

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SCOUT ENERGY MANAGEMENT, LLC, and
CHEVRON U.S.A. INC.,
Petitioners,

v.

PILOT INTELLECTUAL PROPERTY, LLC,
Patent Owner.

Case IPR2024-00385
Patent 8,505,332 B1

DECLARATION OF TREVOR BORS

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TABLE OF EXHIBITS

Exhibit	Description
2001	Declaration of Trevor Bors
2002	<i>Curriculum Vitae</i> of Trevor Bors
2003	U.S. Patent No. 4,529,411 (“Goddin”)
2004	Table of Similarities (Demonstrating similarities between Goddin ‘411 Patent Fig. 11 and Three-Column Ryan/Holmes Process)
2005	GPA Engineering Data Book (12th Ed. 2006, FPS version)
2006	U.S. Patent No. 4,318,723 (“Cryogenic Distillative Separation of Acid Gases from Methane”)
2007	U.S. Patent No. 4,462,814 (“Distillative Separations of Gas Mixtures Containing Methane, Carbon Dioxide and Other Components”)
2008	Holmes AS, Ryan JM, Price BC, Styring RE. Process Improves Acid Gas Separation. <i>Hydrocarbon Processing</i> 1982; 61:131–136
2009	Hannah Kent-Webb PhD, Best Practices for Biological Sample Storage and Management. <i>Biocompare</i> . (Oct. 2022)
2010	Vortex Expansion Devices for High Temperature Cryogenics. Proceedings of The 26 th Intersociety Energy Convention Engineering Conference (1991)
2011	Penflex Engineering Bulletin #113 (including table from The American Society of Materials “ASM Specialty Handbook: Stainless Steels,” published in 1994)
2012	Hydrate Formation in Chevron Mabee Unit for NGL Recovery and CO ₂ Purification for EOR (Submitted to Gas Processors Association 2017)

I. Introduction

1. My name is Trevor Bors. I have prepared this Declaration in connection with Patent Owner Pilot Intellectual Property, LLC's Preliminary Response to Scout Energy Management, LLC and Chevron U.S.A. Inc.'s Petition for *Inter Partes* Review of U.S. Patent No. 8,505,332 (the "'332 Patent") (EX1001), which is to be filed concurrently with this Declaration.

2. In the course of preparing this Declaration, I reviewed the Petition, the Declaration of David A. Rockstraw (EX1002), the '332 Patent, its prosecution file history, and the other documents discussed in this Declaration.

3. I have been retained by Pilot Intellectual Property, LLC ("Patent Owner") as an expert in the fields of chemical engineering and related technologies. I have been asked to provide my opinion regarding the state of the art of the technology described in the '332 Patent and on the patentability of the claims of this patent. I am being compensated at my normal consulting rate for my time. My compensation is not dependent on and in no way affects the substance of my statements in this Declaration. I have no financial interest in the outcome of this matter, Patent Owner, or the '332 Patent.

II. Background and Qualifications

4. My professional qualifications and experience are outlined in my attached *Curriculum Vitae* (EX2002).

5. I received a Bachelor of Science in Mechanical Engineering from the University of Calgary in 1990, and a Diploma of Technology from the Southern Alberta Institute of Technology in 1984.

6. From 2016 to 2021 I was employed by Pilot Energy solutions in various roles, primarily as the Manager of Engineering. In that role, I was responsible for the engineering design, preliminary cost estimation, economic evaluation and project management of potential new projects and modification to existing Pilot facilities.

7. Prior to joining Pilot, I was the Manager of Engineering, Construction and Asset Integrity at Enerplus Corporation from 2013 to 2016. In that role, I oversaw a group of facility Engineers, Technologists, Construction Supervisors, administrative personnel and the Chief Inspector. Enerplus Corporation is an oil and gas exploration and production company with assets at the time I was there in Canada and the United States.

8. From 2000 to 2013 I worked for Cenovus Energy and its predecessor companies EnCana Corporation and PanCanadian Petroleum. My final role with Cenovus was the Manager of Facilities Engineering and Construction. During my

tenure with Cenovus, I oversaw the Facilities Engineering and Construction related to the Weyburn CO2 project.

9. I was formerly a member of APEGA (Association of Professional Engineers and Geoscientists of Alberta) and APEGS (Association of Professional Engineers and Geoscientists of Saskatchewan). I have resigned from these associations upon retirement.

III. Documents and Materials Considered

10. In forming my opinions, in addition to my knowledge, education, training, and experience, I have considered the materials cited in this Declaration and the documents and things that I have obtained, or that have been provided to me, as listed in the Table of Exhibits.

11. I reserve the right to supplement or amend this Declaration if additional information that affects my opinions becomes available.

IV. Relevant Legal Principles

12. I am not an attorney, and I offer no opinions on the law. Counsel has informed me of legal standards that apply to the issue of patent validity and patentability, which are the same as those set forth by Rockstraw in paragraphs 14-

25 of his Declaration (EX1001), repeated verbatim below. I have applied these standards in arriving at my conclusions.

13. I understand that in an *Inter Partes* review the Petitioners have the burden of proving a proposition of unpatentability by a preponderance of the evidence. I understand this standard is different from the standard that applies in a district court, where I understand a challenger bears the burden of proving invalidity by clear and convincing evidence.

14. I understand that a patent may not be valid even though the invention is not identically disclosed or described in the prior art if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art in the relevant subject matter at the time the invention was made.

15. I understand that obviousness must be tested as of the time the invention was made. I understand that the test for obviousness is what the combined teachings of the prior art references would have suggested, disclosed, or taught to one of ordinary skill in the art.

16. To determine if a claim is obvious, the following factors should be considered: (1) the level of ordinary skill in the art at the time the invention was made; (2) the scope and content of the prior art; (3) the differences between the claimed invention and the prior art; and (4) secondary considerations, including

evidence of commercial success, long-felt but unsolved need, unsuccessful attempts by others, copying of the claimed invention, unexpected and superior results, acceptance and praise by others, independent invention by others, and the like.

17. For example, I understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand that an obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim because a court can take account of the inferences and/or creative steps that a person of ordinary skill in the art would employ.

18. I understand that the following rationales may be used to determine whether a piece of prior art can be combined with other prior art or with other information within the knowledge of one of ordinary skill in the art:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Predictable use or combination of prior art elements according to their established functions;
- Use of known techniques to improve similar devices (methods, or products) in the same way;

- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- “Obvious to try” - choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; or
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

19. I understand that when a work is available in one field of endeavor, design incentives and/or other market forces, for example, can prompt variations of it, either in the same field or a different one. Moreover, if a person of ordinary skill can implement a predictable variation, I understand this likely bars its patentability.

20. I understand that another factor to be considered is common sense. For example, I understand that common sense teaches that familiar items may have obvious uses beyond their primary purposes, and, in many cases, a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle.

21. I understand that the Supreme Court articulated additional guidance for obviousness in its KSR decision. My understanding is that the Supreme Court said that technical people of ordinary skill look for guidance in other solutions to problems of a similar nature, and that the obviousness inquiry must track reality, and not legal fictions. I have relied on these understandings in expressing the opinions set forth below.

22. I understand that a new use of an old product or material cannot be claimed as a new product; the apparatus or system itself is old and cannot be patented. I further understand that, in general, merely discovering and claiming a new benefit to an old process cannot render the process newly patentable.

23. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and customary meaning, the words of a claim are first given their plain meaning that those words would have had to a person of ordinary skill in the art ("POSITA"). I understand that the structure of the claims, the specification, and the file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a POSITA to a claim term at the time of filing. I have followed this approach in my analysis, and for all

the claim terms considered in this Declaration, I have applied the plain and ordinary meaning of those terms, unless otherwise stated.

24. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time the alleged invention was made (not today). I have been asked to use the priority date of May 18, 2007.

V. Person of Ordinary Skill in the Art

25. I agree with the level of skill for the POSITA as set forth by Rockstraw in paragraphs 26-28 of his Declaration (EX1001), repeated verbatim below

26. In order to determine the characteristics of a POSITA of the '332 Patent, I have used May 18, 2007 as the relevant time frame. My understanding is that this is the earliest priority date of the application that resulted in the '332 Patent. For purposes of this Declaration, any reference to the priority date of the '332 Patent is intended to refer to this May 18, 2007, date.

27. In determining the characteristics of a person of ordinary skill in the art for the '332 Patent, I have considered the state of the art of chemical engineering processes at that time, the types of problems encountered with separating petroleum mixtures, and the solutions that then existed. I have also considered the then-existing technology for large-scale separation and distillation systems, including the sophistication of the technology involved, and the education and experience of those

working in the field at that time. I have also considered my personal knowledge and experience in the field at that time, including those I worked and interacted with regarding chemical and petroleum engineering. I have also considered the knowledge, education, and experience of those in academia and industry at that time that were working, innovating, or performing research in the field of chemical and petroleum engineering.

28. A person of ordinary skill in the art (POSITA) would have had: (i) a B.S. degree in chemical engineering, petroleum engineering, or an equivalent field and (ii) two or three years of industry experience in chemical processing systems, oil and gas production or refining; or comparable experience. Additional work experience can substitute for educational or research experience, and vice versa. Given this background, a POSITA would have been familiar hydrocarbon streams, natural gas liquids, and hydrocarbon separation techniques.

29. Based on my background and qualifications, I currently am and was as of the priority date of the '332 Patent at least a POSITA in the subject matter of the '332 Patent.

VI. Overview of The Prim '332 Patent Process

30. The Prim '332 Patent describes a process whereby fluids produced from an Enhanced Oil Recovery ("EOR") field "the hydrocarbon feed stream" (Exhibit 1001 at 1:38) are first separated into a liquid stream, the "heavy hydrocarbon rich

stream” (*id.* 1:39), and a vapor stream, the “carbon dioxide recycle stream” (*id.* 1:40). The liquid stream contains oil (heavy hydrocarbon), and the vapor stream includes carbon dioxide, methane, ethane, NGL’s, hydrogen sulfide, helium, and nitrogen, that is, everything included at id 2:61-65 except for the heavy hydrocarbon removed in the above separation. This stream is then processed using a distillation separation to produce an overhead stream which contains virtually all of the methane, virtually all of the ethane, most of the CO₂, over 90% of the H₂S, and about 30% of the C₃+ liquids. The bottom product consists of soluble amounts of methane and ethane, less than 10% of the H₂S and about 70% of the C₃+ liquids. The recovery level of the C₃+ liquids is dependent upon the economic decision process described in Method 400 of Ex1001 8:48 to 10:21. Because this stream contains H₂S as well as CO₂ it is referred to as the “sour NGL rich stream” and is further processed to remove the H₂S and CO₂. This sour NGL rich stream is then treated to separate the sweet NGL rich stream from the acid gas stream. The sweet NGL rich stream consists of C₃-C₈ hydrocarbons.

31. The purpose of this process as the title “Natural Gas Liquid Recovery Process” would imply is to make a marketable NGL stream that is suitable for sale. It is not to separate a methane stream for use as fuel or for sale, and it is not to make ethane, either as a single component or as part of the natural gas liquids stream.

32. Prior to May 18, 2007 (the priority date) a POSITA would have had limited choices for a process to recover natural gas liquids from an EOR project. Although other options may have been available at the time, the most common were a Mechanical Refrigeration Unit (MRU) or the Ryan/Holmes process. Although an MRU is a widely accepted method to separate hydrocarbons based on their relative boiling points, separations involving CO₂ are much more difficult. The use of a MRU is relatively simple and quite inexpensive to build, but the recovery of natural gas liquids is limited to C₄+. Another known process available at the time would have been the Ryan Holmes process, which is described extensively below.

33. The main deciding factor for a POSITA in the decision of which type of facility to build would have been the economics. The economics would have been based on the forecasted revenues from the sale of product, less operating cost and less an allowance for the recovery of the initial capital cost. When considering the forecasted revenues not only would the volume of product been important, but also the price of the product. A POSITA would have known that the local price of products can vary significantly based on the presence of infrastructure and availability of capacity and market. For example, some areas may not have access to a pipeline capable of transporting ethane. Since ethane has a very high vapor pressure, it is impractical to move by truck or rail. Other areas may have pipeline constraints which make the transportation cost of methane higher than the value of

the product, making the recovery of methane uneconomic. Incidentally, a low price of methane in an area can be a further benefit to a plant which does not recover methane since purchased fuel can be a significant part of the operating expense.

34. The Prim '332 Patent invention provides a middle ground for the POSITA to consider. If the potential revenue stream for the plant is insufficient to support the higher capital cost of a Ryan/Holmes facility, but the POSITA wanted to recover more products than an MRU is capable of, the Prim invention could be considered.

VII. Summary of The '332 Patent

A. Brief Description

35. The '332 Patent relates to a method of recovering and processing natural gas liquids from an oil and natural gas feed stream. EX1001, Abstract, 2:22-28. The patent describes a processing method that requires three hydrocarbon separations. EX1001 at FIG. 1, FIG.2. The first separation occurs at separator 102, where the heavy hydrocarbons 154 are removed from the hydrocarbon feed stream 152 derived from subterranean formation 114:

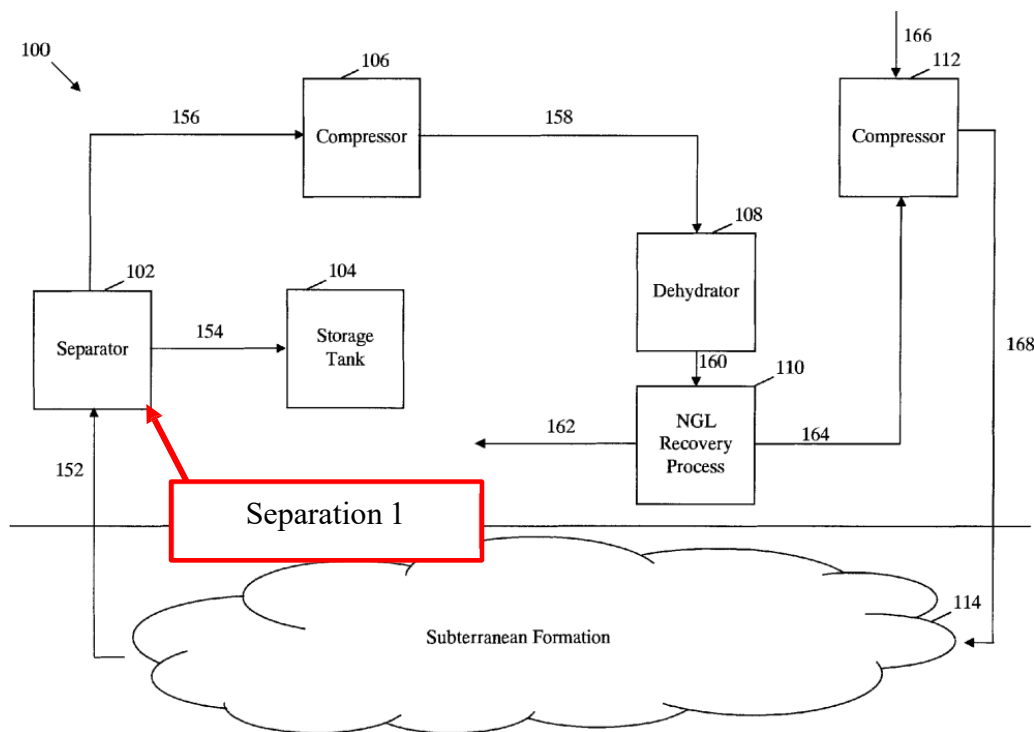


FIG. 1

36. EX1001 at FIG. 1 (annotated, future annotations also in red). The heavy hydrocarbons are shunted to a storage tank 104, while the remaining carbon dioxide (CO₂), hydrogen sulfide (H₂S), and lighter hydrocarbons (i.e., the carbon

dioxide recycle stream 156) are compressed at compressor 106 and dehydrated at dehydrator 108. This dehydrated carbon dioxide recycle stream 160 is passed into the NGL recovery process 110.

