

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 (May 13, 2024)
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) (Pages 1-300 of 821) (replaced by Ex. 2025 (Part 1 of 3), Ex. 2026 (Part 2 of 3), and Ex. 2027 (Part 3 of 3))
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)

2013	Canada Patent No. 294,939 (Prosecution File History – including Re-examination)
2014	Proposed Discovery Requests (including annotated Ex. 2012 Figure 3, specifically identifying four particular streams)
2015	Claim Chart_’332 Patent Claims 1-4 6-7_Secondary Considerations_Copying
2016	United States Patent No. 4,753,666 (“Pastor”)
2017	Naomi Baker e-mail “Memo to file. conversation with Allen Hein, Chevron” (2012-02-12) (highlighted) (“He [Chevron’s Allen Hein] told me [Pilot’s Naomi Baker] that they were building a plant identical to their Rangeley (CO) plant”)
2018	Notice Letter from Pilot Energy Solutions to Chevron (August 15, 2013)
2019	Response Letter from Chevron to Pilot Energy Solutions (August 29, 2013) (attaching Pastor ‘666 Patent)
2020	<i>Pilot Energy Solutions, LLC et al. v. Chevron U.S.A. Inc. et al.</i> , Case No. 4:23-cv-02505-AHB, in the U.S. District Court for the Southern District of Texas, Houston Division, Order on Defendants’ Motion to Dismiss (Granting in Part, Denying in Part) (Doc. 41)
2021	<i>Pilot Energy Solutions, LLC et al. v. Chevron U.S.A. Inc. et al.</i> , Case No. 4:23-cv-02505-AHB, in the U.S. District Court for the Southern District of Texas, Houston Division, Agreed Joint Motion to Stay Pending Final Written Decision in Inter Partes Review Proceedings (Doc. 42)
2022	OSHA § 1910.119(d)(3)(i)(B) (requiring “Piping and instrument diagrams (P&ID’s)” for Process safety management of highly hazardous chemicals) (highlighted)
2023	Chevron Mabee Plant Air Permit Application – Texas Commission for Environmental Quality (“TCEQ”) (November 5, 2012)

2024	Transcript (Full) of Deposition of David A. Rockstraw (October 18, 2024)
2025	GPA Engineering Data Book (12th Ed. 2006, FPS version) (Sections 1-15) (Part 1 of 3) (replacing Ex. 2005)
2026	GPA Engineering Data Book (12th Ed. 2006, FPS version) (Sections 16-23) (Part 2 of 3) (replacing Ex. 2005)
2027	GPA Engineering Data Book (12th Ed. 2006, FPS version) (Sections 24-26) (Part 3 of 3) (replacing Ex. 2005)
2028	Declaration of Trevor Bors (November 22, 2024)
2029	Declaration of Eric Prim (November 22, 2024)
2030	Holloman Job No. 3228 New Construction – Description: Plant (Propane) Estimated Start Date: 8/13/01
2031	Exxon Means project development – sketches and notes
2032	Exxon Means project development – HYSYS process simulation (August 9, 2001)
2033	Exxon Means GCF Processing Plant Preliminary Piping and Instrumentation Diagram (“P&ID”) 50 MM Case (August 9, 2001)
2034	Exxon Means project development – Equipment needed (August 16, 2001)
2035	Exxon Means - Material Balance of Gas Available for Processing (January 5, 2002)
2036	Exxon Means Optimization (November 17, 2002)
2037	Exxon Means Processing Proposal (December 17, 2002) (“The optimized results from the means processing proposal have yielded results that are a little unexpected. Optimization of the system has demonstrated that the best economics are found with an inlet flow of 50 MMSCFD with relatively low propane

	recovery. Small increases in the propane recovery rate result in major increases in the capital cost.”)
2038	Exxon Means GCF Operations Initial Proposal (January 25, 2003) (“If the operations of the GCF are coupled with the proposed NGL recovery plant, savings will be realized through the synergy of operating both facilities.”)
2039	Exxon Means Processing Proposal (January 30, 2003)
2040	Exxon Means Processing Proposal (March 27, 2003) (“The optimized results from the means processing proposal have yielded results that are a little unexpected. Optimization of the system has demonstrated that the best economics are found with an inlet flow of 50 MMSCFD with relatively low propane recovery. Small increases in the propane recovery rate result in major increases in the capital cost.”)
2041	Exxon Means San Andres Unit - Means Field - Hydrocarbon Gas Production Forecast (June 2003)
2042	Exxon Means NGL Recovery Proposal e-mail (July 16, 2003)
2043	Exxon Means Processing Information (July 21, 2003) (“The original plant was intended to be a <u>high recovery</u> 60MMSCFD plant that was estimated to cost \$12MM to \$15MM. Next the plant size was reduced to 25MMSCFD, also with <u>high propane recovery</u> . The 25MM option was estimated to cost around \$5MM. The current case is designed for 50MMSCFD with <u>low (25%) propane recovery</u> and is estimated to cost around \$7MM.”) (emphasis added)
2044	Exxon Means project development – Process Flow Diagram (“PFD”) Front Page (July 21, 2003) HYSYS process simulation (July 21, 2003)
2045	Exxon Means project development – All Equipment List (notes reducing Costs from \$7,461,160 to \$5,152,492)

2046	Exxon Means Optimization (November 17, 2002 Optimization Corrected for Presentation (August 30, 2003)
2047	U.S. Provisional Application No. 60/938,726, filed May 18, 2007 ('322 Patent Provisional Application)
2048	NGL Recovery in CO2 Floods, Options and Reasons, Eric Prim & Naomi Baker, Midland CO2 Conference (December 2011) (available at https://www.co2conference.net/wp-content/uploads/2012/12/1.4-EricPrim_NGL_Recovery_Options_in_CO2_Floods_2011-CO2FloodingConf.pdf)
2049	NGL Recovery in CO2 Floods, Options and Reasons, Eric Prim & Naomi Baker, 6th Annual Wyoming CO2 Conference, Casper, Wyoming (July 11-12, 2012)
2050	Rangely Weber Sand Unit Case History, Rory Clark – Reservoir Engineer, Chevron North America E&P, 6th Annual Wyoming CO2 Conference, Casper, Wyoming (July 12, 2012)
2051	New Process Recovers NGLs From CO2, Naomi Baker, The American Oil & Gas Reporter (February 2013)
2052	Summary of Charts Demonstrating that Pilot's CO2Flex [®] Plants Perform the Steps of the Challenged '332 Patent Claims 1-4, 6-7 ("coextensive" – "essentially the claimed invention")
2053	Monell 20 Chart Demonstrating One-to One Correspondence between Challenged '332 Patent Claims 1-4, 6-7 and Monell 20 CO2Flex [®] Plant as Shown in Process Flow Diagram
2054	Monell 20 NGL Recovery Plant, Piping and Instrumentation Diagram (April 9, 2007 – Revised per PHA Review)
2055	Monell 20 CO2Flex [®] Plant, Process Flow Diagram, NGL Fractionation System (November 11, 2024)

2056	HYSYS Chemical Process Simulation, Monell 20, (May 3, 2007 [regenerated November 11, 2024])
2057	Goldsmith - Golden Hammer Chart Demonstrating One-to One Correspondence between Challenged '332 Patent Claims 1-4, 6-7 and Goldsmith - Golden Hammer CO2Flex® Plant as Shown in Process Flow Diagram
2058	Goldsmith Processing Plant, Process Flow Diagram, Project No. 5100928 (March 13, 2012 – Final Design)
2059	Mobile Analytical Labs, Inc., Goldsmith Feed Gas Analysis Gas Extended Analysis (2012-10-12), and Gas Analysis Report (2018-01-11)
2060	Pantechs Laboratories, Goldsmith Feed Gas Analysis C6+ Gas-Vapor Fractional Analysis (2017-01-08)
2061	Weyburn Chart Demonstrating One-to One Correspondence between Challenged '332 Patent Claims 1-4, 6-7 and Weyburn 20 CO2Flex® Plant as Shown in Process Flow Diagram
2062	Weyburn NGL Recovery Plant, Process Flow Diagram and Material Balance (April 23, 2012 – Approved)
2063	Bureau Veritas Laboratories, Weyburn Plant Gas Analysis, Extended Gas Analysis (2020-12-15)
2064	Wellman Chart Demonstrating One-to One Correspondence between Challenged '332 Patent Claims 1-4, 6-7 and Wellman CO2Flex® Plant as Shown in Process Flow Diagram
2065	Wellman CO2Flex® Plant, Process Flow Diagram (February 19, 2015 – Final as Built)
2066	Wellman CO2Flex® Plant, Corrected Stream Table
2067	Pantechs Laboratories, Wellman Plant Gas Analysis, C6+ Gas- Vapor Fractional Analysis (2018-01-17)

2068	Pantechs Laboratories, Wellman Plant, Extended Crude Oil Fractional Analysis (2017-01-04)
2069	Monell 120 Chart Demonstrating One-to One Correspondence between Challenged '332 Patent Claims 1-4, 6-7 and Monell 20 CO2Flex® Plant as Shown in Process Flow Diagram
2070	Monell 120 CO2Flex® Plant, Process Flow Diagram, Project No. 14154 (July 31, 2015 – Issued Final)
2071	American Mobile Research, Inc., Monell Plant Extended Hydrocarbon Gas and Liquid Analysis (2016-08-31)
2072	Financials
2073	Maintenance Fee Record for U.S. Patent No. 4,753,666 (“Pastor”) (“Patent expired on 06/28/1992 due to non-payment of [first – 3.5Year] maintenance fee”)
2074	Google Earth Images – Chevron Mabee CO2 Recycle Facility (02/21/2013) (before addition of NGL Recovery Plant) https://earth.google.com/web/@32.21102082,-102.2292088,884.43526729a,580.57327589d,35y,-0.00009674h,26.71434883t,0r/data=ChYqEAgBEgoyMDEzLTAYLTixGABCAggBOgMKATBCAggASg0I_____ARAA
2075	Google Earth Images – Chevron Mabee CO2 Recycle Facility (10/4/2014) (after addition of NGL Recovery Plant) https://earth.google.com/web/@32.21102082,-102.2292088,884.43526729a,580.57327589d,35y,-0.00009674h,26.71434883t,0r/data=ChYqEAgBEgoyMDE0LTExwLTA0GABCAggBOgMKATBCAggASg0I_____ARA_A
2076	Comparison of Pilot Monell 20 CO2Flex® Plant to Chevron Mabee NGL Recovery Plant

2077	E-mail from Julie K. Huff, Chevron Facilities Engineer – CO2 Injection Projects, to three other Chevron personnel (Shintaku/Hein/Acero) and three Pilot personnel (Prim/Baker/Holloman), regarding plan for flights to visit Pilot’s Monell 20 CO2Flex® plant in Wyoming (November 11, 2008) (“[T]rip confirmed ... to visit the Anadarko/[Pilot] Monell CO2 recovery plant. Purpose of trip, understand the [Pilot] process for CO2 removed and Q&A with Anadarko Operations.”)
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I. Introduction

1. My name is Trevor Bors. I have prepared this Declaration in connection with Patent Owner Pilot Intellectual Property, LLC's 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, including the Board's Decision Granting Institution of *Inter Partes* Review (Paper 11) ("Institution Decision"). I have also reviewed the testimony of Dr. David Rockstraw presented in the deposition which occurred on October 18, 2024. (EX2024.)

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, except for the preparation of section XII which is my testimony as a Fact Witness. 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 claimed invention was made (not today). I have been asked to use the priority date of May 18, 2007, which is the filing date of the Provisional application related to the May 16, 2008 application that issued as the '332 Patent.

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 hydrocarbons removed in the above separation.

31. 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 at 8:48 to 10:21. Because this bottom stream contains H₂S as well as CO₂, it is referred to as the “sour NGL rich stream”. 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.

32. 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.

33. 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 an MRU is relatively simple and quite inexpensive to build, but the recovery of natural gas liquids is limited to C₄+. In other words, substantially no recovery of propane (C₃) as a component of the natural gas liquids recovered. Another known process available at the time would have been the Ryan/Holmes process, which is described extensively below.

34. 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.

35. The Prim '332 Patent goes to a great deal of detail describing the economic evaluation process. Fig.3, Fig. 4, and 8:3 to 10:21 are dedicated to the iterative process used to determine the optimum level of propane (C3) recovery. Every Prior Art asserted by Petitioners described in Exhibits 1005, 1006, 1007, 1010, and 2008 recovers virtually 100% of the propane (C3), as well as ethane (C2) and methane (C1).

36. 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

37. 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:

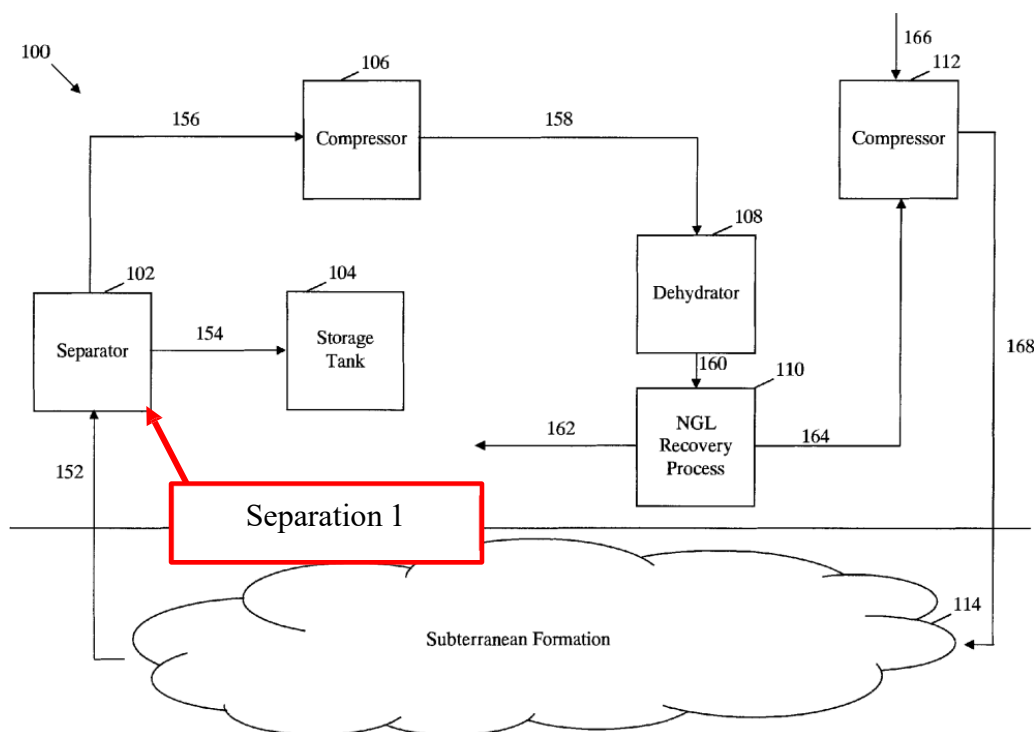


FIG. 1

38. 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.

