

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.

PETITION FOR INTER PARTES REVIEW
OF U.S. PATENT NO. 8,505,332

Case No. IPR2024-00385

Mail Stop Patent Board
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

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EXHIBIT LIST

Exhibit	Description
1001	U.S. Patent No. 8,505,332 (the “’332 Patent”)
1002	Declaration of Dr. David Rockstraw
1003	Prosecution History of the ’332 Patent
1004	U.S. Pat. No. 4,474,591 (“Arand”)
1005	Reducing Carbon Dioxide Emissions with Enhanced Oil Recovery Projects: A Life Cycle Assessment Approach (“Aycaguer”)
1006	U.S. Pat. No. 4,976,849 (“Soldati”)
1007	Treating Acid & Sour Gas: CO ₂ Recovery by the Ryan/Holmes Process (“Ryan”)
1008	Declaration of Dr. Sylvia Hall-Ellis
1009	Original Complaint, 4:23-cv-02505, DI. 1 (complaint and exhibits) (“Complaint”)
1010	Pilot Tests Prove Ryan/Holmes Cryogenic Acid Gas/Hydrocarbon Separations (“Holmes”)
1011	Plaintiffs’ Response in Opposition to Defendants’ Motion to Dismiss For Failure to State a Claim Under FRCP 12(B)(6) (“Opposition”)
1012	Separation Process Engineering (“Wankat”)
1013	Scheduling Order, 4:23-cv-02505, D.I. 27 (“Scheduling Order”)
1014	Comparison of Districts (“Comparison”)
1015	Curriculum Vitae of Dr. David Rockstraw
1016	U.S. Pat. No. 4,563,202 (“Yao”)

Exhibit	Description
1017	https://trc.nist.gov/cryogenics/aboutCryogenics.html (“About Cryonics”)
1018	Encyclopedia of Chemical Technology, Volume 18 (“Kirk”)
1019	Organic Chemistry, Fourth Edition (“Morrison”)
1020	Perry’s Chemical Engineers’ Handbook, Seventh Edition (“Perry”)
1021	Applied Thermodynamics (“DePriester”)
1022	U.S. Pat. No. 4,070,165 (“Colton”)
1023	Schlumberger Energy Glossary Entry for “Natural Gas Liquids”
1024	Sizing of Throttling Device for Gas/Liquid Two-Phase Flow Part 1: Safety Valves (“Diener”)

LISTING OF CHALLENGED CLAIMS

Claim 1	
[1.P]	A method comprising:
[1.1]	receiving a hydrocarbon feed stream, wherein the hydrocarbon feed stream comprises carbon dioxide, natural gas liquid (NGL), heavy hydrocarbons, and acid gas, wherein the NGL comprises C ₃ -C ₈ hydrocarbons, and wherein the heavy hydrocarbons comprise C ₉₊ hydrocarbons;
[1.2]	separating the hydrocarbon feed stream into a heavy hydrocarbon rich stream and a carbon dioxide recycle stream, wherein the heavy hydrocarbon rich stream comprises the C ₉₊ hydrocarbons, and wherein the carbon dioxide recycle stream comprises the carbon dioxide, the C ₃ -C ₈ hydrocarbons, and the acid gas;
[1.3]	separating the carbon dioxide recycle stream into a sour NGL rich stream and a purified carbon dioxide recycle stream, wherein the sour NGL rich stream comprises the C ₃ -C ₈ hydrocarbons and the acid gas, and wherein the purified carbon dioxide recycle stream comprises the carbon dioxide; and,
[1.4]	separating the sour NGL rich stream into a sweet NGL rich stream and an acid gas stream, wherein the sweet NGL rich stream comprises the C ₃ -C ₈ hydrocarbons, and wherein the acid gas stream comprises the acid gas,
[1.5]	wherein the carbon dioxide is not removed from the hydrocarbon feed stream and is not removed from the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream into the sour NGL rich stream and the purified carbon dioxide recycle stream, and wherein the hydrocarbon feed stream, the carbon dioxide recycle stream, and
[1.6]	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.

Claim 2	
[2.1]	The method of claim 1, further comprising: compressing the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream;
[2.2]	dehydrating at least part of the carbon dioxide recycle stream using a dehydration solvent prior to separating the carbon dioxide recycle stream;
[2.3]	combining a carbon dioxide makeup stream external to the method with the purified carbon dioxide recycle stream; and
[2.4]	injecting the combined carbon dioxide makeup stream and the purified carbon dioxide recycle stream into a subterranean formation.
Claim 3	
[3]	The method of claim 1, further comprising cooling the carbon dioxide recycle stream with the purified carbon dioxide recycle stream.
Claim 4	
[4]	The method of claim 3, wherein the sweet NGL rich stream comprises no more than 1 molar percent methane, no more than 1 molar percent ethane, and no more than 1 molar percent acid gases.
Claim 6	
[6.1]	The method of claim 1, wherein separating the carbon dioxide recycle stream into the sour NGL rich stream and the purified carbon dioxide recycle stream comprises: refluxing part of the purified carbon dioxide recycle stream;
[6.2]	reboiling part of the sour NGL rich stream; and
[6.3]	cooling and throttling the sour NGL rich stream.

Claim 7	
[7]	The method of claim 6, wherein the sour NGL rich stream 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.

I. INTRODUCTION

Scout Energy Management, LLC and Chevron U.S.A. Inc. (“Petitioners”) petition for *Inter Partes* Review (“IPR”) of claims 1-4, 6 & 7 of U.S. Patent 8,505,332 (the “’332 Patent”), assigned to Pilot Intellectual Property, LLC (“Pilot” or “Patent Owner”).

II. MANDATORY NOTICES UNDER 37 C.F.R. §42.8

A. Real Parties-In-Interest Under 37 C.F.R. §42.8(b)(1)

Petitioner Scout Energy Management, LLC, Scout Energy Group V LP, Scout Energy Partners V-A, LP, and Chevron U.S.A. Inc. are the real parties-in-interest. Scout Energy Management is the indirect partial owner of Scout Energy Group V LP and Scout Energy Partners V-A, LP. Scout Energy Group V LP and Scout Energy Partners V-A, LP own the Mabee Plant, an oil and gas facility relevant to *Pilot Energy Solutions, LLC v. Chevron U.S.A. Inc. et al.*, CA 4:23-CV-02505-AHB (discussed below). Scout Energy Management, LLC is the contract operator of the Mabee Plant. Chevron U.S.A. Inc. is a wholly owned indirect subsidiary of Chevron Corporation.

B. Related Matters Under 37 C.F.R. §42.8(b)(2)

Pilot asserted the ’332 Patent against Scout in *Pilot Energy Solutions, LLC v. Chevron U.S.A. Inc. et al.*, CA 4:23-CV-02505-AHB (S.D. Tex.), in a complaint, filed on July 7, 2023 and served on July 10, 2023, that asserts the ’332 Patent.

C. Lead and Back-Up Counsel under 37 C.F.R. §42.8(b)(3)

Petitioners provide the following designation of counsel.

Petitioner Represented	Lead Counsel	Backup Counsel
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Chevron U.S.A. Inc.		Naveen Modi (Reg. No. 46,224) Daniel Zeilberger (Reg. 65,349) Michael A. Wolfe (Reg. No. 71,922) Paul Hastings LLP 2050 M St., N.W., Washington DC, 20036 TEL: 202.551.1700 EMAIL: Pilot-Chevron@paulhastings.com

D. Service Information

Please address all correspondence to the address above. Petitioners consent to electronic service by email at ScoutMWETeam@mwe.com and Pilot-Chevron@paulhastings.com.

III. PAYMENT OF FEES UNDER 37 C.F.R. §42.103

Petitioners authorize the Office to charge Deposit Account No. 50-0417 for the petition fee set in 37 C.F.R. §42.15(a) and for any other required fees.

IV. REQUIREMENTS FOR IPR UNDER 37 C.F.R. §42.104

A. Grounds for Standing Under 37 C.F.R. §42.104(a)

Petitioners certify that the '332 Patent is available for IPR and that
Petitioners are not barred or estopped from requesting IPR.

B. Challenge under 37 C.F.R. §42.104(b) and Relief Requested

Petitioners request IPR of claims 1-4, 6 & 7 of the '332 Patent on the grounds listed below. In support, this petition includes a declaration of Dr. David Rockstraw (EX1002).

Ground	Claim(s)	Basis for Rejection
1	1	35 U.S.C. §103 over Aycaguer
2	1	35 U.S.C. §103 over Aycaguer and Arand
3	1-4, 6 & 7	35 U.S.C. §103 over Aycaguer and Soldati
4	2	35 U.S.C. §103 over Aycaguer, Soldati, and Ryan
5	1-4, 6 & 7	35 U.S.C. §103 over Aycaguer, Soldati, and Arand
6	2	35 U.S.C. §103 over Aycaguer, Soldati, Ryan, and Arand

V. SUMMARY OF THE '332 PATENT

A. Brief Description

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; EX1002. The patent broadly 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:

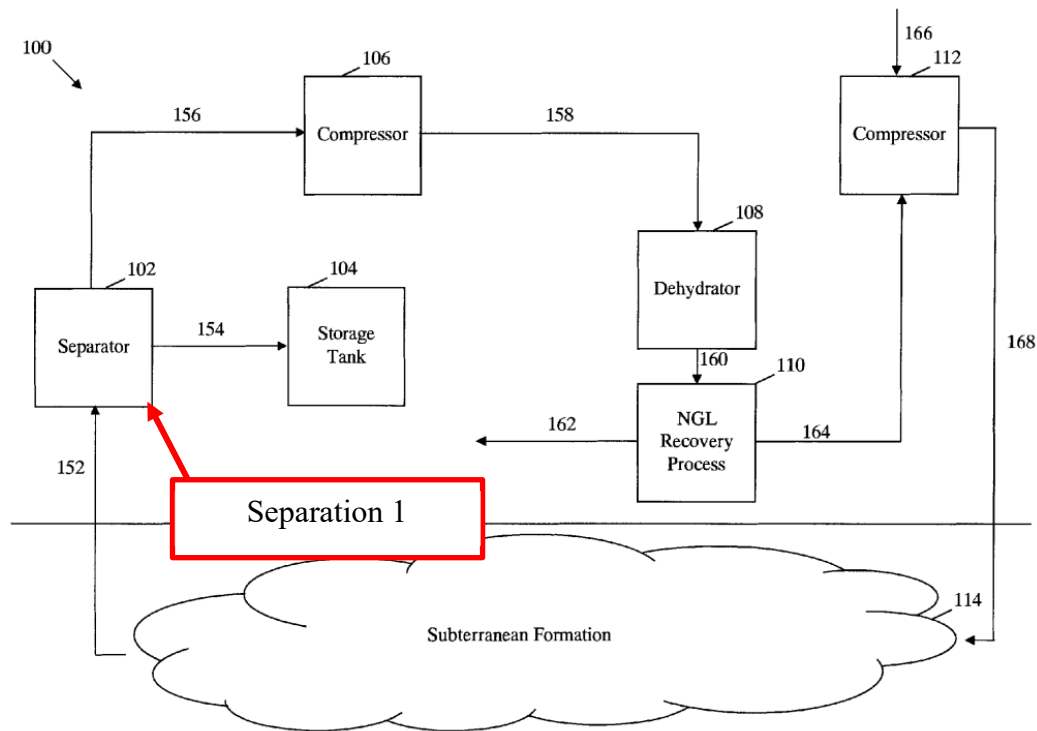


FIG. 1

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.

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

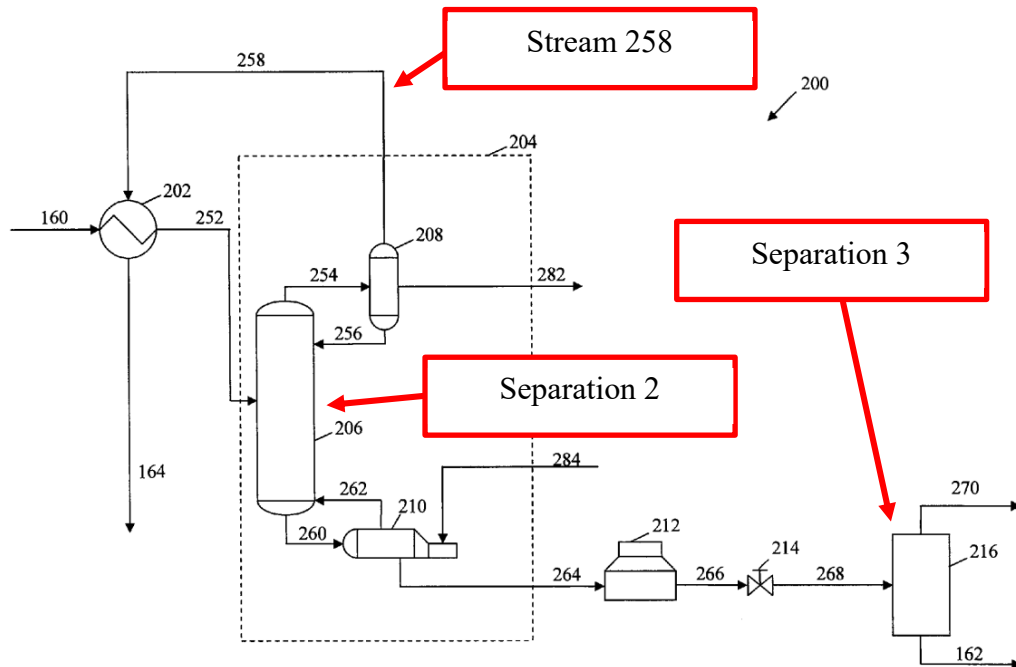


FIG. 2

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

264.¹ *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.

As explained by the '332 Patent, the term “‘natural gas liquids’ or NGLs” was well-understood in the art to include the C₃-C₈ hydrocarbons, and it is used in the '332 Patent as such. EX1001, 3:4-8; EX1002, ¶86. Similarly, the term “heavy hydrocarbons” was also known in the art, and it included “liquid crude oil,” which contains C₉₊ hydrocarbons. EX1001, 8-13; EX1002 at ¶¶45-49; *see also* EX1004, 5:44-45.

B. Summary of the Prosecution

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

¹ Purified carbon dioxide stream 258 and sour NGL rich stream 264 are first passed through a condenser 208 and a reboiler 210, respectively, before the stream continues through the process. EX1001, 7:1–30.

priority to Provisional Application No. 60/938,726, filed May 18, 2007 (“Priority Date”), and listed 20 claims.² EX1003 at 31-35.

During prosecution, the Examiner rejected Claim 1 as anticipated by U.S. Pat. No. 4,529,411 (“Goddin”). EX1003 at 140. In response to this rejection, the applicant amended Claim 1 to recite “wherein carbon dioxide is not removed from the hydrocarbon feed stream and is not removed from the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream into the NGL rich stream and the purified carbon dioxide recycle stream” and argued that Goddin performed such a separation. EX1003 at 171 (amending Claim 1).

The Examiner then rejected Claim 1 as obvious over a combination of Goddin and U.S. Pat. No. 6,128,919 (“Daus”). EX1003 at 195. In response to the new rejection, the applicant amended Claim 1 to recite what each stream comprises, and further amended Claim 1 to recite “wherein the hydrocarbon feed stream and the carbon dioxide recycle stream are not subjected to cryogenic conditions, membranes, and solvents between being received and being separated

² For this IPR only, Petitioners assume that the ’332 Patent can claim the benefit of priority to the U.S. Provisional Application No. 60/938,726 and that the priority date is thus May 18, 2007. All prior art used herein predates that date.

into the NGL rich stream and the purified carbon dioxide recycle stream.” EX1003 at 235. The Applicant argued that (i) Goddin and Daus did not disclose a “sour NGL stream,” and (ii) Goddin and Daus did disclose the use of membranes, cryogenic conditions, and/or carbon dioxide recovery solvents in their separations. EX1003 at 256-58.

VI. LEVEL OF ORDINARY SKILL IN THE ART

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 academic or industry experience in chemical processing systems, oil and gas production and/or refining; or comparable experience. EX1002 at ¶¶26-29. Additional work experience can substitute for educational or research experience, and vice versa.

VII. CLAIM CONSTRUCTION UNDER 37 C.F.R. §42.104(B)(3)

Claim terms are construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Explicit construction of terms is unnecessary because it is not dispositive—the art teaches the claims under any reasonable construction. *Cf. Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

VIII. OVERVIEW OF THE PRIOR ART

Before the '332 Patent, techniques to separate out the components of a natural gas liquid stream resulting from CO₂ injection were well known, as were solutions to purify the stream of the contaminants that result from injection. *See, e.g.*, EX1005 at 303-05, EX1002 ¶¶30-42. Indeed, many elements of the challenged claims are described in the background section of the '332 Patent. *See* EX1001, 1:24-33 (explaining that CO₂ injection into subterranean formations was a known method to recover heavy hydrocarbons and natural gas liquids (NGLs)); EX1002 ¶¶45-49.

A. Applicant-Admitted Prior Art (AAPA)

According to the '332 Patent, the prior art generally understood that CO₂ injection into subterranean formations was a known method to recover heavy hydrocarbons and NGLs. EX1001, 1:24-33. The '332 Patent explains that the term NGLs—both as used in the '332 Patent and in the prior art—means a natural gas composition that includes C₃-C₈. *Id.*, 3:4-8. The '332 Patent further explains that the term heavy hydrocarbons describes a composition that includes “liquid crude oil,” and that liquid crude oil includes the C₉₊ hydrocarbons. *Id.*, 3:8-12.

