gas natural liquido y un lodo espesado que comprende el dióxido de carbono sOlido, y una segunda porción del gas natural liquido.

En la reivindicación independiente 25 se propone una planta de licuefacciOn caracterizada porque comprende:

Una entrada de planta configurada para estar acoplada de forma hermØtica y fluida con una fuente de gas natural no punficado;

Un turbo-expansor posicionado y configurado para recibir una primera corriente de gas natural conducida a travØs de la entrada de la planta y para producir una corriente de enfriamiento expandida a partir de ella;

Un compresor mecÆnicamente acoplado al turbo-expansor y posicionado y configurado para recibir una segunda corriente de gas natural conducida a travØs de la entrada de Ia planta, y para producir una corriente de proceso comprimida a partir de la misma;

Un primer intercambiador de calor posicionado y configurado para recibir la corriente de proceso comprimida y la corriente de enfriamiento expandida en un arreglo de flujo a contracornerite, para enfriar la corriente de proceso comprimida;

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Una primera salida de la planta posicionada y configurada para estar acoplada de forma hermØtica y fluida con la fuente de gas no purificado y para descargar la corriente de enfriamiento expandida en ella despuØs del pasaje de la misma a travØs del intercambiador de calor.

Una primera vÆlvula de expansion posicionada y configurada para recibir y expandir una primera porciOn de la corriente de proceso comprimida y enfriada, para formar una corriente de enfriamiento adicional, incluyendo la planta adicionalmente una estructura de conductos para combinar la corriente de enfriamiento adicional con la corriente de enfriamiento expandida, y entrando la corriente de enfriamiento expandida al primer intercambiador de calor;

Una segunda vÆlvula de expansiOn posicionada yconfigurada para recibir una segunda porciOn de la corriente de proceso comprimida y enfriada, para formar una mezcla gas-sOlido-lIquido a partir de Ia misma;

Un primer separador gas/liquido posicionado y configurado para recibir la mezcla gas-sOlido-lIquido; y

Una segunda salida de la planta posicionada y configurada para estar acoplada de forma hermØtica y fluida con un recipiente de almacenamiento, estando el primer separador gas-lIquido posicionado y configurado para entregar un lIquido contenido en el mismo hacia la segunda salida de la planta.

En la reivindicaciôn independiente 50 se plantea un mØtodo para producir gas natural liquido caracterizado porque comprende:

Proporcionar una fuente de gas natural sin purificar, conducir una porciOn de gas natural de la fuente; dividir la porción de gas natural en una corriente de proceso y una primera corriente de enfriamiento; conducir la primera corriente, de enfriamiento a travØs de un turbo expansor y obtener potencia de trabajo a travØs de la misma;

Impulsar un compresor con la potencia de trabajo del turbo expansor; hacer fluir la corriente de proceso a travØs del compresor, enfriar (a corriente de proceso comprimida con al menos la corriente de enfriamiento expandida;

Dividir la corriente de proceso comprimida y enfriada en una corriente de proceso y una segunda corriente de enfriamiento;

Expandir la segunda corriente de enfriamiento y combinar la segunda corriente de enfriamiento expandida con la primera corriente de enfriamiento expandida;

Expandir la corriente de producto para formar una mezcla que contiene lIquido, vapor y sOlido; separar el lIquido y el sOlido del vapor; y

Separar al menos una porción del lIquido del sOlido.

En la reivindicación independiente 54 se plantea un intercambiador de calor caracterizado porque comprende:

Al menos dos serpentines dispuestos en el tanque;

Al menos una entrada de serpentin configurada para admitir una primera corriente a travØs de al menos uno de los al menos dos serpentines;

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Una pluralidad de salidas de serpentin configuradas para hacerfluir una segunda corriente a travØs del tanque, estando posicionada cada una de las at menos dos entradas de tanque próximas a un serpentmn correspondiente de los at menos dos serpentines, para hacer que la segunda corriente fluya at menos sobre el serpentIn respecto at cual la entrada al tanque correspondiente estÆposicionada de manera cercana; y

Una salida de tanque configurada para retirar la segunda corriente desde el tanque y donde el intercambiador estÆ configurado demanera tal que la primera corriente pueda hacerse fluir selectivamente a travØs de un nümero deseado de los al menos dos serpentines y de manera tat que la segunda corriente pueda hacerse fluir prÆctcamentede manera simultÆneasobre los mismos serpentines a travØs de los cuales la primera corriente se hace fluir selectivamente.