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

40.

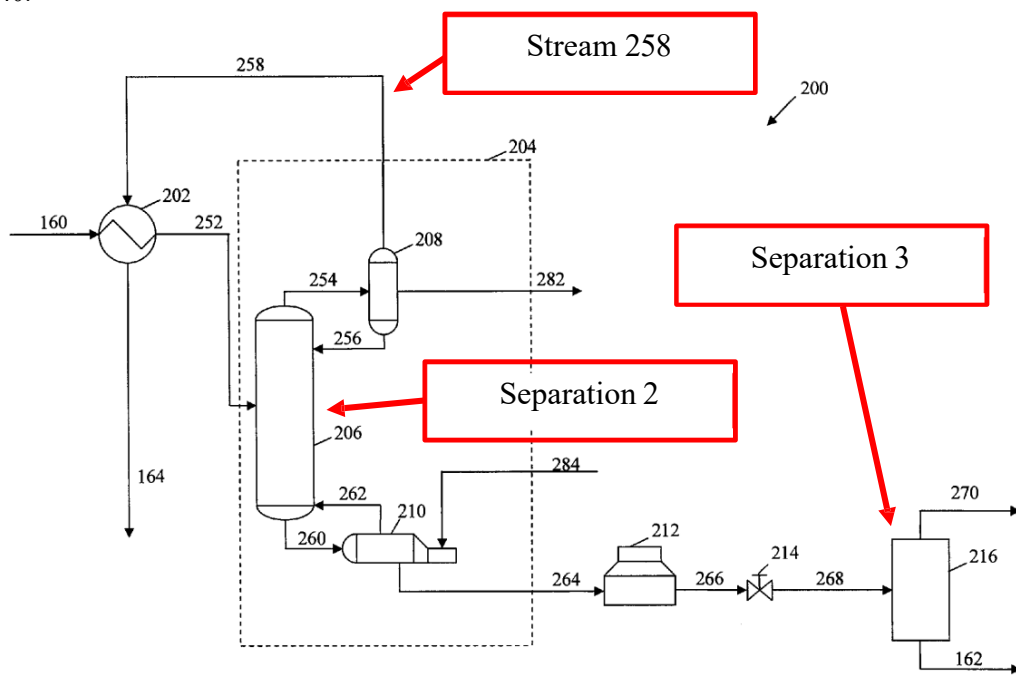


FIG. 2

41. 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.

42. In the context of the Prim '332 Patent 3:4-7, "NGLs may refer to natural gases that may be liquified without refrigeration, and may include C3-C8 hydrocarbons." Other processes, such as the Ryan/Holmes process, describe NGLs as C2-C3 and C4+ (see Exhibit 1007 Figures 2 and 3). Arand, Exhibit 1004 at 5:46-49 also states that "As used herein, the term 'natural gas liquids components' will be used to refer to any or all of C2 through about C8 hydrocarbons."

B. Summary of the Prosecution

43. 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).

44. 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.

45. 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.

46. 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.

47. 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

48. 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.

49. 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

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

challenged claims, after the Examiner meaningfully addressed the Ryan/Holmes prior art.

VIII. Claim Construction

A. Cryogenic Conditions:

50. 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).)

51. 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 (Fig. 3 at Page 4 (“Cryogenic Fractionation System”), Fig.11 at Page 12 (“Cryo Demethanizer”), 3:14 at Page 15 (“separating CO₂ ... by cryogenically fractionating”), 10:7 at Page 18 (“Cryogenic Fractionation”), 10:10-68 at Page 18 (“cryogenic distillative fractionation process,” “cryogenic fractionation process,” “cryogenic fractionation system,” and “cryogenic process”), 12:53-13:14 at Pages 19-20 (“cryogenic fractionation for CO₂ removal” and “cryogenic fractionation

system”), 16:12-18:26 at Pages 21-22 (“cryogenic fractionation for CO₂ removal,” “cryodemethanizer column,” and “cryogenic processes for CO₂ removal”), at Page 24: claims 11 and 12 (“cryodemethanizer column”), 13 (“cryodemethanizing; and cryogenically fractionating”), and 14 (“cryodemethanizer column”)); EX1010 at Page 1, Title (“Ryan/Holmes Cryogenic Acid Gas/Hydrocarbon Separations”), and Abstract (“Cryogenic CO₂/H₂S/hydrocarbon separation processes were tested”); EX2006, Title (“Cryogenic Distillative Separation of Acid Gas from Methane”), and throughout the patent; EX2008 at Page 3, Title (“Ryan/Holmes cryogenic processes overcome roadblocks to distillation of C₁-CO₂, C₂-CO₂ and CO₂-H₂S systems”).)

52. 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).

53. 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.

54. These definitions for the same situation (the liquification of gases) differs by 60C (108F), which would hardly describe a consensus within that industry.

55. 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.)

56. 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.)

57. 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.)

58. 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.

59. 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” (Exhibit 2012), 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. Exhibit 2008 “Process Improves Acid Gas Separation” on 131 describes the article as “Best Papers From NPRA, GPA and API.”

60. In the Claim Construction portion of the Institution Decision (Section IV, Analysis, Part B at 13), the Board states that “we generally give terms their ordinary and customary meanings as would be understood by a person of ordinary skill in the art.” Since the Board adopted the parties’ agreed assessment of the level of ordinary skill in the art for the POSITA as including “academic or industry experience in chemical processing systems, oil and gas production and/or refining” (Part A at 13), it is my assertion that the definitions of Cryogenic Conditions taken from references describing the liquification of permanent gases is outside of the expertise of the Board’s adopted definition of a POSITA. It would be more appropriate to expect a POSITA in the context of this IPR to understand and accept the definition of Cryogenic Conditions as used in the *oil and gas industry* and defined in the well-known industry publication from the Gas Processors Association, the “GPA Engineering Data Book” (Exhibit 2005).

61. Given the above, it is clear that there is no single definition of cryogenic temperatures that applies to all industries. Since the Board’s Institution Decision recognizes that the POSITA’s field of experience is related to the upstream

(production) oil and gas industry, it would seem reasonable to accept the GPA “Engineering Data Book” definition of -50F.

62. During Dr. Rockstraw’s deposition, he testified that he “found numerous definitions of cryogenic” (EX2024 at 12:13), although he indicated he still maintains his opinion as it relates to this IPR. It is interesting that Dr. Rockstraw, by his own admission during deposition, confirmed that he has never had a publication or presentation relating to the gas processing industry (EX2024 at 8:2-7), yet we are supposed to accept his definition of cryogenic over the definitions of known experts in the industry such as Drs Ryan and Holmes (see Section 51 above).

B. Carbon Dioxide Recovery Solvents:

63. The Board states in its Institution Decision that “we need not and do not formally construe the term ‘carbon dioxide recovery solvents,’ including whether such solvents must have an affinity for CO₂” (Section IV Analysis, Part B at 17). It would be obvious to a POSITA that solvents by many names are used extensively within the processes described in Exhibits 1005, 1006, 1007, 1010, 1016, 2003, 2005, 2006, 2007, and 2008.

64. It is difficult to ignore the presence of the all important additives in the above listed articles and patents, but somehow Rockstraw’s testimony does.

65. Dr. Rockstraw’s deposition testimony indicates that he understands the importance of the additive stream and that they are necessary for the Ryan/Holmes

process to work. When asked if the Ryan Holmes processes would work without the use of additives, he replied “the answer to that is no” (EX2024 at 66:6). When asked “why,” Dr. Rockstraw explained that “because you are changing the nature of the vapor-liquid equilibria” (EX2024 at 66:8-9), and further stated that the “process will fail under those conditions” without additives (EX2024 at 67:6-7).

66. 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.”

67. 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 liquid 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 EX1005 at Page 6 (“using an additive introduced at the top of the distillation tower,” and the “additive is then regenerated and reused in the same process”) ; EX1006 at Page 1 Abstract

(“liquid hydrocarbon stream”), at Page 7, 4:35-38 (“To facilitate propane recovery, the rectification section is fed with an absorbent oil produced in the plant”), and every column except 6; EX1007 throughout (at least 42 times) (“NGL-based additive” or “recycled additive”)); and EX1010 at Page 1 (“These Ryan Holmes separations all involve the use of an additive to provide a particular benefit to the distillation.”) and throughout, but never in Exhibit 1002.

IX. Overview of The Prior Art

A. The Ryan/Holmes Process

68. A POSITA, having reviewed the article by Aycaguer (Exhibit 1005) which specifically mentions the Ryan/Holmes process by name at 305,² and its footnote references 21 (Exhibit 2008) and 22 (Exhibit 1007), would have realized that all three describe the Ryan/Holmes process. Further to the Aycaguer article, a POSITA may have reviewed the Soldati patent Exhibit 1006 which also mentions the Ryan/Holmes process by name at 1:21-25.³ Soldati also provides a concise

² “The separation of CO₂ from hydrocarbons and H₂S can be achieved by using the Ryan/Holmes process. This technology is a distillation separation relying on the relative volatility of the gas components and using an additive introduced at the top of the distillation tower [referencing footnotes 21 and 22].” (Exhibit 1005, Page 6.)

³ “A fractionation process of the known art is described hereinafter from the teachings of A. S. Holmes and J. M. Ryan given in U.S. Pat. No. 4,350,511 and in ‘Hydrocarbon Processing’ (April 1984 page 71) ‘Ryan-Holmes Technologies’.” (Exhibit 1006, Page 6 at 1:21-25)

description of Ryan/Holmes at 1:25-53, and goes on to provide a detailed description complete with the results of process simulations in 8:49 to 13:20. Suffice it to say that any reference to Aycaguer or Soldati is really a reference to Ryan/Holmes.

69. 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, specifically for enhanced oil recovery ("EOR") operations in the Oil and Gas industry. The Ryan/Holmes process uses hydrocarbon solvents ("additives"), and an extensive amount of process equipment (up to four distillation columns plus a sweetening step), to solve two particular problems in the separation of methane and ethane from carbon dioxide recycle streams.

70. The Ryan/Holmes additives avoid carbon dioxide freezing (solidification) in the separation of methane from carbon dioxide.

71. The use of the additives also allows the separation of ethane from carbon dioxide to occur, by eliminating the formation of the ethane-carbon dioxide azeotrope. Ryan and Holmes, in describing their Ryan/Holmes process, state that "An azeotrope is a constant boiling mixture whose vapor composition is identical to its liquid composition, thus precluding further separation by conventional distillation." EX1010 at Page 3. When this occurs, the two components, ethane and carbon dioxide in this case, cannot be separated in a practical manner by conventional distillation. In the oil and gas industry, the ethane – carbon dioxide

azeotrope is eliminated by using an additive (solvent) to remove the ethane by solubility rather than by boiling point differences.

72. 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.”⁴

73. 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,

⁴ (EX1001, 4:55-60 (“By taking a less aggressive cut of the NGLs and/or disregarding the recovery of methane, ethane, and optionally propane from the dehydrated carbon dioxide recycle stream 160, the NGL recovery process 110 may produce a relatively high quality NGL rich stream 162 with relatively little process equipment or energy.”).)

having little to no methane and ethane, while using significantly less process equipment and energy, and thereby recovers NGLs with significantly less costs.

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

75. Petitioners rely upon one of the Ryan/Holmes journal articles (EX1007) 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.

76. Petitioners made a similar attempt to incorporate another Ryan/Holmes journal article (EX1010) 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.

77. 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)).

78. Exhibit 1010 at page 9 describes the application of the 3 column Ryan/Holmes process – EOR application in Fig.12. In the description of this figure, Ryan and Holmes describe their Ryan/Holmes process as achieving sales gas with 2% CO₂ when “column 1 condenser operates at about -120°F.

79. 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 during “low methane content in years of peak CO₂ production” in which these warmer conditions were accomplished by increasing the flow of the CO₂ recovery solvents (“NGL-based additives”). See EX1010 at Page 9 (“By increasing the volume of recycle additive to the column, the overhead temperature can be raised to -35°F.”).

80. 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.

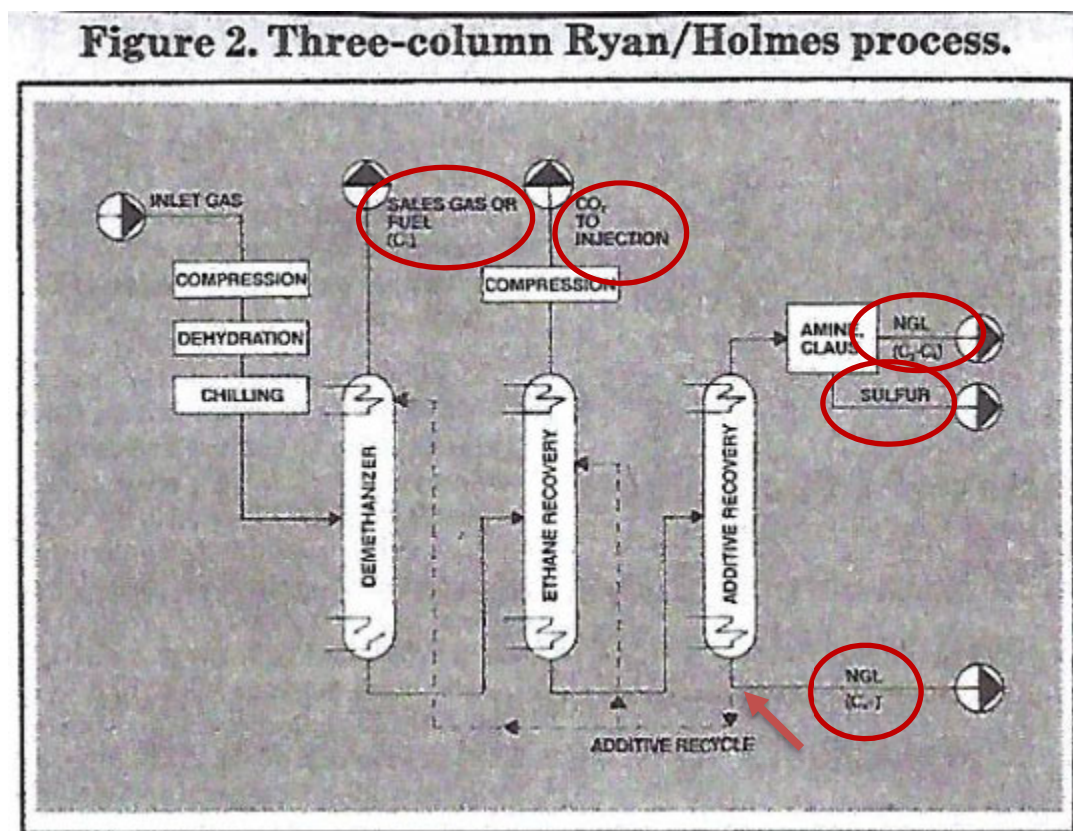
Four-column scheme

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).)