37. The second and third separations occur during the NGL recovery process:

38.

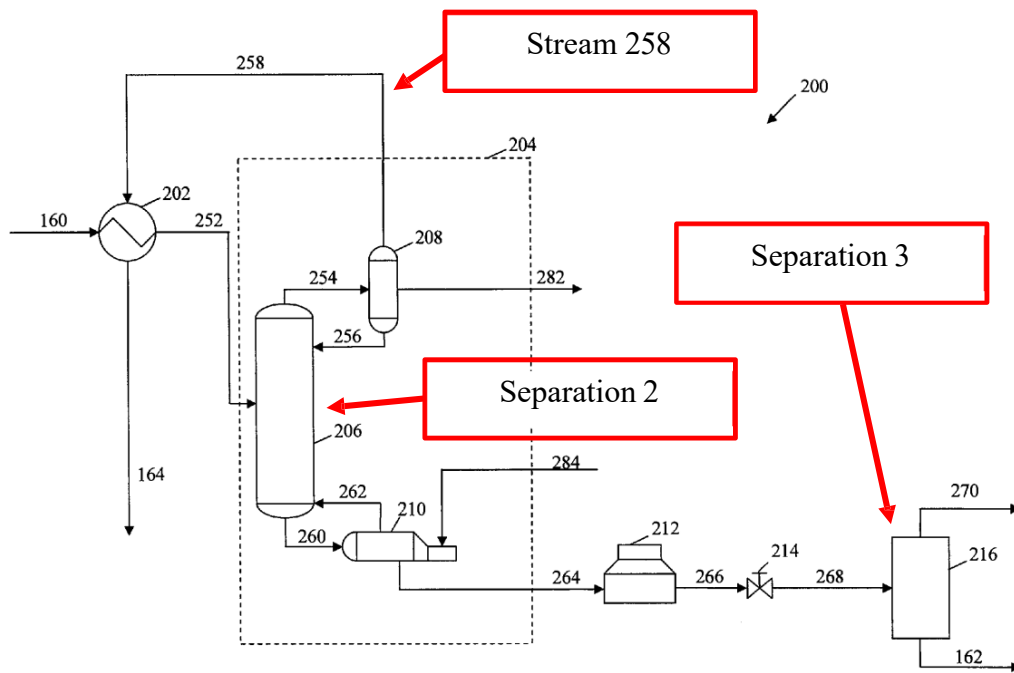


FIG. 2

39. EX1001 at FIG. 2 (annotated). The dehydrated carbon dioxide recycle stream 160 is passed to column 206 for separation. *Id.* at FIG. 2, 7:1-6. Column 206 separates stream 160 into a purified carbon dioxide stream 258 and a sour NGL rich stream 264. *Id.* at FIG. 2, 7:6-10, 7:21-24. The sour NGL rich stream 264 is passed to separator 216, which separates the sour NGL rich stream into a sweet NGL rich stream 162 and an acid gas stream 270. *Id.*, 7:51-52, 61-62, FIG. 2.

B. Summary of the Prosecution

40. The '332 Patent was filed as Application No. 12/122,336 (the "'336 Application") on May 16, 2008 ("U.S. Filing Date"). The '336 Application claims priority to Provisional Application No. 60/938,726, filed May 18, 2007 ("Priority Date"). (EX1003 at 31-35).

41. There were three Office Actions issued by the Examiner during prosecution of the '332 Patent, three Responses to those Office Actions, two Examiner Interviews, and a Notice of Allowance including a Notice of Allowability setting forth the Examiner's reasons for allowance.

42. Beginning with the second Office Action, the Examiner cited U.S. Patent No. 4,529,411 ("Goddin") (EX2003) as the basis for rejecting application claims, including those that ultimately issued as the challenged claims in this matter.

43. Responses to the second and third Office Actions argued against the Goddin-based rejections, and the two Examiner Interview summaries reflect the Examiner's suggestions to amend claims to overcome the rejections by adding negative limitations to distinguish the '332 Patent claims from Goddin. Amendments were made to distinguish the '332 Patent claims from Goddin, and the Examiner confirmed those distinctions and patentability in the reasons for allowance.

44. The Goddin patent describes two alternative processes for CO₂ removal, including a first stage using membranes for removal of CO₂, and a second stage using either: 1) cryogenic distillation; or 2) CO₂ solution absorption.¹

45. In Goddin's first alternative, the second stage is the Ryan/Holmes cryogenic distillation process. In response to the Examiner's rejections, amendments were made to the '332 Patent claims specifically to distinguish the claimed invention from the Ryan/Holmes process, including the negative limitations suggested by the Examiner to specify that the '332 Patent process does not use cryogenic conditions, membranes, or CO₂ recovery solvents.

46. As confirmed by the Examiner in the reasons for allowance set forth in the Notice of Allowability, these amendments distinguished the '332 Patent process from the Ryan/Holmes cryogenic distillation process, and led to the issuance of the challenged claims, after the Examiner meaningfully addressed the Ryan/Holmes prior art.

¹ (EX2003, 7:24-33 ("CO₂ is further removed from the hydrocarbon enriched process stream by cryogenic fractionation and/or by CO₂ solution absorption.")).

VIII. Claim Construction

A. Cryogenic Conditions:

47. Challenged Claim 1 of the Prim '332 Patent includes the negative limitations suggested by the Examiner during prosecution to distinguish the claimed invention from the prior art Goddin cryogenic distillation process, including the requirement that the “hydrocarbon feed stream, the carbon dioxide recycle stream, and the sour NGL rich stream” in the Prim process “are not subjected to cryogenic conditions.” (*See supra*, Section VII(B).)

48. The Goddin patent, just like the Ryan/Holmes patents and journal articles, repeatedly refer to their process as “cryogenic distillation” and “cryogenic fractionation,” or “cryogenic distillative fractionation.” (*See, e.g.*, EX2003, EX1010, EX2006, EX2008.)

49. The term Cryogenic does not have a universal definition, and is often different depending on the context and the industry. In Exhibit 1011 at 8-9, the Plaintiffs describe cryogenic conditions as -130F (-90C) or less. The first reference cited is the EPA websites definition of cryogenic conditions. This reference is related to the storage of gases which have been liquified such as air, argon, carbon monoxide, ethylene, fluorine, helium, hydrogen, methane, nitrogen, and oxygen. The second reference is from the American Institute of Chemical Engineers. They

define cryogenic liquid as a refrigerated liquid gas having a boiling point below -130 F (-90 C) at atmospheric pressure. (NFPA 30).

50. In Exhibit 1017, the Defendants provide a definition of cryogenic from the National Institute of Standards and Technology of -150C (-238F), again related to the liquification of permanent gases.

51. These definitions for very similar situations (the liquification of gases) differs by 60C (108F), which would hardly describe a consensus within the industry.

52. Further investigation into other industries reveals an even broader range of temperatures. From the *Biocompare* editorial article Best Practices for Biological Sample Storage and Management by Hannah Kent-Webb PhD published in October 2022, “long-term storage requires ultra-low temperature (-112 F) or Cryogenic storage.” (EX2009.)

53. From the proceedings of the 26th intersociety energy convention engineering conference in 1991, the abstract of the “vortex expansion devices for high temperature cryogenics” described the range of cryogenic temperatures as “-320 degrees F (-195 degrees C) up to -58 degrees F (-50 degrees C), the generally defined upper limit of study referred to as cryogenic.” (EX2010.)

54. Penflex, a supplier of cryogenic hoses, released Engineering Bulletin #113 which describes Mechanical Properties at Cryogenic Temperatures. The bulletin includes a table from The American Society of Materials “ASM Specialty

Handbook: Stainless Steels,” published in 1994 which describes mechanical properties of austenitic stainless steels. In this table, cryogenic temperatures include temperatures as high as -40F. (EX2011.)

55. In the oil and gas industry, a well-known and most widely used publication is the Gas Processors Association (GPA) and the Gas Processors Suppliers Association (GPSA) “Engineering Data Book.” The Twelfth Edition (2004), Section 1 includes Definitions of Words and Terms Used in the Gas Processing Industry, which includes the following;

cryogenic plant

A gas processing plant which is capable of producing natural gas liquid products, including ethane, at very low operating temperatures, usually below minus 50°F.

56. The GPA, in addition to publishing the Engineering Data Book, also sponsors an annual technical convention and publishes technical papers such as Exhibit 1010 “Pilot Tests Prove Ryan/Holmes Cryogenic Acid Gas/Hydrocarbon Separations.” The “Hydrate Formation in Chevron Mabee Unit for NGL Recovery and CO₂ Purification for EOR,” which was submitted to the Gas Processors Association conference 2017 also lists the 1998 edition of the GPSA Engineering Data Book as a reference. The GPA (and GPSA) Engineering Data Book is also referenced in the Exhibit 1022 at 1:30, and was acknowledged in the reference (21)

of Exhibit 1005 as being presented at the 61st Annual Gas Processors Association Convention. Exhibit 1007 reference 3 is also a GPA publication from 1983.

57. Given the above, it is clear that there is no single definition of cryogenic temperatures. Since the current Petition for Inter Partes Review is related to the upstream oil and gas industry, it would seem reasonable to accept the GPS “Engineering Data Book” definition of -50F.

B. Carbon Dioxide Recovery Solvents:

58. In the Prim ‘332 Patent, Claim 1 specifically excludes the use of “carbon dioxide recovery solvents” in the process. Those words in the claim were chosen specifically with the intention of not limiting the solvents to carbon dioxide solvents. Had Prim intended the exclusion to include only solvents with an affinity to CO₂, the patent would have used the term “carbon dioxide solvents.”

59. With this in mind, the additives in the Ryan/Holmes processes and the Soldati process are used extensively to allow the separation of CO₂ from the hydrocarbons. This separation is accomplished by relying on the solubility of the hydrocarbons into the additive. Additives, also referred to as agents, liquid hydrocarbon streams, recycled hydrocarbon stream, absorbent oil, stream 10 and stream 32 (in Soldati), recirculating hydrocarbon, lean oil, among others, amounts to the use of carbon dioxide recovery solvents. The use of these carbon dioxide

recovery solvents is mentioned by one of the terms above in Exhibits 1005, 1006, 1007, and 1010, but never in Exhibit 1002.

IX. Overview of The Prior Art

A. The Ryan/Holmes Process

60. Ryan/Holmes is a cryogenic distillation process developed in the late 1970's and early 80's to improve the process of separating methane and ethane from carbon dioxide recycle streams in enhanced oil recovery ("EOR") operations. The Ryan/Holmes process uses hydrocarbon solvents ("additives"), and an extensive amount of process equipment (up to four distillation columns), to solve two particular problems in the separation of methane and ethane from carbon dioxide recycle streams. The Ryan/Holmes additives avoid carbon dioxide freezing (solidification) in the separation of methane from carbon dioxide, and allows for the separation of ethane from carbon dioxide, by eliminating the formation of what is known as the ethane-carbon dioxide "azeotrope" which otherwise would preclude a separation of ethane from carbon dioxide.

61. While the Ryan/Holmes process uses additives and extensive process equipment to improve the process of separating methane and ethane from carbon dioxide recycle streams, the innovative process described and claimed in the '332 Patent improves the process of recovering NGLs from carbon dioxide recycle

streams by “disregarding the recovery” of methane and ethane from the carbon dioxide recycle stream, to recover NGLs “with relatively little process equipment or energy.”²

62. The purpose, process, and result of implementation of the Ryan/Holmes process is to separate methane and ethane from carbon dioxide recycle streams, using additives and extensive processing equipment, to produce methane and ethane for sales. The Prim ‘332 invention goes in the opposite direction by NOT using additives or extensive processing equipment to separate methane and ethane from carbon dioxide recycle streams. This innovative process leaves all (or almost all) of the methane and ethane in the carbon dioxide recycle streams, to produce NGLs, having little to no methane and ethane, while using significantly less process equipment and energy, and thereby recovers NGLs with significantly less costs.

63. Ryan and Holmes authored several journal articles describing their cryogenic distillation process that were published in the early 1980’s, and were issued several U.S. patents for their process. Petitioners included two of the Ryan/Holmes journal articles in the Petition, Exhibits 1007 and 1010. Patent Owner adds in this Preliminary Response an additional Ryan/Holmes journal article as

² (EX1001, 4:55-60.)

Exhibit 2008. Patent Owner also includes two of the Ryan/Holmes patents, as Exhibits 2006 and 2007.

64. Petitioners rely upon one of the Ryan/Holmes journal articles as the primary basis for each of the six obviousness Grounds asserted in the Petition. Petitioners incorporate Ryan's 1984 Chemical Engineering Progress article (EX1007 ("Ryan")) into the Aycaguer (EX1005) reference, by asserting that Aycaguer's citing of the Ryan article (at footnote 22) "evidences a POSITA's knowledge at the relevant time" (Petition at 35). Aycaguer, and by incorporation Ryan, is the primary reference for each of the six obviousness Grounds asserted in the Petition. Grounds 4 and 6 explicitly add Ryan to the combination of references for those Grounds.

65. Petitioners made a similar attempt to incorporate another Ryan/Holmes journal article into their obviousness grounds, but mistakenly cited to the wrong article. Petitioners mistakenly assert that Aycaguer cites to a Ryan/Holmes 1982 Gas Processors Association article (EX1010), and quote from that article in support of their obviousness grounds. (Petition at 35-36.) The additional Ryan/Holmes article actually cited in Aycaguer (at footnote 21) is a different 1982 article authored by Ryan and Holmes, published in the Hydrocarbon Processing journal, which Patent Owner attaches as Exhibit 2008.

66. In both of these 1982 journal articles authored by Ryan and Holmes, they refer to their distillation processes as being “cryogenic.” (EX1010, entitled “Pilot Tests Prove Ryan/Holmes Cryogenic Acid Gas/Hydrocarbon Separations” (emphasis added); EX2008, subtitled “Ryan/Holmes cryogenic processes overcome roadblocks to distillation of C₁-CO₂, C₂-CO₂ and CO₂-H₂S systems” (emphasis added)).

67. At pages 35-36 of the Petition, Petitioners rely upon two particular quotes from the Ryan/Holmes journal articles that reference non-cryogenic temperatures for particular proposed configurations of the Ryan/Holmes process, referencing operating temperatures as warm as “-30 to -40°F” (EX1010 at 81), and “-35°F” (*id.* at 83). Upon a closer review of these Ryan/Holmes journal article descriptions of the process, the non-cryogenic (warmer than -50°F) conditions referenced are particular proposed configurations of the Ryan/Holmes process in which these warmer conditions were accomplished by increasing the flow of the CO₂ recovery solvents (“NGL-based additives”). See EX1010 at 83 (“By increasing the volume of recycle additive to the column, the overhead temperature can be raised to -35°F.”).