B. Aycaguer (EX1005)

Reducing Carbon Dioxide Emissions with Enhanced Oil Recovery Projects: A Life Cycle Assessment Approach (“Aycaguer”) is prior art under §§102(a)-(b)

because it is a printed publication that was publicly accessible more than a year before the Priority Date and the U.S. Filing Date. Aycaguer is an article published in a well-known journal—Energy & Fuel—managed by the American Chemical Society. EX1002. Energy & Fuel has been received by the University of California Berkely since January 1987, and it has been catalogued as part of the National Serials Data Program at the Library of Congress. EX1008 at ¶¶52-53. The journal was cataloged and indexed at the Library of Congress, made part of the OCLC bibliographic database, and received at the University of California - Berkeley Libraries on March 1, 2001. *Id.* at ¶¶54-55. Aycaguer was therefore publicly available on or shortly after March 1, 2001. *Id.*

Aycaguer describes a process that includes: (i) taking a stream of oil and natural gas from a reservoir, (ii) removing the crude oil from the stream to create a produced gas stream including natural gas liquids, CO₂, and H₂S (acid gas), (iii) removing the CO₂ from the produced gas stream using a Ryan/Holmes process, leaving the natural gas liquids and H₂S, (iv) removing the H₂S from the natural gas liquids using an amine solution, and (v) converting the captured H₂S to elemental sulfur:

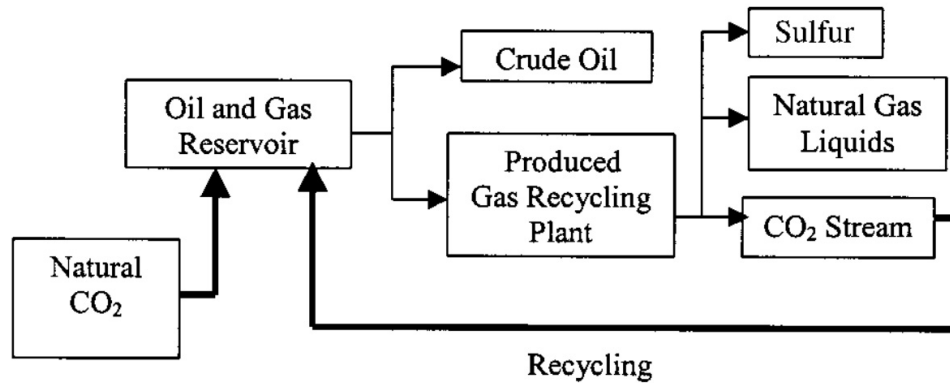


Figure 1. Schematic of processes investigated in the case studies.

Id. at FIG. 1, 305; EX1002.

Aycaguer further explains that the CO₂ derived from its process can be recycled for further injection. *Id.* at 306. This recycled CO₂ is combined with CO₂ derived from natural CO₂ reservoirs before injection back into the reservoir:

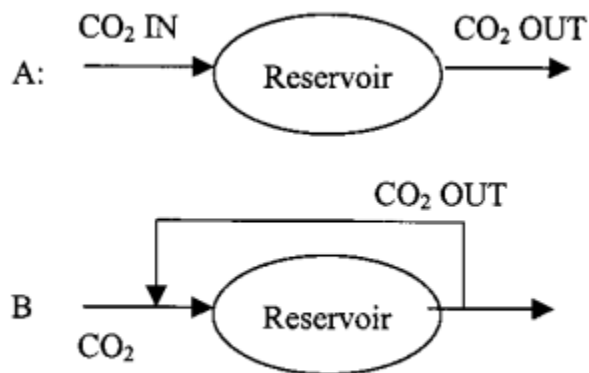


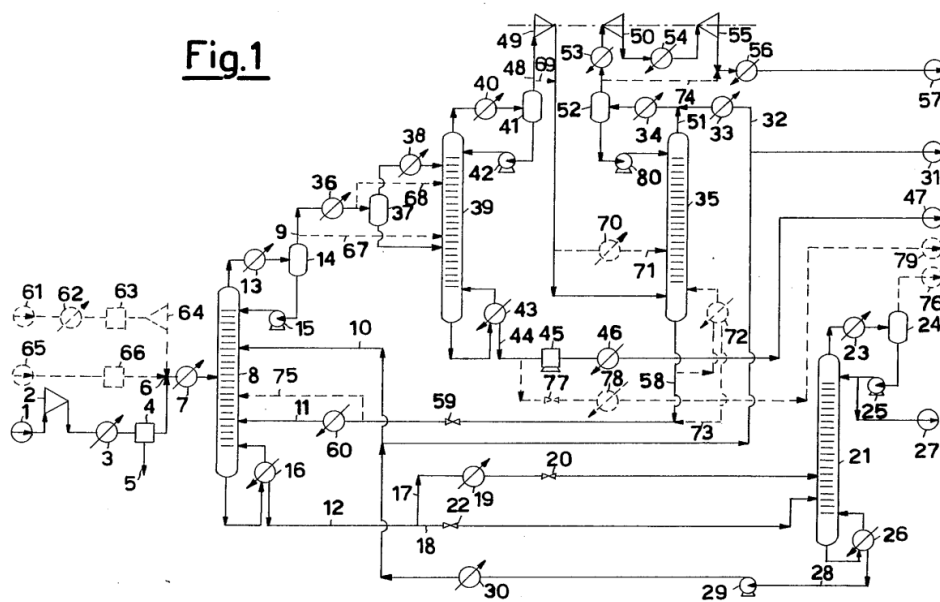
Figure 2. Designs of EOR process operations.

EX1005 at FIG. 2B, 306.

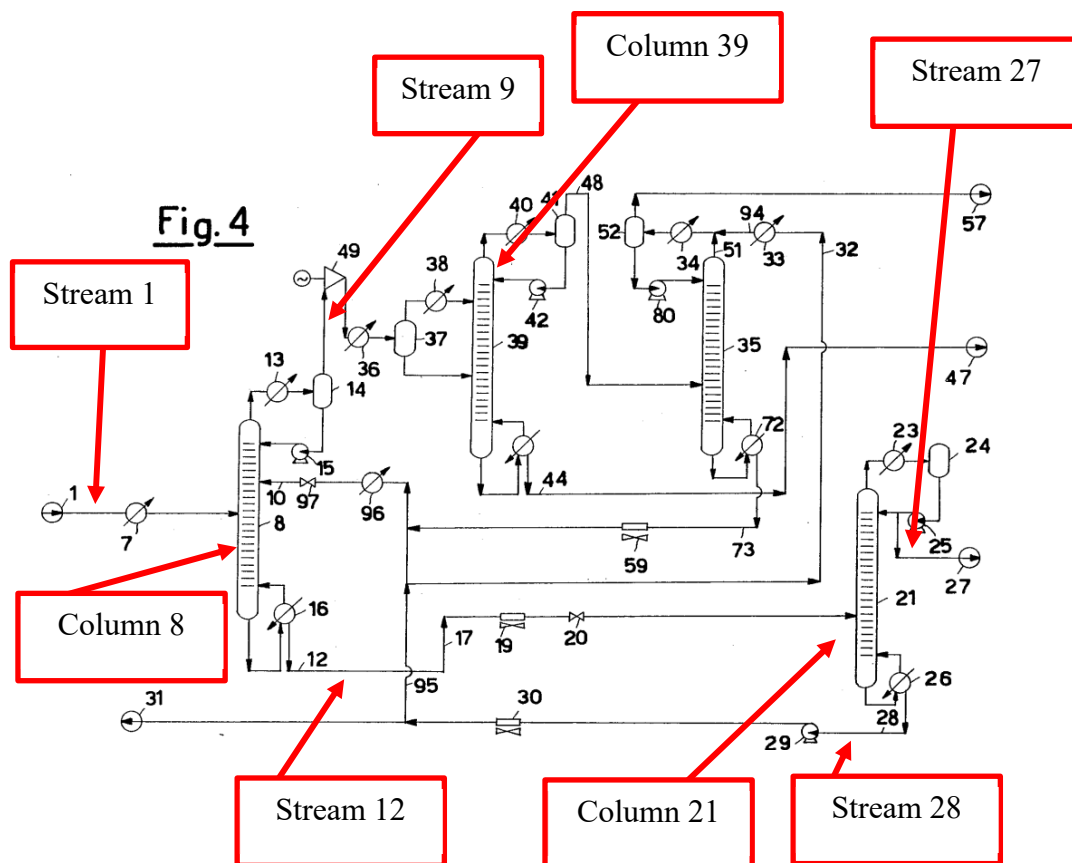
C. Soldati (EX1006)

U.S. Patent No. 4,976,849 (“Soldati”) was filed on September 20, 1988, issued on December 11, 1990, and is thus prior art under §§102(a), 102(b), and 102(e). EX1006 at 1.

Similar to Aycaguer, Soldati discloses methods of processing oil and natural gas streams to remove CO₂ and H₂S. Soldati explains that it offers an improved Ryan/Holmes processing method for removal of CO₂, affording a “considerable reduction in energy consumption.” EX1006, 1:54-58. It outlines its method as including four separations taking place in four distillation columns:



EX1006 at FIG. 1, 1:67-2:26. Soldati further describes a prior-art version of its method, using a more traditional Ryan/Holmes separation of CO₂:



EX1006 at FIG. 4 (annotated), 4:21 (“FIG. 4 is a process diagram of the known prior art.”); EX1002 at ¶69.

According to Soldati, the initial gaseous hydrocarbon stream 1 is introduced into column 8 and separated into two different streams—an upper stream 9 that contains primarily CO₂ and a lower stream 12 that includes “propane and higher hydrocarbons.” *See* EX1006, 4:30-32; Table III. The lower stream 12 is also contaminated with H₂S:

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

EX1006 at Table III.

The lower stream 12 from column 8 is brought to column 21, where the hydrogen sulfide and carbon dioxide are removed in stream 27, leaving behind the C₃₊ hydrocarbons in stream 28:

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	28	10	95
NITROGEN	—	—	—
HYDROGEN SULPHIDE	—	—	—
CARBON DIOXIDE	—	46.64	—
METHANE	—	7.03	—
ETHANE	—	10.54	—
PROPANE	12.11	11.97	12.00
N-BUTANE	1092.03	1081.98	1082.60
N-PENTANE	81.06	80.26	80.25
THROUGHPUT KMOLS/H	1513.37	1563.53	1500.00
PHASE	L	L	L
TEMPERATURE °C.	122.0	16.0	48.0
PRESSURE ATA	19.2	39.6	44.0

See EX1006 at Table III.

The upper stream 9 from column 8 is further purified in column 39, where it is separated into a predominantly CO₂ stream 44 and a predominantly methane stream 48:

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

EX1006 at Table III. Soldati teaches that Stream 44 is then pumped to 47 for reinjection into an oil well. EX1006, 5:8-13.

D. Ryan (EX1007)

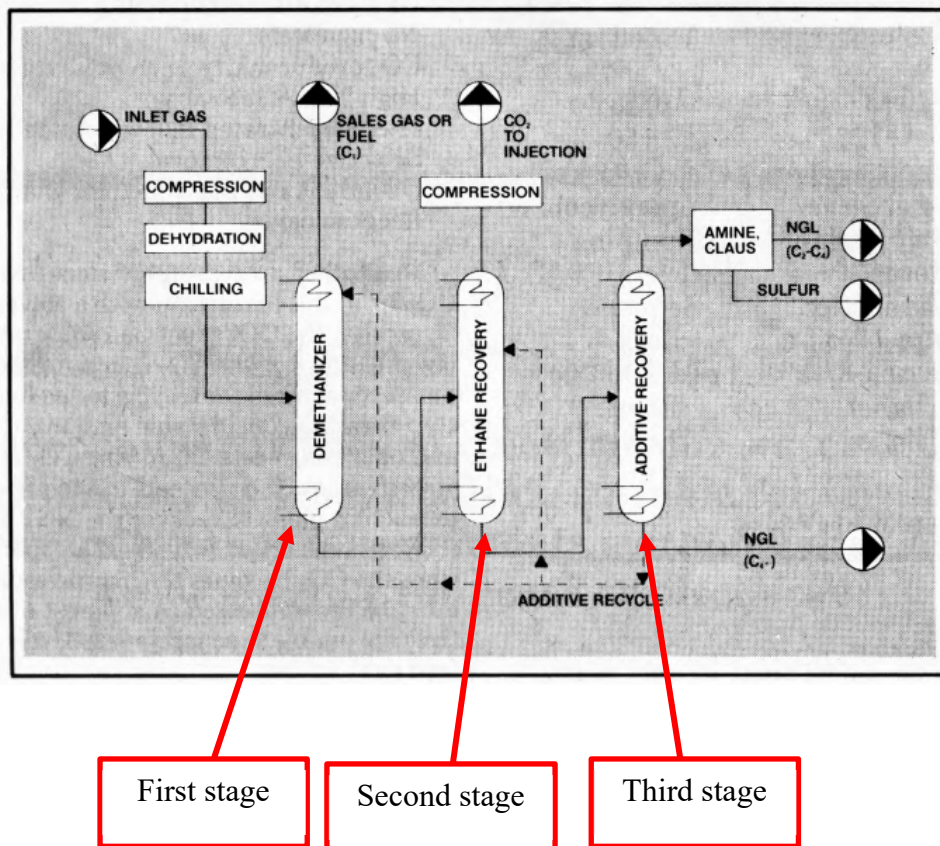
CO₂ Recovery by the Ryan/Holmes Process (“Ryan”) is prior art under §§102(a)-(b) because it is a printed publication that was publicly accessible more than a year before the Priority Date and the U.S. Filing Date. Ryan is an article published in a well-known journal—Chemical Engineering Progress—managed by the American Institute of Chemical Engineers. EX1002 at ¶74.

Chemical Engineering Progress has been received by the Linda Hall Library of Science since January 1947, and it has been catalogued as part of the National

Serials Data Program at the Library of Congress. EX1008 at ¶¶59-60. The journal was cataloged and indexed at the Library of Congress, made part of the OCLC bibliographic database, and received at the Linda Hall Library of Science, Engineering & Technology on October 31, 1984. *Id.* at ¶¶61-62. Ryan was therefore publicly available on or shortly after October 31, 1984. *Id.*

Ryan describes methods of processing CO₂ and hydrocarbon liquids derived from natural gas streams. EX1007 at 53. In particular, it relates to processing natural gas streams derived from enhanced oil recovery projects that use CO₂ injection, the same projects described by Aycaguer. *Compare id. with* EX1005 at 303; EX1006, 5:11-13. One Ryan/Holmes process described in Ryan takes place in three stages:

Figure 2. Three-column Ryan/Holmes process.



EX1007 at FIG. 2 (annotated). In the first stage, the methane is removed from the hydrocarbon stream. *Id.* In the second stage, the CO₂ is removed from the hydrocarbon stream. *Id.* And in the third stage, the stream is separated into a sweet NGL stream with the C₄+ hydrocarbons and a sour NGL stream with C₂-C₃ hydrocarbons. *Id.* The sour NGL stream is then sweetened using amine solvent. *Id.*

E. Arand (EX1004)

U.S. Patent No. 4,474,591 (“Arand”) was filed on July 21, 1983, issued on October 2, 1984, and thus is prior art under §§102(a), 102(b), and 102(e). EX1004 at 1.

Arand describes methods of processing oil and natural gas streams derived from high-pressure underground reservoirs. EX1004, 1:6-10. In particular, it describes a method of separating a hydrocarbon stream from a gas condensate reservoir into three different streams: “a residue gas stream comprising predominantly methane, a natural gas liquids stream, and a stabilized condensate stream.” *Id.*, 4:1-7. As with the AAPA, Arand further explains that natural gas liquids refers to hydrocarbons from C₃-C₈, and heavy condensate refers to hydrocarbons from C₉₊. *Id.*, 5:41-46.

IX. THE BOARD SHOULD CANCEL THE CHALLENGED CLAIMS OF THE '332 PATENT

A. Ground 1: Claim 1 is obvious over Aycaguer

1. Claim 1

a. “A method comprising:” [1.P]

Aycaguer teaches the preamble to the extent it is limiting. Aycaguer discloses a method for gas processing, including “the extraction of the oil and associated gas from the oil reservoir, the processing of the associated gas for

separation of the individual components (water, hydrogen sulfide –H₂S, CO₂, CH₄, natural gas liquids), the compression of the separated CO₂ stream destined for injection, and the transport and injection of the CO₂ in the oil reservoir for the extraction of additional oil and for long-term storage.” EX1005 at 305; EX1002, ¶79.

b. “receiving a hydrocarbon feed stream, wherein the hydrocarbon feed stream comprises carbon dioxide, natural gas liquid (NGL), heavy hydrocarbons, and acid gas, wherein the NGL comprises C₃-C₈ hydrocarbons, and wherein the heavy hydrocarbons comprise C₉₊ hydrocarbons” [1.1]

As shown below, the process described by Aycaguer includes receiving, from an “Oil and Gas Reservoir,” an oil and associated gas stream (i.e., “a hydrocarbon feed stream”) that has as its components separated into different outputs, “Crude Oil” (i.e., heavy hydrocarbons), “Natural Gas Liquids” (i.e., C₃-C₈), and “CO₂ Stream” (i.e., carbon dioxide):

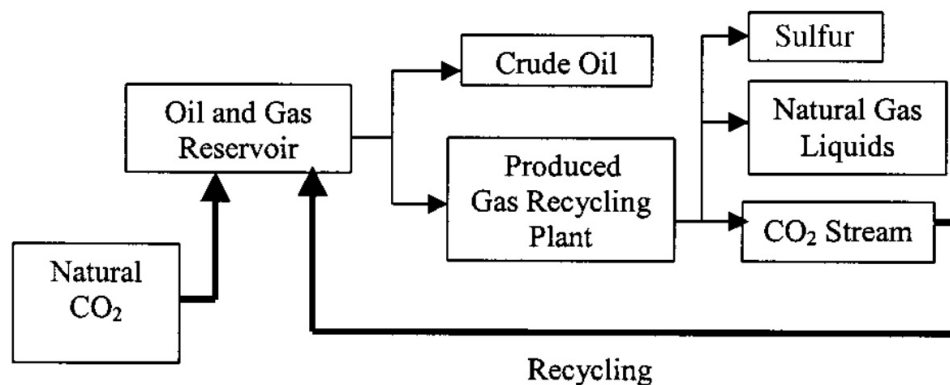


Figure 1. Schematic of processes investigated in the case studies.

EX1005 at FIG. 1; EX1002, ¶80. The stream from the oil and gas reservoir is generated from a CO₂ injection process. EX1005 at 305. This stream from the oil and gas reservoir in Aycaguer thus teaches the “hydrocarbon feed stream.” EX1002, ¶81.

