

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TOPSOE, INC.,
Petitioner

v.

L'AIR LIQUIDE, SOCIÉTÉ ANONYME POUR L'ETUDE ET
L'EXPLOITATION DES PROCÉDÉS GEORGES CLAUDE,
Patent Owner

Inter Partes Review No. IPR2025-01173

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

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TABLE OF EXHIBITS SUBMITTED WITH PETITIONER'S REPLY

Exhibit	Description
1031	Reply Declaration of Prof. Dr. Harald Klein, Jul. 13, 2026
1032	Deposition Transcript of Joseph D. Smith, Ph.D., Jul. 7, 2026

I. INTRODUCTION

For Ground 1 (anticipation), Patent Owner (“PO”) recasts Reinertsen’s express disclosures as mere “inherency” arguments, then attacks that strawman. POR, 5-9. This Reply refocuses on Reinertsen’s express teachings, which suffice for anticipation because a POSA would “at once envisage” the claimed arrangement. *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015) (quoting *In re Petering*, 301 F.2d 676, 681 (C.C.P.A. 1962)). Reinertsen expressly discloses each element of claims 1, 11, and 12.

For Grounds 2 and 3 (obviousness), PO insists that PSA H₂ separation must be categorically superior to Pd-membrane H₂ separation before a POSA would adopt it. POR, 16-19, 33-36. That is not the law. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415 (2007); *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380-81 (Fed. Cir. 2023) (a known technique need only be a “suitable option,” not the best one); *Everstar Merch. Co. v. Willis Elec. Co.*, No. 2023-1686, 2025 WL 1501940, at *3 (Fed. Cir. May 27, 2025) (rejecting a “precise quantification” requirement as “overly rigid”). The inquiry is not whether the combination is the best engineering choice, but whether it was taught, suggested, or within a POSA’s predictable grasp.

Patent Owner likewise urges the Board to disregard Darde because it purportedly teaches a less efficient, non-preferred embodiment. POR, 20-24. But “a known or obvious composition does not become patentable simply because it has

been described as somewhat inferior to some other product for the same use.” *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). And PO never addresses that Reinertsen, Rytter, and Darde present precisely the situation *KSR* describes: a design need, a finite number of identified, predictable solutions, and a POSA with “good reason to pursue the known options within his or her technical grasp.” *KSR*, 550 U.S. at 421.

Patent Owner’s “teaching away” theory fails factually and legally. A reference teaches away only if it “criticize[s], discredit[s], or otherwise discourage[s]” the claimed path; a “general preference for an alternative” does not suffice. *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009); *see also Syntex (U.S.A.) LLC v. Apotex, Inc.*, 407 F.3d 1371, 1380 (Fed. Cir. 2005) (“A statement that a particular combination is not a preferred embodiment does not teach away absent clear discouragement of that combination”). As shown below, Reinertsen and Rytter affirmatively encourage the claimed option.

As shown herein, in the Petition (Paper 1), and in Dr. Klein’s Reply Declaration (EX1031), the ’805 Patent claims a known reforming technology followed by well-established separation processes in their known order. The challenged claims should be cancelled.

II. ANTICIPATION BY REINERTSEN (GROUND 1)

It is undisputed that Reinertsen expressly teaches: (1) PSA is a feasible H₂-separation alternative (POR, 7-8); (2) when selected, PSA H₂ separation operates on

the gas output of the WGS reactor, necessarily upstream of cryogenic CO₂ separation (POR, 6); and (3) cryogenic CO₂ separation is always downstream of the chosen H₂-separation process (POR, 6-7). “[A] reference can anticipate a claim even if it ‘d[oes] not expressly spell out’ all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would ‘at once envisage’ the claimed arrangement or combination.” *Kennametal*, 780 F.3d at 1381 (quoting *Petering*, 301 F.2d at 681).