68. While these Ryan/Holmes 1982 journal articles described their proposed configurations to operate at non-cryogenic conditions by increasing the flow of CO₂ recovery solvents (“NGL-based additives”), by 1984 Ryan and Holmes

were teaching away from this configuration by promoting their new four-column process, and criticizing their old increased additives three-column process.

Four-column scheme

The major objectives which lead to the development of the four-column arrangement were to lower the energy consumption and capital cost of the overall processing scheme. After some study it became apparent that reducing the flow of additive and producing the CO₂ product as a liquid-column bottoms stream would help accomplish these objectives. If a liquid CO₂ product bottoms stream were to be produced, it would have to be from a column into which no additive was fed. Figure 3 shows the resulting four-column flow schematic.

(EX1007 at 84 (emphasis added).)

69. In other words, although the Ryan/Holmes process back in 1982 may have included a proposed non-cryogenic configuration for the Ryan/Holmes cryogenic distillation process, within a few short years in 1984 Ryan and Holmes were teaching away from that particular proposed configuration.

B. Goddin (EX2003)

70. The Goddin patent describes two alternative processes for CO₂ removal, including a first stage using membranes for removal of CO₂, and a second stage using either: 1) cryogenic distillation; or 2) CO₂ solution absorption.³

³ (EX2003, 7:24-33 (“CO₂ is further removed from the hydrocarbon enriched process stream by cryogenic fractionation and/or by CO₂ solution absorption.”)).

71. In Goddin's first alternative, the second stage is the Ryan/Holmes cryogenic distillation process.⁴ In response to the Examiner's Goddin-based rejections, amendments were made to the '332 Patent claims specifically to distinguish the claimed invention from the Ryan/Holmes process, including the negative limitations suggested by the Examiner to specify that the '332 Patent process does not use cryogenic conditions, membranes, or CO₂ recovery solvents.

72. As confirmed by the Examiner in the reasons for allowance set forth in the Notice of Allowability, these amendments distinguished the '332 Patent process from the Ryan/Holmes cryogenic distillation process, and led to the issuance of the challenged claims, after the Examiner meaningfully addressed the Ryan/Holmes prior art.

The following Table demonstrates the similarities between the process described in Figure 11 of the Goddin '411 Patent (EX2003), which was meaningfully addressed during prosecution of the Prim'332 Patent, and the three-column Ryan/Holmes process asserted as the primary basis for each of the obviousness Grounds in the Petition.

73. As demonstrated below for each of the three distillation columns in this process, and the final step of sweetening the NGL output stream, the input, process,

⁴ *See* Ex. 2004, Table of Similarities (demonstrating similarities between Goddin '411 Patent Figure 11 and Three-Column Ryan/Holmes Process).

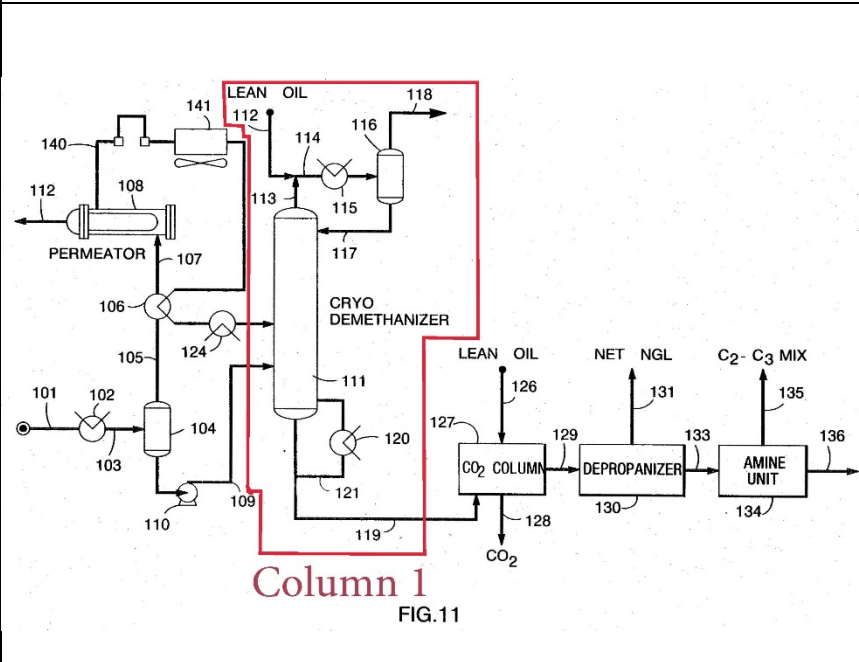
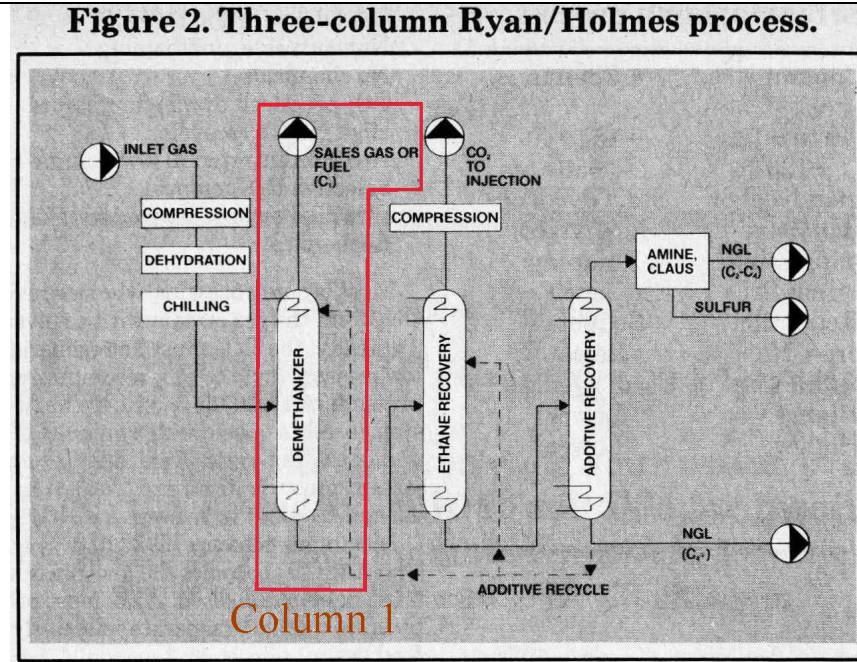
and output for each of the three distillation columns, and the final sweetening step, are the same. In other words, the cryogenic distillation process in the Goddin '411 Patent, which was meaningfully addressed during prosecution of the Prim '332 Patent, is the same art asserted as the primary basis for each of the six obviousness Grounds in the Petition.

74. The following presentation for brevity excludes the footnotes referencing the source of each item. The corresponding attached Exhibit 2004 Table of Similarities includes the footnotes referencing the source of each item.

Goddin '411 Patent Figure 11

Three-Column Ryan/Holmes Process

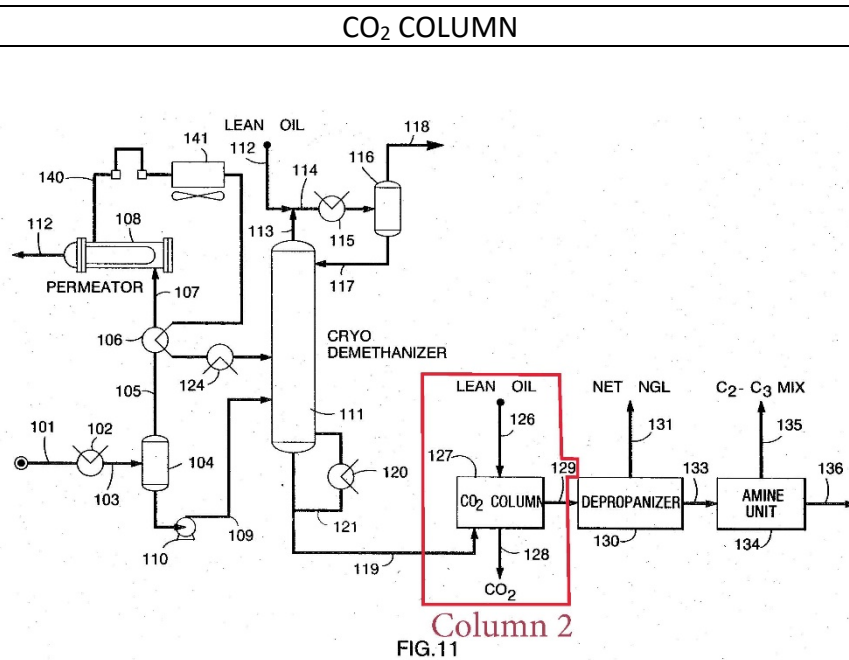
Column 1

CRYO DEMETHANIZER	DEMETHANIZER
 Column 1 FIG. 11	Figure 2. Three-column Ryan/Holmes process.  Column 1
INPUT: Primarily C_{1,2,3,4+} and CO₂, some H₂S and N₂, and “Lean Oil” (C_{4,5} hydrocarbon solvent).	INPUT: Primarily C_{1,2,3,4+} and CO₂, some H₂S and N₂, and “NGL-based additive” (C₄₊ hydrocarbon solvent).
PROCESS: Separation of Methane C₁ from CO₂ for sales of Methane C₁, using “Lean Oil” (C_{4,5} hydrocarbon solvent) to avoid CO₂ freeze-up.	PROCESS: Separation of Methane C₁ from CO₂ for sales of Methane C₁, using “NGL-based additive” (C₄₊ hydrocarbon solvent) to avoid CO₂ freeze-up.
OUTPUT – Overhead: Primarily Methane C₁ Residue [sales] gas stream. Bottom: “bulk of” CO₂ and C₂₊	OUTPUT - Overhead: Primarily Methane C₁ Sales Gas or Fuel Bottom: CO₂ and C₂₊

Goddin '411 Patent Figure 11

Three-Column Ryan/Holmes Process

Column 2

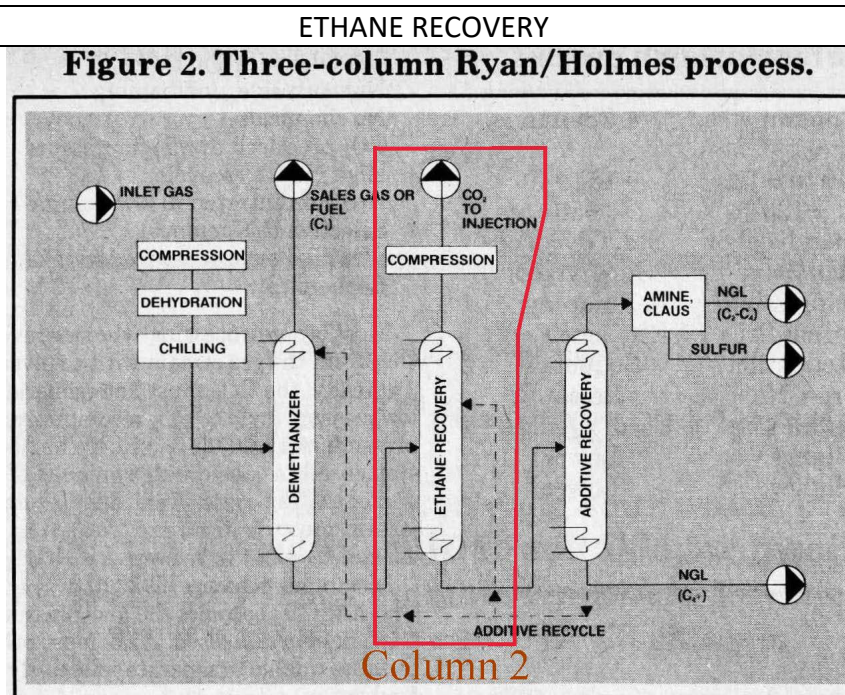


INPUT: CO₂ and C₂₊, and “Lean Oil” (C_{4,5} hydrocarbon solvent).

PROCESS: Separation of Ethane C_2 from CO_2 , using “Lean Oil” ($C_{4,5}$ hydrocarbon solvent) to facilitate separation of Ethane C_2 from CO_2 .

OUTPUT- Overhead: Sweet high purity CO₂ product stream.

Bottom: Ethane C₂ and other hydrocarbons.



INPUT: CO₂ and C₂₊, and “NGL-based additive” (C₄₊ hydrocarbon solvent).

PROCESS: Separation of Ethane C_2 from CO_2 , using “NGL-based additive” (C_{4+} hydrocarbon solvent) to facilitate separation of Ethane C_2 from CO_2 .

OUTPUT - Overhead: CO₂ product stream.

Bottom: Ethane C₂ and other hydrocarbons.

Three-Column Ryan/Holmes Process

Column 3

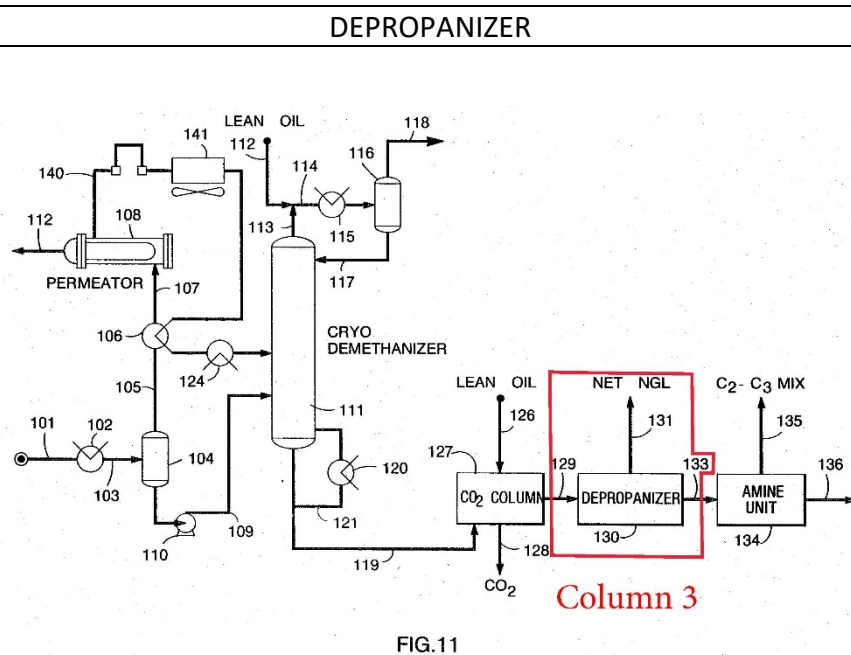


FIG.11

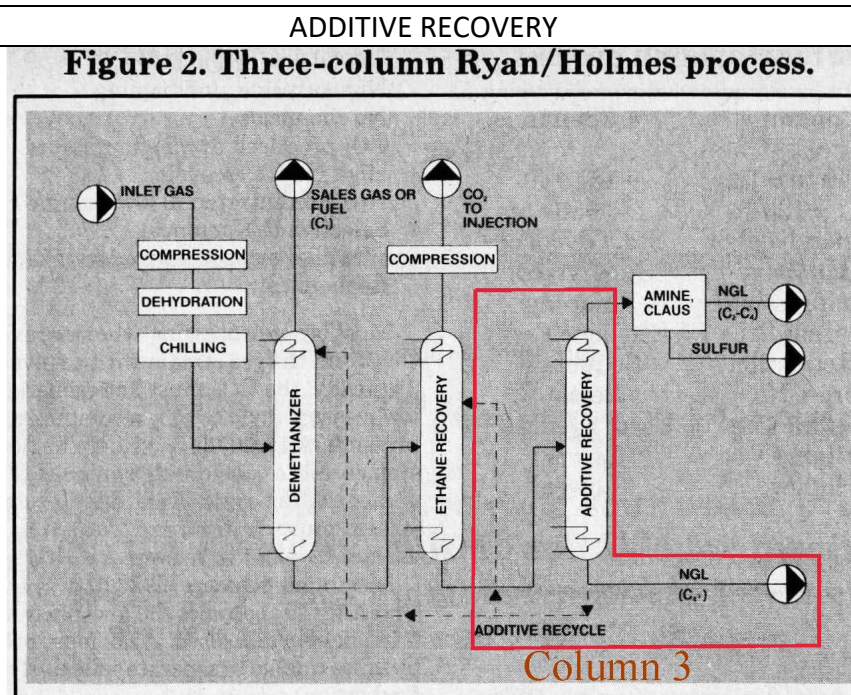


Figure 2. Three-column Ryan/Holmes process.