A POSITA, relying on their background knowledge in the art, would have understood that a hydrocarbon feed stream derived from an oil and gas reservoir undergoing enhanced oil recovery with CO₂ injection would include at least C₃-C₉₊ hydrocarbons, carbon dioxide, and hydrogen sulfide. EX1002, ¶82. Based on this understanding, a POSITA reading Aycaguer would have understood that the stream processed by Aycaguer would contain each of those components. *Id.*

Aycaguer confirms that its hydrocarbon feed stream includes at least C₃ through C₉₊ hydrocarbons, carbon dioxide, and hydrogen sulfide. The first separation described by Aycaguer results in two streams: one that contains “crude oil” and one that is sent to a produced gas recycling plant. *See* EX1005 at FIG. 1. A POSITA would have understood, and at the very least found it obvious, that crude oil contains C₉₊ (as well as some residual lighter hydrocarbons), and thus the hydrocarbon feed stream described in Aycaguer would have contained at least C₉₊ (which are heavy hydrocarbons) in order for crude oil to be separated from it.

EX1002, ¶83; EX1004, 5:41-46 (explaining that C₉₊ are the heavy condensate); EX1001, 3:11-12 (explaining that liquid crude oil contains C₉₊ hydrocarbons).

Similarly, Aycaguer explains that its produced gas recycling plant separates an incoming hydrocarbon stream into natural gas liquids (NGLs) and a CO₂ stream. EX1005 at FIG. 1, 305 (explaining that the stream contains “water, hydrogen sulfide –H₂S, CO₂, CH₄ [i.e., methane], natural gas liquids”). A POSITA reading Aycaguer would have thus understood that: (i) the natural gas liquids and the CO₂ were a part of the stream entering the recycling plant; and (ii) those components were ultimately derived from the hydrocarbon feed stream that came from the oil and gas reservoir. EX1002, ¶84.

Based on their background understanding of the technology, a POSITA would understand that “natural gas liquids” is a term that includes C₃-C₈ hydrocarbons. *See, e.g.*, EX1002, ¶¶34-36; EX1004, 5:44–45. A POSITA reading Aycaguer would have thus understood, and at the very least found it obvious, that the “natural gas liquids” disclosed by Aycaguer include the entire range of C₃-C₈—and not just a subset of C₃-C₈—because Aycaguer discloses a hydrocarbon feed stream from an oil and natural gas reservoir that contains methane (C₁), natural gas liquids, and crude oil (C₉₊). Hydrocarbon feed streams from an oil and natural gas reservoirs naturally contain all the hydrocarbons within the full range between the

lightest produced hydrocarbon and the heaviest produced hydrocarbon; underground oil reservoirs do not “skip” certain sizes of hydrocarbon.³ EX1002, ¶85. Thus, a POSITA would have understood a reference describing an oil and natural gas reservoir feed stream that contains methane (C₁), natural gas liquids, and crude oil (C₉₊) to disclose a reservoir that contains some amount of every hydrocarbon between C₁ and C₉₊. EX1002, ¶85. A POSITA reading Aycaguer would have thus understood, and at the very least found it obvious, that the hydrocarbon feed stream of Aycaguer includes C₃-C₈. *Id.* Moreover, this understanding of a POSITA that “natural gas liquids” include C₃-C₈ is confirmed by other prior art. EX1004, 4:41–46.

Furthermore, to the extent that the Patent Owner incorrectly disputes any of the above, the ’332 Patent includes AAPA confirming that a POSITA would have understood the hydrocarbon feed stream of Aycaguer to include C₃-C₉₊. As

³ This is due to how hydrocarbons are formed underground. Hydrocarbons start as large molecules (C₉₊), and slowly break down over time to form smaller and smaller molecules. EX1002, ¶85. Thus, the presence of both C₁ and C₉₊ would indicate to a POSITA that the heavy hydrocarbon breakdown had not finished, and all the intermediate breakdown products (C₂-C₈) are also present. *Id.*

explained by the AAPA, the term “Natural Gas Liquids” was a term known in the art to “include C₃-C₈ hydrocarbons.” EX1001, 3:4-8. As further explained by the AAPA, a POSITA would have understood that “liquid crude oil” comprises “C₉₊ hydrocarbons.” EX1001, 3:11-13. Thus, a POSITA would have understood, and at the least found it obvious, that the stream produced from the oil and gas reservoir in Aycaguer, which is subsequently split into crude oil (C₉₊) and a gas stream containing NGLs (C₃-C₈), CO₂, and H₂S, included C₃-C₉₊ hydrocarbons. EX1002, ¶86.

At the very least, a POSITA would have found it obvious to apply the oil and gas processing methods taught in Aycaguer on a feed stream from a reservoir containing each of C₃-C₈. A POSITA would have been motivated to apply the Aycaguer method to a stream containing all components C₃-C₈ because that would allow the system to work as intended to remove the crude oil (C₉₊), and maximize NGLs (C₃-C₈) for recovery. EX1002, ¶87. Such a POSITA would have expected the separation steps taught in Aycaguer to successfully result in a separation of such a feed stream due to the well-known and predictable nature of the distillation and processing steps employed. *Id.*

Finally, Aycaguer also teaches that its separation process includes the removal of H₂S from the natural gas liquids to pass safety requirements. EX1005 at

305. Because those natural gas liquids were derived from the hydrocarbon feed stream, a POSITA would have understood that Aycaguer teaches a hydrocarbon feed stream containing H₂S, which is an acid gas. EX1005 at 305; EX1001, 5:18-19; EX1002, ¶88.

Aycaguer thus teaches claim element [1.1]. EX1002, ¶¶80-89.

c. “separating the hydrocarbon feed stream into a heavy hydrocarbon rich stream and a carbon dioxide recycle stream, wherein the heavy hydrocarbon rich stream comprises the C₉₊ hydrocarbons, and wherein the carbon dioxide recycle stream comprises the carbon dioxide, the C₃-C₈ hydrocarbons, and the acid gas” [1.2]

As discussed for claim element [1.1], the hydrocarbon stream released by the oil and gas reservoir described in Aycaguer teaches the claimed “hydrocarbon feed stream.” *Supra* §IX.A.1.b. As shown below, the process described by Aycaguer discloses separating the hydrocarbon stream released by the oil and gas reservoir (“hydrocarbon feed stream”) into a “Crude Oil” stream (“heavy hydrocarbon rich

stream”) and a stream sent to a Produced Gas Recycling Plant (“carbon dioxide recycle stream”):

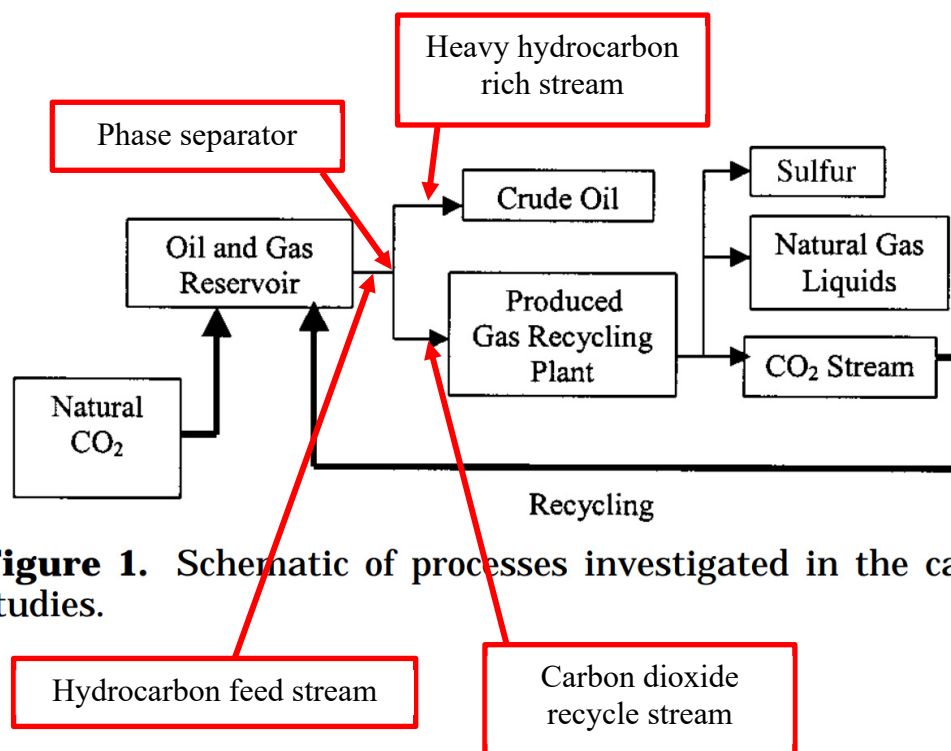


Figure 1. Schematic of processes investigated in the case studies.

EX1005 at 305, FIG. 1 (annotations in red); EX1002, ¶90. As explained in Aycaguer, this separation is “a simple process assisted by heat, chemicals, and retention time in the vessels and relies on phase separation.” EX1005 at 305.

The liquid phase resulting from Aycaguer’s phase separation includes the “crude oil for sale.” EX1005 at 305. As discussed above for claim element [1.1], a POSITA reading Aycaguer as of the Priority Date would have understood the term “crude oil” to mean a composition with C₉₊ hydrocarbons. *See supra* at Section IX.A.1.b; EX1002, ¶90; EX1004, 5:44-45. Thus, crude oil resulting from the liquid

phase of the phase separator teaches the claimed “heavy hydrocarbon rich stream compris[ing] the C₉₊ hydrocarbons.”

Additionally, the AAPA confirms that Aycaguer teaches the claimed heavy hydrocarbon rich stream. As admitted in the '332 Patent, a POSITA would have understood—prior to the filing of the '332 Patent—that liquid crude oil contains C₉₊. EX1001, 3:9-10; EX1002, ¶93. Because, based on the AAPA, a POSITA would have understood that the crude oil removed in the liquid phase of Aycaguer is made of C₉₊ hydrocarbons a POSITA would have understood that Aycaguer teaches separating the claimed “heavy hydrocarbon rich stream compris[ing] the C₉₊ hydrocarbons” from a hydrocarbon feed stream. EX1005 at 305, FIG. 1; EX1002, ¶93.

The gas phase resulting from the phase separation in Aycaguer is sent to the produced gas recycling plant. EX1005 at 305, FIG. 1. Aycaguer explains that this gas phase must be processed to separate the natural gas liquids in the stream from the hydrogen sulfide and carbon dioxide. EX1005 at 305, FIG. 1. Aycaguer thus

teaches that the gas phase entering the recycling plant includes natural gas liquids,⁴ carbon dioxide, and hydrogen sulfide. EX1005 at 305, FIG. 1.

As discussed above in §IX.A.1.b, a POSITA reading Aycaguer as of the priority date would have understood that the term “natural gas liquids”—as used in Aycaguer—refers to a composition with at least C₃-C₈ hydrocarbons. *See* EX1002, ¶95; EX1004, 5:44-45. Because the term “natural gas liquids” as used in Aycaguer refers to C₃-C₈ hydrocarbons, and because hydrogen sulfide is an acid gas, the stream entering into the produced gas recycling plant that contains natural gas liquids, carbon dioxide, and hydrogen sulfide teaches the claimed “carbon dioxide recycle stream compris[ing] carbon dioxide, the C₃-C₈ hydrocarbons, and the acid gas.” EX1002, ¶95.

⁴ Natural gas liquids are those hydrocarbons capable of being liquified at room temperatures, and are referred to as “natural gas *liquids*” even when they exist in the vapor phase. EX1002, ¶94; *see also, e.g.*, EX1005 at 305 (disclosing that the NGLs are removed in the gas phase); EX1001 at 3:5-6 (explaining that a POSITA have understood NGLs are “natural gases that may be liquefied without refrigeration”); EX1004 at 5:44-45 (explaining “natural gas liquids (C₃-C₈)”).

A POSITA reading Aycaguer would have additionally understood that the natural gas liquids found in the gas phase entering the gas processing plant would include at least C₃-C₈ based on their understanding of how Aycaguer's phase separation works. EX1005 at 305; EX1002 ¶96. Aycaguer's phase separation—which primarily uses time and temperature to separate out the heavy hydrocarbons—is imperfect; a phase separation designed to separate, for example, C₅- into the gas phase and C₆₊ into the liquid phase would include some C₆₊ in the gas phase and some C₅- in the liquid phase. EX1002, ¶¶ 37-38; EX1005 at 305. Thus, a POSITA would have understood that performing Aycaguer's phase separation on a hydrocarbon feed stream to remove some NGLs in the liquid phase along with the crude oil—e.g., the NGLs used to make gasoline like C₆, C₇, and C₈—would still result in a gas phase that contains at least some C₆, C₇ and C₈. EX1002, ¶96. A POSITA would have thus understood—and certainly have found obvious—that the gas phase disclosed by Aycaguer (i.e., the carbon dioxide recycle stream) contains C₃-C₈. EX1002, ¶96.

Aycaguer's disclosure additionally teaches that the stream entering into the produced gas recycling plant teaches the claimed “carbon dioxide recycle stream compris[ing] carbon dioxide, the C₃-C₈ hydrocarbons, and the acid gas” based on AAPA. EX1002, ¶97. As discussed above for claim element [1.1], the '332 Patent states that the term “NGL” was well known in the art and is used in the '332 Patent

as such. *Supra* §IX.A.1.b; EX1001, 3:7-8. The '332 Patent further explains that NGL “may refer to natural gases that may be liquified without refrigeration, and may include the C₃-C₈ hydrocarbons.”⁵ *Id.*, 3:4-7. Based on the AAPA, a POSITA reading Aycaguer would therefore have understood, and would have at least found it obvious, that when Aycaguer teaches that the stream entering into the produced recycling plant contains NGL, that stream includes at least the C₃-C₈ hydrocarbons. EX1002, ¶¶97. At the very least, for the reasons described for claim element [1.1], a POSITA would have found it obvious to apply Aycaguer’s separation methods to a stream containing each of C₃-C₈. *See supra* §IX.A.1.b; EX1002, ¶¶97.

Thus, Aycaguer teaches claim element [1.2]. *See* EX1002, ¶¶90-98

d. “separating the carbon dioxide recycle stream into a sour NGL rich stream and a purified carbon dioxide recycle stream, wherein the sour NGL rich stream comprises the C₃-C₈ hydrocarbons and the acid gas, and wherein the purified carbon dioxide recycle stream comprises the carbon dioxide; and,” [1.3]

As discussed for claim element [1.2], the gas phase resulting from the phase separation of Aycaguer teaches the claimed “carbon dioxide recycle stream.”

Supra §IX.A.1.c. Aycaguer explains this stream is “directed to the gas processing

⁵ This AAPA understanding is consistent with Dr. Rockstraw’s understanding of the art as of the Priority Date. *Supra* §IX.A.1.b.

plant.” EX1005 at 305, FIG. 1. Aycaguer then discloses that the gas processing plant may use the “Ryan/Holmes process.” EX1005 at 305, FIG. 1.

Aycaguer teaches that the Ryan/Holmes process performed by the gas processing plant is “highly compound-specific and will only separate CO₂ from the remaining gas stream.” EX1005 at 305, FIG. 1. Because—as discussed for claim element [1.2]—a carbon dioxide recycling stream with C₃-C₈ hydrocarbons, CO₂, and H₂S, is directed into the gas processing plant, Aycaguer thus teaches separating the CO₂ from a carbon dioxide recycle stream, resulting in one stream containing CO₂ and a second stream containing C₃-C₈ hydrocarbons and H₂S. EX1005 at 305, FIG. 1; EX1002, ¶100. Aycaguer further explains that the H₂S must be removed from the natural gas liquids after the CO₂ is removed, confirming that the second stream contains both the C₃-C₈ hydrocarbons and H₂S. EX1005 at 305 (“To separate H₂S from the natural gas liquids . . .”).

The first stream with CO₂ thus teaches the claimed “purified carbon dioxide recycle stream . . . compris[ing] the carbon dioxide.” The second stream with C₃-C₈ hydrocarbons and H₂S thus teaches the claimed “sour NGL rich stream compris[ing] . . . the C₃-C₈ hydrocarbons and the acid gas.”:

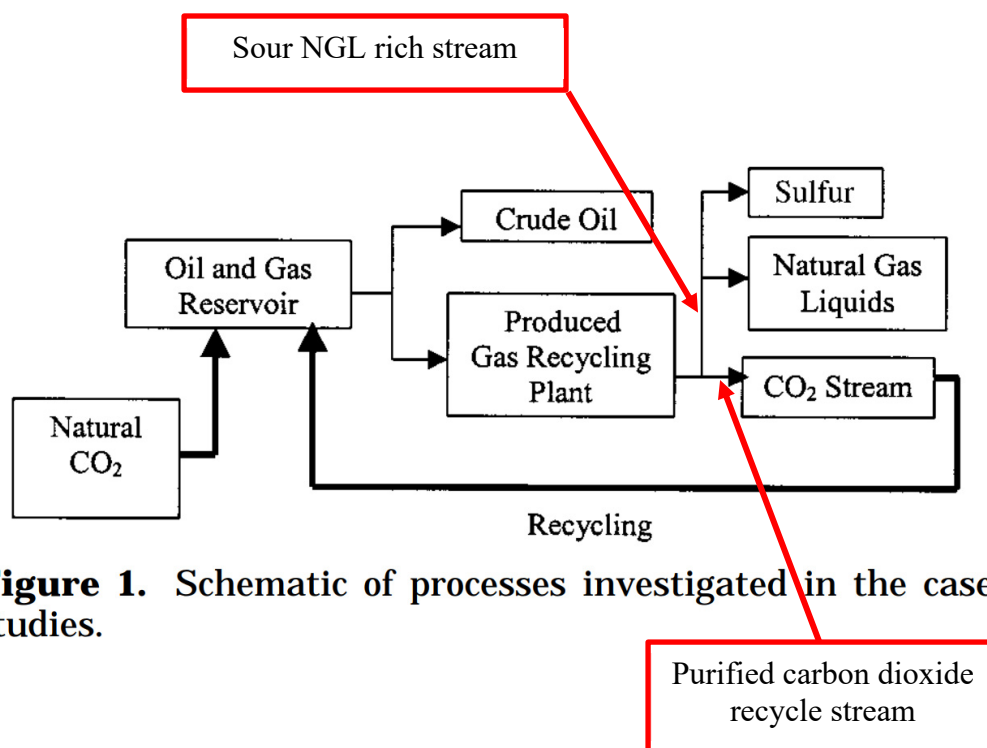


Figure 1. Schematic of processes investigated in the case studies.