En la reivindicación independiente 66 se plantea un intercambiador de calor caracterizado porque comprende:

Un tanque que posee una pluralidad de entradas de tanque y at menos una salida de tanque;

Al menos dos serpentines de enfriamiento dispuestos en el interior del tanque, acoplados entre si en sene y configurados de manera tat que una primera corriente pueda hacerse fluir selectivamente a travØs de uno 0 mÆs delos at menos dos serpentines, donde at menos una de la pluralidad de las entradas de tanque estÆ asociada con cada uno de los at menos dos serpentines de enfriamiento y configurada de manera tat que una segunda corriente pueda hacerse fluir selectivamente a travØs de una o mÆs entradas de tanque en correspondencia con el flujo selectivo de primera corriente.

Se afirma que los ciclos en cascada para producir GNL presenta unos costos de inversiOn relativamente altos asociados con el intercambiador de calor caro y el equipo asociado con el sistema refngerante. AdemÆs, unaplanta de licuefacciOn que incorpora este tipo de sistema puede ser imprÆctica en lugares donde el espacio fIsico es limitado, dado que los componentes empleados son muy grandes.

De otro lado los ciclos de expansion resultan imprÆcticos porque nose preve el manejo de algunos de los componentes presentes en el gas natural que se congelan a las temperaturas encontradas en los intercambiadores de calor, como por ejemplo, agua y diOxido de carbono.

AdemÆsde lo anterior, convencionalmente se construyen sistemas a gran escala para manejar grandes volUmenes de gas natural los cuales son muy costosos y como resultado, se construyen pocas instalaciones, haciendo mÆs difIcil proporcionar el gas crudo a la planta o a la instalaciôn de licuefacción y haciendo de la distribuciOn del producto licuado un problema.

Otro problema de las grandes instalaciones es el costo asociado al almacenamiento de combustible anticipÆndosea su uso y/o transporte futuro.

Dado to anterior, se han realizado esfuerzos para superar dichos problemas pero se afirma que no ha sido satisfactorio porque los procesos convencionales impllcan una remociOn preliminar de diOxido de carbono, agua o hidrocarburos pesados pues de to contrarlo se congelan durante el proceso provocando obstrucciones. Esto agrega costo y complejidad a la construcciOn y operaciOn de dichas plantas o instalaciones.

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De acuerdo con (a Clasificación Internacional de Patentes, el objeto de la invenciOn se catalogO como FI7C 5100 y F25J 3/00.

3. De (a soticitud de Patente

3.1. DescripciOn (artIculo 28 D 486)

El capitulo descriptivo contiene las expresiones "rib arriba" o "rio abajo" las cuales no son las adecuadas segün el campo tØcnico que se estÆ tratando.Se recomienda emplear las expresiones "aguas arriba" o "aguas abajo" tal como es convencional en la identificación de procesos y equipos de proceso.

El capitulo presenta cantidades en el sistema inglØs, por ello se recomienda realizar las conversiones al Sistema Intemacional de Unidades y silo requiere, dejar entre parØntesis los equivalentes del sistema inglØs.

En conclusion, el capitulo descriptivo no cumplirla con los requisitos de claridad exigidos segün el art. 28 de la DecisiOn 486.

3.2. Reivindicaciones (artIculo 30 D 486)

Para mejorar la inteligibilidad del capItulo reivindicatorio se recomienda incluir entre parØntesis los nimeros correspondientes a TODAS las corrientes de proceso y aparatos que constituyen (a materia de la invenciôn, segün estÆn designados en los dibujos de (a solicitud. Esto facilita que el capitulo reivindicatorio sea comprendido por Si mismo, con ayuda de los dibujos pero sin
la necesidad de acudir al capitulo descriptivo, dada la importancia tØcnica y legal que tienen las reivindicaciones.