81. 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.

82. The Ryan/Holmes process shown in Figure 2 of Exhibit 1007 describes the 3 column Ryan/Holmes process.



Note the 5 individual outputs from the process.

- Sales gas or fuel (C1) [methane]
- NGL (C₂-C₃) [ethane-propane] and (C₄+) [butane-plus]
- Sulfur

-CO₂ to Injection

83. From Exhibit 1007 page 54, Ryan states that “The role of the additive recovery column is to remove lighter NGL’s to prevent them from being recycled. Butane-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.” The “net heavier NGL make” in this sentence refers to “NGL (C₄+)” shown in the bottom right corner of Figure 2. It is important to note that the “lighter NGL’s” refer to the circle in the top right corner of Figure 2, and specifically mention the presence of ethane (C₂). In his testimony, Rockstraw states that “a POSITA would understand that ‘natural gas liquids’” is a term that includes C₃-C₈ hydrocarbons” (see Institution Decision page 27). This statement is misleading since all the Ryan/Holmes exhibits (and exhibits which reference Ryan/Holmes) include references to C₂ in the NGL.

84. During the deposition of Dr. Rockstraw, he testified that “the ethane appears in a separate NGL stream that the author refers to as a light NGL stream.” (EX2024 at 77:16-17). This is consistent with the “NGL (C₂-C₃)” shown in figures 2 and 3 of Exhibit 1007.

85. The article goes on to say that “H₂S, if present in the plant feed, will be produced in the overhead of the additive recovery column.” It will be shown in the Soldati description of the Ryan/Holmes process that 100% of the H₂S contained in

the inlet is produced in the overhead of the additive column. Also, the next sentence in the article (Ex 1007 at 54) states that “The sour NGL’s of the overhead are processed by conventional amine treatment to produce sweet NGL product.” Figure 2 and this direct quote from Ryan clearly show an external step after the additive recovery column is required to produce a sweet NGL rich stream, the NGL (C2-C3). This is contrary to the Rockstraw testimony where he contends that the sweet NGL rich stream is produced from the bottom of the additive recovery column (Soldati’s stream 28) as shown on page 42 of the Board’s Institution Decision. It will be discussed later, but stream 28 (the additive recovery column bottom stream) mentioned in Rockstraw’s testimony is mischaracterized as an NGL stream since it is over 99% additive which is continuously recycled to other parts of the plant. Less than 1% of stream 28 is included in the “NGL C4+” stream shown in the bottom right corner of Figure 2 shown with a red arrow.

86. Exhibit 2008 at 135 says “A slip stream, taken from the bottom to remove the net C4+ contained in the feed, is mixed with net overhead for NGL product,” with the “overhead” referring to the C2-C3 stream described in section 82 above. This confirms that the sweet NGL rich stream from Ryan/Holmes (and by direct association Aycaguer and Soldati) contains C2-C8 hydrocarbons.

87. Figure 6 from Exhibit 1010 also shows the combination of the light NGL stream (the overhead product of the column labeled “3”) and the slipstream off of the “Additive Recycle” stream from the bottom of Column “3”.

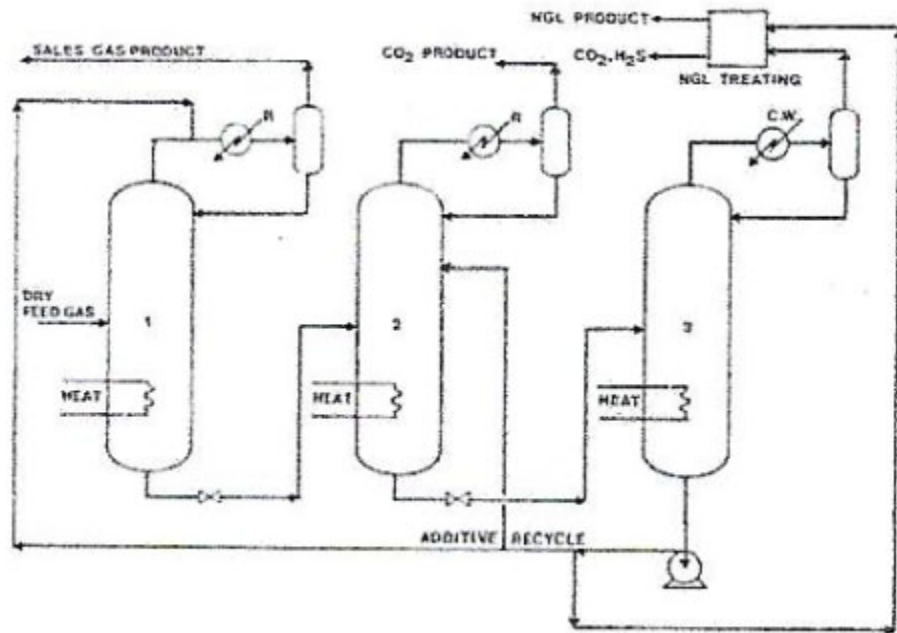


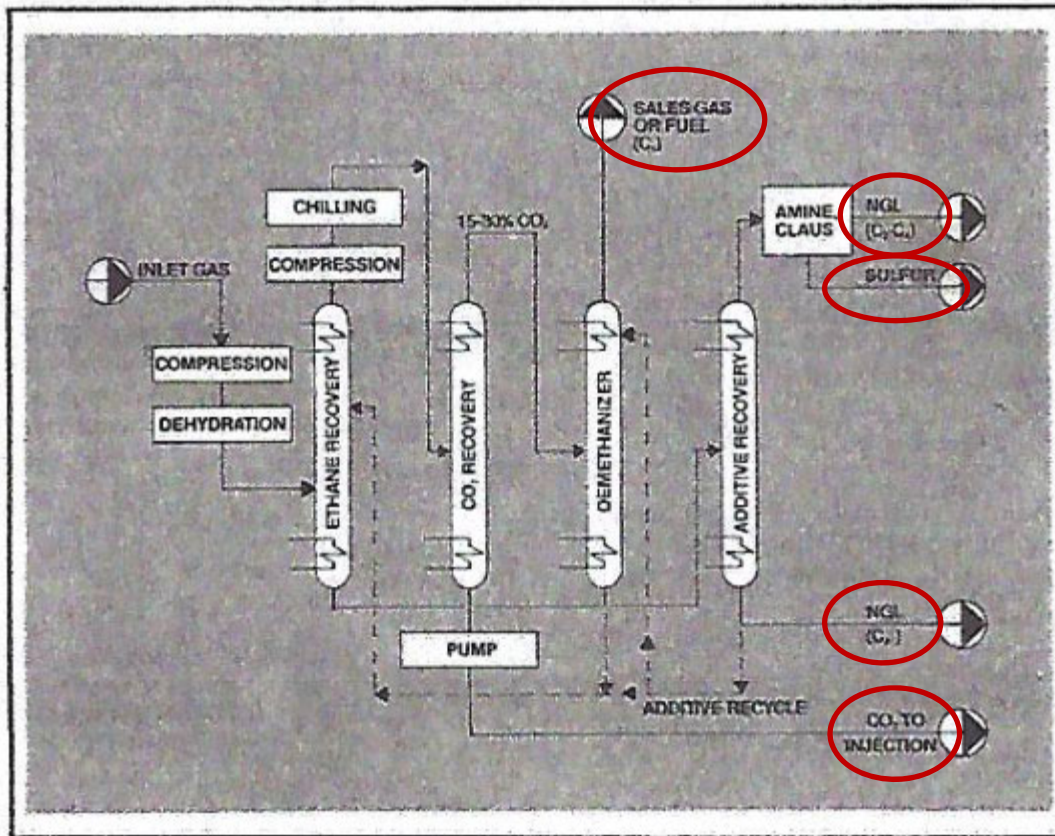
FIG. 6. Ryan/Holmes process—EOR plant.

88. Exhibit 1010 at 79 describes the “NGL Treating” shown in the figure as “NGL product can be treated either as a liquid or vapor by an amine system to remove the acid gas content.”

89. Figure 3 from Exhibit 1007 describes an alternative (four-column) embodiment of the Ryan/Holmes process.

90. A detailed description of the Ryan/Holmes Four-Column process, complete with simulated component throughputs is included in the Soldati (EX 1006) Prior Art discussion.

Figure 3. Four-column Ryan/Holmes process.



Note the 5 individual outputs from the process.

- Sales gas or fuel (C₁) [methane]
- NGL (C₂-C₃) [ethane-propane] and (C₄+) [butane-plus]
- Sulfur
- CO₂ to Injection

B. Goddin (EX2003)

91. 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.⁵

92. In Goddin's first alternative, the second stage is the Ryan/Holmes cryogenic distillation process.⁶ 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.

93. 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

⁵ (EX2003, 7:24-33 ("CO₂ is further removed from the hydrocarbon enriched process stream by cryogenic fractionation and/or by CO₂ solution absorption.")).

⁶ *See* Ex. 2004, Table of Similarities (demonstrating similarities between Goddin '411 Patent Figure 11 and Three-Column Ryan/Holmes Process).

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.

94. 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, 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.

95. 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

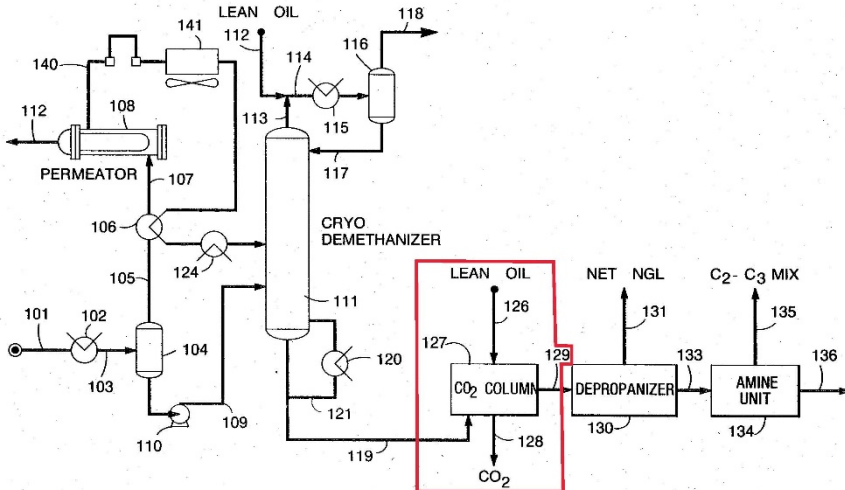
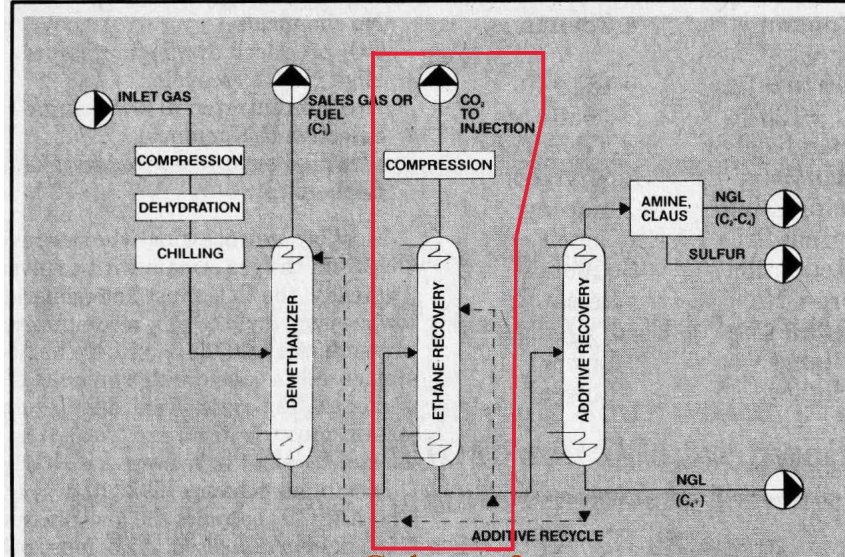
Column 1

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

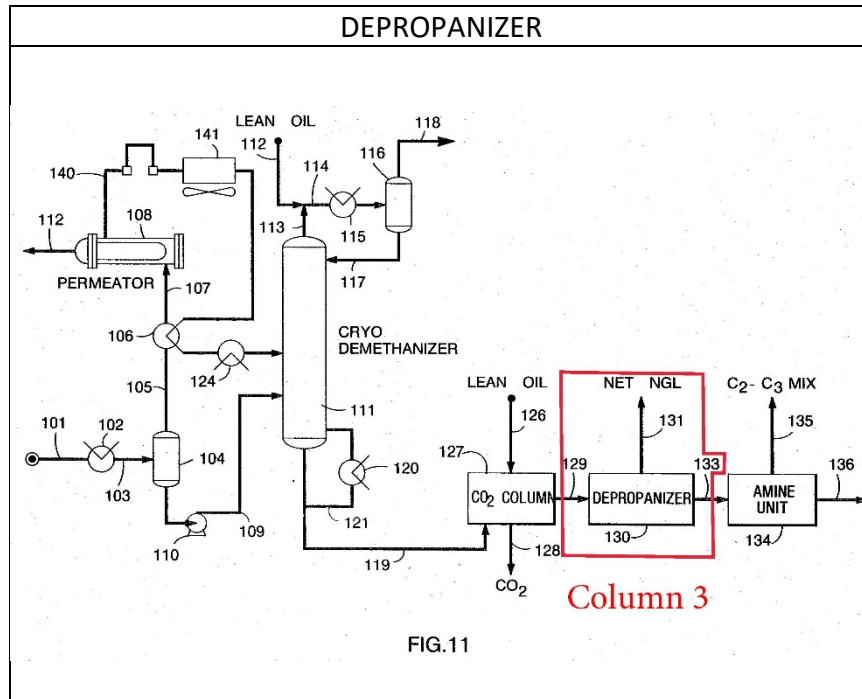
Column 2

CO ₂ COLUMN	ETHANE RECOVERY
 Column 2 FIG.11	Figure 2. Three-column Ryan/Holmes process.  Column 2
INPUT: CO₂ and C₂₊, and “Lean Oil” (C_{4,5} hydrocarbon solvent).	INPUT: CO₂ and C₂₊, and “NGL-based additive” (C₄₊ hydrocarbon solvent).
PROCESS: Separation of Ethane C₂ from CO₂, using “Lean Oil” (C_{4,5} hydrocarbon solvent) to facilitate separation of Ethane C₂ from CO₂.	PROCESS: Separation of Ethane C₂ from CO₂, using “NGL-based additive” (C₄₊ hydrocarbon solvent) to facilitate separation of Ethane C₂ from CO₂.
OUTPUT- Overhead: Sweet high purity CO₂ product stream. Bottom: Ethane C₂ and other hydrocarbons.	OUTPUT - Overhead: CO₂ product stream. Bottom: Ethane C₂ and other hydrocarbons.