EX1005 at FIG. 1 (annotated).

Aycaguer therefore teaches claim element [1.3]. EX1002, ¶¶99-102.

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

As discussed for claim element [1.3], Aycaguer teaches that applying the Ryan/Holmes process to a carbon dioxide recycle stream results in a sour NGL rich stream that includes C₃-C₈ hydrocarbons and H₂S. *Supra* §§IX.A.1.d.

Aycaguer further teaches that the gas processing plant uses a “nonselective chemical absorption amine process” to “separate H₂S from the natural gas liquids.” EX1005 at 305, FIG. 1. H₂S is an acid gas, as acknowledged in the ’332 Patent (see, e.g., EX1001, 5:15-19). EX1002, ¶104. This separation of H₂S results in a sweet natural gas liquids stream described in Figure 1:

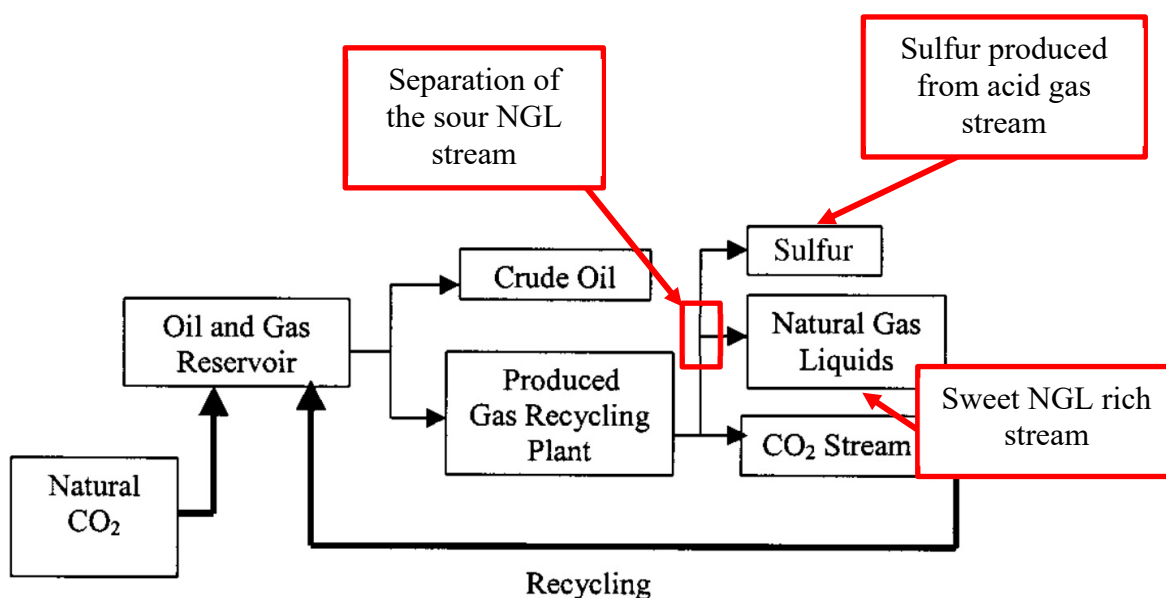


Figure 1. Schematic of processes investigated in the case studies.

EX1005 at 305, FIG. 1 (annotated); EX1002, ¶104. The natural gas liquids stream includes the C₃-C₈ originally found in the sour NGL stream. EX1005 at FIG. 1; EX1002, EX1002, ¶105. The H₂S is removed to “pass safety requirements.” EX1005 at 305. An NGL stream with H₂S removed from it was known in the art as a sweet NGL stream. EX1002, ¶105; *see also* EX1001, 7:51-65 (describing sweetening processes). The sweet NGL stream produced after the H₂S is removed thus teaches the claimed “sweet NGL rich stream.”

According to Aycaguer, the H₂S is absorbed into an amine solution before being “transformed into elemental sulfur or incinerated.” EX1005 at 305. This stream of amine/H₂S solution thus teaches the claimed “acid gas stream.”

Aycaguer therefore teaches claim element [1.4]. EX1002, ¶¶103-107.

f. “wherein the carbon dioxide is not removed from the hydrocarbon feed stream and is not removed from the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream into the sour NGL rich stream and the purified carbon dioxide recycle stream, and” [1.5]

Aycaguer discloses no steps that remove CO₂ before the carbon dioxide recycle stream is processed using the Ryan/Holmes process:

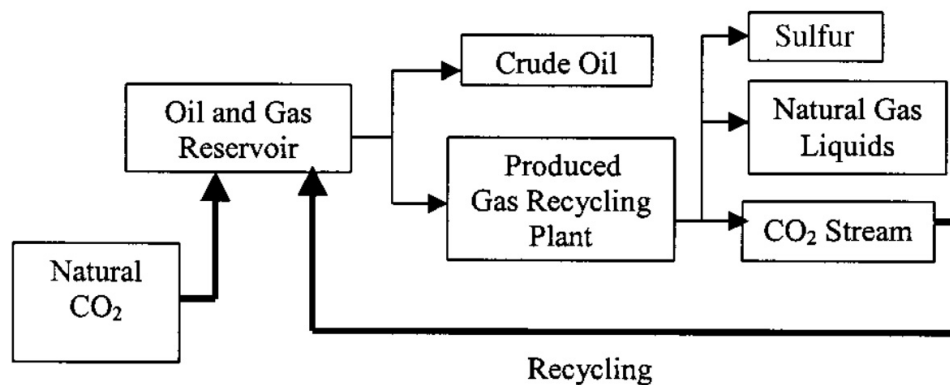


Figure 1. Schematic of processes investigated in the case studies.

See EX1005 at 305, FIG. 1; EX1002, ¶108. Aycaguer thus teaches claim element [1.5]. EX1002, ¶¶108-109.

g. “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]

Aycaguer does not disclose cryogenic conditions, membranes, or carbon dioxide recovery solvents being used at any step. While Aycaguer discloses the use of amine solution to recover the hydrogen sulfide, the amine solution is used only after the CO₂ is removed using the Ryan/Holmes process, and thus is not used to remove CO₂. See EX1005 at 305; EX1002, ¶110; EX1009 at 80 (explaining that under the Patent Owner’s understanding of the term “carbon dioxide recovery

solvent,”⁶ the solvent must be “for carbon dioxide recovery”—and not for another purpose (for example, “dehydrating the stream”)—to qualify as a carbon dioxide recovery solvent).

The Ryan/Holmes process also does not use cryogenic conditions, membranes, or carbon dioxide recovery solvents. In fact, Ryan—which is one of two references cited by Aycaguer describe the Ryan/Holmes process and evidences a POSITA’s knowledge at the relevant time—expressly distinguishes its process from those using “solvent[s] having CO₂ affinity” or “[m]embrane schemes.” EX1007 at 55. As to cryogenic conditions, Ryan explains that even the coldest temperature for its distillation columns is “–40 to –120°F,” which does not meet Patent Owner’s understanding of the term “cryogenic.” *Compare* EX1011 at 8-9 & n.2 (proposing a “well-accepted meaning of ‘cryogenic conditions’” as –130° F) *with* EX1007 at 55. Similarly, the other Ryan/Holmes publication cited to by Aycaguer—Holmes—explains that satisfactory results were “obtained using ethylene refrigeration in the overhead condenser (temperatures –110 to –130°F) and also using only propane refrigeration (–30 to –40°F).” EX1010 (emphasis added). The two pilot systems described in Holmes were operated at –120 °F and –

⁶ Petitioner does not endorse Patent Owner’s understanding, but applies Patent Owner’s interpretation for the purposes of this petition.

35 °F. *Id.*, 82-83. As such, a POSITA would not have understood either Ryan or Holmes as subjecting its streams to “cryogenic” conditions, as understood by the Patent Owner or NIST definition.⁷ EX1002, ¶111.

Aycaguer thus teaches claim element [1.6]. EX1002, ¶¶110-112.

B. Ground 2: Claim 1 is obvious over Aycaguer and Arand

1. Motivation to Combine the References

Ground 2 combines Aycaguer and Arand. As explained below, Arand teaches a method of processing fluids produced from oil and gas reservoirs to yield a natural gas liquid stream, a residue gas stream, and a stabilized condensate stream. EX1004, 1:6-13. A POSITA would have been motivated to combine Aycaguer and Arand, and would have had a reasonable expectation of success in doing so, because both references relate to methods of natural gas liquid separation, and for the additional reasons below. EX1005 at 305; EX1004, 1:6-13, EX1002, ¶114.

Aycaguer teaches that heavy hydrocarbons, such as the crude oil, should be separated from a hydrocarbon feed stream derived from the oil well before further

⁷ Petitioner does not endorse Patent Owner’s understanding, but applies Patent Owner’s interpretation for purposes of this Petition.

processing. EX1005 at 305. Aycaguer also teaches that natural gas liquids are a valuable product of oil and gas wells. *Id.* However, Aycaguer does not explicitly disclose the particular hydrocarbons that would be found in the components of natural gas liquids or heavy hydrocarbons.

Arand provides such teachings. Arand teaches that natural gas liquids are hydrocarbons that have between three and eight carbon atoms (C_{3-8}). EX1004, 5:44-45. Arand also teaches that heavy hydrocarbons contain nine or more carbon atoms (C_{9+}). EX1004, 5:44-45.

Thus, a POSITA would have been motivated to implement Aycaguer's Produced Gas Recycling Plant using the understanding of natural gas liquids and heavy hydrocarbons found in Arand to identify the constituent hydrocarbons in the mixtures that would result from the separations performed by Aycaguer. EX1002, ¶¶114-117.

2. Claim 1

a. Claim elements [1.P], [1.3], [1.4], [1.5], and [1.6].

As explained above for Ground 1, Aycaguer teaches limitations [1.P], [1.3], [1.4], [1.5], and [1.6]. *Supra* §§IX.A.1.a, IX.A.1.d-IX.A.1.g.

b. “receiving a hydrocarbon feed stream, wherein the hydrocarbon feed stream comprises carbon dioxide, natural gas liquid (NGL), heavy hydrocarbons, and acid gas, wherein the NGL comprises C₃-C₈ hydrocarbons, and wherein the heavy hydrocarbons comprise C₉₊ hydrocarbons” [1.1]

As explained above for claim element [1.1], Aycaguer teaches this limitation. *Supra* §IX.A.1.b. But, to the extent that the Patent Owner incorrectly disputes that either (i) a POSITA as of the Priority Date would not have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊ or (ii) a POSITA as of the Priority Date would not have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊, Arand provides such understanding.

As explained above for claim element [1.1], Aycaguer teaches that the hydrocarbon feed stream includes liquid crude oil, which is separated from the NGLs, CO₂, and H₂S (which are gases that are then processed in the gas plant). *Supra* §IX.A.1.b. A POSITA would have understood that the crude oil is the heavy condensate of this separation because the NGLs, CO₂, and H₂S are gases that are lighter than the heavier crude oil. EX1002, ¶120. Arand discloses that such heavy condensate includes C₉₊. EX1004, 5:45. The combination of Aycaguer and Arand thus teaches that Aycaguer’s hydrocarbon feed stream includes C₉₊. EX1002, ¶120.

As explained above for claim element [1.1], Aycaguer also teaches that its hydrocarbon feed stream includes natural gas liquids. *Supra* at §IX.A.1.b. Arand discloses that natural gas liquids include C₃-C₈. EX1004, 5:44-45. The combination of Aycaguer and Arand thus teaches that Aycaguer's hydrocarbon feed stream includes C₃-C₈. EX1002, ¶121. At the very least, a POSITA would have found it obvious to apply the oil and gas processing methods taught in Aycaguer on a feed stream from a reservoir containing C₃-C₈ as expressly taught in Arand. *Id.* A POSITA would have been motivated to apply the Aycaguer method to a feed stream containing each of C₃-C₈, as taught in Arand, because that would allow the Aycaguer system to work as intended to remove the crude oil (C₉₊), and maximize NGLs (C₃-C₈) for recovery. *Id.* Such a POSITA would have expected the separation steps taught in Aycaguer to successfully result in a separation of such a feed stream due to the well-known and predictable nature of the distillation and processing steps employed, and thus the combination of Aycaguer and Arand renders obvious receiving such a stream. *Id.*

The combination of Aycaguer and Arand therefore teaches claim element [1.1]. EX1002, ¶¶119-122.

c. “separating the hydrocarbon feed stream into a heavy hydrocarbon rich stream and a carbon dioxide recycle stream, wherein the heavy hydrocarbon rich stream comprises the C₉₊ hydrocarbons, and wherein the carbon dioxide recycle stream comprises the carbon dioxide, the C₃-C₈ hydrocarbons, and the acid gas” [1.2]

The combination of Aycaguer and Arand teaches this limitation. As discussed above for claim element [1.2], Aycaguer teaches a feed stream from an oil and gas reservoir (“hydrocarbon feed stream”) that is received for processing, and that the feed stream is separated using a phase separator into a stream sent to a Produced Gas Recycling Plant (“carbon dioxide recycle stream”) and a “Crude Oil” stream (“heavy hydrocarbon rich stream”). *Supra* §IX.A.1.c.

But, to the extent that the Patent Owner incorrectly disputes that (i) a POSITA as of the Priority Date would have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊, (ii) a POSITA as of the Priority Date would have understood that Aycaguer discloses a carbon dioxide recycle stream that includes C₃-C₈, or (iii) a POSITA as of the Priority Date would have understood that Aycaguer discloses a heavy hydrocarbon rich stream that includes C₉₊, Arand provides such understanding.

As explained above for claim element [1.1], Aycaguer teaches that the hydrocarbon feed stream includes liquid crude oil, which is separated from the NGLs, CO₂, and H₂S. *Supra* §IX.A.1.c. As understood by a POSITA, crude oil is

the heavy condensate of this separation, as the NGLs, CO₂, and H₂S are gases that are lighter than the heavier crude oil. EX1002, ¶125. Arand discloses that such heavy condensate includes C₉₊. EX1004, 5:45. The combination of Aycaguer and Arand thus teaches that Aycaguer's crude oil stream includes the C₉₊, and thus teaches the claimed heavy hydrocarbon rich stream separated from the hydrocarbon feed stream. EX1002, ¶125.

As explained above for claim element [1.2], Aycaguer also teaches separating the hydrocarbon feed stream into a carbon dioxide recycle stream that contains natural gas liquids. *Supra* at §IX.A.1.c. Arand discloses that natural gas liquids range from C₃-C₈. EX1004, 5:44-45. The combination of Aycaguer and Arand thus teaches that Aycaguer's carbon dioxide recycle stream contains C₃-C₈ hydrocarbons, and thus teaches the claimed carbon dioxide recycle stream. EX1002, ¶126. At the very least, for the reasons described for claim element [1.1], a POSITA would have found it obvious to apply Aycaguer's separation methods to a stream containing each of C₃-C₈ as expressly taught in Arand. *See supra* §IX.A.1.c; EX1002, ¶126.

The combination of Aycaguer and Arand therefore teaches claim element [1.2]. EX1002, ¶¶123-127.

C. Ground 3: Claims 1-4 and 6-7 are obvious over Aycaguer and Soldati

1. Motivation to Combine Aycaguer and Soldati

Ground 3 combines Aycaguer with Soldati such that the fractionation process/plant of Soldati is used to implement the gas processing plant (i.e., the “Produced Gas Recycling Plant” of Figure 1) in Aycaguer, where the natural gas liquids, CO₂, and H₂S described as outputs of that plant in Aycaguer are the outputs of the Soldati fractionation process/plant.

A POSITA would have been motivated to combine Aycaguer with Soldati, and would have a reasonable expectation of success in doing so, because both references relate to methods of processing natural gas liquid streams, and for the reasons discussed below. *See* EX1005 at 305; EX1006, 1:59-66; EX1002, ¶¶129-131.

Aycaguer explains that oil and associated gas derived from subterranean formations must be processed for sale. EX1005 at 305, EX1002, ¶130. It further discloses that the crude oil is separated from the gases as the first step of this processing. *Id.* (“The liquid phase undergoes further separation to recover the crude oil for sale, while the gas phase is directed to the gas processing plant.”) Aycaguer explains that the gas phase is processed in a plant to separate its constituent natural gas liquids, CO₂, and H₂S. *Id.* Aycaguer discloses already-

known processes that could be used to perform that separation. *Id.* (describing the “Ryan/Holmes process” as a method of gas processing and citing to 1982 and 1984 articles outlining the Ryan/Holmes process). *Id.*

Soldati teaches variations of and improvements on the Ryan/Holmes process, which it described as being used to separate the different components of natural gas liquid mixtures. EX1006, 1:6-58; EX1002, ¶131. The Ryan/Holmes variations disclosed by Soldati further include a sweetening step adapted for use in its process, in which hydrogen sulfide is removed from the natural gas liquid stream through distillation. EX1002, ¶131; *see infra* IX.C.2.c.

Because Aycaguer instructs the reader to use a Ryan/Holmes process, and because Soldati teaches a version of the Ryan/Holmes process, Aycaguer provides an explicit teaching, suggestion, or motivation to combine Aycaguer with Soldati. *Compare* EX1005 at 305 (“The separation of CO₂ from hydrocarbons and H₂S can be achieved by using the Ryan/Holmes process.”), *with* EX1006, 8:52-53 (“The process flow diagram of the known art is shown in FIG. 4.”); EX1002, ¶132; *see also* *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (explaining that a teaching, suggestion, or motivation in the art provides “helpful insight” into whether there is a motivation to combine).

Additionally, the combination of the system of Aycaguer with the processes of Soldati is a simple substitution of one known element for another to obtain predictable results. *See MPEP* §2143.B; *KSR*, 550 U.S. at 416. Aycaguer generally describes the use of a Ryan/Holmes process to process a natural gas stream into natural gas liquids and carbon dioxide. EX1005 at 305; EX1002, ¶133. Soldati discloses a known Ryan/Holmes method to process a natural gas stream into natural gas liquids and carbon dioxide. EX1006, 1:6-13; EX1002, ¶133. A POSITA would have understood that the method of Soldati when applied to the natural gas streams disclosed in Aycaguer would predictably result in the processing of that natural gas stream as described in Soldati and would have had a reasonable expectation of success in doing so. EX1002, ¶133.