A. Patent Owner’s Hyper-Strict Reading of Reinertsen’s “Process Schemes” Is Inappropriate

Patent Owner’s Response largely ignores the text of Reinertsen, focusing instead on the fixed order of steps in individual embodiments. POR, 6-8. As PO notes, Reinertsen analyzes a number of “process schemes,” including four non-exhaustive “implementations of embodiments”:

A number of process schemes are analyzed. These include one comparative example and *a number of implementations of embodiments, four of which are summarized in Table 1* in FIG. 10. The schemes vary in WGS temperature, *use of Pd-membrane or PSA for hydrogen separation, use of amine solvents or cryogenic CO₂ separation*, as well as the position of water condensation.

EX1005, ¶[0097] (emphasis added).

Although PO insists on a strict reading of these four embodiments as prescribing a specific order of process steps, Reinertsen itself forecloses that reading with an express “no fixed order” instruction:

The flow charts and descriptions thereof herein should not be understood to prescribe a *fixed order* of performing the method steps described therein. Rather, ***the method steps may be performed in any order that is practicable***. . . . it should be understood that various changes, substitutions, and alterations apparent to those skilled in the art can be made to the disclosed embodiments without departing from the spirit and scope of the invention as set forth in the appended claims.

EX1005, ¶[0223] (emphasis added).

Patent Owner’s hyper-strict reading cannot be squared with Reinertsen’s own interpretive instruction. This is a textual point requiring no expansion of the Petition’s mapping. *See* EX1003 ¶67 (Dr. Klein characterizing Pd-membrane and PSA as “readily interchangeable”).

B. Claim Elements [1.5] & [1.6]: Reinertsen Expressly Teaches PSA H₂ Separation Upstream of Cryogenic CO₂ Separation

Patent Owner does not dispute that Reinertsen expressly teaches PSA as an option for H₂ separation and a cryogenic process as an option for CO₂ separation. *See, e.g.*, EX1005, ¶[0012] (“Preferably, the hydrogen separation process comprises a PSA process.”); ¶[0027] (“Preferably, the carbon dioxide separation process is conducted cryogenically.”); ¶[0097]. PO’s sole remaining argument concerns the order of these separations (POR, 5-9), and it is wrong.

First, cryogenic CO₂ separation occurs downstream of H₂ separation in each of the five Reinertsen embodiments that use it. EX1031 ¶19; *see* EX1005, Embodiment Example 2 (Figure 4, Element 13; ¶¶[0109]-[0110]), Embodiment Example 4 (Figure 6, Element 13; ¶¶[0114]-[0116]), Embodiment Examples 5-7

(Figure 7, Element 13; ¶¶[0122]-[0123]). Dr. Smith admitted this fact in his deposition. Smith Dep. Tr. (EX1032), 117:9-118:18 (Embodiment Examples 2, 4, and 5-7 each show the cryogenic separation unit downstream of the hydrogen removal unit); 213:5-19 (“Q. And in terms of the order of steps, when cryogenic CO₂ removal is used, it’s always downstream of the hydrogen removal. Would you agree with that? . . . A. I believe that’s correct.”).

That ordering is no coincidence: separating hydrogen first reduces the gas fed to the cryogenic CO₂ separation unit, allowing a smaller unit and lower capital and operating costs, as a POSA would have understood at the critical date. EX1003, ¶238. Dr. Smith agreed that placing cryogenic CO₂ separation after H₂ removal is a “best practice”: “[O]ne of the best practices is that you remove the component with the highest volume percent in the mixture first . . . if hydrogen has got the most composition, most volume, then you remove hydrogen first.” EX1032, 194:14-195:3. Dr. Smith further agreed that, in a steam-reforming plant, hydrogen is “most likely” the higher-volume component, such that “a POSITA would be led to remove the hydrogen first before CO₂ removal.” EX1032, 195:4-12. Although Dr. Smith noted that best practices are a “starting point” subject to case-specific evaluation (EX1032, 195:13-196:3), that starting point is precisely the ordering recited in the claims. EX1031, ¶20.