El capitulo presenta cantidades en el sistema inglØs (reivindicaciOn 41), por elIo
se recomienda realizar (as conversiones al Sistema Intemacional de Unidades y
silo requiere, dejar entre parØntesis los equivalentes del sistema ingles.

En conclusiOn, el capItulo reivindicatorio no cumpliria con el requisito de claridad como se requiere segün el art. 30 de (a Decision 486.

4. Unidad de invención (articulo 25 D 486)

Luego de analizar (as reivindicaciones independientes del capitulo reivindicatorio
se encontraron los siguientes grupos de invenciones:

Reivindicaciones I a 24 MØtodo y el aparato para retirar diôxido de
carbono usando un hidrociclón

Reivindicaciones 25 a 53 MØtodo y el aparato (planta) de producción del
GNL

Reivindicaciones 54 y 55 Un intercambiador de calor

Con las reivindicaciones independientes de las reivindicaciones I a 53 se comprende que el concepto comUn inventivo es separar Un componente solidificado que estÆcontenido en el gas natural. No obstante, este concepto es conocido para los tØcnicos del estado del arte y no es una caracteristica tØcnica especial. De otro (ado dicho concepto tampoco es comün en las reivindicaciones 54 y 55 del intercambiador de calor.

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Dado que no parece haber caracteristicas tØcnicas comunes en los grupos de invenciones seæalados arriba,no se puede establecer la relaciOn tØcnica entre ellas. Por lo tanto, se recomienda realizar dMsionales de modo que cada una de ellas posea un grupo de invenciones relacionadas entre SI cuidando de no ampliar la materia inicialmente presentada.

En conclusiOn, los grupos de reivindicaciones I a 24, 25 a 53 y 54 a 55, no cumplirian con el requisito de unidad de invenciOn entre si, como se requiere segün el art. 25 de la DecisiOn 486.

5. Determinación del Estado de la TØcnica

La fecha que se ha tenido en cuenta para determinar el Estado de la TØcnica es:

Fecha de presentaciOn de la solicitud prioritaria: 27 de febrero de 2002

Teniendo en cuenta la fecha indicada, se realizô la büsqueda en el estado de la

00 siguientes:

de documentos relacionados con la solicitud encontrÆndose los siguientes:

NO Documento* TItulo Fecha de publicaciôn

"SEPARATION OF NORMALLY 25 de agosto Dl US2900797 GASEOUS ACIDIC COMPONENTS de 1959 AND METHANE"
"REMOVAL OF CARBON DIOXIDE 22 de febrero D2 US3236057 AND/OR HYDROGEN SULPHIDE de 1966 FROM METHANE"
"LOW TEMPERATURE 24 de octubre D3 US3349020 ELECTROPHORETIC LIQUIFIED de 1967 GAS SEPARATION"

Las copias de los documentos se anexaron a la presente comunicaciOn.

40 Comentarios sobre el estado de la tØcnica:
El estado de la tØcnica definido para el presente caso abarca diversos procesos y aparatos para la separación de contaminantes del gas natural licuado tal como el diOxido de carbono, el agua, ÆcidosulthIdrico, entre otros.

Particularmente, los siguientes documentos son relevantes:

US2900797 (Dl) se divulga una invenciOn relacionada con la separación de componentes acidicos normalmente gaseosos e hidrocarburos normalmente gaseosos, particularmente a la purificaciOn de corrientes de metano que contienen diOxido de carbono y particularmente a la purificaciOn de corrientes de gas natural.

US3236057 (D2) se divulga un proceso para la remoción de constituyentes que se encuentran en el gas natural, los cuales se solidifican a bajas temperaturas, tal como diOxido de carbono, Æcido sulfhIdrico, neopentano,etc.

US3349020 (D3) se divulga un proceso de separaciOn de constituyentes de las mezclas gaseosas las cuales han sido licuadas bajo presiOn considerable. Entre los constituyentes retirados como impurezas se encuentra el dióxido de carbono.