Thus, a POSITA would have been motivated to implement Aycaguer's Produced Gas Recycling Plant using the natural gas liquid processing methods described by Soldati. This straightforward modification of Aycaguer's oil and natural gas processing system uses a known process (e.g., the processing steps described in Soldati) to improve a similar system (e.g., the gas processing plant described in Aycaguer) in the same way (using the Ryan/Holmes process, which is the process used by the gas processing plant in Aycaguer). EX1002, ¶¶128-134.

2. Claim 1

a. Claim elements [1.P], [1.1], and [1.2]

As explained above for Ground 1, Aycaguer teaches limitations [1.P], [1.1] and [1.2]. *Supra* §§IX.A.1.a-IX.A.1.c.

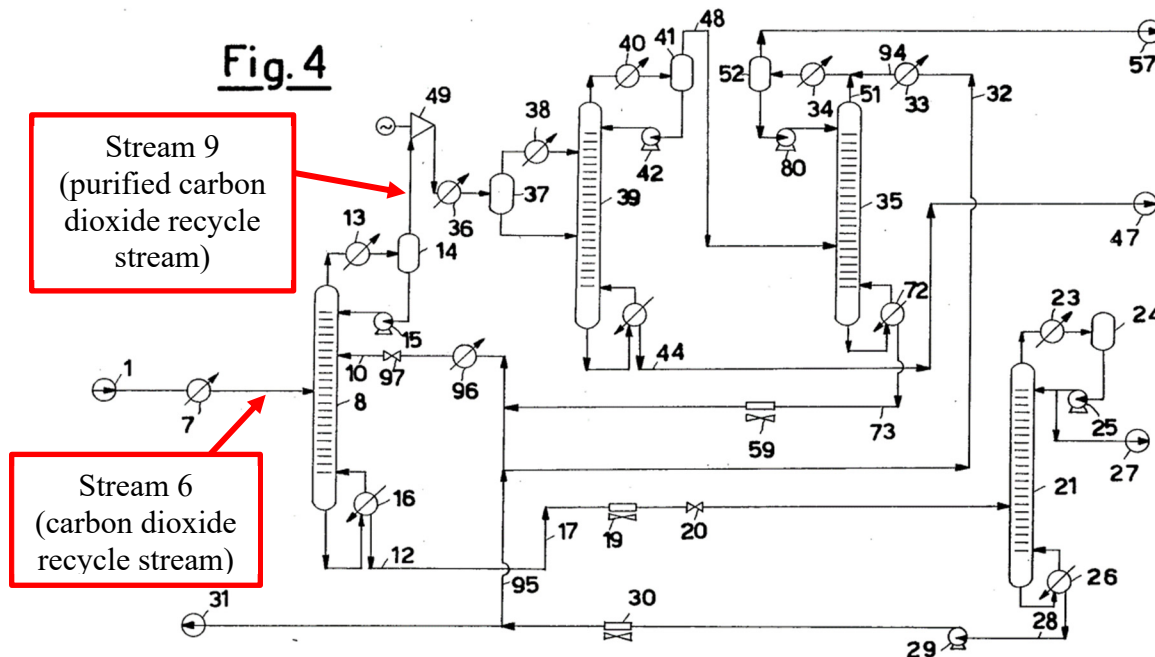
b. “separating the carbon dioxide recycle stream into a sour NGL rich stream and a purified carbon dioxide recycle stream, wherein the sour NGL rich stream comprises the C₃-C₈ hydrocarbons and the acid gas, and wherein the purified carbon dioxide recycle stream comprises the carbon dioxide; and,” [1.3]

As discussed above for claim element [1.2], the phase separation described in Aycaguer results in (i) a crude oil stream (the heavy hydrocarbon stream) and (ii) a carbon dioxide recycle stream that includes C₃-C₈, CO₂, and H₂S, the latter of which Aycaguer discloses as being sent to a gas processing plant.

Supra §§IX.A.1.c, IX.C.2.a.

In combination with Soldati, a POSITA would have implemented Aycaguer’s gas processing plant (the “Produced Gas Recycling Plant” of its Figure 1) using the gas processing method disclosed in Soldati. EX1002, ¶137. Thus, the carbon dioxide recycle stream of Aycaguer containing C₃-C₈, CO₂, and H₂S would

enter into the process described in Fig. 4 of Soldati as stream 1, before being compressed and cooled to become stream 6:⁸



⁸ While streams 6 and 9 are not labeled in FIG. 4, a POSITA reading the specification have understood that the two indicated positions in the annotated figure below are streams 6 and 9. EX1002, ¶137. Comparing to FIGs. 1 and 3 confirms this understanding, as does Table III, which describes the flow through streams 6 and 9 for the embodiment described in FIG. 4. See EX1010 at 9:6-7 (describing the Fig. 4 process and explaining the “other reference numerals in the figure have the same meaning as on the preceding diagrams”); FIGs. 1, 3, Table III.

EX1006 at FIG. 4; EX1002, ¶137. Soldati teaches that stream 6 enters into column 8. EX1006 at FIG. 4. As shown in Figure 4, stream 6 is separated within column 8 into an upper stream 9 and a lower stream 12. EX1006 at FIG. 4 (explaining that stream 6 is the stream entering column 8 and stream 9 is the stream exiting separator 14). Soldati teaches that upper stream 9 exits separator 14. EX1006 at FIG. 4.

Soldati teaches that stream 9 includes CO₂ that was in stream 6:⁹

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

⁹ Petitioners note that stream 9 actually has more CO₂ flowing through it than enters into column 8 through stream 6. EX1006 at Table III. This is due to the fact that column 8 is fed by the products of streams 9 and 12, causing a recirculation through the system at stream 10. *See, e.g.*, EX1006 at FIG. 4; EX1002, ¶139.

EX1006 at Table III. A POSITA would have thus understood that running the carbon dioxide recycling stream of Aycaguer through column 8 of Soldati would result in stream 9 containing CO₂. EX1002, ¶140. This stream 9 thus teaches the claimed “purified carbon dioxide recycle stream . . . compris[ing] the carbon dioxide.” *Id.*

Soldati also teaches that stream 9 undergoes further processing, and eventually becomes stream 44. EX1006 at FIG. 4, 5:8-13. Stream 44 contains CO₂ from stream 9, and is therefore merely a further-purified version of the purified carbon dioxide stream (stream 9):

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

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

EX1006 at FIG. 4, Table III. Stream 44 was separated from the carbon dioxide recycle stream using columns 8 and 39, and is therefore a claimed purified carbon dioxide recycle stream.¹⁰ EX1002, ¶142.

¹⁰ According to the '332 Patent, purification of a stream does not change its character. For example, dehydration of the carbon dioxide recycle stream yields the same carbon dioxide recycle stream, despite its composition changing. *See* EX1001 at Claim 8 (claiming “dehydrating” a carbon dioxide recycle stream “prior to separating the carbon dioxide recycle stream.”). Furthermore, there is nothing in claim 1 that prevents the claimed separation from occurring in multiple steps (i.e., using both columns 8 and 39).

Soldati explains that stream 12 contains “ethane and higher hydrocarbons.” EX1006, 7:36-40. A POSITA would have thus understood that running the carbon dioxide recycling stream of Aycaguer (which contains C₃-C₈) through column 8 of Soldati would result in a bottoms stream 12 containing at least C₃-C₈ (because ethane is C₂H₆ and thus heavier hydrocarbons are C₃₊). EX1002, ¶143. At the very least, for the reasons described for claim element [1.1] for Ground 1, a POSITA would have found it obvious to apply Aycuguer’s separation methods to a stream containing each of C₃-C₈. *See supra* §IX.A.1.b; EX1002, ¶143. A POSITA would have expected the separation of such a stream to occur in a similar fashion and with similar proportions as taught in Soldati due to the predictable nature of the distillation methods taught in Soldati. EX1002, ¶143.

Soldati also explains that column 8 only partially separates the H₂S, and thus stream 12 is contaminated with hydrogen sulfide:¹¹

¹¹ Stream 6 has less H₂S than the sum of streams 9 and 12 due to recirculation, as described *supra* note 9.

COMPONENT THROUGHPUT KMOLS/H	STREAM			
	6	12	31	9
NITROGEN	16.46	0.00	—	16.46
HYDROGEN SULPHIDE	0.03	<u>0.03</u>	—	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

EX1006 at Table III (hydrogen sulfide concentration underlined in red). A

POSITA would have thus understood that running the carbon dioxide recycle

stream of Aycaguer through column 8 of Soldati would result in a stream 12

containing C₃-C₈ and H₂S. EX1002, ¶145. Stream 12 thus teaches the claimed

“sour NGL rich stream . . . compris[ing] the C₃-C₈ hydrocarbons and the acid gas.”

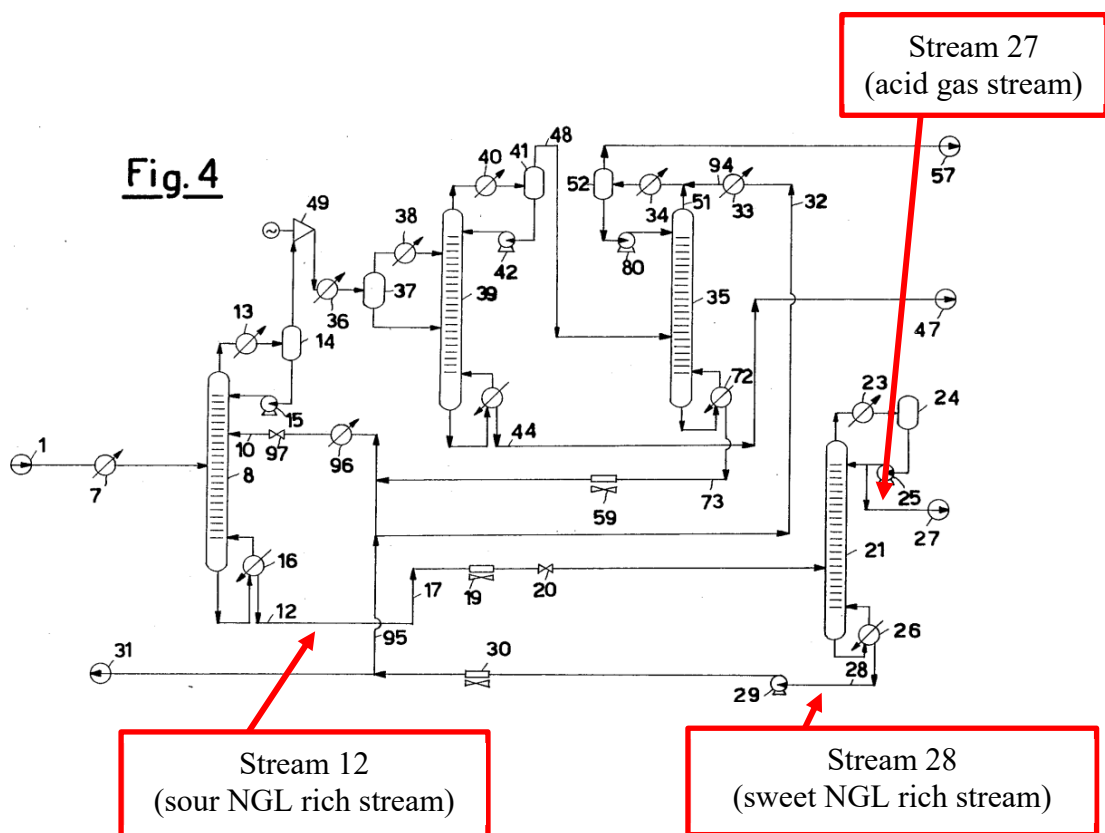
Id.

The combination therefore teaches claim element [1.3]. EX1002, ¶¶136-46.

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

As discussed for claim element [1.3], the combination results in stream 12 (a sour NGL rich stream), which contains C₃-C₈ hydrocarbons and H₂S.

Supra §IX.C.2.b. Soldati teaches that stream 12 enters column 21 and is separated into streams 27 and 28:



EX1006 at FIG. 4. Soldati teaches that column 21 produces a bottom product that includes “propane and heavier hydrocarbons.” EX1006, 4:57-60. Soldati further discloses that stream 28 includes no hydrogen sulfide or carbon dioxide, as shown in Table III:

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	28	10	95
NITROGEN	—	—	—
HYDROGEN SULPHIDE	—	—	—
CARBON DIOXIDE	—	46.64	—
METHANE	—	7.03	—
ETHANE	—	10.54	—
PROPANE	12.11	11.97	12.00
N-BUTANE	1092.03	1081.98	1082.60
N-PENTANE	81.06	80.26	80.25
THROUGHPUT KMOLS/H	1513.37	1563.53	1500.00
PHASE	L	L	L
TEMPERATURE °C.	122.0	16.0	48.0
PRESSURE ATA	19.2	39.6	44.0

EX1006 at Table III (Stream 28 and amounts of hydrogen sulfide and carbon dioxide highlighted).

Because stream 12 contains C₃-C₈ hydrocarbons, and the bottoms product of column 21 includes the C₃+ hydrocarbons, a POSITA would thus have understood that stream 28 would contain those C₃-C₈ hydrocarbons. EX1002, ¶149. Further, by removing H₂S from stream 28, column 21 sweetened this C₃-C₈ hydrocarbon stream. *Id.* Stream 28 thus teaches the claimed “sweet NGL rich stream . . . compris[ing] the C₃-C₈ hydrocarbons.” *Id.*

Soldati also teaches that the separation performed in column 21 “produces an overhead product (stream 27).” EX1006, 7:41-43. According to Table III, this overhead product includes all of the hydrogen sulfide and carbon dioxide from stream 12:

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 at Table III (underlining the H₂S in stream 27). Stream 27 thus teaches the claimed “acid gas stream . . . compris[ing] the acid gas.” EX1002, ¶¶150-51.

The combination thus teaches claim element [1.4]. EX1002, ¶¶147-52.

d. “wherein the carbon dioxide is not removed from the hydrocarbon feed stream and is not removed from the carbon dioxide recycle stream prior to separating the carbon dioxide recycle stream into the sour NGL rich stream and the purified carbon dioxide recycle stream, and” [1.5]

Aycaguer discloses no steps that remove CO₂ before the carbon dioxide recycle stream enters the produced gas recycling plant for processing using the method described in Soldati. Soldati discloses no steps that remove CO₂ before the carbon dioxide recycle stream enters column 8 for separation. EX1002, ¶153.

The combination thus teaches claim element [1.5] EX1002, ¶¶153-54.

e. “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]

Aycaguer does not disclose any cryogenic conditions, membranes, or carbon dioxide recovery solvents before the carbon dioxide recycle stream enters the produced gas recycling plant for processing using the method described in Soldati.

Soldati discloses no steps that include cryogenic conditions, membranes, or carbon dioxide recovery solvents. EX1002, ¶155. Soldati does not even use the words “membrane” or “solvent.” *See generally* EX1006. As to “cryogenic conditions,” the minimum temperature disclosed for the streams in Soldati in the Table III embodiment being relied upon for this Petition is -35° C, which is well above Patent Owner’s understanding of the term “cryogenic conditions” as being below -90° C EX1006 at Table III; *see supra* §IX.A.1.g; EX1011 at 8-9 & n.2.

The combination thus teaches claim element [1.6]. EX1002, ¶155

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]**

As explained above for claim element [1.3], the carbon dioxide recycle stream generated by the phase separator of Aycaguer is directed into the system of Soldati as stream 1. *See* IX.C.2.b. As explained in Soldati, before the carbon dioxide recycle stream enters column 8, it is compressed to 28.6 atmospheres:

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

EX1006 at Table III (showing that stream 6 of the embodiment described in FIG. 4 is compressed), 4:26-30 (explaining that the incoming hydrocarbon stream 1 is compressed to a working pressure before entering column 8 as stream 6).

The combination thus teaches claim element [2.1]. EX1002, ¶¶156-57.

b. “dehydrating at least part of the carbon dioxide recycle stream using a dehydration solvent prior to separating the carbon dioxide recycle stream” [2.2]

As explained above for claim element [2.1], Aycaguer passes a carbon dioxide recycle stream to the system of Soldati. *Supra* §IX.C.3.a. Both Aycaguer and Soldati further explain that this stream is dehydrated before processing. *See* EX1005 at 305 (“The gas is dried to avoid pipeline corrosion arising from the association of CO₂ and water.”); EX1006, 4:26-30.