Column 3

INPUT: Ethane C₂ and other hydrocarbons.

PROCESS: Separation of light (Ethane C_2 and Propane C_3) and heavier hydrocarbons (Butane C_4 and heavier hydrocarbons C_{5+}).

OUTPUT - Overhead: Ethane C₂ and Propane C₃ (“E-P mix”), and some acid gases CO₂ and H₂S.
Bottom: Butane and heavier hydrocarbons (C₄+ aka “Net NGL”).

INPUT: Ethane C_2 and other hydrocarbons.

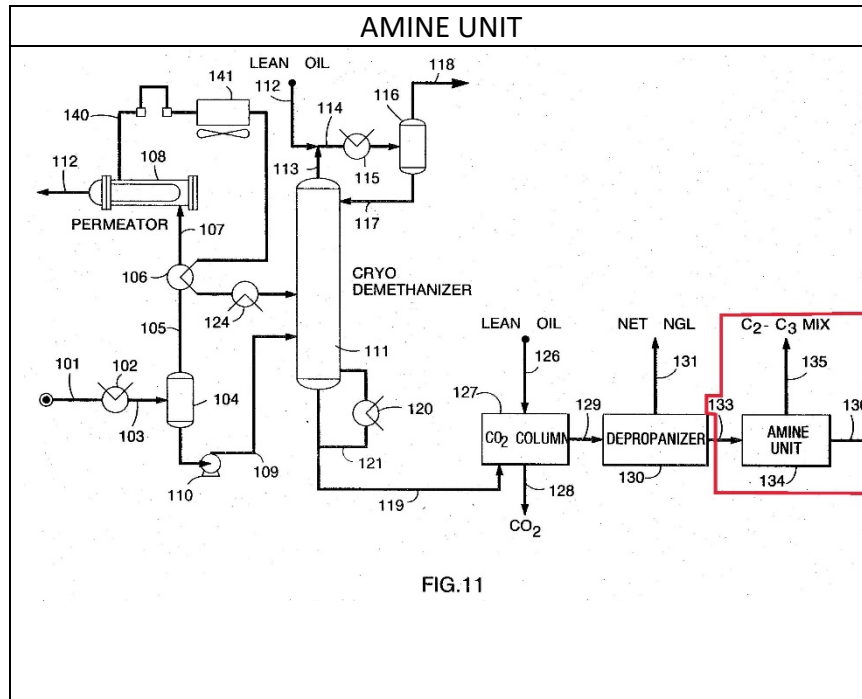
PROCESS: Separation of light (Ethane C₂ and Propane C₃) and heavier hydrocarbons (Butane C₄ and heavier hydrocarbons C₅₊).

OUTPUT - Overhead: Ethane C₂ and Propane C₃, and some acid gases CO₂ and H₂S.
Bottom: Butane and heavier hydrocarbons (C₄₊ aka “NGL” and “Additive Recycle”)

Goddin '411 Patent Figure 11

Three-Column Ryan/Holmes Process

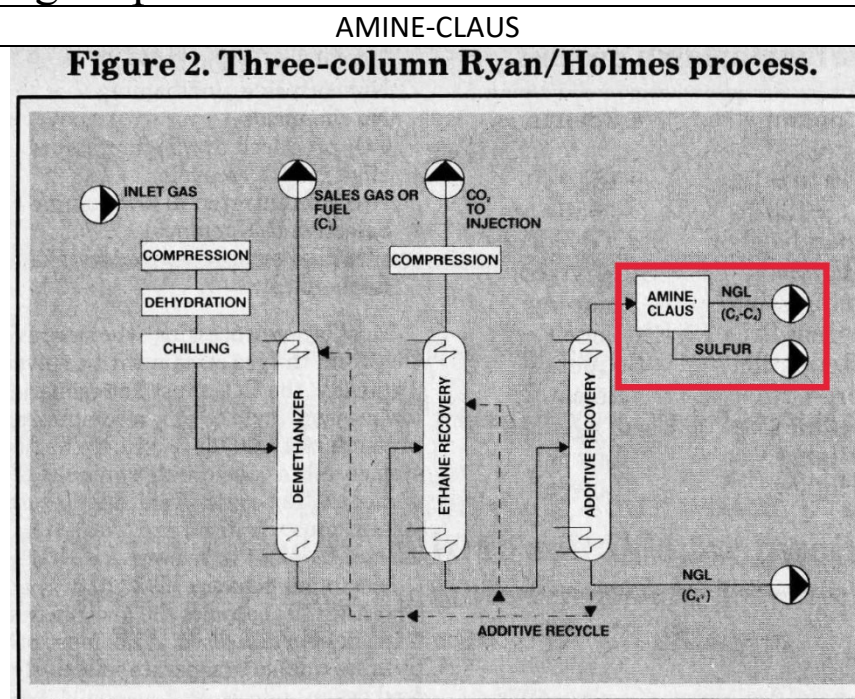
Sweetening Step



INPUT: Ethane C_2 and Propane C_3 , and some acid gases CO_2 and H_2S (sour "E-P mix").

PROCESS: Amine Scrubbing (sweetening of the Ethane C_2 and Propane C_3 ("E-P mix")).

OUTPUT: - Overhead: Sweet Ethane C_2 and Propane C_3 (sweet "E-P mix").
Bottom: Acid gases CO_2 and H_2S .



INPUT: Ethane C_2 and Propane C_3 , and some acid gases CO_2 and H_2S .

PROCESS: Conventional amine treatment to produce sweet NGL product.

OUTPUT: Overhead: Sweet Ethane C_2 and Propane C_3 ("sweet NGL product")
Bottom: Sulfur

C. Overview of Aycaguer (EX1005)

75. Aycaguer is an article written from an Environmental, Health and Safety perspective about CO₂ emissions in EOR. A POSITA may not have been motivated to read the article since the title does not evoke thoughts of Gas Processing. Had a POSITA begun reading the article, they may have gotten to the third column where Aycaguer, describing the benefits of EOR being “extraction of additional oil and repressurization of the formation, thus avoiding ground collapse that could follow the depletion of the reservoir,” and closed the magazine. To my knowledge, there has never been an EOR oil reservoir that has collapsed as the result of removing the oil. There may have been cases of minor subsidence following oil production, but reservoirs suitable for EOR are made of solid rock.

76. Aycaguer does not render the challenged Prim ‘332 Patent claims obvious, although Aycaguer does correctly state that “the gas processing stage is the most complex stage of the system.” (EX1005 at 305.) Rockstraw, in section 56 of Ex 1002 states that Aycaguer alone renders Claim 1 of the ‘332 Patent obvious. Aycaguer alone does not show any detail of how the Ryan/Holmes process works, nor does it explain any of the internal processes. Figure 1, relied upon by Rockstraw as proof of obviousness does not even do the Ryan/Holmes process justice as it leaves off the methane stream. Aycaguer may describe what happens in Ryan/Holmes, but it does not describe how Ryan/Holmes works. One thing that

Aycaguer does is introduce the presence of “additives” into the discussion. Looking into the references cited in Aycaguer would introduce Exhibit 1007 (“Ryan”), which will be discussed later. (EX1005 at 305, footnotes 21 (1982) and 22 (1984) are journal articles authored by Ryan and Holmes, describing the Ryan/Holmes process.)

77. Interestingly, Rockstraw only refers to one of the two cited articles in Aycaguer (EX1002, ¶ 111 (referring to EX1007 (“Ryan”)))⁵. The other article, “Process improves acid gas separation,” written by Holmes et al was published in the May 1982 edition of Hydrocarbon Processing.⁶ It describes the three-column version of the Ryan/Holmes process, which is also described in Exhibit 1007. The article includes some interesting descriptions of the Ryan/Holmes processes in general such as “Carbon Dioxide separated cleanly from troublesome systems when

⁵ Rockstraw refers to EX1007 Ryan as “one of two references cited by Aycaguer to describe the Ryan/Holmes process and evidences a POSITA’s knowledge at the relevant time.” EX1002, ¶ 111. Rockstraw then mistakenly refers to EX1010 (“Holmes”) as “the other Ryan/Homes publication cited to by Aycaguer,” and quotes from this Holmes publication in support of Rockstraw’s opinions. The other Ryan/Holmes publication cited to by Aycaguer is not Holmes EX1010, but instead is a different 1982 publication by Holmes, which is attached as EX2008.

⁶ Holmes AS, Ryan JM, Price BC, Styring RE. Process Improves Acid Gas Separation. Hydrocarbon Processing 1982; 61:131–136 (EX2008). Process improves acid gas separation is an article published in a well-known journal - Hydrocarbon Processing. Hydrocarbon Processing has been published since 1922. Through its monthly magazine, website and e-newsletters, Hydrocarbon Processing covers technological advances, processes and optimization developments from throughout the global Hydrocarbon Processing Industry.

distillation additives are strategically used.” (EX2008 at 131.) The article also describes how the Ryan/Holmes process accomplishes three otherwise impossible distillations using additives including:

- methane from CO₂ - Prim makes no attempt to recover methane from any stream;
- CO₂ from ethane and heavier hydrocarbons - Prim does not recover ethane, and makes no attempt to separate ethane from CO₂. Prim avoids this separation, because the use of additives is required to break the CO₂ - C₂ azeotrope (EX2008 at 134, 8:1-4); and
- CO₂ from H₂S - Although Prim does a partial separation between CO₂ and H₂S, more than 90% of the H₂S remains in the Purified CO₂ Recycle Stream. Ryan/Holmes performs an almost complete separation between H₂S and CO₂, down to <100 ppm (Exhibit 2008 at 134, 8:23-24).

78. Although minor in nature, Aycaguer states that the “injection step consists of sending the gas phase under supercritical conditions (CO₂ in this case) down the injection well.” (EX1005 at 305.) A POSITA would again question the sophistication of Aycaguer since they would recognize that the gas phase cannot be under supercritical conditions. Supercritical condition is a phase unto itself, not gas and not liquid, and occurs when a substance or mixture is at a pressure higher than its critical pressure and/or a temperature higher than its critical temperature.

D. Overview of Soldati (EX1006)

79. Soldati describes a fractionation process for high acid gas streams. The patent at 1:14-19 states that “the purpose of the process according to the present invention is to separate a fraction formed of ethane, propane and heavier

hydrocarbons, a fraction formed essentially of acid gases, and a fraction formed essentially of methane,” contrary to the Rockstraw description in section 68 where it is stated that “Soldati discloses methods of processing oil and natural gas streams to remove CO₂ and H₂S.”

80. Soldati incorporates four distillations to complete the separation described above, and makes use of carbon dioxide recovery solvents referred to as the “liquid hydrocarbon stream” shown in Figures 1, 3, and 4 as streams 10 and 32.

81. The Soldati patent makes reference to a “known art” described as “the teachings of A.S. Holmes and J.M. Ryan.” (EX1006, 1:21-25.) Soldati describes his innovation as an improvement over the Ryan/Holmes process by incorporating “a considerable reduction in energy consumption mainly by recycling smaller liquid hydrocarbon stream throughputs while at the same time increasing the percentage of ethane recovery.” (EX1006, 1:54-58.)

82. Although this Exhibit 1006 is the Soldati patent, the Rockstraw Declaration focuses most of the discussion referencing the prior art Ryan/Holmes process. All of the component throughput data used in the Declaration refer to Table III, which is the data for Example 2, Ryan/Holmes Fig 4. (EX1006, 8:49-10-23, 11:1-13-7.)

83. In the Rockstraw Declaration, the Ryan/Holmes known art description is usually referenced, however there are instances where the references are to the

Soldati process. For example, in section 70 Rockstraw references the lower stream of column 8 using the Ryan Holmes Table III and the Soldati process description at 4:30-32, quoting “propane and higher hydrocarbons.” He could have referenced the Ryan/Holmes process description at 1:31-32 “ethane and higher hydrocarbons” but he didn’t. The presence of ethane in this stream is a significant deviation from the Prim patented process.

84. In section 71, Rockstraw describes column 21 as “where the hydrogen sulfide and carbon dioxide are removed.” Although it is true that these components are included in stream 27, this stream is made up of 94.54% hydrocarbons. It would be more accurate to describe stream 27 as a sour NGL rich stream, which is further processed as described in Aycaguer (Ex 1005) using “a nonselective chemical absorption amine process.” (EX1005 at 305.)

85. Rockstraw mischaracterizes column 21 as if its purpose is to remove the hydrogen sulfide and carbon dioxide, while in reality the purpose and function of column 21 is to separate the C4 butane and heavier hydrocarbons from the lighter hydrocarbons (C2 ethane and C3 propane), which is always the function of the fourth column in the Ryan/Holmes process.⁷ The C4+ heavier hydrocarbons are produced

⁷ See, for example, EX1007 at 54 (Ryan describing the “additive recovery” fourth column in the Four-Column Ryan/Holmes process) (“The role of the additive recovery column is to remove lighter NGL’s to prevent them from being recycled. Butanes-plus is produced from the bottom of the column providing the net heavier NGL make and recovered additive to be recycled to the first two columns. H2S, if

as a bottom product for recycling as the “liquid hydrocarbon stream” (aka “additives”), while the C2/C3 lighter hydrocarbons are produced as an overhead product.

86. The C2/C3 overhead stream is a sour NGL stream, meaning it contains some hydrogen sulfide and carbon dioxide acid gasses, which are further processed to produce sweet NGL product, by removing the hydrogen sulfide and carbon dioxide acid gasses. This sleight of hand mischaracterization by Rockstraw is purposeful, done in order to support Rockstraw’s later opinion for Grounds 3 and 5, regarding challenged Claim 4, which specifies that the sweet NGL rich stream comprises “no more than 1 molar percent ethane.”