Reinertsen expressly describes the PSA as operating on the gas output of the WGS reactor: “Embodiments may alternatively use PSA to separate hydrogen from the gas output from the WGS reactor.” EX1005, ¶85. That placement is necessarily upstream of any CO₂ removal, consistent with Reinertsen’s teaching that cryogenic CO₂ separation occurs downstream of H₂ separation. EX1031, ¶15. The sentence parallels Reinertsen’s description of its preferred membrane two paragraphs earlier: “Embodiments preferably separate hydrogen from the gas output from the WGS reactor using a membrane. In particular, a Pd-film membrane may be used.” EX1005, ¶[0083]. PSA is thus a direct substitute for Pd-membrane at the same position (Unit 12 of Figures 3-7), operating on the full, CO₂-containing shifted gas. EX1005, ¶[0085] (“CO, CO₂ and CH₄ are adsorbed”); EX1031, ¶15.

Dr. Smith’s contrary opinion—that the “alternatively” sentence of ¶[0085] refers to “alternative embodiments” of the Figure 2 type, in which amine CO₂ removal precedes the PSA (EX2021, ¶37; POR at 6-8)—cannot be reconciled with Reinertsen’s own text. In Figure 2, the PSA (Unit 10) does *not* receive “the gas output from the WGS reactor.” Reinertsen states expressly that in Figure 2, the PSA “separates the hydrogen from the gas 82 *that has already been depleted of CO₂* by the [amine type separation] process 8.” EX1005, ¶[0103] (emphasis added). The only configuration disclosed in Reinertsen in which a PSA separates hydrogen “from the gas output from the WGS reactor”—the words of ¶[0085]—is therefore one in

which the PSA occupies the Unit-12 position of Figures 3-7, upstream of CO₂ separation. EX1031, ¶16. Dr. Smith's reading does not place ¶[0085] "in context"; it rewrites it.

Dr. Smith's deposition testimony confirms this plain reading. He agreed that ¶[0085] "does say after . . . from the water-gas shift means it's after the water-gas shift" (EX1032, 150:9-151:8), and that a reading under which the PSA "is right after the water-gas shift" is a reading a POSA "would believe . . . as well" (EX1032, 191:16-192:14). Nor do claim elements [1.5] and [1.6] require the PSA to sit immediately after the WGS reactor with no intervening equipment; the claims use the open transition "comprising" and require PSA separation of the fourth (shifted) synthesis gas stream, with cryogenic separation of the resulting residual stream. EX1031, ¶17; *Invitrogen Corp. v. Biocrest Mfg., L.P.*, 327 F.3d 1364, 1368 (Fed. Cir. 2003) ("comprising" in a method claim indicates that the claim is open-ended and allows for additional steps). The cooling and water condensation between the WGS reactor and the PSA taught by Reinertsen (EX1005, ¶[0085]), Rytter (EX1009, p.12/35, l.29), and Darde (EX1008, p.9, l.37-p.10, l.3, steps e)-g)) are consistent with these elements. Under any reading, the PSA operates on the shifted, CO₂-containing gas upstream of CO₂ separation.

C. Claim 11: Reinertsen Expressly Teaches Compression of the CO₂-Rich Product Stream Following PSA H₂ Separation

PO's Response rests on a strawman—that no compression would be required for cryogenic CO₂ removal if Reinertsen's Pd-membrane embodiment were selected for upstream H₂ separation. POR, 10-12. That ignores Reinertsen's express teaching concerning the need for compression when PSA H₂ separation is implemented, which is the relevant teaching for claim 11.

Reinertsen expressly teaches that “[e]mbodiments may alternatively use PSA to separate hydrogen from the gas output from the WGS reactor.” EX1005, ¶[0085]. Reinertsen then teaches that the H₂ product from the PSA unit is “released at low pressure, e.g. atmospheric pressure, and so there is a subsequent need for compression and cooling. Still, it can be feasible to use PSA for some hydrogen production plants.” EX1005, ¶[0056]. This is dispositive: Reinertsen expressly teaches compressing the feed to cryogenic CO₂ separation when PSA H₂ separation is performed upstream.