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6. AnÆlisis de patentabilidad (articulo 14 D 486)

6.1. Novedad (artIculo 16 D 486)

En la reMndicaciOn independiente 1 se plantea un mØtodo para retirardiOxido de
carbono a partir de una masa de gas natural. Este mØtodo consiste en las
etapas de:

- Enfriar al menos una porción del gas natural para formar una suspensiOn que
incluye al menos gas natural lIquido y diOxido de carbono sOlido;
- Hacer fluir la suspension a travØs de un hidrociclón;
- Retirar et diOxido de carbono sôlido y una porción del gas natural lIquido a
travØs de una salida inferior del hidrociclOn.

Ahora bien, en DI se divulga ’un proceso para la separación de diOxido de
carbono y metano el cual comprende mantener una mezcla de metano y dióxido
de carbono a una presiOn elevada y a una muy baja temperatura para permitir la
licuefacción del metano y en el cual el diOxido de carbono estÆdisuelto; despuØs
. de esto, reducir la temperatura sobre dicho lIquido de modo que el dlóxido de carbono precipite como un sólido y separar dicho dióxido de carbono sOlido’
(Dl; Columna 4, lineas 50 - 58)

En la figura 5 de Dl se ilustra un aparato para remociOn continua de diOxido de
carbono del gas natural. Se explica en la descripción, que durante (a sección de
expansion y enfriamiento, el dióxido de carbono se congela en finos cristales y
es conducido en la corriente hasta un separador de ciclOn convencional (Columna 4, lIneas 1 - 12).

En (a reivindicación independiente 14 se plantea un sistema para retirardióxido de carbono a partir de una masa de gas natural que comprende:

- Un compresor
- Un intercambiador de calor

- Medios para la expansion de la corriente - Un hidrociclôn

No obstante, en Dl tambiØn se divulgan dichos aparatos (Columna 3, lmnea 56, lIneas 60-65, Columna 3, linea 75 Columna 4, lInea 5, Columna 4, lIneas 7-13, respectivamente)

En los documentos D2 y D3 (tornados de manera independiente, es decir, sin combinar enseæanzas)se encuentra revelada la misma tØcnica de separación del dióxido de carbono de la corriente licuada de gas natural. En 02 se divulga el proceso para la separaciOn de mezclas incluyendo dos diferentes gases, uno de los cuales se solidifica a una temperatura mÆsalta que el otro, proceso que comprende el paso de enfriar la mezcla de forma que una suspension es producida donde uno de dichos constituyentes estÆ enfase lIquida y el otro estÆ en fase sôlida; separar las fases mediante un ciclôn (ver figura 1). En 03, tambiØn se remueve el diOxido de carbono con la misma soluciOn tØcnica de enfriar, hacer que el diOxido de carbono estØ en fase sólida y separar mediante ciclones.

Se allegaron tres documentos independientes entre si para demostrar que la propuesta planteada en las reivindicaciones independientes I y 14 son muy conocidas.

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Dado to anterior, se puede concluir que la soluciOn tØcnica de enfriar el gas natural, obtener una mezcla de gas en fase liquida y dióxido de carbono en fase sOlida para luego separarlos con mecanismos como ciclones, es algo que ya se conoce y por lo tanto, las reivindicaciones independientes I y 14 no cumplirian
con el requisito de novedad como se requiere segin el art. 16 de la DecisiOn
486.

7. ConclusiOn

Los requisitos de patentabilidad de la presente solicitud se encuentran afectados
asi:

No *Documento No Reivindicaciones

afectadas

Requisito que
afecta
Dl US2900797 1,14 Novedad
D2 US3236057 1,14 Novedad
D3 US3349020 1,14 Novedad
*Analizados de manera independiente

En cumplimiento del artIculo 45 de la Decision 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del tØrmino de 60 dIas contados a partir de la fecha de notificaciOn de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesiOn, se denegarÆla patente.

Notifiquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capItulo quinto del titulo primo,de (a Circular Unica No 10 de 2001.

ALIX CARM,NZA CESPEDES DE VERGEL
Jefe de Dy(siOn de Nuevas Creaciones

El anterior requerimiento fue notificado por fijaciôn en lista, de fecha

30 NOV. 2Q07

CONCEPTO TECNICO EXAMINADOR TECNICO

No. 2329 1 COd iqo No. 202042