87. Rockstraw purposefully incorrectly reverses the overhead and bottom products of column 21, intentionally mischaracterizing the stream 28 bottom product as the sweet NGL rich stream. (EX1002, ¶177.) The stream 28 bottom product is used for recycling as the “liquid hydrocarbon stream” (aka “additives”), while the overhead product is the sour NGL stream produced for sale, containing about 50% ethane. See Soldati Table III components, showing the sour NGL stream 27 as about 50/50 ethane/propane.

present in the plant feed, will be produced in the overhead of the additive recovery column. The sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.”).

TABLE III

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	94	57	27
NITROGEN	—	16.44	—
HYDROGEN SULPHIDE	—	—	0.03
CARBON DIOXIDE	—	1.20	3.65
METHANE	—	57.46	—
ETHANE	—	—	32.57
PROPANE	1.20	0.03	30.51
N-BUTANE	108.25	0.65	0.67
N-PENTANE	32.52	0.05	—
HEXANE	8.03	—	—
THROUGHUT KMOLS/H	150.00	75.83	67.43
PHASE	L	V	L
TEMPERATURE °C.	−20.0	−35.0	5.5
PRESSURE ATA	41.5	40.5	18.5

EX1006, Table III (annotated to highlight the ethane/propane components in the overhead stream 27 of the fourth column). Ryan and Holmes refer to this stream 27, the overhead stream of the fourth column of their four-column Ryan/Holmes process, as the “sour NGL” stream, which is further processed “to produce sweet NGL product.”⁸

88. Rockstraw presents a similar mischaracterization to support Rockstraw’s opinion for Grounds 3 and 5, regarding challenged Claim 7, which specifies that the sour NGL rich stream comprises “no more than 5 molar percent

⁸ EX1007 at 54 (Ryan describing the “additive recovery” fourth column in the Four-Column Ryan/Holmes process) (“H₂S, if present in the plant feed, will be produced in the overhead of the additive recovery column. The sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.”).

ethane.” Rockstraw purposefully incorrectly presents the stream 12 bottom product of column 8 (the first column of the four-column Ryan/Holmes process) as the sour NGL rich stream. (EX1002, ¶189.) Rockstraw attempts to disguise the fact that the stream 12 bottom product of column 8 is subsequently fed into the “additive recovery” column 21, which produces the sour NGL rich stream as the stream 27 overhead product, containing about 50% ethane and 50% propane. (EX1006, Fig. 4, Table III.) And as Ryan and Holmes themselves specifically refer to the overhead product of the fourth column as the “sour NGL” stream, which is further processed “to produce sweet NGL product.”⁹

89. Table IV of Soldati shows the typical recoveries of the Soldati process compared to the Ryan/Holmes process.

⁹ EX1007 at 54 (Ryan describing the “additive recovery” fourth column in the four-column Ryan/Holmes process) (“H₂S, if present in the plant feed, will be produced in the overhead of the additive recovery column. The sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.”).

TABLE IV

	Example 2 (comparative)	Example 1
Ethane recovery %	78.5	94.1
Propane and higher hydrocarbon recovery (Mol %)	94.2	94.5
Carbon dioxide recovery %	99.6	99.9
Recirculating hydrocarbons Ton/h (stream 32)	93.8	17.2
Absorbed power kW	6150	5350
Steam required for reboilers 10 ⁶ kCal/h	18.8	5.3
	(Psat = 6 ATA)	(Psat = 4 ATA)

90. Prim Claim 5 at 18:39-42 specifies the recovery of C3+ should be in the range of “20 molar percent to 40 molar percent” whereas both examples presented in Soldati show recoveries of over 94%.

91. A review of stream 6 and stream 44 of Table III shows that the inlet stream (the carbon dioxide recycle stream) contains 57.59 kMol/hr of methane, and the purified carbon dioxide stream contains 0.0 kMol/hr of methane. This means that the purified carbon dioxide recycle stream contains 0.0% of the methane contained in the carbon dioxide recycle stream.

92. The carbon dioxide recycle stream also contains 41.50 kMol/hr of ethane and the purified carbon dioxide stream contains 8.86 kMol/hr of ethane. This means that the purified carbon dioxide recycle stream contains 21.35% of the ethane contained in the carbon dioxide recycle stream.

93. Claim 5 of Prim at 18:42-46 states that purifies carbon dioxide stream comprises “at least 94 molar percent of the methane and at least 93 molar percent of the ethane from the carbon dioxide recycle stream.” Since none of the methane and only 21.35% of the ethane are contained in the carbon dioxide stream, the both the Soldati process and the Ryan/Holmes process described in the Soldati patent differ significantly from Prim.

94. The Soldati process and the Ryan/Holmes process described in the Soldati patent both require 4 distillation columns, both use carbon dioxide recovery solvents, both produce a separate methane stream, both produce an NGL stream which contains essentially all of the ethane from the carbon dioxide recycle stream, and produce a purified carbon dioxide stream which is over 99% carbon dioxide. In contrast, the Prim ‘332 Patent process makes no attempt to separate methane from the purified carbon dioxide stream, and recovers less than 7% of the ethane from the carbon dioxide recycle stream (Prim Claim 5).

E. Overview of Ryan (EX1007) and Goddin (EX2003)

95. Rockstraw only describes the three-column Ryan/Holmes process. Rockstraw does not mention the use of additives in the Declaration even though the word appears in the Ryan article 42 times.

96. Exhibit 1007 describes a process including “distillation separations using NGL-based additive.” (EX1007 at 1:12.) The first column “separates methane

as an overhead product from CO₂, C₂, H₂S and C₃ and heavier hydrocarbons.” (*Id.* at 1:18-20.) Prim does not separate methane from any stream. This first distillation step includes the addition of an additive “to avoid freezing in the column.” (*Id.* at 1:21.) The Prim ‘332 Patent process does not include the addition of an additive to “permit the separations to occur” (*Id.* at 1:15), nor are additives used to “avoid freezing in the column” (*Id.* at 1:21).

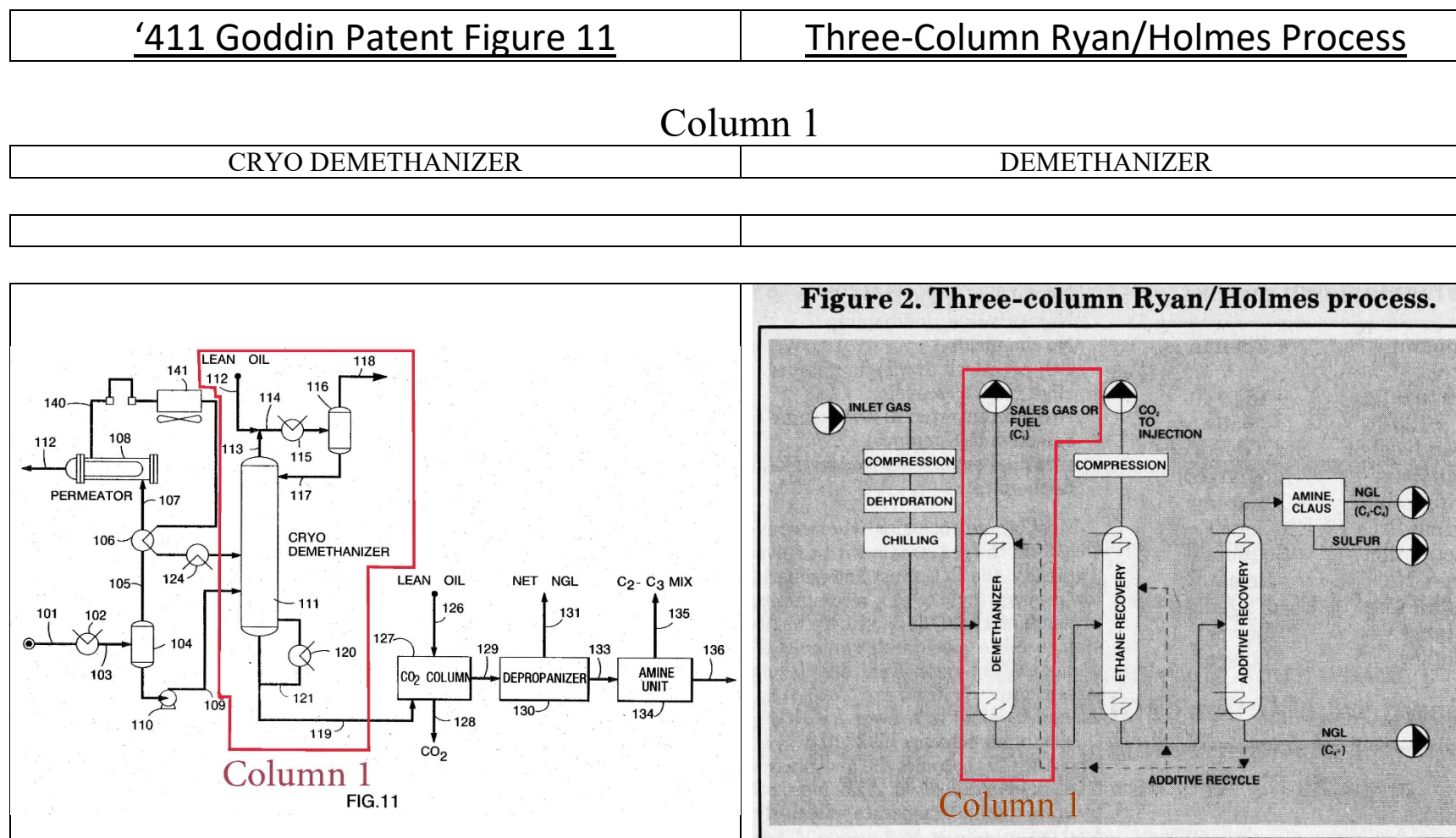
97. The next column produces a CO₂ overhead product and a C₂, H₂S, C₃ and heavier hydrocarbons as a bottom product. (*Id.* at 1:37-39.) “The use of additive in this column breaks the azeotrope which forms between CO₂ and C₂” (*Id.* at 1:39-40). The Prim ‘332 Patent process does not require the use of additives, because there is no desire to break the CO₂ C₂ azeotrope.

98. The third column in this process is an additive recovery column. The article describes “the sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.” (*Id.* at 54, 4:16-18.) The article goes on to say that “Butanes-plus is produced from the bottom of the column providing the net heavier NGL make and recovered additive.” (*Id.* at 4:12-14.)

99. One subtle but significant point is that in the Rockstraw description of the additive recovery column in Soldati (column 21), Rockstraw in section 71 describes it as a sweetening step, whereas Rockstraw in section 75 asserts that the additive recovery column is where “the stream is separated into a sweet NGL stream

with the C4+ hydrocarbons and a sour NGL stream with C2-C3 hydrocarbons,” and then goes on to say that “[t]he sour NGL stream is then sweetened.”

100. The Three-column Ryan/Holmes process described in Exhibit 1007 is very similar to the process described in the '411 Goddin Patent Figure 11 (EX2004).

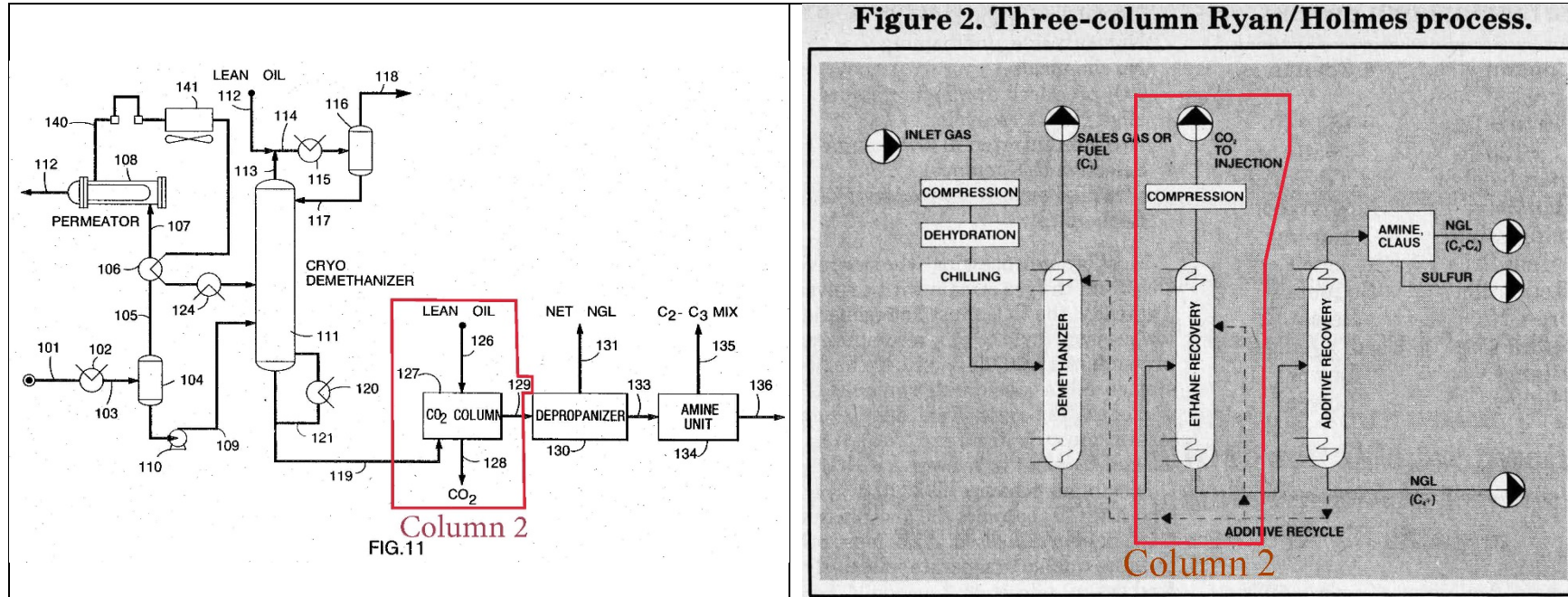


101. The '411 Goddin Patent at 17:65-67 describes "liquid stream 119, which contains the bulk of the CO₂ plus C₂ and heavier hydrocarbons." Figure 11 of the '411 Goddin patent also shows a "LEAN OIL" stream labeled 112 (not to be confused with the stream 112 from the permeator in the same figure), which is described as "to facilitate reduction of the CO₂ content of the methane and lighter overhead gas" and "without CO₂ freezup" at 17:46-51. This stream described as "preferably C₄-C₅" at 18:4, performs the same function as the additive stream described in Aycaguer, Soldati, and Ryan/Holmes.

102. The Ryan/Holmes three-column description in Exhibit 1007 at 4:3-4 says "the bottom product of the demethanizer is CO₂, C₂ and heavier hydrocarbons."

Column 2

CO ₂ COLUMN	ETHANE RECOVERY



103. The '411 Goddin Patent at 18:4-9 says that "lean oil, preferably C4-C5 hydrocarbons via line 126 is introduced into the top of CO2 column 127, thereby produces a sweet high purity carbon dioxide stream." It goes on to say that "Ethane and other hydrocarbons together with the lean oil exit from the bottom of the CO2 column." The presence of H2S is not mentioned, but a POSITA would understand that the H2S described as being present in the downstream Depropanizer column must have come from the CO2 column.