Dr. Smith conceded this at his deposition when confronted with Reinertsen ¶[0056]: “So there is a subsequent need for compression and cooling. Agree completely. . . . We do need a compression step. In the PSA unit we have atmospheric CO₂ coming out. If you're going to use it, you're going to compress it . . . you're going to use it to separate it cryogenically.” EX1032, 161:11-162:22. Asked whether

one reason for that compression “would be for the CO₂ syngas to be fed to a cryogenic CO₂ unit,” Dr. Smith answered: “Agreed.” EX1032, 162:23-163:4.

Rather than addressing Reinertsen’s express compression teaching, PO focuses on a different, inapposite embodiment—the selection of Pd-membrane for H₂ separation upstream of cryogenic CO₂ separation. POR, 10-12. As Dr. Klein explains, although it may be theoretically possible to omit additional compression if the pressure entering the cryogenic unit is already high enough, that is relevant only to Pd-membrane embodiments that release CO₂ at higher pressures—not to PSA, where the feed to the cryogenic CO₂ separation unit is necessarily at low pressure. EX1031, ¶23. Darde confirms and quantifies this—the PSA offgas is at a pressure “below 2 bar(a)” (EX1008, p.8, ll.8-11) and must be compressed to “between approximately 20 and 100 bar(a)” for cryogenic purification (EX1008, p.8, ll.24-30). PO’s own prior art *Technology Handbook* also lists typical PSA offgas pressures of 1.1 to 10 bara, while the H₂ product “is delivered at a pressure close to feed pressure” (EX1018, p.38/108). Dr. Smith agreed that a POSA choosing PSA would know that “you are not going to need a hydrogen compressor, but you are going to need a compressor to compress . . . the CO₂-rich stream for cryogenic separation.” EX1032, 115:11-116:1.

Patent Owner’s contrary argument rests on out-of-context fragments of Dr. Klein’s deposition. POR at 10-13. Dr. Klein’s testimony that Figure 4 shows no

compressor between units 12 and 13 (EX2023, 99:6-9) described the Pd-membrane embodiment as drawn; it says nothing about the PSA path, and even in the membrane case some compression may still be required depending on the natural gas supply pressure (EX2023, 81:20-83:10). His testimony that no compression is required “[i]f the pressure would be high enough” (EX2023, 104:2-11) was expressly conditional—a condition a PSA tail gas released at approximately atmospheric pressure can never satisfy (EX1005, ¶[0056]). And the approximately 32 bar figure (EX2023, 106:22-108:23) is the pressure of the shifted gas at the WGS outlet—the PSA feed, and hence approximately the pressure of the hydrogen product—not the pressure of the PSA offgas. The POR transplants that number onto the wrong stream, as Dr. Smith’s own testimony confirms. EX1031, ¶24; EX1032, 159:5-8.

III. OBVIOUSNESS OVER REINERTSEN + DARDE (GROUND 2) AND RYTTER + DARDE (GROUND 3)

A. Patent Owner Applies the Wrong Legal Standard for Obviousness

Patent Owner demands that PSA H₂ separation be categorically superior to Pd-membrane to support the Grounds 2 and 3 combinations. POR, 16-19, 33-36. That is not the law. Under *KSR*, the question is whether PSA is a “suitable option,” *Intel*, 61 F.4th at 1380-81, among a “finite number of identified, predictable solutions,” *KSR*, 550 U.S. at 421. Where such a finite set exists, selecting one of the known options can be obvious. *Id.* A motivation to combine may rest on the choice

between two known alternatives. *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020).

A POSA's motivation to combine also exists where a known technique would improve a similar device or process "in the same way," and the technique need not be the best option—only a suitable one. *Intel*, 61 F.4th at 1380-81. A modification of the primary reference can be obvious even if it introduces tradeoffs, *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006), and "no precise quantification" of the benefit is required, *Everstar*, 2025 WL 1501940, at *3.