Goddin '411 Patent Figure 11

Three-Column Ryan/Holmes Process

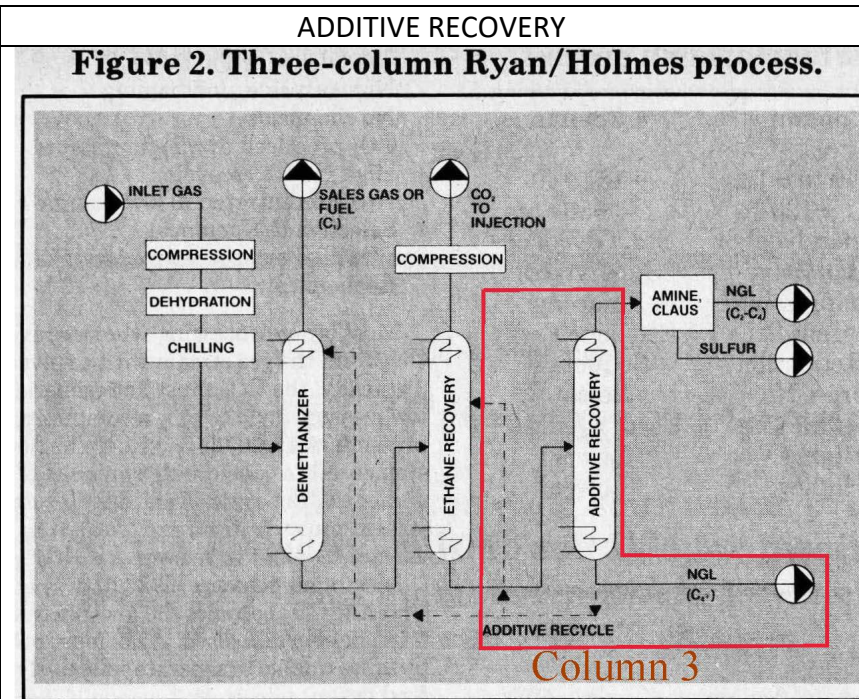
Column 3



INPUT: Ethane C₂ 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 ("E-P mix"), and some acid gases CO₂ and H₂S.
Bottom: Butane and heavier hydrocarbons (C₄₊ aka "Net NGL").



INPUT: Ethane C₂ and other hydrocarbons.

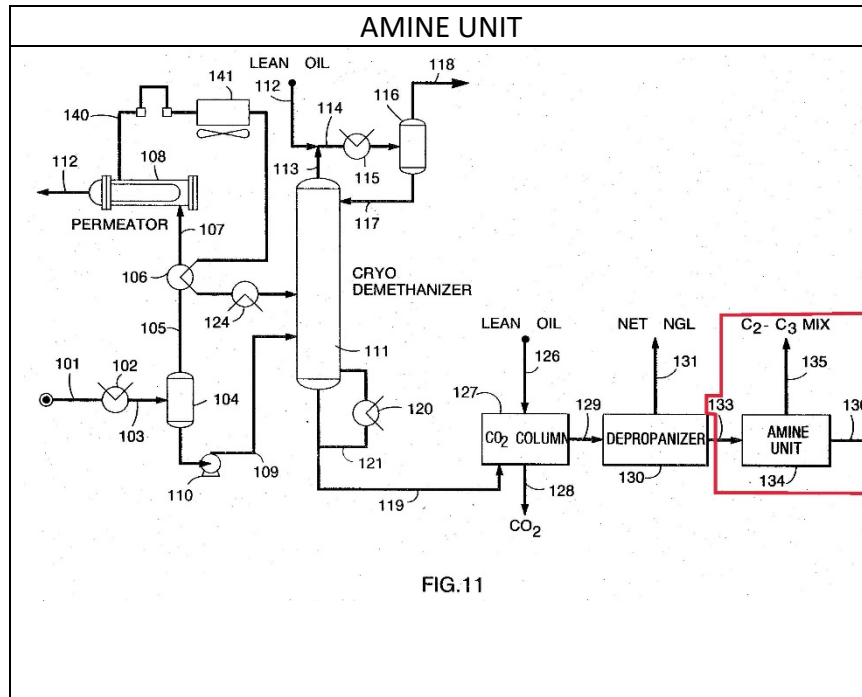
PROCESS: Separation of light (Ethane C₂ and Propane C₃) and heavier hydrocarbons (Butane C₄ and heavier hydrocarbons C₅₊).

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

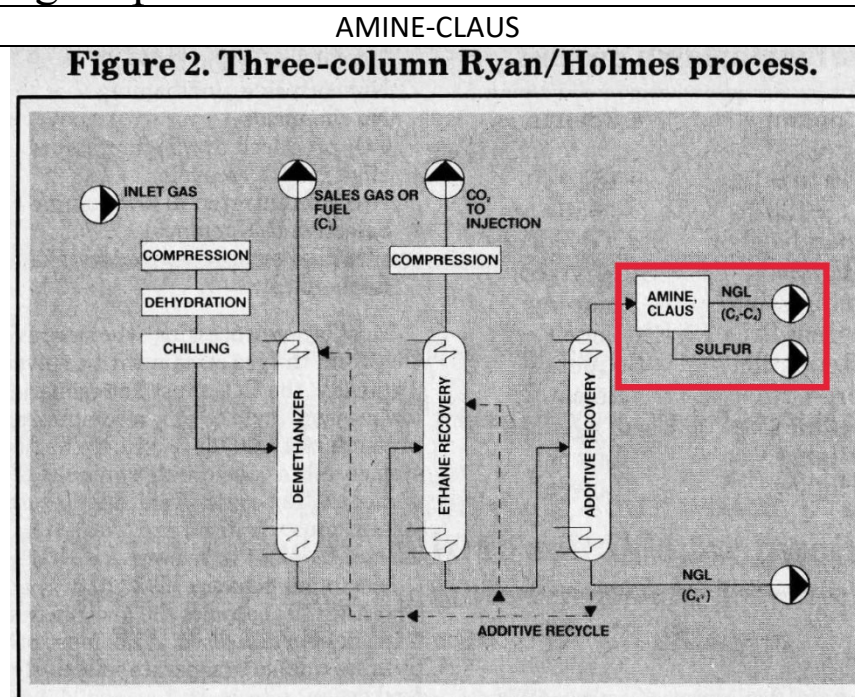
Sweetening Step



INPUT: Ethane C₂ and Propane C₃, and some acid gases CO₂ and H₂S (sour "E-P mix").

PROCESS: Amine Scrubbing (sweetening of the Ethane C₂ and Propane C₃ ("E-P mix")).

OUTPUT: - Overhead: Sweet Ethane C₂ and Propane C₃ (sweet "E-P mix").
Bottom: Acid gases CO₂ and H₂S.



INPUT: Ethane C₂ and Propane C₃, and some acid gases CO₂ and H₂S.

PROCESS: Conventional amine treatment to produce sweet NGL product.

OUTPUT: Overhead: Sweet Ethane C₂ and Propane C₃ ("sweet NGL product")
Bottom: Sulfur

C. Overview of Aycaguer (EX1005)

96. 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 began 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.

97. Aycaguer in Exhibit 1005 at 305 describes the “associated gas for separation of the different components” as “water, hydrogen sulfide – H₂S, CO₂, CH₄, natural gas liquids.” It is important to note that the description does NOT include C₂H₆ (ethane). The absence of ethane in the list of components would lead a POSITA to know that the ethane is included in the “natural gas liquids.” The presence of ethane in the NGL is a critical difference between the Prim ‘332 Patent and the process described in Aycaguer.

98. During his deposition, Dr. Rockstraw testified that that the natural gas liquids stream described above “will contain some of the ethane that’s in the feed

stream.” (EX2024 at 49:5-6) When asked during deposition whether “a POSITA reading Aycaguer would have understood, and at the very least found it obvious that the hydrocarbon feed stream of Aycaguer includes C2 through C8” he testified that “Yes, a POSITA would recognize that the hydrocarbon feed stream of Aycaguer includes C2 through C8.” (EX2024 at 57:16-21.)

99. Dr. Rockstraw further testified that “Aycaguer does not refer to ethane as a specific component, but he groups it in with natural gas liquids.” (EX2024 at 48:22-24)

100. In contrast, the Prim ‘332 Patent refers to the inlet prior to the initial separator at 2:63-65 as “carbon dioxide, methane ethane, NGLs, heavy hydrocarbons, hydrogen sulfides, helium, nitrogen, water,” specifically mentioning ethane and NGLs and further defining NGLs as C3-C8 hydrocarbons at 3:5-7.

101. Aycaguer never directly mentions the composition of the NGL stream as C3-C8. It is Rockstraw, in his testimony, who contends that the NGL in Aycaguer is “at least C3-C8” in section 82, and then later as simply “C3-C8” to imply that the Aycaguer NGLs contain the same hydrocarbons as Prim. The references (21) and (22), as discussed in Sections 81 to 89 above describe NGL streams as C2-C3 and C4+.

102. 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 is incomplete as it leaves off the methane stream, and unlike the references (21) and (22), it does not show the Natural Gas Liquid stream as C2-C3 and C4+. 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.)

103. Aycaguer also introduces the use of amine for sweetening the NGL (Ex 1005 at 305). Aycaguer states that “to separate H₂S from the natural gas liquids, we used a nonselective chemical absorption amine” which is in agreement with Ryan Ex 1007 Figures 2 and 3, Holmes Ex 2008 Fig. 6, and Holmes Ex 1010 Fig. 6.

104. This is contrary to the testimony of Rockstraw which describes the sweetening step taking place in a distillation column shown in Exhibit 1006, column 21. At no place in Exhibit 1006 does Soldati describe column 21 as a sweetening step.

105. Interestingly, Rockstraw only refers to one of the two cited articles in Aycaguer (EX1002, ¶ 111 (referring to EX1007 (“Ryan”)))⁷. The other article, “Process improves acid gas separation,” written by Holmes et al was published in the May 1982 edition of Hydrocarbon Processing.⁸ 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 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;

⁷ 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.

⁸ 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.

- 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).

106. 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)

107. 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 he states that “Soldati discloses methods of processing oil and natural gas streams to remove CO₂ and H₂S.” It is questionable why Rockstraw would present his own apparently purposefully chosen words to describe Soldati rather than quote directly from the patent. Could including “a fraction formed of ethane, propane and heavier hydrocarbons” distance the Soldati patent from the Prim patent, thus weakening the Petitioners’ position?

108. 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.

109. 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 (emphasis added).)

110. Although this Exhibit 1006 is the Soldati patent, the Rockstraw Declaration focuses most of its 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.)

111. The component throughput data shown in Table III is presented in kMol/hr. This is a widely used molar flowrate, especially in process simulations in the oil and gas industry, which is where the data presented in Table III originated. Molar flow rates are particularly useful since they do not take the phase (gas, liquid, solid) of the particular component into account. When components change from gas (typically measured in cubic feet) to liquid (typically measured in gallons or barrels), the units make comparison difficult.

112. 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, which matches the Table III reference, 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 ‘332 process, further distinguishing Soldati (Ryan/Holmes) from Prim.

113. During deposition, when asked “if you change your statement to saying stream 12 includes propane and higher hydrocarbons, C3 through C8 and you change

that to say ethane and higher hydrocarbons, C2 through C8, would that statement be correct?” Dr. Rockstraw testified “that statement would be correct.” (EX2024 at 94:24 – 95:6) Later, Dr Rockstraw testified that “roughly three-quarters of the ethane in the feed stream comes out in stream 12, so it would’ve been more accurate to refer to it as ethane and higher hydrocarbons.” (EX2024 at 98:19-21.)

114. 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 (column 21 overhead), this stream is made up of 94.54% hydrocarbons.⁹ 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). Rockstraw himself in section 42 of his declaration describes the sweetening of natural gas liquid streams using various methods described in Exhibit 1022 (Colton), but does not include a distillation method. In this case, the distillation described in column 21 does not separate H₂S and CO₂ from the inlet stream, it separates the H₂S, CO₂, C₂, and C₃ from the inlet stream, which requires a further sweetening process as

⁹ (EX1005 Table III (showing Stream 27 as 0.03 H₂S and 3.65 CO₂, which totals to 3.68 acid gasses, and 32.57 ethane (C₂), 30.51 propane (C₃), and 0.67 n-butane (C₄), which totals to 63.75 hydrocarbons). 95.54 % hydrocarbons calculated as $3.68 / (3.68 + 63.75) = 0.9454$. These stream composition numbers are shown in the image of Table III presented below.

described in Aycaguer (EX 1005), Ryan (Ex 1007), Holmes et al (Ex 2008, 1010), and Colton (Ex 1022) among others.