104. From Exhibit 1007, Figure 2. Three-column Ryan/Holmes process shows the addition of additive to the Column 2. It goes on to state at 4:7-9 that "CO2 is produced as an overhead fraction. C2, H2S, C3, C4+ and additive are produced from the bottom."

Column 3

DEPROPANIZER	ADDITIVE RECOVERY

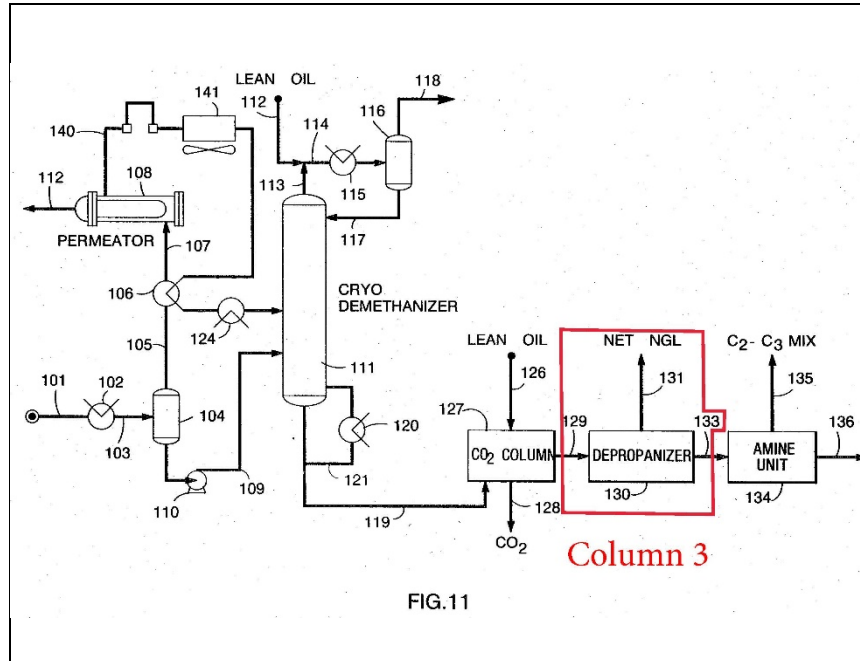
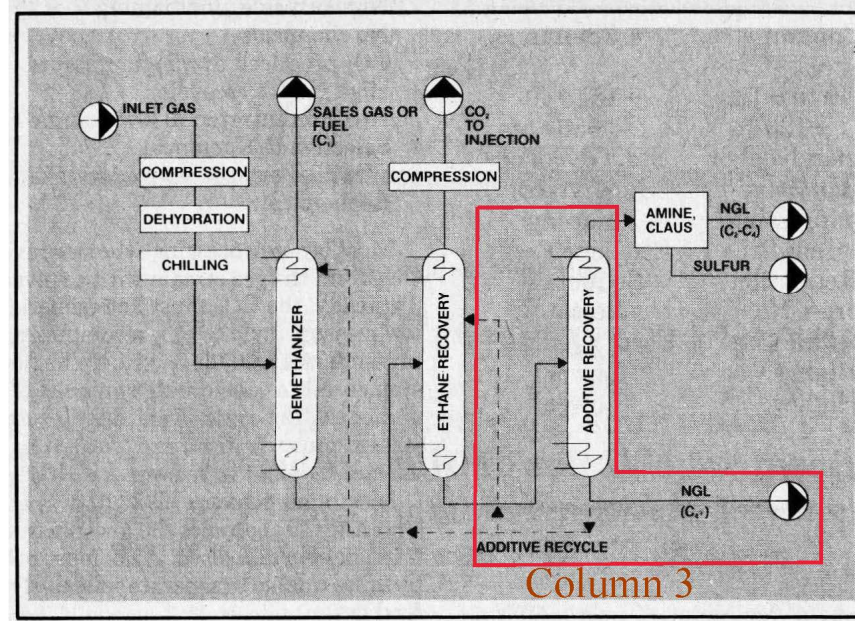


Figure 2. Three-column Ryan/Holmes process.



105. In the ‘411 Goddin Patent at 18:13-15, it states that “In the depropanizer butane and heavier hydrocarbons are separated as bottom stream.” At 18:15-19 it states “[t]he top of depropanizer 130 is preferably subjected to conventional amine scrubbing in amine unit 134 and the acid gases CO₂ and H₂S sent to sulfur recovery (not shown) by line 136. The sweet C₂-C₃ stream 135 from the amine unit 134 can be sold.”

106. In describing the Three-column Ryan/Holmes process, Ryan states that “Butane-plus is produced from the bottom of the column,” and that “H₂S, if present in the plant feed, will be produced in the overhead of the additive recovery column. The sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.” (EX1007 at 4:12-18.)

107. Since ‘411 Goddin was not deemed to reject the Prim ‘332 Patent process as unpatentable by the Examiner during prosecution, and given the similarity between ‘411 Goddin and the Three-column Ryan/Holmes process as described in Ex1007, it therefor stands to reason that Ryan/Holmes cannot render the Prim ‘332 Patent process unpatentable.

F. Overview of Arand (EX1004)

108. The Arand patent describes “Processing produced fluids of high pressure gas condensate reservoirs.” Within the patent at 4:55-56, it states: “natural gas liquid (for example, C₂-C₆ or C₂-C₈, or the like).” Then at 5:46-49, states: “As

used herein, the term “natural gas liquids components” will be used to refer to any or all of C2 through about C8 hydrocarbons or higher.”

109. As stated in Rockstraw at 5:44-45 (which is between the two above references), Arand does refer to natural gas liquids as C3-C8: “natural gas liquids (C3-C8).”

110. There does not seem to be any motivation to combine Aycaguer and Arand. Aycaguer describes “EOR with CO₂ cannot be applied to all types of reservoirs and is most efficient for crude oils with a gravity greater than 22° API.” (EX1005 at 304, 4:21-23.) The Arand patent describes a condensate reservoir which is separated into a residue gas stream, an NGL stream and a stabilized condensate stream. Rockstraw equates the stabilized condensate stream to the heavy hydrocarbon rich stream, referring to both as a C₉+ stream. Although both streams do contain C₉+, the streams are very different. The C₉+ stream of Arand would likely have a gravity of greater than 50° API.

X. The Ryan/Holmes Process “Teaches Away” From the Prim ‘332 Patent Process

111. Ryan/Holmes is a cryogenic distillation process developed in the late 1970’s and early 80’s to improve the process of separating methane and ethane from carbon dioxide recycle streams in enhanced oil recovery (“EOR”) operations. The Ryan/Holmes process uses hydrocarbon solvents (“additives”), and an extensive

amount of process equipment (up to four distillation columns), to solve two particular problems in the separation of methane and ethane from carbon dioxide recycle streams. The Ryan/Holmes additives avoid carbon dioxide freezing (solidification) in the separation of methane from carbon dioxide, and allows for the separation of ethane from carbon dioxide, by eliminating the formation of what is known as the ethane-carbon dioxide “azeotrope” which otherwise would preclude a separation of ethane from carbon dioxide.

112. While the Ryan/Holmes process uses additives and extensive process equipment to improve the process of separating methane and ethane from carbon dioxide recycle streams, the innovative process described and claimed in the ‘332 Patent improves the process of recovering NGLs from carbon dioxide recycle streams by “disregarding the recovery” of methane and ethane from the carbon dioxide recycle stream, to recover NGLs “with relatively little process equipment or energy.”¹⁰

113. The purpose, process, and result of implementation of the Ryan/Holmes process is to separate methane and ethane from carbon dioxide recycle streams, using additives and extensive processing equipment, to produce methane and ethane for sales. The Prim ‘332 invention goes in the opposite direction by NOT using

¹⁰ Ex. 1001, 4:55-60.

additives or extensive processing equipment to separate methane and ethane from carbon dioxide recycle streams. This innovative process leaves all (or almost all) of the methane and ethane in the carbon dioxide recycle streams, to produce NGLs, having little to no methane and ethane, while using significantly less process equipment and energy, and thereby recovers NGLs with significantly less costs.

114. Considering that the Prim ‘332 process conserves costs by “disregarding the recovery” of methane and ethane from the carbon dioxide recycle stream, it would make no sense for a person of ordinary skill in the art to use the Ryan/Holmes methane/ethane recovery process as a starting point to modify it or combine with other teachings to develop the Prim ‘332 Patent process. The Ryan/Holmes process focus on recovery of methane and ethane would lead a person of ordinary skill in the art in a direction divergent from the path that was taken by Prim to develop the ‘332 Patent process. The Ryan/Holmes process and the Prim ‘332 Patent process go in opposite directions for recovering salable components of carbon dioxide recycle streams.

115. The Ryan/Holmes process thereby “teaches away” from the Prim ‘332 Patent process. A person of ordinary skill in the art would not be motivated to modify or combine the Ryan/Holmes process with other teachings to develop the Prim ‘332 Patent process. The Ryan/Holmes process therefore cannot be the basis

for an obviousness finding as asserted by Petitioners in each of their six obviousness grounds.

XI. Claims 1-4, 6, and 7 are Patentable

A. Ground 1: Claim 1 is Not Obvious over Aycaguer

1. No Motivation to Modify or Combine Aycaguer with Other Teachings

116. In my opinion, Aycaguer does not render obvious Claim 1 of the Prim ‘332 Patent. First of all, and as a threshold issue, as set forth in detail above, there is no motivation for a POSITA to modify or combine Aycaguer with other teachings in order to make the Prim ‘332 Patent process.

117. Rockstraw quotes Aycaguer in section 79 saying “separation of the individual components (water, hydrogen sulfide, -H₂S, CO₂, CH₄, natural gas liquids),” and then in section 80 *Rockstraw* defines Natural Gas Liquids as C₃-C₈. This is very important. From the Aycaguer quote, the ethane in the stream must be included in the natural gas liquids stream, which is consistent with the Ryan/Holmes process referenced later in the article. A POSITA would know that ethane must be present, and that the ethane must be in the natural gas liquids stream. Rockstraw confirms this in section 85 stating that “Hydrocarbon feed streams from oil and natural gas reservoirs naturally contain all the hydrocarbons within the full range between the lightest produced hydrocarbon and the heaviest produced hydrocarbon;

underground oil reservoirs do not “skip” members of the homologous series of alkane hydrocarbons.” This confirms that the “Natural Gas Liquids” shown in the Aycaguer Figure 1 below must be a C2-C8 mixture since everything else mentioned is a single component.

118. Since Aycaguer includes the recovery of ethane in the NGL stream and the Prim ‘332 Patent process does not, a POSITA would immediately recognize that the process described must be significantly different than Prim.

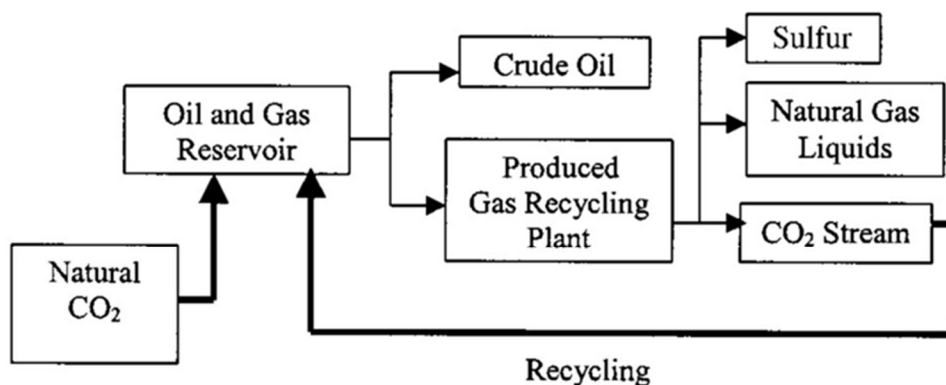


Figure 1. Schematic of processes investigated in the case studies.

119. In section 82, Rockstraw quotes Arand (Ex 1004) at 1:16-18 and 5:41-46, although he never includes the direct quote for 5:41-46. The direct quote, expanded to include 3 additional lines (5:41-49) says: “However, it is expected that the benefits of the invention will be best realized if the produced fluid stream contains in addition to sales quantities of natural gas, a ratio of natural gas liquids (C3-C8) to heavy condensate (C9 and higher) of 0.5 or higher and preferably about 1 or higher. As used herein, the term ‘natural gas liquids components’ will be used

to refer to any or all of C2 through about C8.” Although it is not specified, it is likely that the use of C3-C8 in this context is about economics. Because C2 has a low value relative to C3-C8, including the C2 volume in the ratio could skew the economic decision. Immediately after the Rockstraw referenced sentence (5:41-46), Arand specifies that natural gas liquids includes **C2-C8**.

120. Also in section 82, Rockstraw quotes Yao (EX1016). Yao describes the feed stream as including heavy hydrocarbons, carbon dioxide, hydrogen sulfide, and light hydrocarbons. Neither Yao within the patent nor Rockstraw within his Declaration provides a definition of light hydrocarbons. Upon reviewing details of the Yao patent, 4:43-46 says “The overhead from the demethanizer 18 is a mixture of methane, ethane and carbon dioxide which is separated by conventional means in an absorber such as a Selexol unit.” This would lead a POSITA to conclude that the light hydrocarbons include C1-C8. The recovery of C1 and C2 is again contrary to the Prim ‘332 Patent process.

121. In section 85, Rockstraw again refers to the natural gas liquids as C3-C8. As shown above, Aycaguer clearly defines (and a POSITA would understand) that the natural gas liquids stream is C2-C8. Further in section 85, Rockstraw says that “a POSITA would have understood a reference describing an oil and natural gas reservoir feed stream that contains methane(C1), natural gas liquids, and crude oil

(C9+).” I agree with this definition. Again, because “oil reservoirs do not “skip” members,” ethane must be included in this definition of “natural gas liquids” as well.

122. Although words and definitions are important, and Rockstraw goes to quite a lot of effort defining natural gas liquids (and getting it wrong, I might add), what is really important is whether the process described by Aycaguer somehow renders the Prim ‘332 Patent process obvious. It does not. Aycaguer (at 305) produces a “sales fuel gas whose main component is methane” (although this is left out of Figure 1), Prim ‘332 does not. Aycaguer produces a natural gas liquid which contains ethane (by virtue of not skipping components in the feed), Prim ‘332 does not recover ethane. Aycaguer requires the use of additives (carbon dioxide recovery solvents), which Prim ‘332 does not need.

123. In section 86 Rockstraw quotes the Prim ‘332 Patent (EX1001) at 3:4-8. If one additional word is added, the quote says natural gas liquids “*may* include C3-C8 hydrocarbons.” Prim ‘332 uses C3-C8 as the description of natural gas liquids in the patent because the process does not recover ethane, and the sales stream is C3-C8. To call the natural gas liquid C2-C8 (as shown in Arand Ex1004, Ryan/Holmes Ex1007 or Soldati Ex1006) would be misleading. A POSITA would understand this.

124. Again in section 94, Rockstraw misquotes Arand as explained previously. Again Rockstraw misrepresents the term natural gas liquids shown in

Figure 1 of Aycaguer as C3-C8. The processes described Aycaguer, Soldati and Ryan all have a sales stream which contained ethane. Referring to the natural gas liquids as only C3-C8 is misleading.