B. Neither Reinertsen nor Rytter Teach Away from PSA For H₂ Separation

Teaching away requires criticism, discrediting, or discouragement—not mere preference for one alternative. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). Here, Reinertsen and Rytter both affirmatively identify PSA H₂ separation as a feasible alternative.

Reinertsen expressly identifies PSA as "[p]referabl[e]" for the hydrogen separation process (EX1005, ¶[0012]), as an "alternative" operating on the WGS output (EX1005, ¶[0085]), and as "feasible" (EX1005, ¶[0056]). Rytter likewise identifies PSA as a known H₂-separation technology (EX1009, p. 8/35, 1.18-23) and describes "using any known technique for hydrogen and carbon dioxide separation" (EX1009, p. 12/35, 1.30).

Indeed, Reinertsen frames the relevant tradeoff in terms favoring technologies, like PSA, that keep the hydrogen at pressure: “As it is more demanding to pressurize hydrogen than CO₂, separation technologies that provide hydrogen at high pressure are sometimes preferred. This benefit can, however, be outweighed by the efficiency of a hydrogen-permeable membrane.” EX1005, ¶[0088]. Rytter contains the same teaching nearly verbatim. EX1009, p.13/35, ll.2-9. A reference that identifies the claimed option as “sometimes preferred”—and describes the countervailing membrane benefit as one that merely “can” outweigh it—does not criticize, discredit, or discourage that option. EX1031, ¶27.

Reinertsen’s observation that vendor pricing for its comparative example showed PSA to be “considerably more costly than using a Pd-membrane” (EX1005, ¶¶[0118]-[0119]) does not change the analysis. That intra-reference cost preference explains why Reinertsen’s authors favored their own membrane examples; the same reference simultaneously calls PSA “feasible” (¶[0056]) and preferable (¶[0012]), and a POSA would have understood a vendor-price projection premised on pilot-scale membrane technology to be a projection, not commercial experience. EX1031, ¶31; EX1032, 180:14-181:7.

It is black-letter law that a prior art reference disclosing an option as an alternative does not “teach away” from that option. *Galderma Labs., L.P. v. Tolmar*,

Inc., 737 F.3d 731, 738 (Fed. Cir. 2013); *Fulton*, 391 F.3d at 1201 (“mere disclosure of alternative designs does not teach away”).

C. Patent Owner’s “Inferior Purity and Recovery” Argument Would Not Have Discouraged a POSA

Patent Owner attempts to manufacture a teaching away from purity and recovery numbers in Reinertsen and Darde that a POSA would have recognized as neither accurate nor limiting. POR, 13, 16-22. A reference teaches away only if it would **actually** discourage a POSA from pursuing the claimed approach. *Fulton*, 391 F.3d at 1201; *Gurley*, 27 F.3d at 553. These numbers would not have.

First, PO’s premise that Reinertsen “already performs” at a 93% H₂ capture rate and 99.9% purity (POR, 13, 16-18) mistakes a modeling assumption for a result. Reinertsen states its simulation inputs expressly: “in membrane cases, 93% H₂ separation is assumed.” EX1005, ¶[0100] (emphasis added). The “H₂ recovery factor” shown for the membrane cases in Figure 11 reflects that assumed input, and a POSA would not treat an assumed figure for a technology that had never operated beyond pilot scale as a benchmark an alternative must exceed. EX1031, ¶39; EX2023, 118:11-23; EX1032, 178:16-179:12, 180:14-181:7.

Second, Dr. Smith’s purity comparison (99.9% Pd-membrane versus “99%” PSA, EX2021, ¶59) sets a floor against a maximum. Darde’s “greater than 99%” is a claimed minimum—“a stream of hydrogen . . . having a purity of at least 99%” (EX1008, p.10, ll.1-3, step g))—not the maximum the disclosed PSA can achieve.