115. 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.¹⁰ The C4+ heavier hydrocarbons are produced 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 along with all of the H2S included in the inlet and a portion of the CO2.

116. 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,

¹⁰ 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 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.”).

regarding challenged Claim 4, which specifies that the sweet NGL rich stream comprises “no more than 1 molar percent ethane.”

117. During deposition Dr. Rockstraw testifies that column 21 of Soldati “sweetens the heavy NGL’s, but it doesn’t sweeten the light ones.” (EX2024 at 105:16:17) Further to this, while discussing the additive recovery column of Ryan/Holmes, Dr. Rockstraw is asked “the stream coming out the top, which then goes into an amine Claus, which you referred to as a sweetening step, correct?” He responds “correct.” (EX2024 at 114:10-13.)

118. When Dr. Rockstraw is asked about the sulfur, “would you refer to that as the acid gas stream,” his response is “I would refer that to ... that as an acid gas stream.” (EX2024 at 114:15-19)

119. When asked “would you then refer to that stream 27 as a sour NGL [rich] stream,” Dr. Rockstraw replied “I think that’s an accurate description also. It contains hydrogen sulfide, that makes it sour. It contains C2 through C4. so it contains components of an NGL.” (EX2024 at 118:13-20.)

120. To further confirm that column 21 does not constitute a sweetening step, in the deposition Dr. Rockstraw is asked: “you say the stream is separated into a sweet NGL rich stream with the C4+ hydrocarbons and a sour NGL rich stream with the C2 and C3 hydrocarbons; is that correct,” to which he responds “that’s correct,” and then he is asked “then you say the sour NGL stream is then sweetened

using amine solvent; is that correct,” to which he responds “that’s correct.” (EX2024 at 119:19 - 120:1.)

121. 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.

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.”¹¹

122. 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 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.”¹²

¹¹ 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.”).

¹² 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.”).

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

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)

124. 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%.

125. 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 in Soldati contains 0.0% of the methane contained in the carbon dioxide recycle stream. In contrast, purified carbon dioxide recycle stream in Prim ‘332 contains 100% of the methane contained in the carbon dioxide recycle stream. (EX1001, Prim ‘332 Patent, Stream Composition Tables 2A-C, 5A-C, and 8A-C showing no methane (0.000) in the NGL streams

264/266/268/162 (Tables 2A-C, 5A-C, and 8B-C), and Stream Composition Tables 2A-B, 5A-B, and 8A-B showing the purified carbon dioxide recycle streams 164/258 containing all of the methane from the carbon dioxide recycle streams 160/252.)

126. The table below shows the composition and flow rates of various streams taken from the Prim '332 patent Tables 1A, 1B, 1C, 2A, 2B, and 2C.

127. Unlike Soldati, the data in Prim '332 is not presented in kmol/hr. To be able to make comparisons, the stream flow rates in Millions of Standard Cubic Feet per Day (MMSCFD) are multiplied by the mole fraction of the individual components and multiplied by 1000 to give the flow rate for the individual components in a stream in thousands of Standard Cubic Feet per Day (MSCFD). For example, in stream 160, the flow rate is 17 MMSCFD, and the H₂S has a mole fraction of 0.0333, thus there are $(17 \times .0333) \times 1000 = 566$ MSCFD (as shown in the table below).

Dehydrated CO2 Recycle Stream Stream 160			Purified CO2 Recycle Stream Stream 164			Percent of inlet component in the Purified CO2 Recycle Stream		
Flow	17 MMSCFD		Flow	15.88 MMSCFD				
	Mole Frac.	MSCFD		Mole Frac	MSCFD			
H2S	0.0333	566	H2S	0.0327	519	91.7%		
CO2	0.7842	13331	CO2	0.8359	13274	99.6%		
Methane	0.0521	886	Methane	0.0558	886	100.0%		
Ethane	0.0343	583	Ethane	0.0348	553	94.9%		
Propane	0.0406	690	Propane	0.0313	497	72.0%		
Dehydrated CO2 Recycle Stream Stream 160			Acid Gas Stream 270			Percent of inlet component in the Acid Gas Stream		
Flow	17 MMSCFD		Flow	0.103 MMSCFD				
	Mole Frac.	MSCFD		Mole Frac	MSCFD			
H2S	0.0333	566	H2S	0.4568	47	8.3%		
CO2	0.7842	13331	CO2	0.5432	56	0.4%		
Methane	0.0521	886	Methane	0	0	0.0%		
Ethane	0.0343	583	Ethane	0	0	0.0%		
Propane	0.0406	690	Propane	0	0	0.0%		
Dehydrated CO2 Recycle Stream Stream 160			NGL Rich Stream Stream 162			Percent of inlet component in the NGL Rich Stream		
Flow	17 MMSCFD		Flow	1.016 MMSCFD				
	Mole Frac.	MSCFD		Mole Frac	MSCFD			
H2S	0.0333	566	H2S	0	0	0.0%		
CO2	0.7842	13331	CO2	0	0	0.0%		
Methane	0.0521	886	Methane	0	0	0.0%		
Ethane	0.0343	583	Ethane	0.0309	31	5.3%		
Propane	0.0406	690	Propane	0.1903	193	28.0%		
Dehydrated CO2 Recycle Stream Stream 160			Sour NGL Rich Stream Stream 264			Percent of inlet component in the Sour NGL Rich Stream		
Flow	17 MMSCFD		Flow	1.119 MMSCFD				
	Mole Frac.	MSCFD		Mole Frac	MSCFD			
H2S	0.0333	566	H2S	0.0421	47	8.3%		
CO2	0.7842	13331	CO2	0.05	56	0.4%		
Methane	0.0521	886	Methane	0	0	0.0%		
Ethane	0.0343	583	Ethane	0.0281	31	5.3%		
Propane	0.0406	690	Propane	0.0728	81	11.7%		

128. In addition to the methane recoveries distinguishing the Prim '332 process from Soldati and Ryan/Holmes, the contrasting ethane recoveries further highlight the dramatic differences in these processes. The carbon dioxide recycle stream in Soldati also contains 41.50 kMol/hr of ethane (Table III, Stream 6) and the purified carbon dioxide stream contains 8.86 kMol/hr of ethane (Table III, Stream 44).

COMPONENT THROUGHPUT KMOLS/H	STREAM			
	6	12	31	9
NITROGEN	16.46	0.00	—	16.46
HYDROGEN SULPHIDE	0.03	0.03	—	0.03
CARBON DIOXIDE	1167.21	3.65	—	1210.20
METHANE	57.59	0.00	—	64.62
ETHANE	41.50	32.61	—	19.44
PROPANE	31.79	42.63	0.10	1.13
N-BUTANE	11.57	1092.68	9.59	0.87
N-PENTANE	3.06	328.17	2.88	—
HEXANE	0.80	81.06	0.71	—
THROUGHPUT KMOLS/H	1330.01	1580.83	13.28	1312.75
PHASE	V	L	L	V
TEMPERATURE °C.	40.0	138.0	48.0	-13.1
PRESSURE ATA	28.6	27.8	42.0	27.0

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	48	44	73
NITROGEN	16.45	—	—
HYDROGEN SULPHIDE	—	—	—
CARBON DIOXIDE	47.78	1162.50	46.61
METHANE	64.56	—	7.02
ETHANE	10.56	8.86	10.57
PROPANE	—	1.12	1.17
N-BUTANE	—	0.87	107.65
N-PENTANE	—	—	32.47
HEXANE	—	—	8.02

129. This means that the purified carbon dioxide recycle stream in Soldati contains 21.35% of the ethane contained in the carbon dioxide recycle stream (calculated as $8.86 / 41.50 = 0.2135$), and 0% of the methane. In contrast, the purified carbon dioxide recycle stream in Prim '332 contains almost 95% of the

ethane contained in the carbon dioxide recycle stream and 100% of the methane as shown by the arrows in the table above. (EX1001, Prim '332 Patent, Stream Composition Tables 2A-C, 5A-C, and 8A-C showing no or almost no methane (0.0281, 0.0613, or 0.000.) in the NGL streams 264/266/268/162 (Tables 2A-C, 5A-C, and 8B-C), and Stream Composition Tables 2A-B, 5A-B, and 8A-B showing the purified carbon dioxide recycle streams 164/258 containing all or almost all of the ethane from the carbon dioxide recycle streams 160/252.)

130. Claims 4 and 7 of the Prim '332 Patent specify that the “sweet NGL rich stream” (Claim 4), and the “sour NGL rich stream” (Claim 5) “comprises no more than 1 molar percent methane.” (EX1001, 18:35-37 and 18:54-56) And although not a challenged claim in this proceeding, Claim 5 of the Prim '332 Patent specifies that “the purified carbon dioxide recycle 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.” (*Id.* at 18:42-46) Since none of the methane and only 21.35% of the ethane are contained in the carbon dioxide stream, both the Soldati process and the Ryan/Holmes process described in the Soldati patent differ significantly from Prim.

131. 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 with all of the methane from the

carbon dioxide recycle 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 stark contrast, the Prim '332 Patent process makes no attempt to separate methane or ethane from the carbon dioxide recycle stream.

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

132. 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.

133. 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).

134. 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-

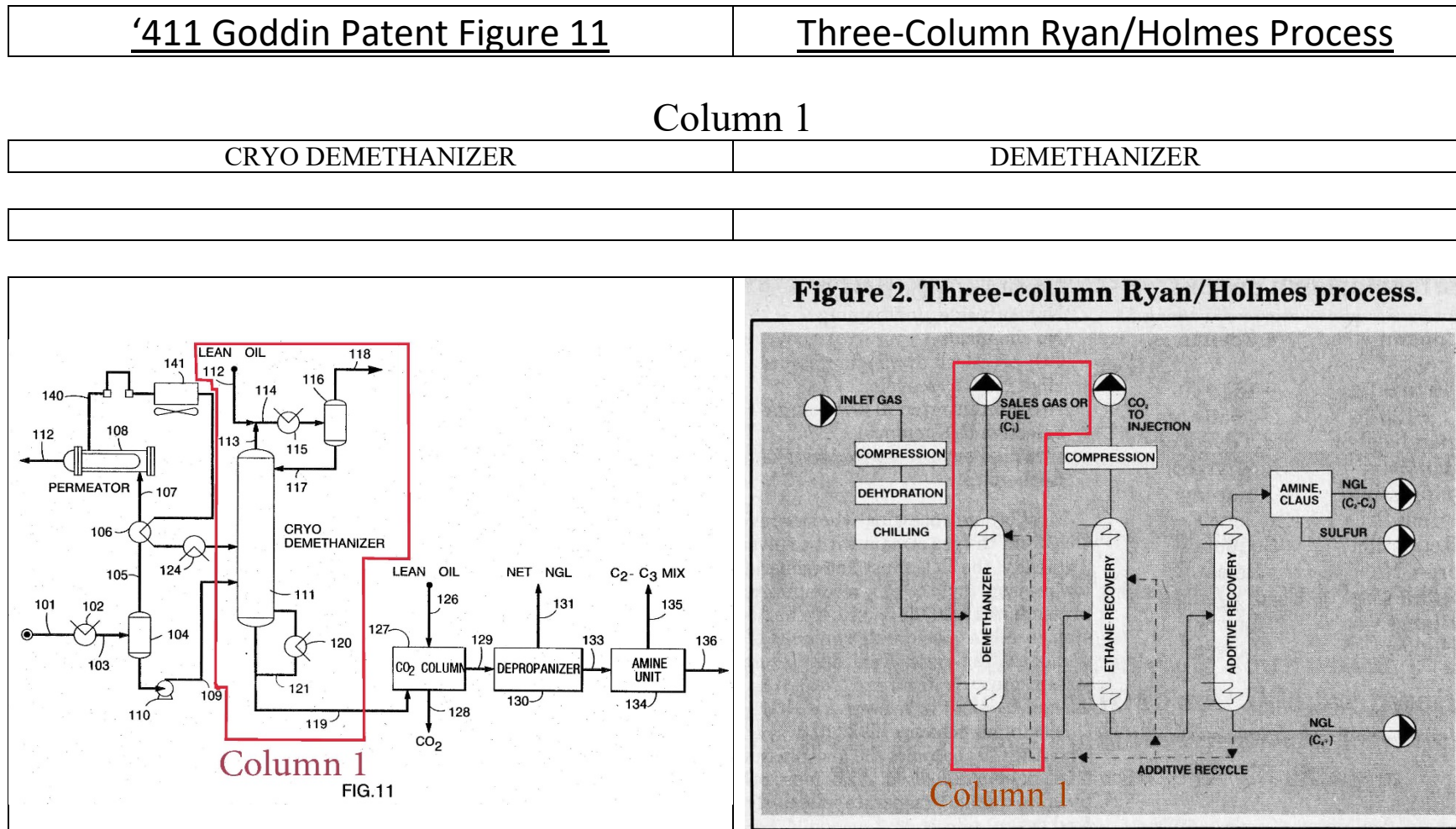
40). The Prim '332 Patent process does not require the use of additives, because there is no desire to break the CO₂ C₂ azeotrope.

135. 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.)

136. 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.”

137. During deposition, Dr. Rockstraw testified, when asked to describe the overhead of column 21, he replied that an “accurate description” is a “sour NGL [rich] stream.” (EX2024 at 118:11-18.)

138. 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).