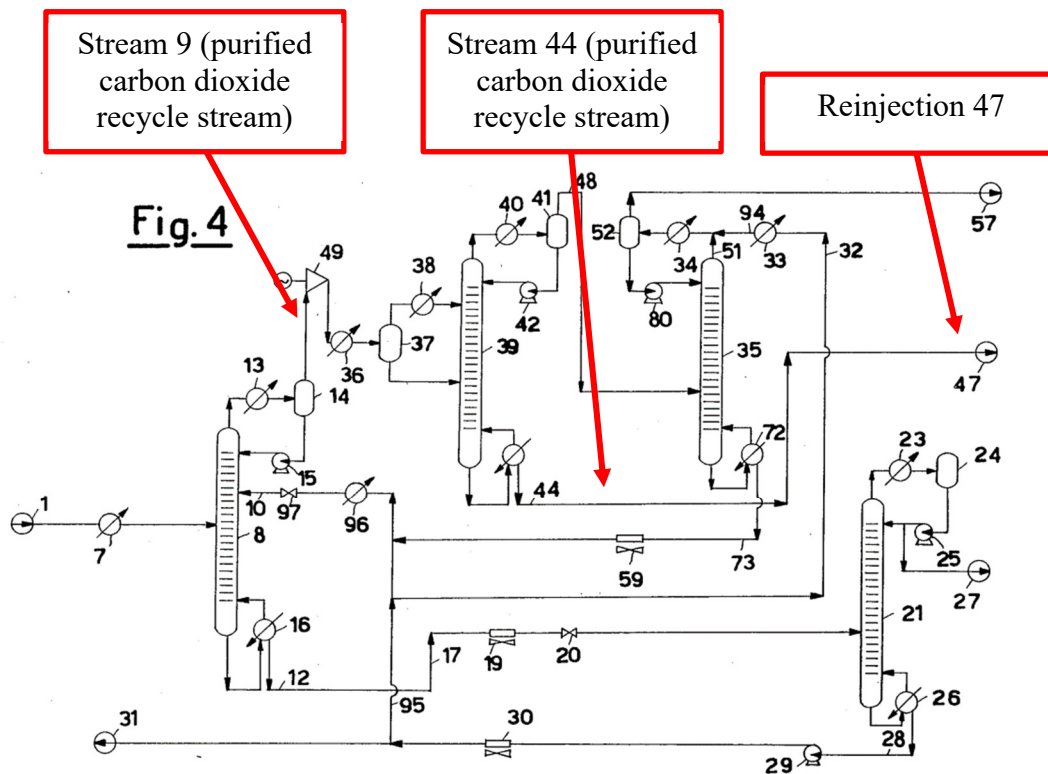
A POSITA reading either Aycaguer or Soldati before the Priority Date of the ’332 Patent would have known that dehydration solvents were a routine and

conventional way to dehydrate hydrocarbon streams. EX1002, ¶159. One of the most common of these solvents was triethylene glycol (TEG). *Id.* A POSITA would thus have found triethylene glycol an obvious design choice for dehydrating the carbon dioxide recycle stream because it is a known alternative in the prior art, and would have a reasonable expectation of success for the same reason. *Id.*

The combination thus teaches claim element [2.2]. EX1002, ¶¶158-60.

c. “combining a carbon dioxide makeup stream external to the method with the purified carbon dioxide recycle stream; and” [2.3]

As explained above in claim element [1.3], Soldati creates a purified carbon dioxide recycle stream as stream 9. *Supra* §IX.C.2.b. Soldati teaches that this stream undergoes further processing, and eventually becomes stream 44 and is ready for injection into a well at 47:



EX1006 at FIG. 4, 5:8-13. Stream 44 contains CO₂ from stream 9, and is therefore a further-purified version of the purified carbon dioxide stream (stream 9):

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

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

EX1006 at FIG. 4, Table III. Stream 44 was therefore separated from the carbon dioxide recycle stream using columns 9 and 39, and is therefore also the claimed purified carbon dioxide recycle stream. EX1002, ¶163; *supra* note 10.

Aycaguer also teaches that the CO₂ stream that exits the gas processing plant is injected into a well. EX1005 at 305 (“The separation of the produced gas stream does not isolate all compounds perfectly, and the CO₂ stream destined for reinjection also contains some methane and C₂”). To this end, Aycaguer describes a system where the CO₂ stream that exits the gas processing plant is combined with external CO₂ (a CO₂ makeup stream) and then injected into the well:

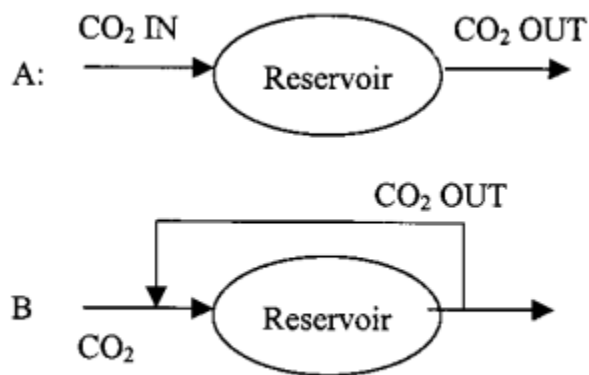


Figure 2. Designs of EOR process operations.

EX1005 at FIG. 2B, 306; EX1002, ¶¶164-65. Using this system, Aycaguer explains that “approximately 43% of the cumulative CO₂ needed for injection will be supplied by the recycling plant.” EX1005 at 306.

The combination thus teaches claim element [2.3]. EX1002, ¶¶161-66.

d. “injecting the combined carbon dioxide makeup stream and the purified carbon dioxide recycle stream into a subterranean formation.” [2.4]

As explained above in claim element [2.3], Aycaguer teaches combining a carbon dioxide makeup stream with the purified carbon dioxide recycle stream derived from the gas processing plant described in Soldati. *Supra* §IX.C.3.c.

Aycaguer teaches that this combined stream is injected into an oil and gas reservoir (i.e., a subterranean formation):

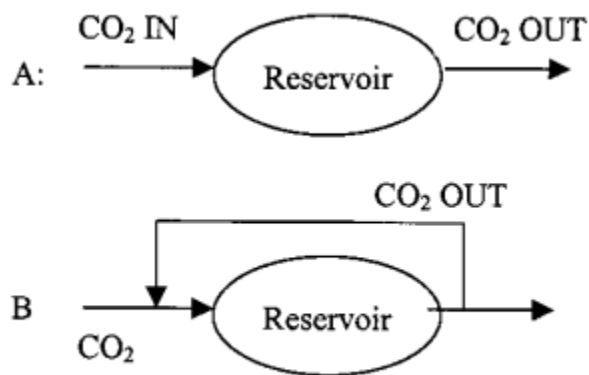


Figure 2. Designs of EOR process operations.

EX1005 at FIG. 2B; EX1002, ¶¶168-69. Using this system, Aycaguer explains that “approximately 43% of the cumulative CO₂ needed for injection will be supplied by the recycling plant.” EX1005 at 306.

The combination thus teaches claim element [2.4]. EX1002, ¶¶167-70.

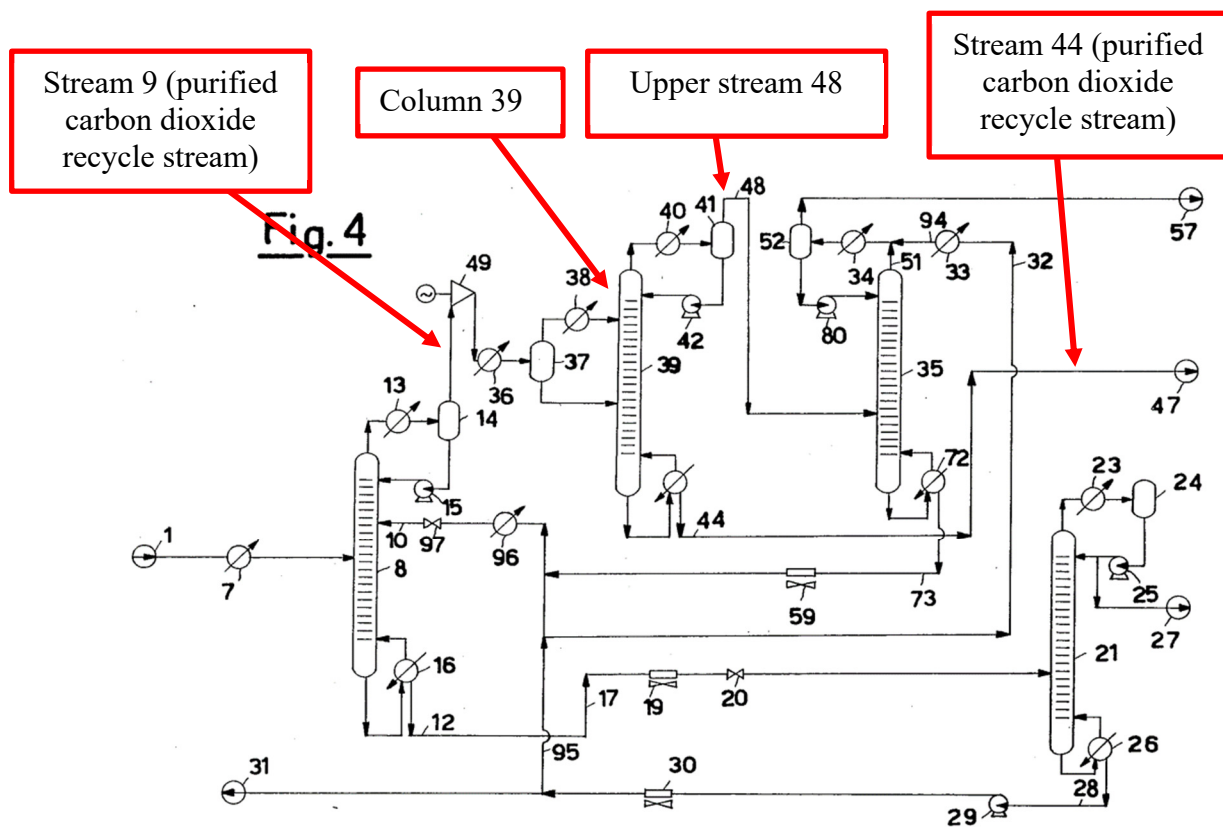
4. Claim 3: “The method of claim 1, further comprising cooling the carbon dioxide recycle stream with the purified carbon dioxide recycle stream.”

As discussed above for claim element [1.2], the phase separation described in Aycaguer results in a carbon dioxide recycle stream that includes C₃-C₈, CO₂, and H₂S. *Supra* §§IX.A.1.c, IX.C.2.a. This stream is then directed into the gas processing system described in Soldati as stream 1. *Id.* Soldati explains that this

gas stream 1 “is cooled in 7¹² and fed into the column 8.” EX1006, 4:30-31. Soldati thus teaches cooling the carbon dioxide recycle stream (cooling carbon dioxide recycle stream 1, resulting in cooled carbon dioxide recycle stream 6). EX1002, ¶171.

Soldati also teaches that the “bottom product of the second distillation column [39] can be expanded and the produced cold be used for cooling other process streams.” EX1006, 3:22-24. The second distillation column is the column fed with the “overhead stream from the first column” (EX1006, 1:33-37)—i.e., column 39:

¹² As illustrated in Figure 1 of Soldati, this cooling at 7 is in addition and subsequent to a prior condensing and cooling of the mixture that occurs at compressor 2 and heat exchanger 3. Although not shown in Figure 4, a POSITA would have understood from the description of Soldati that these steps are also included in the Figure 4 embodiment. EX1002, ¶171.



EX1006 at FIG. 4. Column 39 is fed the purified carbon dioxide (stream 9), and separates it into upper stream 48 and lower stream 44. *Id.*; *supra* §IX.C.2.b (explaining that stream 9 is the purified carbon dioxide stream). Stream 44 contains CO₂ from stream 9, and is therefore a further-purified version of the purified carbon dioxide stream (stream 9):

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

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

EX1006 at FIG. 4, Table III. Stream 44 was therefore separated from the carbon dioxide recycle stream using columns 9 and 39, and is therefore also the claimed purified carbon dioxide recycle stream. EX1002, ¶174; *supra* note 10.

Thus, because Soldati teaches that the “bottom product [44] of the second distillation column [39] can be expanded and the produced cold be used for cooling other process streams,” it teaches that a purified recycle stream can be used to cool

other process streams. EX1006, 3:22-24; EX1002, ¶175. Furthermore, a POSITA would have understood that the carbon dioxide recycle stream (stream 6) is an “other process stream” and thus would have understood Soldati to teach, or at the very least render obvious, that the stream 44 (the purified recycle stream) is used to cool the steam 6 (carbon dioxide recycle stream) at 7.¹³ EX1002, ¶175; EX1003 at 149 (the Examiner explaining that “[u]tilizing recycled streams is a common practice and is more efficient for upstream cooling or heating to avoid the utilization of external refrigeration.”).

The combination thus teaches the elements of claim 3. EX1002, ¶¶171-76.

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

¹³ Soldati’s explicit disclosure that stream 44 should be used to cool process streams, and Soldati’s explicit disclosure that process stream 6 should be cooled at 7, would certainly motivate a POSITA to use stream 44 to cool stream 6 at 7, and—as explained by the Examiner—such recycled cooling is a common and efficient practice which would provide a reasonable expectation of success. EX1006 at 3:22-24; EX1005 at 149.

more than 1 molar percent ethane, and no more than 1 molar percent acid gases.”

As discussed for claim element [1.4], stream 28 teaches the sweet NGL rich stream. *Supra* §IX.C.2.c. According to Table III, stream 28 contains *no* methane, ethane, CO₂, or hydrogen sulfide; thus, it includes less than 1% methane, less than 1% ethane, less than 1% CO₂, and less than 1% hydrogen sulfide:

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	28	10	95
NITROGEN	—	—	—
HYDROGEN SULPHIDE	—	—	—
CARBON DIOXIDE	—	46.64	—
METHANE	—	7.03	—
ETHANE	—	10.54	—
PROPANE	12.11	11.97	12.00
N-BUTANE	1092.03	1081.98	1082.60
N-PENTANE	81.06	80.26	80.25
THROUGHPUT KMOLS/H	1513.37	1563.53	1500.00
PHASE	L	L	L
TEMPERATURE °C.	122.0	16.0	48.0
PRESSURE ATA	19.2	39.6	44.0

EX1006 at Table III.

While a POSITA would not expect the percentages of components in the sour NGL stream described by Table III of Soldati to exactly match the percentages of components of a sour NGL stream produced by the combination of Aycaguer and Soldati, a POSITA would expect the percentages to be similar. EX1002, ¶178. This is because hydrocarbon streams derived from oil and gas wells all produce different concentrations of particular hydrocarbons. *Id.* Tables such as

Table III, therefore, exist to give POSITA reading the Soldati an idea of what to expect when they apply the teachings of the Soldati to their system. *Id.*

Furthermore, a POSITA would have understood how chemicals interact with changes in temperature and pressure, allowing them to adjust those variables to predictably modify the system output. *Id.* A POSITA would have reasonably expected that the separation method of Soldati applied to the feed stream of Arand would have resulted in less than 1% methane, less than 1% ethane, less than 1% CO₂, and less than 1% hydrogen sulfide, because Soldati teaches that its separation steps result in none of those components in the sweet NGL rich stream 28. *Id.*

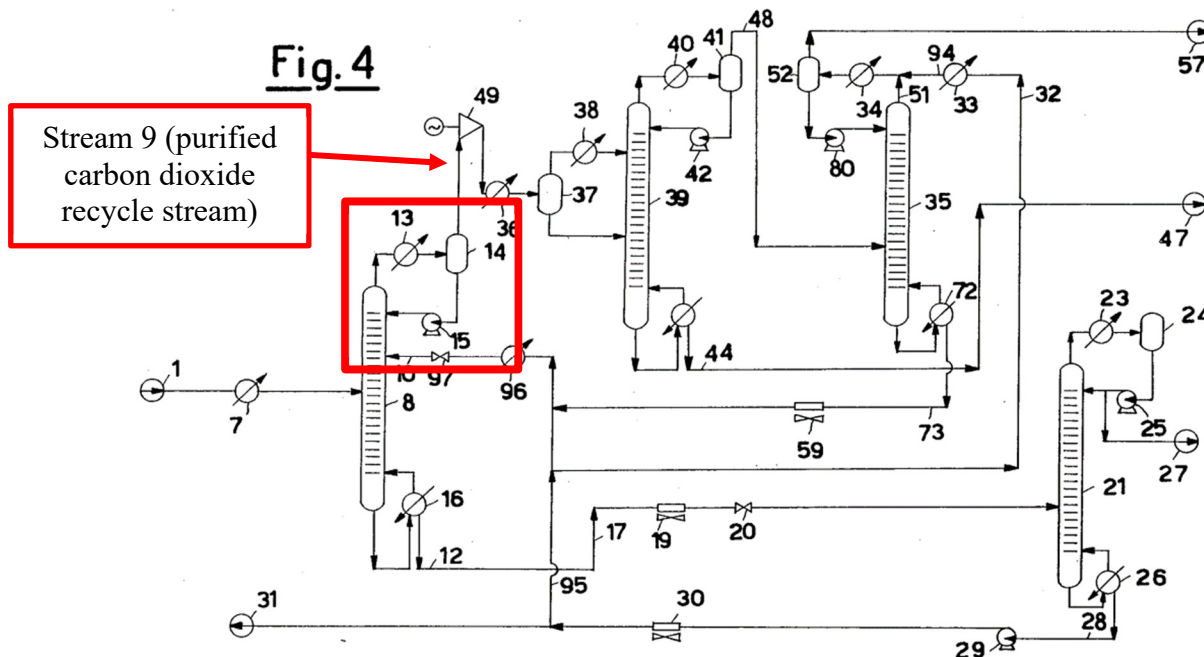
The combination thus teaches the elements of claim 4. EX1002, ¶¶177-79.

6. Claim 6

a. “The method of claim 1, wherein separating the carbon dioxide recycle stream into the sour NGL rich stream and the purified carbon dioxide recycle stream comprises: refluxing part of the purified carbon dioxide recycle stream;” [6.1]

As described in claim element [1.3], column 8 of Soldati separates the carbon dioxide recycle stream into a sour NGL rich stream that exits the bottom of column 8 and a purified carbon dioxide recycle stream that exits the top of column 8. *Supra* §IX.C.2.b.