EX1031, ¶40. A POSA would have known that commercial PSA achieves H₂ purities up to 99.9999%, with recovery of 60-90% as a design-selectable parameter—figures readily verifiable from PO’s own prior art *Technology Handbook*. EX1018, p.38/108; *see also* EX1019, p.3/6; EX1016; EX1031, ¶39. Patent Owner’s own Ground 3 purity benchmark proves the point: Rytter’s hydrogen specification of “≥ 99.97 mol% for fuel cells” is satisfied in Rytter’s Figure 3 simulation, in which the hydrogen is separated by PSA. EX1009, p.15/35, ll.24-28; EX1031, ¶40. The very purity figure PO cites as evidence of PSA’s inferiority was achieved with PSA.

Third, single-pass recovery differences do not translate into lost hydrogen in these integrated processes: Reinertsen’s PSA rest gas is used as fuel or recycled to the reformers at rates of at least 50%, 80%, or 90%, and Rytter likewise recycles the off-gas “for maximum carbon efficiency.” EX1005, Abstract, ¶¶[0057], [0061], [0081], [0103]; EX1009, p.15/35, ll.20-21; EX1031, ¶41. And the 86% PSA recovery in Reinertsen’s comparative example sits within the 60-90% commercial design range published by PO itself. EX1018, p.38/108.

Dr. Smith conceded the point at deposition: PSA purity is a design parameter (“99, 99.9 is not unreasonable to expect”); “99 versus 99.9 versus 99.9999, that’s pretty high”; and—directly contrary to his declaration, where purity was his deciding consideration (EX2021, ¶59)—purity “won’t be a deciding factor for me.” EX1032, 197:15-199:5, 202:1-6, 203:5-6; EX1031, ¶42.

Patent Owner's remaining performance points fare no better. Reinertsen's statement that a plant is "not favorably designed for separating a pure CO₂-stream for storage" (POR, 25-26) describes, in context, a historical ammonia-plant design that included no CO₂ capture unit at all; the criticism is of venting CO₂, not of PSA—and it articulates the very design need (capture the CO₂) that motivates adding cryogenic capture downstream of a PSA. EX1005, ¶¶[0093]-[0094]; EX1031, ¶43. And Dr. Smith's suggestion that a POSA would "suspect" unfavorable capture rates from Darde's silence (EX2021, ¶¶48-52) is speculation contradicted by PO's own documents: Darde's cryogenic unit achieves CO₂ purities greater than 99% (EX1008, p.8, ll.20-21), and Air Liquide's commercial embodiment of cryogenic capture applied to PSA offgas—Cryocap H₂—advertises "[m]ore than 98% of CO₂ recovery from syngas." EX1018, p.24/108; EX1031, ¶¶44-45.

Dr. Smith's reading also ignores the commercial reality a POSA would have known: PSA was (and remains) the dominant commercial H₂-separation technology, while Pd-membrane technology was essentially pre-commercial. EX1031, ¶30. PO's own *Technology Handbook* (Feb. 2018) identified more than 70 PSA references "in operation or under construction" (EX1018 at p.38/108) while listing no Pd-membrane H₂ separation; its only H₂ membrane offering is a polymeric hollow-fiber membrane used to recover H₂ from a refinery purge gas (EX1018, p.42/108). EX1031, ¶30. Dr. Smith confirmed that he was aware of no commercial Pd-

membrane installation in operation or under construction for a steam-reforming plant (EX1032, 180:14-181:7), and that in 2020 “palladium membrane was the exception, PSA hydrogen removal was the rule” (EX1032, 204:11-15).¹