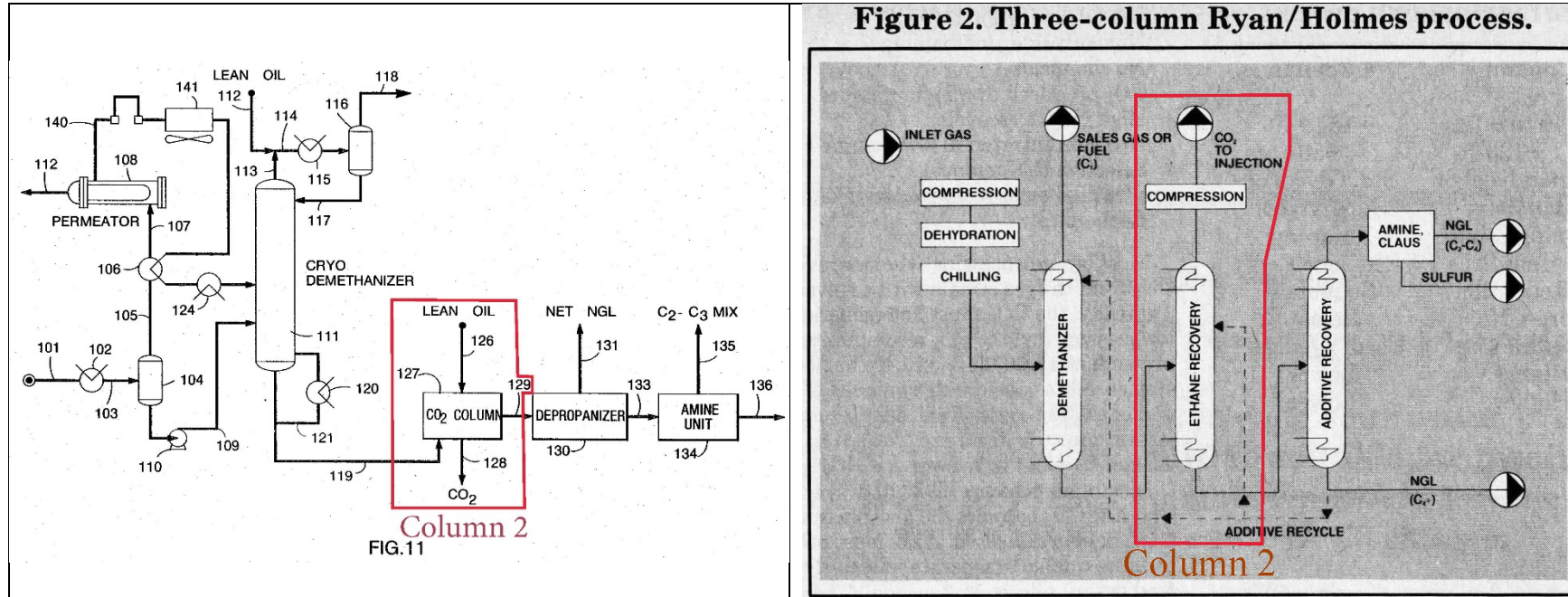


139. The '411 Goddin Patent at 17:65-67 describes "liquid stream 119, which contains the bulk of the CO₂ plus C₂ and heavier hydrocarbons." Figure 11 of the '411 Goddin patent also shows a "LEAN OIL" stream labeled 112 (not to be confused with the stream 112 from the permeator in the same figure), which 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.

140. 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

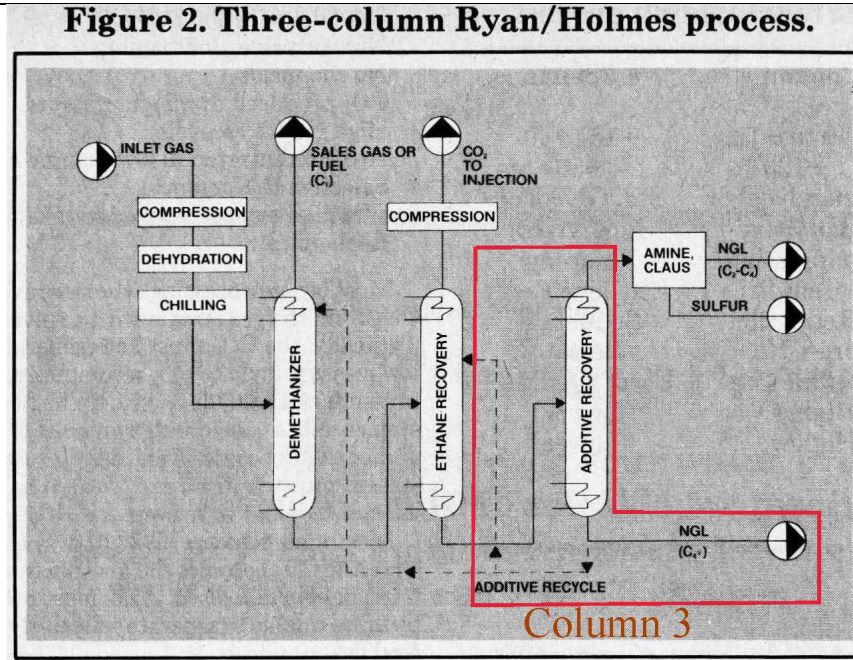
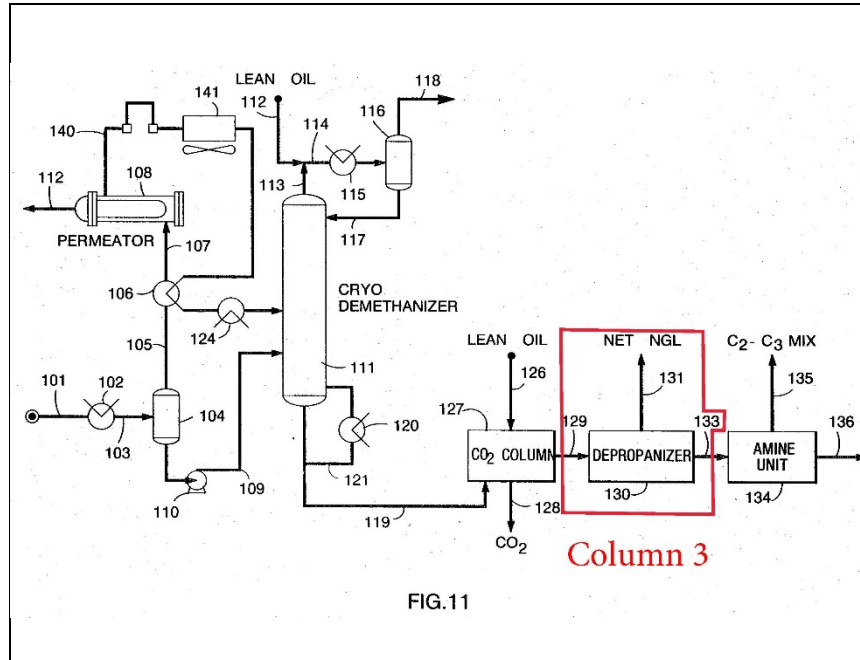


141. The '411 Goddin Patent at 18:4-9 says that "lean oil, preferably C4-C5 hydrocarbons via line 126 is introduced into the top of CO2 column 127, thereby produces a sweet high purity carbon dioxide stream." It goes on to say that "Ethane and other hydrocarbons together with the lean oil exit from the 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.

142. 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



143. 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."

144. 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.)

145. 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)

146. 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)" and at 5:32-33 "natural gas

liquids fraction comprising C2 to as high as, for example C8.” 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.” Arand also refers to ethane as among the “condensable hydrocarbons, that is, those that can ordinarily be collected and stored in liquid form.” 1:19-21 Furthermore, Arand table 1B (11:15-39) shows a stream labeled “NGL” which contains 33.76% ethane (calculated as 281.60 moles ethane / 834.14 moles total = 0.3376).

147. As stated in Rockstraw, Arand at 5:44-45 (which is between two of the above references) does refer to natural gas liquids as C3-C8, however, the reference is used to describe an approach to making an economic decision about further processing of the gas. The full quote at 5:41-46 “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.” It is unclear why a POSITA reading through the Arand patent would ignore the three descriptions which define NGL as C2-C8 (one of which says “as used herein”) and the component table which shows an NGL stream containing 33.76% ethane in favor of one description of NGL as C3-C8.

148. It is unclear why the Board has accepted Rockstraw’s testimony which describes NGL as C3-C8, based on one quote, when there are three other instances

within the Arand patent which refer to NGL as C2-C8. The Institution Decision at 36 appears to accept Rockstraw's mischaracterization of Arand as specifying NGLs as C3-C8 by relying on Rockstraw's clipped quote of Arand at 5:44-46 as referring to NGLs as C3-C8 when referring to a ratio of natural gas liquids to heavy condensate, while apparently unaware that in the immediately following sentence, not included in the quote, Arand specifically defines NGLs as C2-C8, not C3-C8. (EX1004, at 5:46-50 ("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.")) There does not seem to be any motivation to combine Aycaguer and Arand. Aycaguer teaches that "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. In EX1002 Section 116, Rockstraw states "Arand also teaches that heavy hydrocarbons contain nine or more carbon atoms," while the reference in Arand quoted by Rockstraw says "heavy condensate (C₉ and higher)" (EX1004 at 5:44-45). Although both streams do contain C₉+, the streams are very different. Arand Table 3 (Ex 1004 at 14:30-38) refers to

the production streams as BBL/day NGL and BBL/day Condensate, not oil, or not heavy hydrocarbons.

G. Overview of U.S. Patent No. 4,753,666 (“Pastor”) (EX2016)

149. The Pastor patent describes a method for the Distillative Processing of CO₂ and Hydrocarbons for Enhanced Oil Recovery. The Patent is specific to the processing of EOR gas since its focus is on preserving the minimum miscibility properties of the reinjected gas. The goal of the Pastor process is to “mitigate the “negative effects of C₁ on the miscibility of the CO₂ injection gas” Exhibit 2016 3:7-8. The minimum miscibility pressure (MMP) is the lowest pressure that is required to make the CO₂ EOR process work.

150. Pastor recognizes that the alternative processes considered including a reference to CO₂ solvents at 1:48 “chemical solvents (such as amines) have been considered for the removal of CO₂ from the hydrocarbon components. Use of these solvents becomes impractical in gas streams containing high concentrations of CO₂ because of the large energy demands of amine reboilers”

151. Pastor also describes a distillative process and quotes two Ryan/Holmes patents at 1:64 “4,318,723, 4,293,322”.

152. Pastor describes the shortfalls of the Ryan/Holmes processes stating that (2:1-5) “Initially, these processes are extremely expensive from both a capital

and operating perspective since it is necessary to provide multiple distillation columns and massive refrigeration capacity to cool the entire inlet gas stream to -40F or colder.” In addition, Pastor at 2:7-9 states that the Ryan Holmes patent ‘723 (EX2006) states that “the feed temperature is reduced to -65 F. This also results in the need to use exotic materials of construction for the process equipment.”

153. Pastor also describes an alternative referred to as “Straight Refrigeration” at 2:21-22, which is synonymous with a mechanical refrigeration unit (“MRU”) described in this Declaration.

154. Pastor dismisses the use of an MRU stating at 2:25-35 that “the inlet stream must be cooled to -40F or colder for the recovery of C3+, requiring extremely high refrigeration capacity. Furthermore the liquid stream produced by this process will have a high vapor pressure (approximately 40 psia RVP) as well as unacceptable CO2 and H2S concentrations. Finally, a large portion of the C4+ would go overhead and be unnecessarily wasted.”

155. The Pastor process may have been successful at mitigating a minimum miscibility problem, but by leaving all of the propane and a significant portion of the butane in the reinjection gas, it fails to improve upon the economics of the mechanical refrigeration process despite being able to reduce the refrigeration load.

H. Composition of the NGL Stream

156. The composition of the NGL Stream is of paramount importance for understanding that the processes described in Aycaguer, Ryan/Holmes, and Soldati are significantly different than the process of Prim '332 patent.

157. As shown in the "Physical Constants" Fig. 23-2 of Exhibit 2026, Page 262, the boiling point (and thus the dewpoint) of hydrocarbons varies significantly.

<u>Compound</u>	<u>Boiling Point °F (14.696 psia)</u>
Methane (C1)	-258.67
Ethane (C2)	-127.48
Propane (C3)	-43.72
n Butane (C4)	31.09

158. A POSITA would understand that there would need to be a significant increase in the amount of refrigeration horsepower (cost) required to condense methane (C1) and ethane (C2) (like Ryan/Holmes does), rather than to condense only propane (C3) and heavier hydrocarbons (C4+) like Prim does.

159. As shown above in Sections 96 through 106, Aycaguer describes an NGL stream which contains ethane (C2). The references (21) and (22), which are included as Exhibits 1007 (Figure 2) and 2008 (Table 2) confirm the presence of C2 in the NGL stream. The claim by Rockstraw that the NGL stream described in Aycaguer is a C3-C8 stream is misleading.

160. As discussed in Section 97 of this Declaration, when asked during deposition whether “a POSITA reading Aycaguer would have understood, and at the very least found it obvious that the hydrocarbon feed stream of Aycaguer includes C2 through C8,” Rockstraw testified that “Yes, a POSITA would recognize that the hydrocarbon feed stream of Aycaguer includes C2 through C8.” (EX2024 at 57:16-21)

161. As discussed in Section 113 above, during deposition when asked “if you change your statement to saying stream 12 includes propane and higher hydrocarbons, C3 through C8 and you change that to say ethane and higher hydrocarbons, C2 through C8, would that statement be correct,” Rockstraw testified “that statement would be correct.” (EX2024 at 94:24-95-3) Later, Rockstraw testified that “I would say it would be more accurate.” (EX2024 at 96:6.)

162. As further discussed in Section 113 above, Rockstraw testifies that “roughly three-quarters of the ethane in the feed stream comes out in stream 12.” (EX2024 at 96:19-20.)

163. When asked: “would you then refer to that stream 27 as a sour NGL [rich] stream,” Rockstraw replied: “I think that’s an accurate description also.” (EX2024 at 118:13-18.)

164. When describing stream 27 in his deposition, Rockstraw states: “It contains hydrogen sulfide, that makes it sour. It contains C2 through C4, so it contains components of an NGL” (EX2024 at 118:18-20)

165. Soldati (Ex 1006) describes a process which makes an NGL product shown in Fig.4 as stream 27. The component throughput shown in Table III shows a stream which contains ethane (C2).

166. Table IV from Soldati also shows that the recovery of ethane (C2) is 94.1%, again confirming that the NGL stream contains ethane (C2).

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

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
	(P _{sat} = 6 ATA)	(P _{sat} = 4 ATA)

167. As discussed above in sections 127 to 129, Arand (Ex 1004) makes 4 references to the composition of the NGL stream. Three of these references mention NGL as C2-C8, including the last reference at 5:47 which says “herein, the term “natural gas liquids components” will be used to refer to any or all of C2 through about C8.” One reference does mention NGL as C3-C8, however, it is not clear whether the context of the comment refers to the makeup of the NGL stream or whether it is a commentary on the economic recovery of C3-C8 given that C2 has a lower value and thus contributes less to the economics.