Soldati further discloses that the top of column 8 has “the condenser 13, the separator 14, and the pump 15” at its top. EX1006, 4:44-46:

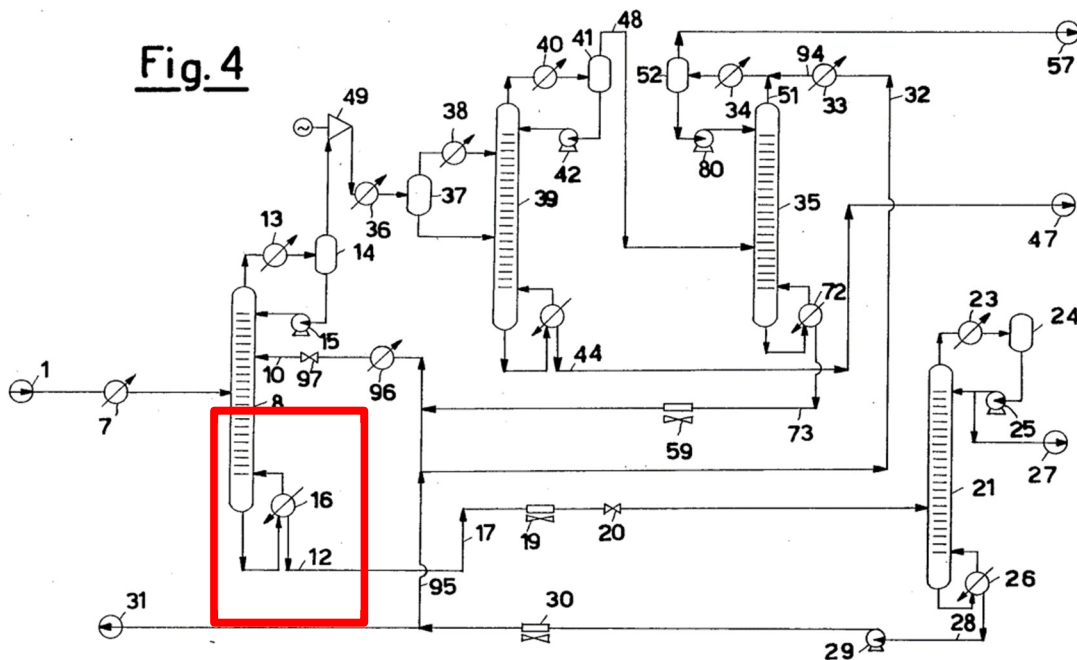


EX1006 at FIG. 4 (highlighting condenser 13, separator 14, pump 15, and stream 9). A POSITA would have understood that liquid forms at condenser 13. EX1002, ¶182. This liquid, called “reflux,” is returned to the column by pump 15 and it is separated from the vapor phases by accumulator tank 14. EX1006 at FIG. 4; EX1002 at ¶182. Thus, the liquid stream in equilibrium with vapor stream 9 (the carbon dioxide recycle stream) exiting the bottom of tank 14 is “refluxed” by pump 15. EX1002 at ¶182.

The combination thus teaches claim element [6.1].EX1002, ¶¶180-83.

**b. “reboiling part of the sour NGL rich stream; and”
[6.2]**

As described above in claim element [1.3], Soldati describes a sour NGL rich stream exiting the bottom of column 8. *Supra* §IX.C.2.b. Soldati further discloses that the bottom of column 8 has reboiler 16, which reboils fluid from the bottom of column 8 back into the middle of column 8:



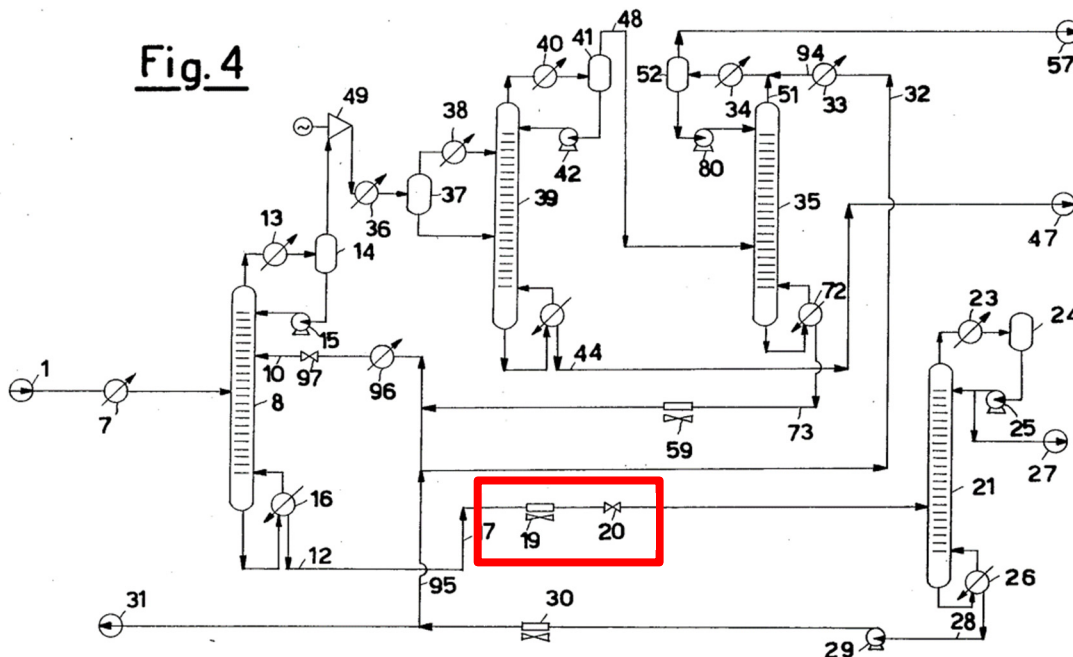
EX1006, 4:44-46, FIG. 4 (reboiler highlighted).

The combination thus teaches claim element [6.2]. EX1002, ¶¶184-85.

**c. “cooling and throttling the sour NGL rich stream.”
[6.3]**

As shown in claim element [1.3], a sour NGL rich stream exits the bottom of column 8. *Supra* §IX.C.2.b. As the sour NGL rich stream passes from column 8 to

column 21, it passes through heat exchanger 19 which cools it. EX1006, 4:48-50 (explaining that the stream is cooled at element 19), 8:47 ("heat exchanger[] 19").



EX1006 at FIG. 4 (highlighting the heat exchanger and expansion valve).

Following heat exchanger 19, the sour NGL rich stream passes through valve 20. EX1006, 4:48-50, FIG. 4. Valve 20 expands stream 17. EX1006, 4:48-50. Valves affect the flow and/or pressure of a fluid by throttling it. EX1002, ¶187. A valve that controls pressure independent of flow rate is considered a throttling valve. *Id.* An expansion valve, in particular, throttles flow through a small aperture to produce a vapor. *Id.* Therefore valve 20 throttles stream 17. *Id.*

The combination thus teaches claim element [6.3]. *Id.*, ¶¶186-88.

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

As described in claim element [1.3], stream 12 is a sour NGL stream.

Supra §IX.C.2.b. Stream 12 contains 0.23% carbon dioxide (3.65 KMOLS/H of 1580.83 total KMOLS/H), 0% methane, and 2.1% ethane (32.61 KMOLS/H of 1580.83 total KMOLS/H):

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

EX1006 at Table III; EX1002, ¶189. As explained above for claim 4, while a POSITA would not expect the percentages of components in the sour NGL stream described by Table III of Soldati to exactly match the percentages of components of a sour NGL stream produced by the combination of Aycaguer and Soldati, a POSITA would expect the percentages to be similar. *Supra* §IX.C.5. This is because hydrocarbon streams derived from oil and gas wells all produce different

concentrations of particular hydrocarbons. EX1002, ¶190. Tables such as Table III, therefore, exist to give POSITA reading Soldati an idea of what to expect when they apply the teachings of Soldati to their system. *Id.* Furthermore, a POSITA would have understood how chemicals interact with changes in temperature and pressure, allowing them to adjust those variables to predictably modify the system output. *Id.*

As described above in claim element [1.4], stream 28 teaches the sweet NGL rich stream. *Supra* §IX.C.2.c. Soldati teaches that column 21 removes the CO₂ from stream 12 to yield stream 28:

COMPONENT THROUGHPUT KMOLS/H	STREAM		
	28	10	95
NITROGEN	—	—	—
HYDROGEN SULPHIDE	—	—	—
CARBON DIOXIDE	—	46.64	—
METHANE	—	7.03	—
ETHANE	—	10.54	—
PROPANE	12.11	11.97	12.00
N-BUTANE	1092.03	1081.98	1082.60
N-PENTANE	81.06	80.26	80.25
THROUGHPUT KMOLS/H	1513.37	1563.53	1500.00
PHASE	L	L	L
TEMPERATURE °C.	122.0	16.0	48.0
PRESSURE ATA	19.2	39.6	44.0

EX1006 at Table III; EX1002, ¶191.

Additionally, a POSITA would have found it obvious that the carbon dioxide recycle stream disclosed by Aycaguer could have had the same composition as stream 6 of Soldati, as Aycaguer teaches removing crude oil from a

hydrocarbon feed stream to yield a carbon dioxide recycle stream with NGLs, and Soldati teaches a carbon dioxide recycle stream with NGLs. EX1002, ¶192; EX1006 at Table III. Processing such a stream through the system of Soldati would achieve the same percentages found in Table III, and thus result in a sour NGL rich stream with “no more than 5 molar percent carbon dioxide, no more than 1 molar percent methane, and no more than 5 molar percent ethane” and a sweet NGL rich stream “substantially free of carbon dioxide.” EX1002, ¶192.

Furthermore, a POSITA would have been motivated to optimize the separation steps in the combined Aycaguer and Soldati system such that the sour NGL rich stream contains minimal carbon dioxide, methane, and ethane, and the sweet NGL rich stream is substantially free of carbon dioxide, as required in Claim 7. The successful extraction of NGLs from a carbon dioxide-rich reservoir stream (i.e., the separation of CO₂ from NGLs) is the entire point of NGL distillations as taught in Aycaguer and Soldati. EX1002, ¶193. And Soldati expressly taught minimal carbon dioxide in its sour NGL rich stream and no carbon dioxide in its sweet NGL rich stream. *Id.* Additionally, a POSITA would have expected the percentages of methane and ethane in the NGL rich stream to be low as compared with the NGLs (which a POSITA would have understood to be the C₃-C₈) because the system is designed for NGL recovery. *Id.* The 1% and 5% thresholds recited in Claim 7 are merely design choices that a POSITA could have easily achieved using

routine and predictable optimizations to the process variables (for instance, by adjusting the reboiler temperature). *Id.*

The combination thus teaches that the elements of claim 7. *Id.*, ¶¶186-94.

D. Ground 4: Claim 2 is obvious over Aycaguer Soldati, and Ryan

1. Motivation to Combine Aycaguer, Soldati, and Ryan

Ground 4 combines Aycaguer and Soldati (as discussed in Ground 3) with Ryan. *Supra* §IX.C. As explained below, Ryan teaches a method of dehydrating a natural gas feed stream before it is used in a distillative separation, and it would have been obvious to implement such a method of dehydration as the “dehydrator” in Soldati.

A POSITA would have been motivated to combine Aycaguer and Soldati with Ryan, and would have had a reasonable expectation of success in doing so, because all three references relate to methods of natural gas liquid separation. *See* EX1002, ¶197; EX1005 at 305; EX1006, 1:67-2:26; EX1007 at 53. Indeed, Aycaguer explicitly refers to the Ryan reference and describes it as an acceptable method of natural gas liquid separation, and Soldati describes itself as an improved version of the Ryan/Holmes process. EX1005 at 305; EX1006, 1:54-58; EX1002, ¶197.

Both Aycaguer and Soldati teach that the natural gas liquid stream should be dehydrated before it is separated. EX1005 at 305; EX1006, 4:24-30, Table III (showing dehydrated mixture 6). However, neither Aycaguer nor Soldati specify what dehydrator to use.

Ryan teaches that “[f]eed dehydration by TEG” is an appropriate method of dehydrating oil and natural gas feed streams for use in distillative approaches to enhanced oil recovery operations. EX1007 at 56. Ryan thus provides an explicit teaching, suggestion, or motivation to combine with Soldati. *Compare* EX1006, 4:24-30 (describing the need for a dehydrator) *with* EX1007 at 56 (disclosing a dehydrator for use in distillative methods of processing natural gas); EX1002, ¶199; *see also KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (explaining that a teaching, suggestion, or motivation in the art provides “helpful insight” into whether there is a motivation to combine).

Additionally, the substitution of the generic dehydrator of Soldati with the specific TEG dehydration of Ryan is a simple substitution of one known element for another to obtain predictable results and a POSITA would have had a

reasonable expectation of success in using TEG for dehydration.¹⁴ *See MPEP* §2143.B; *KSR*, 550 U.S. at 416. Soldati generically recites a generic, well-known requirement for a “dehydrator,” and Ryan provides a well-known system to perform that function. EX1006, 4:24-30; EX1007 at 56; EX1002, ¶200.

Thus, a POSITA would be motivated to implement Aycaguer’s Produced Gas Recycling Plant using the natural gas liquid processing methods described by Soldati, and a POSITA would be further motivated to use the TEG dehydration method described in Ryan to perform the dehydration disclosed by Soldati’s method. EX1002, ¶¶196-201.

2. Claim 2

As explained above for Ground 3, Aycaguer and Soldati teaches the limitations of Claim 1. *Supra* §§IX.C.2, IX.C.4-7. The combination of Aycaguer, Soldati, and Ryan teaches the additional limitations of Claim 2.

¹⁴ This could also be considered filling in a gap in the description provided by Soldati with the explicit teaching of Ryan.

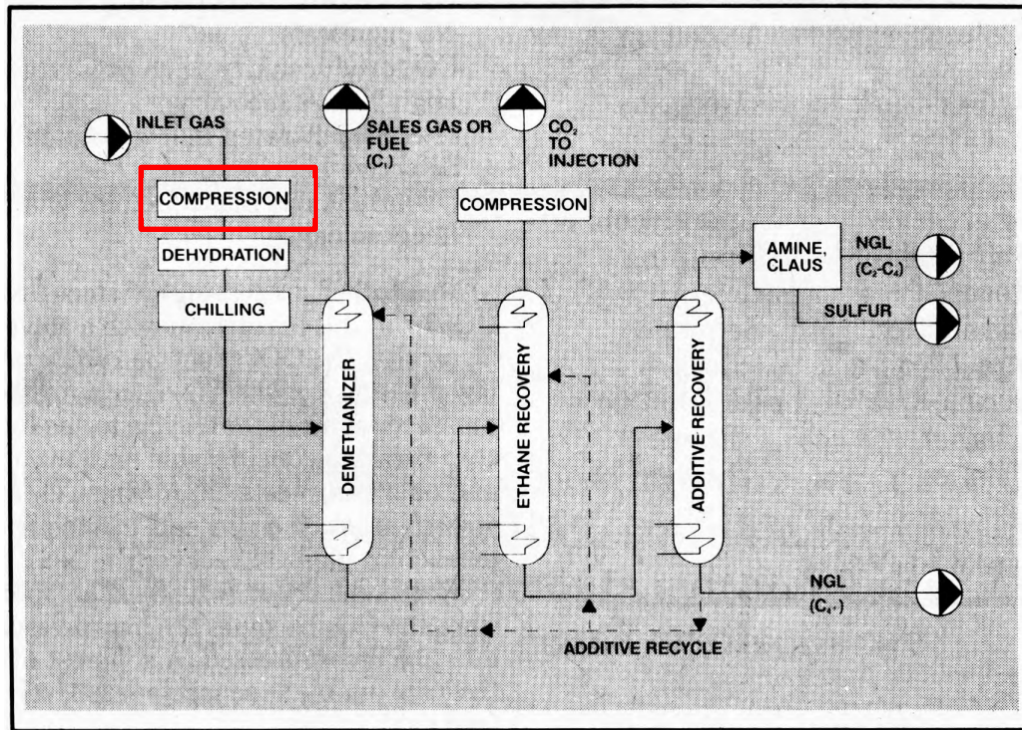
**a. “The method of claim 1, further comprising:
compressing the carbon dioxide recycle stream prior to
separating the carbon dioxide recycle stream” [2.1]**

As explained above for claim element [1.3], the carbon dioxide recycle stream generated by the phase separator of Aycaguer is directed into the system of Soldati as stream 1. *See* IX.C.2.b. As explained in Soldati, before the carbon dioxide recycle stream enters column 8, it is compressed to 28.6 atmospheres:

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

EX1006 at Table III, 4:26-30 (explaining that the incoming hydrocarbon stream 1 is compressed to a working pressure before entering Column 8). Ryan agrees, and also describes a compressor used to increase the pressure of the carbon dioxide recycle stream before it flows into the first separation column:

Figure 2. Three-column Ryan/Holmes process.



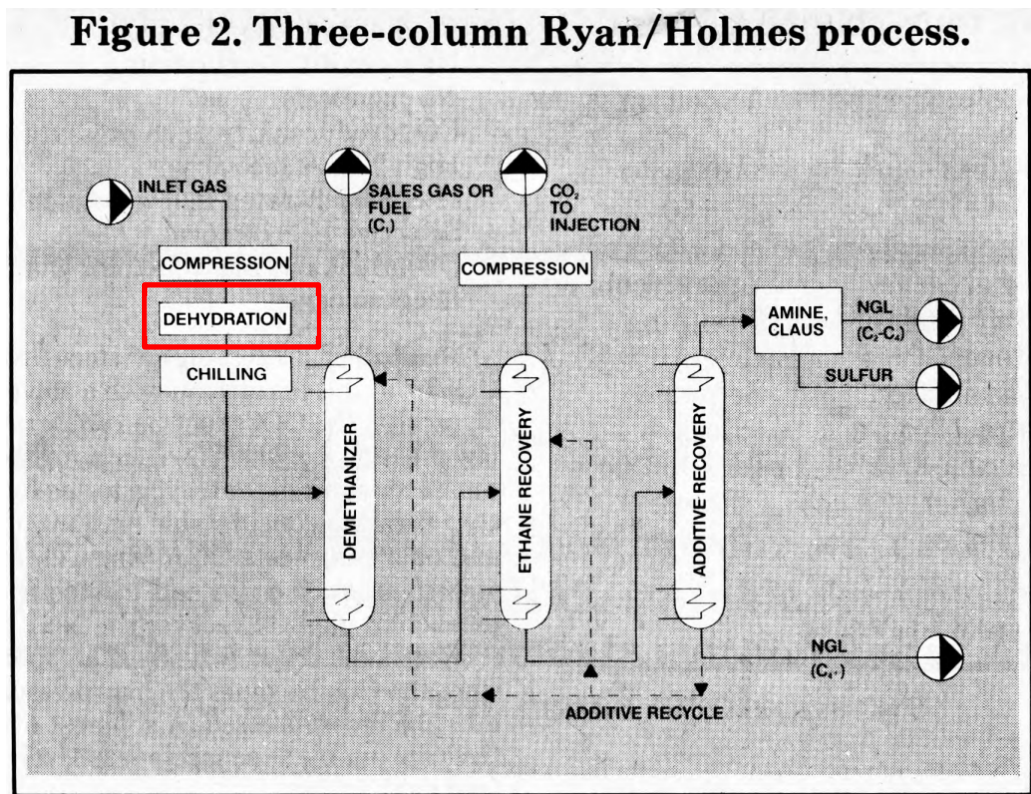
EX1007 at FIG. 2 (compressor highlighted).