125. In section 100, Rockstraw quotes Aycaguer, describing Ryan/Holmes as “highly compound -specific and will only separate CO₂ from the remaining gas stream.” This is wrong. A POSITA would have been motivated to learn more about the Ryan/Holmes process, and would have been compelled to read the reference 22 *Process improves acid gas separation* (Holmes et al), and reference 23 *Treating Acid and Sour Gas: CO₂ Recovery by the Ryan/Holmes Process* (Ryan et al). Both of these widely available publications would have shown that the Ryan/Holmes process(es), thru various distillation processes and amine treating create a CO₂ stream, a sweet NGL stream which contains C₂, a methane stream and a sulfur stream. Note that the sweet NGL stream contains C₂. Reference 22 in column 4 describes a “Separation of CO₂ from C₂+,” and further mentions in column 6 that “it is often desirable to recover ethane with the other NGL components as a saleable product.” Reference 23 (Ex1007), Figures 2 and 3 both show a C₂+ stream leaving the box labeled “Amine, Claus.” Of note in Aycaguer and the two referenced articles, is the importance of “additives” in the Ryan/Holmes processes. It is worthwhile to again state that the Prim ‘332 Patent process does not create an NGL stream which contains ethane, does not create a methane stream, and does not use

carbon dioxide recovery solvents. As discussed earlier, the additives described in Aycaguer and Ryan/Holmes (EX1007) are carbon dioxide recovery solvents.

126. Although the definition of cryogenic varies from industry to industry, a well-accepted definition from the GPA is -50F.

127. The subtitle of reference 22, described above, is *Ryan/Holmes cryogenic process overcomes roadblocks to distillation of C1-CO2, C2-CO2 and C)2-H2S systems*. Column 10 of the reference indicates that “Column 1 condenser operates at about -120F,” which is certainly is cryogenic.

2. Claim 1

a. “wherein the hydrocarbon feed stream, the carbon dioxide recycle stream, and the sour NGL rich stream are not subjected to cryogenic conditions, membranes, and carbon dioxide recovery solvents between being received and being separated into the heavy hydrocarbon rich stream, the purified carbon dioxide recycle stream, the sweet NGL rich stream, and the acid gas stream.” [1.6]

128. Aycaguer. as presented by Petitioners to describe a three-column Ryan/Holmes process, subjects the carbon dioxide recycle stream to cryogenic conditions and carbon dioxide recovery solvents in the process steps in which limitation [1.6] specifically excludes cryogenic conditions and carbon dioxide recovery solvents. Therefore, even if there could somehow be found a motivation

to modify Aycaguer or combine it with other teachings, Aycaguer does not render Claim 1 unpatentable as obvious.

B. Ground 2: Claim 1 is Not obvious over Aycaguer and Arand

1. No Motivation to Combine Aycaguer and Arand

129. In my opinion, Aycaguer in combination with Arand does not render obvious Claim 1 of the '332 Prim Patent. As another threshold issue, as set forth in detail above, there is no motivation for a POSITA to combine Aycaguer and Arand in order to make the Prim '332 Patent process.

130. Rockstraw, in section 116 of the declaration (Ex1002), references Arand 5:44-45, but never bothers to include the quote which says: "natural gas liquids (C3-C8) to heavy hydrocarbons (C9 and higher)." Again, as mentioned in the response to Ground 1, the context of the quote is around an economic decision. Also missing (but surely read) is the next sentence (5:46-49) which says: "As used herein, the term "natural gas liquids components" will be used to refer to any or all of C2 through about C8." Therefore, Arand defines natural gas liquids as C2-C8.

131. It is agreed that heavy hydrocarbons include C9 and heavier hydrocarbons (C9+). With this definition and the Aycaguer description of "associated gas separation of the different components (water, hydrogen sulfide - H₂S, CO₂, CH₄, natural gas liquids)," a POSITA would be able to figure out that the natural gas liquids do not include C1, and do not include the C9+ hydrocarbons,

leaving only the C2-C8 hydrocarbons. Because the Prim ‘332 Patent in Claim 1 describes a C3-C8 natural gas stream as a separate and distinct stream, a POSITA would recognize that the process of Aycaguer must be different than Prim because it takes a deeper cut of the associated gas stream to be able to recover ethane. Aycaguer also acknowledges that a distinct C1 separation is made. Although the Prim ‘332 Patent process does not specifically mention C1 as a separate stream, the absence of mention would lead a POSITA to conclude that it is not present.

132. The next 10 sections of the Rockstraw Declaration focus on the erroneous assumption that the distinct natural gas liquid stream described by Aycaguer is a C3-C8 hydrocarbon stream. It is not. Prim ‘332 includes a distinct C3-C8 stream but Aycaguer makes a C2-C8 stream.

2. Claim 1

a. Claim element [1.6].

133. As explained above for Ground 1, Aycaguer does not teach limitation [1.6].

134. The addition of Arand does nothing to overcome Aycaguer’s failure to teach limitation [1.6].

135. Therefore, even if there could somehow be found a motivation to combine Aycaguer and Arand, the combination does not render Claim 1 unpatentable as obvious.

C. Ground 3: Claims 1-4 and 6-7 are Not obvious over Aycaguer and Soldati

1. No Motivation to Combine Aycaguer and Soldati

136. In my opinion, Aycaguer in combination with Soldati does not render obvious Claims 1-4 and 6-7 of the '332 Prim Patent. As another threshold issue, as set forth in detail above, there is no motivation for a POSITA to combine Aycaguer and Soldati in order to make the Prim '332 Patent process.

137. In section 131, Rockstraw incorrectly describes column 21 of the Soldati patent (EX1006) as a sweetening step. Because Rockstraw is referencing Fig. 4, it is understood that this comment relates to the Ryan/Holmes prior art described in the Soldati patent. Referring to Fig 4 and 1:45-48, the stream 17 enters the column 21 and is separated into an overhead stream 27 and a bottom stream 28. The Soldati patent reference 1:45-48 describes these streams as “an overhead stream containing ethane and propane and a bottom stream containing butane and higher hydrocarbons.” There is no mention of acid gas in this part of the patent, but referring to Table III, which shows the component throughput of the Comparative Example 2 (the Ryan/Holmes prior art), stream 27 includes all of the H₂S in the inlet (stream 6) and a small amount (less than 0.03%) of the inlet CO₂. Since this stream

contains 94.54% hydrocarbons, I would hardly consider Column 21 a sweetening step. Aycaguer, in the referenced article Exhibit 1007, shows in Figure 3 an additive recovery column (equivalent to column 21 in Soldati) with the overhead stream going to a process box including the words “amine” and “Claus.” The Figure 3 shows the outlet of this process consists of NGL (C2-C4) and Sulfur. Furthermore, Aycaguer mentions in Exhibit 1005 that there is a required step to “separate H₂S from the natural gas liquids” and states that to accomplish this step “we used a non selective chemical absorption amine.” A POSITA would have understood that the process box in Figure 3 of Exhibit 1007 is the *actual* sweetening step in Ryan/Holmes. A stream containing 94.54% hydrocarbon goes into an amine plant, a stream containing 100% hydrocarbon comes out (identified in the figure as C2-C4), and an acid gas stream goes to a Claus plant where sulfur is produces.

138. In section 133, Rockstraw quotes the Soldati patent at 1:6-13 as (without quotations) a Ryan/Holmes method to process a natural gas stream into natural gas liquids and carbon dioxide, while the actual reference says “a process for recovering ethane and heavy hydrocarbons and for removing acid gases such as carbon dioxide and hydrogen sulfide by distillation.” Acknowledging that Soldati recovers ethane differentiates Soldati (and by association Ryan/Holmes) from the Prim ‘332 Patent process. One should question Rockstraw’s motivation to leave out the mention of the recovery of ethane.

139. As already explained, the Aycaguer carbon dioxide recycle includes “water, hydrogen sulfide – H₂S, CO₂, CH₄, natural gas liquids,” and we have also already explained that the “natural gas liquids” includes C₂-C₈ (see *infra*, Bors Declaration Ground 1).

140. In section 139, Rockstraw almost describes the additive stream. Rockstraw refers to it as a “recirculation” stream which increases the amount of CO₂ in stream 9 compared to stream 6, when it is really an integral part of the process. From Exhibit 1007: “recycled additive is introduced to the condenser or to the top of the column to avoid freezing,” “the use of additive in this column breaks the azeotrope.” In Exhibit 1010: “uses an additive to avoid CO₂ freezing,” “separation uses an additive to break the CO₂-ethane azeotrope,” in the reference 21 of Aycaguer (which is mentioned in Rockstraw but never included as an exhibit) “distillation additives are strategically used. This technique is used in the Ryan/Holmes process for three otherwise impossible distillations.” A POSITA, having read Aycaguer would surely have looked at reference 21 and reference 22, and would have sought out additional Ryan/Holmes references such as Soldati, and come to their own conclusion that the additive stream is required to make the Ryan/Holmes process(es) work.

141. To further emphasize the importance of the carbon dioxide recovery solvent, the flow of the entire inlet stream (stream 6) shown in Table III is 1330.01

kMol/hr and the flow of stream 10 (also from Table III) is 1563.53 kMol/hr. It is difficult to understand how a recycled carbon dioxide recovery solvent stream which is larger than the entire plant inlet is never mentioned in the Rockstraw Declaration (Exhibit 1002).

142. In section 140 Rockstraw describes how stream 9 is the purified carbon dioxide stream, and then in section 141 that stream 44 is really the “further” purified carbon dioxide stream. This “further” purification of stream 9 comes at the expense of additional capital cost for the column 39 and all the associated reflux and reboil equipment, pumps, exchangers and separators. In Prim ‘332, the separations in column 8 and 39 are completed in a single step, thus reducing the capital and operating cost, but at the expense of methane sales.

143. In section 142 Rockstraw mentions that nothing “prevents the claimed separation from occurring in multiple steps.” I agree. If a POSITA wanted to build a Ryan/Holmes plant to recover methane, they would have no choice but to make the separation using both columns 8 and 39. If a POSITA wanted to build a plant that did not recover methane or ethane, they would build a plant using the patent of Prim ‘332.

144. In section 143, Rockstraw describes sending the Aycaguer stream, erroneously described as C3-C8, through the Soldati process. There is no

explanation of what happened to the C2, although as explained in Ground 1, a POSITA would know that it Aycaguer stream is really C2-C8.

145. In section 145, the described stream 12 must contain the ethane as well. In Soldati Table III, 78.57% of the ethane contained in the inlet (stream 6) leaves the bottom of column 8 in stream 12. Since the operation of a distillation column is quite predictable, it would be expected that if the stream described by Aycaguer were processed by the equipment described by Soldati, ethane would be included in stream 12. It should be pointed out again that the Aycaguer associated gas stream must contain ethane as explained in Ground 1.

146. As previously mentioned, Rockstraw uses the Soldati patent, for the most part, to introduce the Ryan/Holmes prior art. Every reference to the “component throughput” table is the Ryan/Holmes Comparative Example 2 (Table III). The only time the Soldati description of the patent is referenced is when it is more convenient.

147. In section 148 Rockstraw uses the Soldati patent to describe stream 28 as “propane and heavier hydrocarbons.” He could have used the Ryan/Holmes prior art description at 1:46-49, but that describes stream 28 as “butane and higher hydrocarbons which is partly recycled to the first and third distillation columns,” which not only describes a different stream than the Soldati reference, it also mentions the additives.

148. In section 149, Rockstraw says “by removing the H₂S from stream 28, column 21 sweetened this C₃-C₈.” It is interesting that Rockstraw refers to this stream as C₃-C₈. Although there is C₃ present in this stream, it makes up only 0.80% of the stream. Soldati at 9:1-2 refers to stream 28 as “butane and heavy hydrocarbons.” It is also interesting to note that stream 28 is not a sweet NGL rich stream. Referring to Fig 4 in Soldati and Table III (both Ex1006), stream 28 component through is 1513.37 kMol/h. Stream 28 is then split into an additive stream and an NGL stream (stream 31). Stream 31 component throughput is only 13.28 kMol/h or 0.88% of the stream 28. An additive stream would be a more appropriate description for stream 28. In comparison, stream 21 (the overhead) has a component throughput of 63.75 kMol/h of hydrocarbons, 4.8 times larger than stream 31.

149. In sections 151 and 152, Rockstraw attempts to make stream 27 look like the acid gas stream described in the Prim ‘332 Patent process. The overhead product of this column (stream 27 from Table III) is;

5.46% acid gas (H₂S + CO₂)

48.30% ethane

45.25% propane

1.00% butane

150. This stream is 94.54% hydrocarbon, not an acid gas stream as described in the sweetening step in the Prim ‘332 Patent process, and stated by Rockstraw in section 146.

151. “separating the sour NGL rich stream into a sweet NGL rich stream and an acid gas stream, wherein the sweet NGL rich stream comprises the C3-C8 hydrocarbons, and wherein the acid gas stream comprises the acid gas,” [1.4]

152. Similar to Rockstraw’s argument in section 141, stream 12 (in this case) “undergoes further processing” to complete the sweetening process.

153. Stream 27 which includes 5.46% acid gas and 94.54% hydrocarbons would be more accurately described as the sour NGL rich stream, which is treated with amine (as described in Aycaguer in Ex1005 and Ryan et al in Ex 1007).

154. In order to make the required separations, Soldati and the Ryan/Holmes “known art” require column 21 and the amine plant described in the Aycaguer article and the Ryan et al (Ex1007) article. The Prim ‘332 Patent process only requires the amine plant after the initial separation.

155. In section 155, Rockstraw claims that Aycaguer does not disclose any cryogenic conditions, membranes or carbon dioxide recovery solvents. As discussed above in Section VIII, carbon dioxide recovery solvents include the hydrocarbons which are regenerated and recycled to other separation processes within the plant. In Aycaguer these are the additives mentioned at the bottom of article column 3, and

again at the top of article column 4. Aycaguer, thru the reference included as Exhibit 1007 (“Ryan”) also mentions additives numerous (over 40) times.

156. The Ryan Exhibit 1007 also mentions the presence of cryogenic conditions in the demethanizer of the three-column configuration in the article at 6:10 as “-40 to -120F.” The article says that the temperature in the first column of the four-column configuration (at 6:11-12) is “-10 to +40F.” This does not mean that the four-column configuration is not cryogenic. The coldest part of the four-column configuration is likely the demethanizer (the same as in the three-column configuration) but the article does not specify the temperatures in this column.

157. Contrary to Rockstraw in section 155, Soldati (Ex1006) does make reference to carbon dioxide recovery solvents. As described previously in Section VIII, carbon dioxide recovery solvents includes the streams 10 and 32 in Fig. 4 which are called a “liquid hydrocarbon stream” or “absorbent oil” in the patent.

158. Soldati also makes reference to the temperature in the third column, which is referred to as the “demethanizer” at 5:19, as “preferably of between -57 and 0C” (-70.6F to +32F) at 2:61-61, which is within the generally accepted gas processing definition of cryogenic temperature of -50F.