168. The most significant evidence that Arand describes the NGL stream as C2-C8 is the component throughput shown in Table IB which shows 281.60 Mol/hr of ethane in the NGL stream. The inlet to the first fractionation (Stream 120 of Fig. 1 of Ex 1004) contains 376.27 Mol/hr of ethane, giving a recovery of 74.8%.

169. Ryan Exhibit 1007 Figures 2 and 3 both show an NGL (C2-C3), Holmes Exhibit 1010 at 78 describes “recovery of ethane and higher hydrocarbons as a product,” Goddin Exhibit 2003 Fig 11 shows a C2-C3 Mix, and Holmes ‘723 Exhibit 2006 Fig. 5 shows an ethane plus fraction.

170. The only Exhibit presented which describes NGL as a C3-C8 mixture is Prim ‘332, and that is because Prim only recovers a C3-C8 product. To refer to NGLs as C2-C8 in Prim would have been misleading to the reader.

I. The Prim ‘332 Process Provides an Additional Choice

171. As described above in sections 32-36, the Prim process opened up new opportunities for the processing of an EOR recycle hydrocarbon feed stream. Before the priority date there was no “middle ground” to choose from. The only choices were to individually recover methane, ethane, and NGL for sale, and produce a substantially pure CO₂ product for reinjection into the reservoir using a Ryan/Holmes process, or produce a C₄+ product for sale and reinject everything else using an MRU.

172. The Pastor process (EX2016) described in Section IX(G) of this Declaration proposes an alternative method of NGL recovery primarily focused on maintaining the minimum miscibility pressure of the injected fluid. Recovery of NGLs is not the primary driver of this method, leaving all of the propane and a significant portion of the butane in the injection fluid.

173. Prim provided a middle ground where additional NGLs could be captured and sold based on the economics of the plant. Variable recoveries and capital investment described in the method 400 provided a roadmap to the best possible economics for the situation.

J. Component Destinations

174. A simple way to demonstrate the significant difference between Ryan/Holmes and Prim is to look at where the individual components of the inlet stream end up. In the table below, PCO2RS refers to the Purified carbon dioxide recycle stream which is injected into the reservoir.

Component	Ryan/Holmes (Aycaguer, Soldati)	Prim '332
Methane (C1)	Separate sales stream	Included in PCO2RS
Ethane (C2)	Included in C2-C4 sales stream	Included in PCO2RS
Carbon Dioxide (CO2)	Separate 99.1% pure stream for injection	Included in PCO2RS
Hydrogen Sulfide (H2S)	Separate stream converted to sulfur (100% of the H2S in the Plant inlet)	90% of the H2S in the Plant inlet Included in PCO2RS, 10% Acid Gas stream
Propane (C3)	Included in C2-C3 sales stream	80% to 10% in PCO2RS, remainder in the NGL Rich Stream
Butane and heavier (C4+)	Included in C4+ sales stream	NGL Rich Stream

175. As shown above, Prim does not recover a methane stream for sale, leaves all or substantially all of the ethane in the PCO2RS, leaves about 90% of the H2S in the PCO2RS, and only recovers economically viable amounts of propane.

K. Acid Gas Removal from the Carbon Dioxide Recycle Stream

176. The first column of the Ryan/Holmes process shown in Exhibit 1007 Figure 3 removes all of the CO₂ (part of the acid gas stream) and methane from the carbon dioxide recycle stream out the top of the column (at 54) “The first column entered is the ethane recovery column in which the split between CO₂ overhead and the bottom product of C₂, H₂S, C₃+ and additive.” The second column then removes all of the CO₂ from the stream except for volumes which are later recycled back to the first column.

177. After this removal of the acid gas (CO₂) from the methane, it is reinjected back into the reservoir (refer to the arrow at the bottom of the figure).

178. The other acid gas, H₂S, is contained in the bottom product of the first column, and is captured in the Amine/Claus process, shown in the upper left of the figure, and converted to Sulfur.

179. Prim, in contrast, does not attempt to separate the CO₂ into a separate stream, and only separates out about 10% of the H₂S from the PCO₂RS. By limiting the amount of H₂S in the sour NGL rich stream, the cost to sweeten the NGL stream for sale is much more economical than if 100% of the H₂S had to be removed, as described in Ryan/Holmes.

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

180. 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 plus a sweetening step), 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 hydrocarbons from carbon dioxide and methane, allowing the separation to take place at a higher temperature, 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.

181. 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.” (EX1001 at 4:55-60.)

182. 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.

183. 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.

184. 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.

185. A POSITA on the priority date would have looked at the various components and their concentrations in the particular stream they were intending to process, as well as the current and forecasted flowrates. They would have also looked at the existing infrastructure for sales product pipelines, power infrastructure, road infrastructure, manpower availability and product sales market.

186. If all of the above market and infrastructure were in place, a Ryan/Holmes plant would have been the obvious choice. If they were not, additional investigation would be warranted.

187. Assuming there was no desire or ability to sell methane and ethane, or the local power grid could not support the additional horsepower required by Ryan/Holmes, a POSITA would have seen that Ryan/Holmes process was not going to work. Although unwanted streams (like methane and ethane) could have been recombined to create a stream similar to the Prim purified carbon dioxide recovery stream, this would have been a significant waste of capital to build 4 distillation

columns to arrive at the same destination as Prim. The other problem this recombination would have created would be that all of the H₂S in the inlet stream would need to be removed in the amine plant, which would be about 10 times larger than the amine plant required by Prim.

188. A POSITA in this position would have had to go in another direction to find a better option than Ryan/Holmes.

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

189. Prior to entering into the defense of the challenged claims of the '332 Prim patent, it is important to point out a significant error in the Institution Decision. Within the Decision, the Board accepted the erroneous description provided by Dr. Rockstraw in his Declaration (EX1002) that Natural Gas Liquids includes only C₃-C₈ hydrocarbons.

190. When asked during deposition whether “a POSITA reading Aycaguer would have understood, and at the very least found it obvious that the hydrocarbon feed stream of Aycaguer includes C₂ through C₈,” Dr. Rockstraw testified that “Yes, a POSITA would recognize that the hydrocarbon feed stream of Aycaguer includes C₂ through C₈.” (EX2024 at 57:16-21.) Then Dr. Rockstraw further testified that “Aycaguer does not refer to ethane [C₂] as a specific component, but he groups it in with natural gas liquids.” (EX2024 at 48:22-24.)

191. As shown in detail in Section IX(H) above, all of the references to the NGL streams of the various Exhibits describing the Ryan/Holmes processes all refer to NGL(C2-C3) and NGL(C4+) During the deposition of Dr. Rockstraw (77:16-17), he testified that “the ethane appears in a separate NGL stream that the author refers to as a light NGL stream”. This is consistent with the “NGL (C2-C3)” shown in figures 2 and 3 of Exhibit 1007.

192. The Institution Decision accepts the composition as C3-C8 on pages 22, 23, 27 (twice), 28, 30 (twice), 31, 32 (twice) 36 (twice), 38, and 40. The clarification of the composition should have a material impact on the conclusion arrived at in the Final Written Decision of the Board.

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

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

193. 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 Section X 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. Aycaguer, describing a Ryan/Holmes process, teaches away from the Prim ‘332 Patent process. (See Section X above.)

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]

194. 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.

195. Aycaguer, Exhibit 1005, *Reducing Carbon Dioxide Emissions with Enhanced Oil Recovery Projects: A Life Cycle Assessment Approach* 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.

196. Aycaguer in Exhibit 1005 at 305 describes the “associated gas for separation of the different components” as “water, hydrogen sulfide – H₂S, CO₂, CH₄, natural gas liquids.” It is important to note that the description does NOT

include C₂H₆ (ethane). The absence of ethane as a single component in the list of components would lead a POSITA to know that the ethane is included in the “natural gas liquids.” The presence of ethane in the NGL is a critical difference between the Prim ‘332 Patent and the process described in Aycaguer.

197. During his deposition (47:5-6), Dr. Rockstraw testified that that the natural gas liquids stream described above “will contain some of the ethane that’s in the feed stream.” When asked during deposition (57:16-21) whether “a POSITA reading Aycaguer would have understood, and at the very least found it obvious that the hydrocarbon feed stream of Aycaguer includes C₂ through C₈,” he testified that “Yes, a POSITA would recognize that the hydrocarbon feed stream of Aycaguer includes C₂ through C₈.” This testimony is also significant since the Institution Decision has previously accepted on page 22 of the Decision that the NGL stream of Aycaguer is C₃-C₈.

198. 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.

199. Figure 1 of Exhibit 1005, relied upon by Rockstraw as proof of obviousness, is incomplete as it leaves off the methane stream. References (21) and (22) of the Exhibit, show the methane stream as well as the Natural Gas Liquid streams as C₂-C₃ and C₄+

200. During deposition, when asked “is methane recovered in the process described in Aycaguer,” Rockstraw replied “it would be, yes.” (EX2024 at 44:12-14.)

201. The presence of methane (C1) as a separate stream is another significant difference between Aycaguer and Prim.

202. While dependent Claims 4 and 7 of the ‘332 Patent explicitly recite the Prim process “disregarding the recovery” of methane and ethane from the carbon dioxide recycle stream, by specifically requiring that “the sweet NGL rich stream comprises ... no more than 1 molar percent ethane,” and requiring that “the sour NGL rich stream comprises ... no more than 5 molar percent ethane,” independent Claim 1 implicitly recites the Prim process “disregarding the recovery” of methane and ethane from the carbon dioxide recycle stream, by excluding the use of cryogenic conditions and CO₂ recovery solvents.

203. As discussed above in Part IX(A) at Sections 69-72, and Part IX(C) at Section 105, the Ryan/Holmes cryogenic distillation process use of hydrocarbon solvents makes the recovery of methane and ethane possible, by avoiding carbon dioxide freezing (solidification) in the separation of methane from carbon dioxide, and allowing 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. *See id.*

Without the use of cryogenic conditions and CO₂ recovery solvents, as used in the Ryan/Holmes process, and excluded from use in all of the challenged claims of the ‘332 Patent, recovery of methane and ethane from the carbon dioxide recycle stream is not possible in a distillation process. *See id.*

204. The Aycaguer publication describes the process as a “distillation separation relying on the relative volatility of the gas components and using an additive introduced at the top of the distillation tower.” (EX1005 at Page 6.) A POSITA would have seen that although Prim also incorporates a distillation separation, there is no additive present. In fact, Claim 1 of the ‘332 patent specifically excludes the use of the additive described in Aycaguer.

205. The presence of the additive stream, which is a solvent, confirms that Aycaguer does not disclose the Claim 1 requirement that “the carbon dioxide recycle stream, and the sour NGL rich stream are not subjected to ... carbon dioxide recovery solvents.” The Ryan/Holmes process described in Aycaguer subjects the carbon dioxide recycle stream and the sour NGL rich stream to carbon dioxide recovery solvents. EX1005 at Page 6 (“additive introduced at the top of the distillation tower”). The use of additives in the distillation tower described in Aycaguer subjects the carbon dioxide recycle stream to carbon dioxide recovery solvents. See Section VIII(B) analysis above.

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

1. No Motivation to Combine Aycaguer and Arand

206. 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 Section X above, there is no motivation for a POSITA to modify or combine Aycaguer with other teachings (including Arand) in order to make the Prim '332 Patent process. Aycaguer, describing a Ryan/Holmes process, teaches away from the Prim '332 Patent process. (See Section X above.) The addition of Arand in a combination with Aycaguer does nothing to redirect a POSITA from Aycaguer's teaching away from the Prim '332 Patent process. Arand's own focus on recovery of methane and ethane further teaches away from the Prim '332 Patent process.

207. The addition of Arand (EX1004) does not contribute to making the Prim '332 Patent process obvious.

208. Just like Aycaguer's focus on the recovery of methane and ethane teaches away from the Prim '332 Patent process, which disregards the recovery of methane and ethane, Arand's focus on recovery of methane and ethane also teaches away from Prim. Arand describes its invention as "a method for processing a produced fluid stream ... from a ... reservoir to produce a residue [sales] gas stream comprising predominantly methane, [and] also has the flexibility and capability of including ethane ... in the residue [sales] gas stream if desired." (EX1004, 4:1-9; *see*

also id. at 12:27-31 (producing a stream “comprising predominantly methane or methane and ethane”).)

209. Within the patent (EX1004) at 4:55-56, it states: “natural gas liquid (for example, C2-C6 or C2-C8, or the like)” and at 5:32-33 “natural gas liquids fraction comprising C2 to as high as, for example C8.” 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.” Arand also refers to ethane as among the “condensable hydrocarbons, that is, those that can ordinarily be collected and stored in liquid form.” (EX1004 at 1:19-21.) Furthermore, Arand Table 1B (11:15-39) shows a stream labeled “NGL” which contains 33.76% ethane (calculated as 281.60 moles ethane / 834.14 moles total = 0.3376).

210. Given that Arand also describes a process which recovers methane and a natural gas liquid stream which contains ethane, A POSITA would not have found Prim ‘332 obvious to Aycaguer and Arand.

2. Claim 1

a. Claim element [1.6].

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

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

213. 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

214. 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 Section X above, there is no motivation for a POSITA to modify or combine Aycaguer with other teachings (including Soldati) in order to make the Prim '332 Patent process. Aycaguer, describing a Ryan/Holmes process, teaches away from the Prim '332 Patent process. (See Section X above.) The addition of Soldati in a combination with Aycaguer does nothing to redirect a POSITA from Aycaguer's teaching away from the Prim '332 Patent process. Soldati, itself also describing a Ryan/Holmes process, with its focus on recovery of methane and ethane, further teaches away from the Prim '332 Patent process.

215. The addition of Soldati to Aycaguer still does not render the Prim '332 Patent process obvious, in fact it strengthens the argument that Prim is different.

Soldati provides detailed simulation results which quantify the flows and composition of various streams.

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]

216. As explained above regarding Ground 1, Aycaguer does not teach limitation [1.6]. 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.

217. Soldati, as a four-column Ryan/Holmes process, adds nothing to overcome Aycaguer’s failure to teach limitation [1.6]. 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.

218. 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.

219. Soldati describes a fractionation process for high acid gas streams. The patent 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.” (EX1006, Page 6 at 1:14-18.)