D. PSA Off-Gas Low Pressure Does Not Defeat Motivation to Combine

Patent Owner argues that compression of PSA off-gas is a “burden” that would deter a POSA from combining Reinertsen or Rytter with Darde. POR, 18, 28-30, 46-49. This so-called burden does not defeat obviousness as a matter of law, because even a less-preferred embodiment can render a claim obvious if the prior art teaches or suggests it. *Meiresonne v. Google, Inc.*, 849 F.3d 1379, 1382 (Fed. Cir. 2017) (citing *Galderma Labs., L.P. v. Tokmar, Inc.*, 737 F.3d 731, 738 (Fed. Cir. 2013)); *Fulton*, 391 F.3d at 1200. As discussed in Section II.C, *supra*, Reinertsen expressly teaches that the CO₂-rich product stream from the PSA unit is “released at low pressure, e.g. atmospheric pressure, and so there is a subsequent need for compression and cooling. Still, it can be feasible to use PSA for some hydrogen

¹ The Reinertsen and Rytter Pd-membrane performance metrics cited by Dr. Smith are not POSA design targets; they reflect the common assignee Reinertsen New Energy AS’s promotional framing of its developmental Pd-membrane technology. EX1031, ¶¶31, 39; EX1005; EX1009.

production plants.” EX1005, ¶[0056]. Reinertsen thus not only teaches PSA H₂ separation and the attendant compression, but characterizes the scheme as “feasible,” not a burden defeating motivation.

Dr. Smith’s declaration never addresses the tradeoffs between Pd-membrane and PSA H₂ separation. A combination can be obvious even if it introduces tradeoffs. *Medichem*, 437 F.3d at 1165. Reinertsen and Rytter disclose, and a POSA would readily understand, that the two alternatives present a direct tradeoff between compressing the product H₂ (Pd-membrane) and compressing the feed to the cryogenic CO₂ separation unit (PSA), and that H₂ compression is far more complicated and expensive than CO₂ compression in CAPEX, OPEX, and safety. EX1031, ¶¶26-28.

Although Dr. Smith did not address these facts in his declaration, he agreed with Dr. Klein’s analysis at deposition, including the safety concerns unique to H₂ compression. EX1032, 142:13-144:9 (H₂ compression required for Pd-membrane H₂ separation; unique safety considerations; special seals; contributes to CAPEX and OPEX); 167:1-171:7 (H₂ embrittlement, diffusivity, flammability, leak detection; no CO₂ analogue). Indeed, when Dr. Klein’s deposition testimony at EX2023, 124:22-125:8 was read to Dr. Smith, he adopted it without qualification: “I do. . . . it’s more complicated to compress hydrogen than it is to compress CO₂, and

I agree with that”; a POSA “would weigh . . . that trade-off” (“Sure”); and the tradeoff “definitely would affect CapEx and OpEx.” EX1032 164:22-166:4.

A POSA would understand that PSA is the commercial choice for H₂ separation in syngas production. EX1031, ¶30; EX2023 at 118:11-23; *see* Section III.C, *supra*.

E. Patent Owner’s Attack on the “Two Options” (Ground 2) and “Six Options” (Ground 3) Analyses Conflates H₂ Separation with CO₂ Separation

Dr. Smith argues that Dr. Klein’s “finite options” analysis rests on a “false premise” because Reinertsen and Rytter allegedly disclose many more H₂-separation options—pointing to absorption, “temperature swing” adsorption, and combinations of solid and liquid membranes. EX2021, ¶¶72, 98; POR, 22-23, 38-39. That argument conflates CO₂-separation techniques with H₂ separation. EX1031, ¶37.

Reinertsen’s absorption discussion is explicitly about removing CO₂, the acid gas—not about producing a hydrogen product. EX1005, ¶[0082]; EX1009, p.11/35, l.30-p.12/35, l.9. The “combination of solid membranes and liquid membranes” achieves “a rapid permeation of CO₂, while H₂ is kept back”—again a CO₂-selective route, not an additional H₂-separation technology. EX1005, ¶[0085]; EX1009, p.12/35, ll.19-20. And the temperature-swing sentence of ¶[0085] describes a variant within the same adsorption family as PSA. EX1031, ¶¶37, 48. For separating a H₂ product from shifted syngas, Reinertsen and Rytter each identify exactly two

technologies: a hydrogen-selective membrane, preferably a Pd-membrane, and PSA. EX1005, ¶¶[0011]-[0012], [0083]-[0085], [0097]; EX1009, p.12/35, ll.10-29, p.13/35, ll.7-9.