159. Not that it matters with respect to the defense of the Prim ‘332 Patent process, but in all cases (including Prim), the dehydration at this step has nothing to do with pipeline specifications. Dehydration prior to the processing plant is done to

prevent hydrates and reduce corrosion. It is not about simplifying downstream separations by removing one component Ex1002 section 159 (whatever that means). Also, the TEG is regenerated in a reboiler, not a “separate dehydrator.” A POSITA would never refer to a reboiler as a separate dehydrator.

160. In section 161, Rockstraw shows Figure 4 (the Ryan/Holmes prior art) and references 5:8-13. Rockstraw includes the reference, but never mentions what it says. 5:8-10 states “stream 44 of this is formed from acid gases (carbon dioxide and hydrogen sulfide), which is contrary to Exhibit 1002, section 150, where it states that stream 27 of Figure 4 “includes all of the hydrogen sulfide.”

161. It is true that Figure 4 stream 9 is “further purified” in column 39 to make stream 44, but column 39 also produces an overhead that is fed to column 35 to make a methane overhead product. The Prim ‘332 Patent process does not require either column 39 or column 35 and is thus an improvement over Soldati as well as the Ryan/Holmes prior art.

162. In section 171, Rockstraw describes the cooling of the inlet stream in exchanger 7 in Figures 1, 3, and 4 of the Soldati patent (EX1006). The Soldati patent makes multiple references to exchanger 7 being cooled by mechanical refrigeration. Exhibit 1006 at 6:30-33, 6:57-59, 8:33-36, 9:10-18, as well as Figure 2 which shows stream 7 (along with stream 23) being cooled by the high pressure stage of the refrigeration loop.

163. The Prim ‘332 Patent process teaches in Claim 3 “cooling the carbon dioxide recycle stream with the purified carbon dioxide recycle stream.” See Exhibit 1001 Figure 2, which shows the purified carbon dioxide recycle stream (stream 258) entering exchanger 202 and cooling the carbon dioxide recycle stream (stream 160). This cooling does not include any mechanical refrigeration as described in Soldati Exhibit 1006.

164. In section 172, Rockstraw describes at 3:22 that the “bottom product of the second distillation column can be expanded.” However, in 6:9-13, Soldati explains the circumstances where such an expansion would be practical: “The liquified acid gas produced by column 39 (stream 44), if to be fed to the flare or used in its gaseous state at low pressure, can be expanded through the valve 77.” Since we know from the Prim ‘332 Patent process that the purified carbon dioxide recycle stream is to be used for extracting oil and hydrocarbons from a subterranean formation, the carbon dioxide must be at high pressure.

165. The purified carbon dioxide stream (stream 44 in Ex1006) could certainly be expanded and used to cool the inlet stream in exchanger 7. Although this is possible, it is impractical. This expansion would vaporize and lower the pressure of the stream, resulting in a warm, low pressure vapor after exchanger 7 which would need to be recompressed back up to injection pressure. Since the stream 44 at the conditions shown in Table III is a liquid, it is possible to use a pump

(pump 45 in Fig.1) to increase the pressure to injection pressure. The energy required to *recompress* the warm stream 44 after the exchanger 7 to injection pressure far exceeds the energy required to cool stream 6 with mechanical refrigeration and pump stream 44 to injection pressure. Of further note, although stream 44 is colder than the inlet stream 6 (6.7C vs 40C), it cannot be used in a manner similar to the Prim '332 Patent process. Stream 44 is very close (if not at) its bubble point temperature, which would mean it would vaporize within the exchanger, which would mean that it would need to be compressed, or condensed and pumped to be injected. The Prim '332 Patent process does not have this problem, because stream 258 is already a vapor.

166. In Section 173, Rockstraw again mentions that the purified carbon dioxide recycle stream in Soldati (and the Ryan/Holmes prior art) requires two distillation columns (column 8 and column 39) to produce a stream for injection (stream 44).

167. In section 175, Rockstraw again describes using an expanded stream 44 for cooling the inlet. This time, Rockstraw says (without quoting a direct reference) that Soldati suggests that stream 44 “should” be used to cool process streams. In fact, Soldati in Exhibit 1006 uses the word “can” at 3:23, and then goes on to describe the only circumstances where stream 44 should be used: 6:9-12 “The

liquified acid gas produced by column 39 (stream 44), if to be fed to the flare or used in its gaseous state at low pressure, can be expanded through the valve 77.”

168. In section 177 Rockstraw discusses the composition of the sweet NGL rich stream. As mentioned previously, Column 21 of the Soldati patent does not perform the sweetening step. Stream 27 is the sour NGL rich stream by virtue of its composition. It is 94.54% hydrocarbons. This stream is further purified in an amine plant (as described in Aycaguer Ex1005 and Ryan et al Ex1007). After sweetening, stream 27 becomes (by removal of the acid gas using amine).

	kMol/h	%
C1	0.0	0.0
C2	32.57	51.1
C3	30.51	47.86
nC4	0.67	1.05

169. As shown, the stream contains no methane and no acid gas, but it has over 50% ethane.

170. Further to the discussion of Rockstraw in section 178, a POSITA would have recognized **stream 27** as the sour NGL rich stream.

171. In section 180, I agree with Rockstraw that the bottom of column 8 is “a” sour NGL rich stream, not “the” sour NGL rich stream. The column 8 bottom stream requires further purification since stream 12 contains all the recycled

additive. This stream (from Table III) has 1580.83 kMol/h of flow, which would be impractical to treat with amine. The additional distillation step in column 21 provides an overhead of 67.43 kMol/h, stream 27, the sour NGL rich stream, which can be easily treated with amine.

172. Once again, in Soldati (EX1006), stream 28 is not the sweet NGL rich stream. Stream 28 is an additive stream, of which 99.12% is directed to other parts of the process to allow the process to work. (from Table III, stream 31 is 13.28 kMol/h while stream 28 is 1513.37 kMol/h). In section 190, Rockstraw is incorrect.

2. Claim 1

a. Claim element [1.6]

173. As explained above regarding Ground 1, Aycaguer does not teach limitation [1.6]. Soldati, as a four-column Ryan Holmes process, adds nothing to overcome Aycaguer's failure to teach limitation [1.6].

b. “wherein the hydrocarbon feed stream, the carbon dioxide recycle stream, and the sour NGL rich stream are not subjected to cryogenic conditions, membranes, and carbon dioxide recovery solvents between being received and being separated into the heavy hydrocarbon rich stream, the purified carbon dioxide recycle stream, the sweet NGL rich stream, and the acid gas stream.” [1.6]

174. As explained above regarding Ground 1, Aycaguer. as presented by Petitioners to describe a three-column Ryan/Holmes process, subjects the carbon

dioxide recycle stream to cryogenic conditions and carbon dioxide recovery solvents in the process steps in which limitation [1.6] specifically excludes cryogenic conditions and carbon dioxide recovery solvents.

175. Soldati suffers from the same defects. As a four-column Ryan/Holmes process, Soldati subjects the carbon dioxide recycle stream to the same carbon dioxide recovery solvents as Aycaguer, in the process steps in which limitation [1.6] specifically excludes carbon dioxide recovery solvents.

176. Therefore, even if there could somehow be found a motivation to combine Aycaguer and Soldati, the combination does not render Claim 1 unpatentable as obvious.

3. Claims 2 and 3

177. Claims 2 and 3 each depend from Claim 1. For the same reasons set forth above that a combination of Aycaguer and Soldati does not render Claim 1 unpatentable as obvious, this combination does render dependent Claims 2 and 3 unpatentable as obvious.

4. Claim 4: “The method of claim 3, wherein the sweet NGL rich stream comprises no more than 1 molar percent methane, no more than 1 molar percent ethane, and no more than 1 molar percent acid gases.”

178. Claim 4 depends from Claim 3, which depends from Claim 1. For the same reasons set forth above that a combination of Aycaguer and Soldati does not

render Claim 1 unpatentable as obvious, this combination does not render dependent Claim 4 unpatentable as obvious.

179. In addition, Claim 4 specifically requires that “the sweet NGL rich stream comprises ... no more than 1 molar percent ethane.”

180. Considering that both Aycaguer and Soldati are Ryan/Holmes processes that focus on the recovery of ethane, it should be no surprise that the sweet NGL rich streams in both Aycaguer and Soldati comprise more than 1 molar percent ethane. Therefore, even if there could somehow be found a motivation to combine Aycaguer and Soldati, the combination does not render Claim 4 unpatentable as obvious.

5. Claim 6

181. Claim 6 depends from Claim 1. For the same reasons set forth above that a combination of Aycaguer and Soldati does not render Claim 1 unpatentable as obvious, this combination cannot render dependent Claim 6 unpatentable as obvious.

6. Claim 7: “The method of claim 6, wherein the sour NGL rich steam comprises no more than 5 molar percent carbon dioxide, no more than 1 molar percent methane, and no more than 5 molar percent ethane, and wherein the sweet NGL rich stream is substantially free of carbon dioxide.”

182. Claim 7 depends from Claim 6, which depends from Claim 1. For the same reasons set forth above that a combination of Aycaguer and Soldati does not

render Claim 1 unpatentable as obvious, this combination does not render dependent Claim 7 unpatentable as obvious.

183. In addition, Claim 7 specifically requires that “the sour NGL rich stream comprises ... no more than 5 molar percent ethane.”

184. Considering that both Aycaguer and Soldati are Ryan/Holmes processes that focus on the recovery of ethane, it should be no surprise that the sour NGL rich streams in both Aycaguer and Soldati comprise more than 5 molar percent ethane. Therefore, even if there could somehow be found a motivation to combine Aycaguer and Soldati, the combination does not render Claim 7 unpatentable as obvious.

D. Ground 4: Claim 2 is Not obvious over Aycaguer Soldati, and Ryan

1. No Motivation to Combine Aycaguer, Soldati, and Ryan

185. .

2. Claim 2

186. Claim 2 depends from Claim 1. The addition of Ryan, as an additional cumulative disclosure of the three-column Ryan/Holmes process, adds nothing to overcome the failure of the combination of Aycaguer and Soldati to teach limitation [1.6]. Ryan, as an additional cumulative disclosure of the three-column Ryan/Holmes process, subjects the carbon dioxide recycle stream to the same

cryogenic conditions and carbon dioxide recovery solvents in the process steps in which limitation [1.6] specifically excludes cryogenic conditions and carbon dioxide recovery solvents.

187. For these same reasons that a combination of Aycaguer, Soldati, and Ryan does not render Claim 1 unpatentable as obvious, this combination does not render dependent Claim 2 unpatentable as obvious.

188. Therefore, even if there somehow could be found a motivation to combine Aycaguer, Soldati, and Ryan, this combination does not render dependent Claim 2 unpatentable as obvious.

E. Grounds 5 and 6: Claims 1-4 and 6-7 are Not Obvious over Aycaguer, Soldati, and Arand (Ground 5), and Claim 2 is Not Obvious over Aycaguer, Soldati, Ryan, and Arand (Ground 6)

1. Grounds 5 and 6 are Duplicative of Grounds 3 and 4, Merely Adding Arand

189. The addition of Arand to the combinations asserted in Grounds 3 and 4 does nothing to overcome the defects of Grounds 3 and 4. Therefore, for the same reasons set forth above for Grounds 3 and 4, even if there somehow could be found a motivation to combine these references, the combinations asserted in Grounds 5 and 6 do not render unpatentable as obvious Claims 1-4 and 6-7.

XII. CONCLUSION

190. The Prim '332 Patent process is not obvious based on the content of any of the exhibits presented in the *Inter Partes* Review.

191. Although the Prim '332 Patent, the Aycaguer article, the Soldati patent, and the Ryan/Holmes articles each describe natural gas processes for recovering natural gas liquids from high CO₂ streams, their methods and results are quite different. The uniqueness of Prim is in its simplicity. A POSITA, looking at these processes using Ex1001, Ex1005, Ex1006, and EX1007 would quickly come to the conclusion that the Prim process has very little in common with the other three. To be clear, the Ex1005, Ex1006 and Ex1007 each describe a Ryan/Holmes process or, in the case of Soldati, an improvement on Ryan/Holmes.

192. The major differences are:

193. Hydrocarbon Recovery – From Table III of Ex1006. Total hydrocarbon (C₁ to C₈) in the inlet Stream 6 is 146.31 kMol/h, and the total hydrocarbons in the sales streams (31, 27 and 57) is 135.22 kMol/h. This represents a recovery of 92.42% of the inlet hydrocarbons including 99.77% of the methane, 78.48% of the ethane, and 95.70% of the C₃-C₈. Prim makes no attempt to recover any methane or ethane (although there may be some ethane in the C₃-C₈), and, as stated in 1:50-52 says “wherein the NGL rich stream comprises less than about 70% of the C₃+hydrocarbons from the recycle stream.” Although this may dissuade a POSITA

from choosing Prim, there are other differences which make the Prim process attractive, even with lower recoveries.

194. Equipment – Between the first separation described in Prim and Aycaguer, and including the amine sweetening step described in Prim and Aycaguer, Prim utilizes one distillation column (separator 206 of Fig.2 of Ex1001) to perform the separation of the CO₂ recycle stream into a purified CO₂ recycle stream, a sweet NGL rich stream and an acid gas stream. In Ryan/Holmes and Soldati these same processing steps, plus the equipment required to recover methane and ethane, require four distillation columns (columns 8, 39, 35, and 21 of Fig.1, Fig.3, Fig.4 of Ex 1006 and the ethane recovery, CO₂ recovery, demethanizer, and additive recovery columns of Ex1007) as well as additional pumps, reboilers, exchangers and separators. With all of the additional equipment, a Ryan/Holmes plant becomes extremely large and much more complicated to operate and maintain.

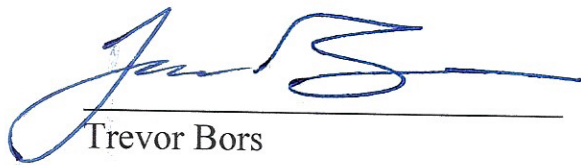
195. Carbon dioxide recovery solvents – each of the described Ryan/Holmes processes require the use of additives. The reference 21 (Holmes et al) of Ex1005 goes so far as to describe the necessity of additives for the otherwise “impossible” distillations. The use of additives also requires a large amount of refrigeration. In Fig.4 and Table III of Ex1006 the additive stream (which is larger than the entire CO₂ recycle stream) must be cooled from 122C (251.6F) as it leaves the bottom of column 21, to 16C (60.8F) when it enters column 8. A POSITA would understand

that the additives are critical to the operation of any Ryan/Holmes (or Soldati) processing plant, and would understand the inherent cost. A POSITA would also understand that the absence of additives in Prim makes the Prim process significantly different from Ryan/Holmes.

196. Cryogenic temperatures – Although there may be some differences about what constitutes cryogenic temperatures, depending on the particular industry, a POSITA who has worked in the oil industry would generally accept the temperature to be below -50F for gas processing applications. Ryan and Holmes (both familiar with oil industry and gas processing terminology), in Exhibit 1010 refer to their process in the title of the article as “Pilot Tests Prove Ryan/Holmes Cryogenic Acid Gas/Hydrocarbon Separations” (emphasis added).

I, Trevor Bors, declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, under Section 1001 of Title 18 of the United States Code.

Dated: May 13, 2024.



Trevor Bors