220. The “separate fraction formed of ethane, propane and heavier hydrocarbons” above is C2-C8, which is the Soldati NGL stream.

221. During his deposition, when asked about the Soldati NGL stream as “ethane and higher hydrocarbons, C2 through C8, would that statement be correct,” Rockstraw testified “that statement would be correct.” (EX2024 at 95:2-6.) Later, Rockstraw testified that “I would say it would be more accurate.” (EX2024 at 94:5.)

222. Rockstraw in his deposition recants his Declaration testimony from EX1002, Section 70 where he describes the Soldati stream 12 as “propane and higher hydrocarbons,” and now admits that “roughly three-quarters of the ethane in the feed stream comes out in stream 12, so it would have been more accurate to refer to it as ethane and higher hydrocarbons,” where “stream 12” refers to the feed stream to column 21 shown in Fig 4. of Exhibit 1006. (EX2024 at 96:9-22.)

223. The table below from the Section 175 above shows the disposition of the components of Soldati (EX1006) and the Prim '332 Patent process.

Component	Ryan/Holmes (Aycaguer, Soldati)	Prim '332
Methane (C1)	Separate sales stream	Included in PCO2RS
Ethane (C2)	Included in C2-C4 sales stream	Included in PCO2RS
Carbon Dioxide (CO2)	Separate 99.1% pure stream for injection	Included in PCO2RS
Hydrogen Sulfide (H2S)	Separate stream converted to sulfur (100% of the H2S in the Plant inlet)	90% of the H2S in the Plant inlet Included in PCO2RS, 10% of the Plant inlet included in the Acid Gas stream
Propane (C3)	Included in C2-C3 sales stream	80% to 10% in PCO2RS, remainder in the NGL Rich Stream
Butane and heavier (C4+)	Included in C4+ sales stream	NGL Rich Stream

224. PCO2RS in the table refers to the term purified carbon dioxide recycle used in the Prim'332 Patent.

225. As seen in the table, the Prim process separates the carbon dioxide recycle stream into a sour NGL rich stream and a purified carbon dioxide recycle stream, and subsequently separates the sour NGL rich stream into a sweet NGL rich stream and an acid gas stream. Prim therefore has only 3 outlet streams.

226. Soldati on the other hand produces a nearly pure methane (C1) (sales stream) stream, a sweet light NGL stream (C2-C4), a 99.1% pure CO2 stream (for re-injection), a C4+ stream, and an acid gas stream (a total of 5 streams).

227. As with Aycaguer, the NGL stream described by Soldati is C2-C8, methane (C1) is produced as a separate stream, and 100% of the hydrogen sulfide is removed from the PCO2RS.

228. From Section VIII above it is clear that there is no single definition of cryogenic temperatures that applies to all industries. Since the Board's Institution Decision recognizes that the POSITA's field of experience is related to the upstream oil and gas industry, it would seem reasonable to accept the GPA "Engineering Data Book" definition of -50°F.

229. Accepting the Patent Owner's proposed interpretation of cryogenic conditions presented in Part VIII(A) above as -50°F, Soldati describes a temperature of -57°F in dependent claim 16 of the Soldati patent (EX1006, Page 12 at 14:66-68), in clear violation of the of the Prim '332 Patent Claim 1 exclusion of cryogenic conditions.

230. Soldati also makes reference to the temperature in the third column, which is referred to as the "demethanizer" (EX1006, Page 8 at 5:19), as "preferably of between -57° and 0°C" (-70.6°F to +32°F) (EX1006, Page 6 at 2:61-61), which is within the generally accepted gas processing definition of cryogenic temperature of -50°F.

231. The Soldati patent introduces the use of a "liquid hydrocarbon stream" which is synonymous with the Ryan/Holmes additive stream. Soldati mentions the

Ryan/Holmes process by name and uses the process as a comparative example in the patent.

232. Rockstraw's deposition testimony indicates that he understands the importance of the additive stream and that they are necessary for the Ryan/Holmes process to work. When asked if the Ryan Holmes processes would work without additives, he replied "the answer to that is no." (EX2024 at 66:6.) When asked "why," Rockstraw explained that "because you are changing the nature of the vapor-liquid equilibria" (*id.* at 66:8-9), and further stated that the "process will fail under those conditions" (*id.* at 67:6-7) without additives.

233. 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."

234. The use of additives or liquid hydrocarbons is yet another critical difference between Ryan/Holmes (Soldati) and the Prim '332 Patent process.

3. Claim 2

- a. “The method of claim 1, further comprising:
compressing the carbon dioxide recycle stream prior to
separating the carbon dioxide recycle stream” [2.1]

235. Claim 2 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 render dependent Claim 2 unpatentable as obvious.

236. In addition, neither Aycaguer nor Soldati (EX1006) describe compression of the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream. Soldati does describe compression of the carbon dioxide recycle stream after the first distillation column separation (e.g. EX1006, Page 6 at 1:33-35), but no disclosure of compression prior to this first separation of the carbon dioxide recycle stream.

4. Claim 3

- a. “The method of claim 1, further comprising cooling
the carbon dioxide recycle stream with the purified carbon
dioxide recycle stream.”

237. Claim 3 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 render dependent Claim 3 unpatentable as obvious.

238. In addition, neither Aycaguer nor Soldati describe cooling the carbon dioxide recycle stream with the purified carbon dioxide stream. Rockstraw in his

Declaration points to Soldati Exhibit 1006 at 4:30-31 quoting “is cooled in 7 and fed into column 8” without any explanation of the source of the cooling. At 9:14-20, Soldati shows that the source of that specific cooling for exchanger 7 is “cooled by the refrigeration cycle” and shows a table with exchanger 7 listed as being the “1st stage.”

5. Claim 4

a. “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.” (Emphasis added.)

239. 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.

240. In addition, Claim 4 specifically requires that “the sweet NGL rich stream comprises ... no more than 1 molar percent ethane [C2].”

241. Considering that both Aycaguer and Soldati are Ryan/Holmes processes that focus on the recovery of ethane (C2), it should be no surprise that the sweet NGL rich streams in both Aycaguer and Soldati comprise more than 1 molar percent ethane (C2). 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.

242. Aycaguer does not provide any compositional information, thus cannot be used to claim obviousness over the Prim '332 Patent Claim 4 requirement of no more than 1 molar percent ethane (C2) in the sweet NGL rich stream. We do, however know that the Aycaguer NGL stream contains ethane (C2).

243. As to the composition of the Soldati NGL stream, during deposition, when asked: “would you then refer to that stream 27 as a sour NGL [rich] stream,” Rockstraw replied “I think that’s an accurate description also. It contains hydrogen sulfide, that makes it sour. It contains C2 through C4, so it contains components of an NGL.” (EX2024 at 118:13-20.)

244. To further confirm that column 21 does not constitute a sweetening step, in the deposition Rockstraw is asked: “the stream is separated into a sweet NGL rich stream with the C4+ hydrocarbons and a sour NGL rich stream with the C2 and C3 hydrocarbons: is that correct,” to which he responds “that’s correct,” and then he is asked “then you say the sour NGL stream is then sweetened using amine solvent: is that correct,” to which he responds “that’s correct.” (EX2024 at 119:19 – 120:1.)

245. Table III of Soldati is recreated below. Note that Rockstraw describes stream 27 as the sour NGL rich stream in the paragraph above.

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

246. A POSITA would know that after amine treating, the outlet stream would still contain all of the ethane, resulting in a stream that would have 32.57 / (67.43-.03-3.65) or 51.1% ethane.

247. Therefore, the sweet NGL rich stream in Soldati has over 50% ethane – way more than the 1 molar percent limit required by the challenged Claim 4.

6. Claim 6

248. 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.

7. Claim 7

a. “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.” (Emphasis added.)

249. 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.

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

251. Considering that both Aycaguer and Soldati are Ryan/Holmes processes that focus on the recovery of ethane (C₂), it should be no surprise that the sour NGL rich streams in both Aycaguer and Soldati comprise more than 5 molar percent ethane (C₂). 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.

252. Once again, Aycaguer does not provide any compositional information, thus cannot be used to claim obviousness over the Prim ‘332 Patent Claim 4 requirement that the sour NGL rich stream have no more than 5 molar percent carbon

dioxide, and no more than 5 molar percent ethane (C₂). We do, however know that the Aycaguer NGL stream contains ethane (C₂).

253. As to the composition of the Soldati sour NGL stream, the analysis set forth above in Sections 244-247 for Claim 4 establish that Soldati's sour NGL rich stream has over 50% ethane – way more than the 5 molar percent limit required by the challenged Claim 7.

254. The Soldati sour NGL rich stream as described above in Sections 244-247 for Claim 4 shows a stream containing 5.4% (3.65/67.43) carbon dioxide, 0.0% methane (0/67.43), and 48.3% (32.57/67.43) ethane. Thus, Soldati does not meet the requirement of no more than 5% carbon dioxide, or the requirement of no more than 5% ethane.

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

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

255. In my opinion, Aycaguer in combination with Soldati and Ryan does not render obvious Claim 2 of the '332 Prim Patent. As another threshold issue, as set forth in Section X above, there is no motivation for a POSITA to modify or combine Aycaguer with other teachings (including Soldati and Ryan) in order to make the Prim '332 Patent process. Aycaguer, describing a Ryan/Holmes process, teaches away from the Prim '332 Patent process. (See Section X above.) The

addition of Soldati and Ryan in a combination with Aycaguer does nothing to redirect a POSITA from Aycaguer's teaching away from the Prim '332 Patent process. Soldati, itself also describing a Ryan/Holmes process, with its focus on recovery of methane and ethane, further teaches away from the Prim '332 Patent process. And Ryan, also describing a Ryan/Holmes process, and its focus on recovery of methane and ethane, even further teaches away from the Prim '332 Patent process.

2. Claim 2

256. 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.

257. 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.

258. 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

259. 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.

260. In addition, as described above in Ground 2 Claim 1, the addition of Arand does not support the obviousness claim since Arand described the recovery of a C2-C8 NGL stream which is contrary to the Prim '332 patent.

XII. Weyburn CO2Flex[®] NGL Recovery Plant

261. In 2010, I was the Manager of Facilities Engineering and Construction for the Weyburn, Saskatchewan assets of Cenovus Energy. Part of my role at the

time was to identify and investigate opportunities to add value to the overall CO2 EOR project through facilities upgrades and capital projects.

262. One of the projects that was being investigated by me and my group was the recovery of natural gas liquids (NGLs) from the recycled CO2 stream. Working with a third-party Engineering firm, we asked that they look for available technologies that could be implemented to recover NGL from inlet gas with high concentrations of CO2. The result of their investigation was either a mechanical refrigeration unit (MRU) or the Ryan/Holmes process.

263. A preliminary cost estimate for the Ryan/Holmes process was prepared by the Engineering firm, which indicated that the project would be prohibitively expensive. As a further drawback, there was no pipeline capable of transporting ethane in the area, meaning the ethane would have to be reinjected with the CO2, thus providing no revenue. Rigorous economics were not run on the project since the outcome was obvious.

264. Process simulations were prepared and cost estimations were developed for the MRU, which indicated that the economics were marginally favorable for a facility to process the entire CO2 recycle stream of 200 MMCFD. Although the MRU economics were much better than the Ryan/Holmes option, there was still the challenge of competing for Capital within the corporate budget. As a compromise,

the decision was made to only proceed with the Engineering of an MRU to process the smaller flash gas stream of 12 MMCFD.

265. In December of 2010, I attended the CO₂ conference in Midland, Texas. During the conference, a field trip was offered for the attendees which included the Hess Corporation's San Anders CO₂ flood facilities and the Legado Resource's Goldsmith Landreth CO₂ flood. The Hess facility is an NGL recovery facility utilizing the Ryan/Holmes process. I was shocked to see the size of the facility. To facilitate the tour, attendees stayed on the bus and we drove through the plant while a Hess employee described the process and answered questions. The Legado facility was in the initial construction phase with work being done on the oil battery at the time of the tour.

266. During the Legado tour, the presenter mentioned that an NGL plant was going to be built by a third party as part of the project. I asked him what process they were going to be using and he told me he didn't know, but he gave me the contact information for Eric Prim with Pilot. This NGL facility became the Pilot Goldsmith plant.

267. I reached out to Mr. Prim to discuss the possibility of building a plant at Weyburn. I was intrigued by the process since it purportedly recovered more NGL than the MRU we were working on, without all of the equipment required to build a Ryan/Holmes plant.

268. After speaking with Mr. Prim, Cenovus entered into a Confidentiality Agreement with Pilot. We provided operating conditions for the plant and Pilot prepared simulations for the process. Our third party Engineering firm vetted the simulations and confirmed the results.

269. Although the capital cost estimate for the Pilot facility was higher than the MRU we were working on, the higher NGL recoveries made the economics of the Pilot facility more favorable.

270. Pilot initially proposed a Percent of Proceeds type of business arrangement, with Pilot providing all of the up-front capital for the project. This type of arrangement is not very common in Canada, and Cenovus wanted to retain an equity position in the plant. Eventually, a processing fee arrangement was agreed to with Cenovus retaining a 65% working interest in the plant. Pilot provided 35% of the capital and technical support during detailed Engineering and construction.

271. I left my position with Cenovus in 2013, just a few months before the startup of the Weyburn NGL plant.

XIII. CONCLUSION

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

273. 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.

274. The major differences are:

275. 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.

276. 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.

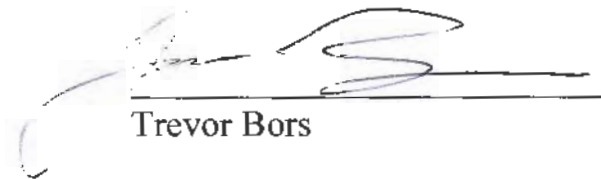
277. Carbon dioxide recovery solvents – each of the described Ryan/Holmes processes require the use of additives. The reference 21 (Holmes et al) of Ex1005 goes so far as to describe the necessity of additives for the otherwise “impossible” distillations. The use of additives also requires a large amount 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.

278. 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: November 22, 2024.

A handwritten signature in blue ink, appearing to read 'Trevor Bors', is written over a horizontal line. The signature is stylized with a large, sweeping 'B' and a trailing flourish.

Trevor Bors