The combination thus teaches claim element [2.1]. EX1002, ¶¶203-05.

b. “dehydrating at least part of the carbon dioxide recycle stream using a dehydration solvent prior to separating the carbon dioxide recycle stream” [2.2]

As explained above for claim element [2.2], Aycaguer passes a carbon dioxide recycle stream to the system of Soldati. *Supra* §IX.C.3.b. Both Aycaguer and Soldati further explain that this stream should be dehydrated before it is processed. *See* EX1005 at 305 (“The gas is dried to avoid pipeline corrosion arising from the association of CO₂ and water.”); EX1006, 4:26-30. However, neither Aycaguer nor Soldati discloses the specific dehydrator to use.

Ryan discloses “[f]eed dehydration by TEG.” EX1007 at 56. A POSITA would have understood that TEG stands for “triethylene glycol,” a solvent commonly used to extract water from gas streams. EX1002, ¶107. Ryan further discloses that this dehydration should occur after compression but before separation in the distillation column:

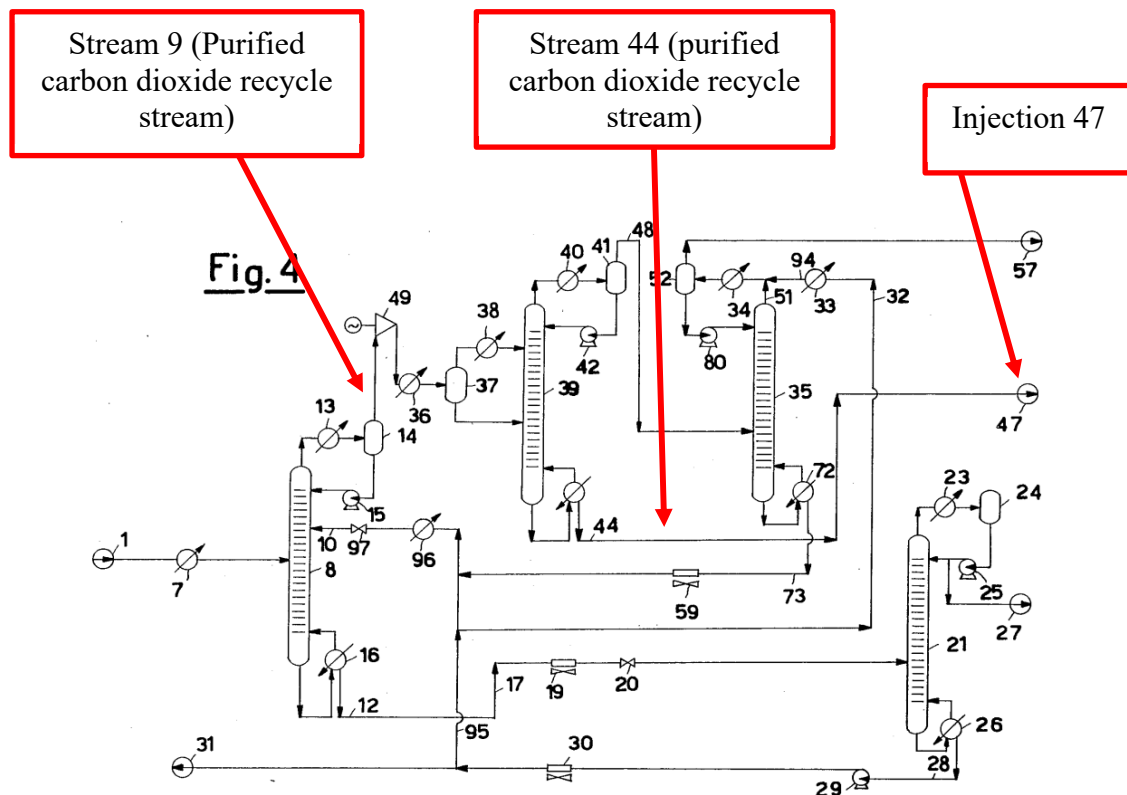


EX1007 at FIG. 2 (dehydrator highlighted).

The combination thus teaches claim element [2.2]. EX1002, ¶¶206-08.

c. “combining a carbon dioxide makeup stream external to the method with the purified carbon dioxide recycle stream; and” [2.3]

As explained above in claim element [2.2], Soldati provides a purified carbon dioxide recycle stream as stream 9. *Supra* IX.C.2.b. Soldati teaches that this stream undergoes further processing, and eventually becomes stream 44 and is ready for injection into a well at 47:



EX1006 at FIG. 4, 5:8-13. Stream 44 contains almost all of the CO₂ from stream 9, and is therefore merely a further-purified version of the purified carbon dioxide stream (stream 9):

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

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

EX1006 at FIG. 4, Table III. Stream 44 was therefore separated from the carbon dioxide recycle stream using columns 9 and 39, and is therefore also the claimed purified carbon dioxide recycle stream. EX1002, ¶211; *supra* note 10.

Aycaguer also teaches that the CO₂ stream that exits the gas processing plant should be injected into a well. EX1005 at 305 (“The separation of the produced gas stream does not isolate all compounds perfectly, and the CO₂ stream destined for reinjection also contains some methane and C₂”).

To this end, Aycaguer describes a system where the CO₂ stream that exits the gas processing plant is combined with external CO₂ and then injected into the well:

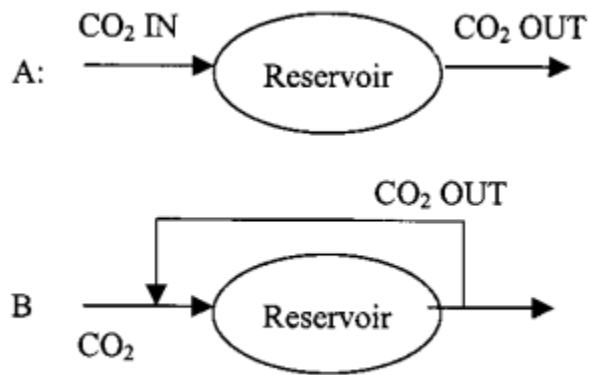


Figure 2. Designs of EOR process operations.

EX1005 at FIG. 2B, 306; EX1002, ¶¶213-14. Using this system, Aycaguer explains that “approximately 43% of the cumulative CO₂ needed for injection will be supplied by the recycling plant.” EX1005 at 306.

The combination thus teaches claim element [2.3]. EX1002, ¶¶209-15.

d. “injecting the combined carbon dioxide makeup stream and the purified carbon dioxide recycle stream into a subterranean formation.” [2.4]

As explained above in claim element [2.3], Aycaguer teaches combining a carbon dioxide makeup stream with the purified carbon dioxide recycle stream derived from the gas processing plant described in Soldati. *Supra* §IX.D.2.c.

Aycaguer teaches that this combination stream is injected into an oil and gas reservoir (i.e., a subterranean formation):

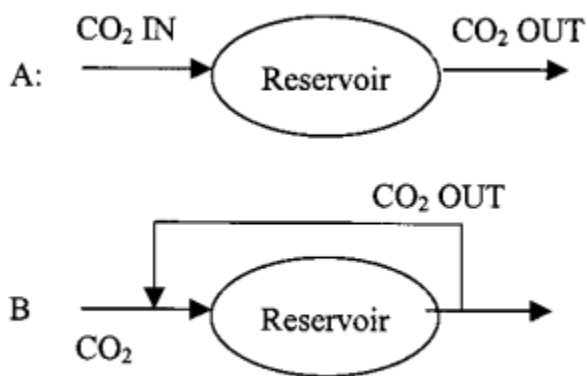


Figure 2. Designs of EOR process operations.

EX1005 at FIG. 2B; EX1002, ¶217. Using this system, Aycaguer explains that “approximately 43% of the cumulative CO₂ needed for injection will be supplied by the recycling plant.” EX1005 at 306.

The combination thus teaches claim element [2.4]. EX1002, ¶¶216-19.

E. Grounds 5 and 6: Claims 1-4 and 6-7 are obvious over Aycaguer, Soldati, and Arand (Ground 5) and Claim 2 is obvious over Aycaguer, Soldati, Ryan, and Arand (Ground 6)

1. Motivation to Combine the References

Ground 5 combines Aycaguer and Soldati (as discussed in Ground 3) with Arand and Ground 6 combines Aycaguer, Soldati and Ryan (as discussed in Ground 4) with Arand. *Supra* §IX.B. As discussed above in §IX.B, Arand expressly discloses that natural gas liquids comprise C₃-C₈ hydrocarbons and that heavy condensate (i.e., heavy hydrocarbons) comprise C₉₊ hydrocarbons, and is used in Ground 2 (and is used similarly here in Grounds 5 and 6) in the event Patent Owner incorrectly argues against the use of the AAPA. Ground 3 explains the motivation to combine Aycaguer and Soldati and Ground 4 explains the motivation for the further combination with Ryan. As discussed below, a POSITA would have been further motivated to combine the teachings of Arand with those of Aycaguer in both of these combinations discussed above.

Arand teaches a method of processing fluids produced from oil and gas reservoirs to yield a natural gas liquid stream, a residue gas stream, and a stabilized condensate stream. *See* EX1004, 1:6-13. A POSITA would have been motivated to combine Aycaguer and Arand, and would have had a reasonable expectation of success in doing so, because both references relate to methods of natural gas liquid

separation, and for the additional reasons below. EX1005 at 305; EX1006, 1:67-2:26; EX1004, 1:6-13; EX1002, ¶222.

Aycaguer teaches that heavy hydrocarbons, such as the crude oil, should be separated from a hydrocarbon feed stream derived from the oil well before further processing. *See* EX1005 at 305. Aycaguer also teaches that natural gas liquids are a valuable product of oil and gas wells. *Id.* However, Aycaguer does not explicitly disclose the particular hydrocarbons that would be found in the components of natural gas liquids or heavy hydrocarbons.

Arand provides such teachings. Arand teaches that natural gas liquids are hydrocarbons that have between three and eight carbon atoms (C_{3-8}). EX1004, 5:44-45. Arand also teaches that heavy hydrocarbons contain nine or more carbon atoms (C_{9+}). EX1004, 5:44-45.

Thus, a POSITA would have been motivated to implement Aycaguer's Produced Gas Recycling Plant using the natural gas liquid processing methods described by Soldati, and a POSITA would have been further motivated to use the understanding of natural gas liquids and heavy hydrocarbons found in Arand to identify the constituent hydrocarbons in the mixtures that would result from the separation performed by Aycaguer and Soldati. EX1002, ¶¶221-25

2. Claim 1

a. Claim elements [1.P], [1.3], [1.4], [1.5], and [1.6].

As explained above for Ground 3, Aycaguer and Soldati teach limitations [1.P], [1.3], [1.4], [1.5], and [1.6]. *Supra* §§IX.C.2.a-IX.C.2.e

b. “receiving a hydrocarbon feed stream, wherein the hydrocarbon feed stream comprises carbon dioxide, natural gas liquid (NGL), heavy hydrocarbons, and acid gas, wherein the NGL comprises C₃-C₈ hydrocarbons, and wherein the heavy hydrocarbons comprise C₉₊ hydrocarbons” [1.1]

As explained above for claim element [1.1], Aycaguer teaches this limitation. *Supra* §IX.A.1.b. But, to the extent that the Patent Owner incorrectly disputes that either (i) a POSITA as of the Priority Date would not have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊ or (ii) a POSITA as of the Priority Date would not have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊, Arand provides such understanding.

As explained above for claim element [1.1], Aycaguer teaches that the hydrocarbon feed stream includes liquid crude oil, which is separated from the NGLs, CO₂, and H₂S (which are gases that are then processed in the gas plant). *Supra* §IX.A.1.b. A POSITA would have understood that the crude oil is the heavy condensate of this separation as the NGLs, CO₂, and H₂S are gases that are lighter

than the heavier crude oil. EX1002, ¶229. Arand discloses that such heavy condensate includes C₉₊. EX1004, 5:45. The combination of Aycaguer and Arand thus teaches that Aycaguer's hydrocarbon feed stream includes C₉₊. EX1002, ¶229.

As explained above for claim element [1.1], Aycaguer also teaches that its hydrocarbon feed stream includes natural gas liquids. *Supra* at §IX.A.1.b. Arand discloses that natural gas liquids include C₃-C₈. EX1004, 5:44-45. The combination of Aycaguer and Arand thus teaches that Aycaguer's hydrocarbon feed stream includes C₃-C₈. At the very least, a POSITA would have found it obvious to apply the oil and gas processing methods taught in Aycaguer on a feed stream from a reservoir containing C₃-C₈ as expressly taught in Arand. EX1002, ¶230. A POSITA would have been motivated to apply the Aycaguer method to a feed stream containing each of C₃-C₈, as taught in Arand, because that would allow the Aycaguer system to work as intended to remove the crude oil (C₉₊), and maximize NGLs (C₃-C₈) for recovery. *Id.* Such a POSITA would have expected the separation steps taught in Aycaguer to successfully result in a separation of such a feed stream due to the well-known and predictable nature of the distillation and processing steps employed. *Id.*

The combination of Aycaguer, Soldati, and Arand therefore claim element [1.1]. *Id.*, ¶¶227-31.

c. “separating the hydrocarbon feed stream into a heavy hydrocarbon rich stream and a carbon dioxide recycle stream, wherein the heavy hydrocarbon rich stream comprises the C₉₊ hydrocarbons, and wherein the carbon dioxide recycle stream comprises the carbon dioxide, the C₃-C₈ hydrocarbons, and the acid gas” [1.2]

The combination of Aycaguer, Soldati, and Arand teaches this limitation. As discussed above for claim element [1.2], Aycaguer teaches a hydrocarbon feed stream that is received for processing, and that the feed stream should be separated using a phase separator into a NGL component and a crude oil component. *Supra* §IX.A.1.c.

But, to the extent that the Patent Owner incorrectly disputes that (i) a POSITA as of the Priority Date would have understood that Aycaguer discloses a hydrocarbon feed stream that includes C₃-C₉₊, (ii) a POSITA as of the Priority Date would have understood that Aycaguer discloses a carbon dioxide recycle stream that includes C₃-C₈, or (iii) a POSITA as of the Priority Date would have understood that Aycaguer discloses a heavy hydrocarbon rich stream that includes C₉₊, Arand provides such understanding.

As explained above for claim element [1.1], Aycaguer teaches that the hydrocarbon feed stream includes liquid crude oil, which is separated from the NGLs, CO₂, and H₂S. *Supra* §IX.A.1.b. As understood by a POSITA, crude oil is the heavy condensate of this separation, as the NGLs, CO₂, and H₂S are gases that

are lighter than the heavier crude oil. EX1002, ¶234. Arand discloses that such heavy condensate includes C₉₊. EX1004, 5:45. The combination of Aycaguer and Arand thus teaches that Aycaguer's crude oil stream includes the C₉₊, and thus teaches the claimed heavy hydrocarbon rich stream separated from the hydrocarbon feed stream. EX1002, ¶234.

As explained above for claim element [1.2], Aycaguer also teaches separating the hydrocarbon feed stream into a carbon dioxide recycle stream that contains natural gas liquids. *Supra* at §IX.A.1.c. Arand discloses that natural gas liquids range from C₃-C₈. EX1004, 5:44-45. The combination of Aycaguer and Arand thus teaches that Aycaguer's carbon dioxide recycle stream contains C₃-C₈ hydrocarbons, and thus teaches the claimed carbon dioxide recycle stream. At the very least, for the reasons described for claim element [1.1], a POSITA would have found it obvious to apply Aycaguer's separation methods to a stream containing each of C₃-C₈ as expressly taught in Arand. *See supra* §IX.A.1.c; EX1002, ¶235.

The combination of Aycaguer, Soldati, and Arand therefore teaches claim element [1.2]. EX1002, ¶¶232-36.

3. Claims 2-4, 6 & 7

As explained above for Ground 3, Aycaguer and Soldati teach the additional limitations of Claims 2-4, 6, and 7. *Supra* §§IX.C.3-IX.C.7. And as explained

above for Ground 4, Aycaguer, Soldati and Ryan also teach the additional limitations of Claim 2. *Supra* §IX.D.2.

X. THE BOARD SHOULD NOT DISCRETIONARILY DENY INSTITUTION

A. Section 325(d)

Advanced Bionics and §325(d) do not support discretionary denial. The references and combinations used in the Grounds herein were not presented to the Office, and no similar references were evaluated during prosecution. Denial under §325(d) is thus unwarranted. *See Thorne Research, Inc. v. Trustees of Dartmouth College*, IPR2021-00491, Paper 18 at 8-9 (PTAB Aug. 12, 2021).

B. Fintiv (Section 314(a))

The *Fintiv* factors favor institution. This petition presents compelling evidence showing the unpatentability of the challenged claims, and thus institution should not be discretionarily denied under *Fintiv*. Although there is a case pending with Petitioners involving the '332 Patent, it was filed in July and remains at an early stage. Initial discovery and contentions have not yet been served, the parties have not briefed or argued claim construction, and any final written decision will likely be issued before trial, which is currently set for July 25, 2025. EX1013. Petitioners also note that the average time from filing to trial in the Southern

District of Texas is 30.7 months, and Petitioners intend to request a stay pending IPR. EX1014.

XI. CONCLUSION

Accordingly, Petitioners request *Inter Partes* Review of Claims 1-4, 6 & 7 pursuant to Grounds 1-6 set forth above.

Date: January 23, 2024

Respectfully submitted,

/Brian W. Oaks/

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CERTIFICATE OF COMPLIANCE WITH WORD COUNT

Under the provisions of 37 C.F.R. §42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,881 words, which is less than the 14,000 allowed under 37 C.F.R. §42.24(a)(1)(i).

Date: January 23, 2024

/Brian W. Oaks/

Brian W. Oaks

CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§42.6(e)(4)(i) *et seq.* and 42.105(a), the undersigned certifies that on January 23, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were provided by Federal Express, cost prepaid, to the Patent Owner by serving the correspondence address of record and another address known to Petitioners as likely to effect service, as follows:

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Additionally, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were served via e-mail on:

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Petitioners know this to be an additional address likely to effect service.

January 23, 2024

/Brian W. Oaks/

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