That two-option framing matched commercial reality. Dr. Smith agreed that PSA was “the proven way commercially to separate hydrogen from syngas” (EX1032, 203:11-14), that a POSA would have been “much more familiar with PSA technology than membrane separation technology” (EX1032, 185:20-186:2), and that PSA had reached a technology-readiness level of roughly 8-10 versus roughly 5-7 for membranes (EX1032, 178:16-179:12, 185:13-19).

Patent Owner’s arithmetic of “six possibilities, much less 14” (POR, 39) inflates the count only by mixing in unclaimed CO₂-separation techniques and their permutations. In any event, the law does not require that the claimed selection be the only, or even the best, option among those disclosed; it is enough that PSA H₂ separation was an expressly identified, suitable option. *KSR*, 550 U.S. at 421; *Uber*, 957 F.3d at 1339; *Fulton*, 391 F.3d at 1200. Both Reinertsen and Rytter unequivocally so identify it. EX1005, ¶[0097] (“use of Pd-membrane or PSA hydrogen); EX1009, p.4/35, ll.8-12 (“Preferably, hydrogen is separated by one or more of a PSA unit, a membrane that is optionally a Pd-membrane”). PO’s unsupported assertion that PSA is nonetheless not “suitable” is attorney argument,

not evidence. *Icon Health & Fitness, Inc. v. Strava, Inc.*, 849 F.3d 1034, 1043 (Fed. Cir. 2017).

F. Patent Owner’s Critique of Dr. Klein’s “Routine Optimization” Testimony Ignores the Express Teachings of Reinertsen, Rytter, and Confirmed by Darde

Patent Owner insists that Dr. Klein’s opinions fail because he did not perform detailed process modeling. POR, 24-25, 29-30, 39. But the implementation details PO demands are supplied by the references themselves, and adapting a primary reference to accommodate a secondary reference’s teaching does not defeat obviousness where adaptation is within the ordinary skill. *Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016). Obviousness requires only a reasonable expectation of success, not absolute predictability. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1364 (Fed. Cir. 2007); EX1031, ¶ 58.

Both Reinertsen and Rytter contain the express “no fixed order” instruction quoted in Section II.A, *supra*—the method steps “may be performed in any order that is practicable,” and “changes, substitutions, and alterations apparent to those skilled in the art” may be made. EX1005, ¶[0223]; EX1009, p.25/35, ll.20-25. Reinertsen further acknowledges that a POSA would understand how to compare process alternatives based on known boundary conditions. EX1005, ¶[0100].

Both references also teach the process considerations for accommodating PSA H₂ separation upstream of cryogenic CO₂ separation. Reinertsen teaches: PSA H₂ separation occurs on the gas output of the WGS reactor, with water condensation before the PSA unit to avoid overloading the adsorbent (EX1005, ¶[0085]); WGS operation may vary across embodiments, and WGS severity would be adapted if substituting PSA for Pd-membrane (EX1005, ¶¶[0080]-[0081]); and the CO₂-rich stream from the PSA is released at low pressure and therefore requires subsequent compression and cooling before cryogenic CO₂ separation (EX1005, ¶[0056]). Rytter teaches the same: PSA H₂ separation is performed on the shifted gas output from the WGS reactor (EX1009, p.4/35, ll.32-33); water is condensed before the PSA unit (EX1009, p.12/35, l.29); the WGS arrangement follows from the H₂-separation choice (EX1009, p.11/35, ll.25-29); and PSA delivers the H₂ product at process pressure while the separated CO₂ “has to be brought to high pressure and in liquid form” for transport and storage (EX1009, p.12/35, ll.27-28, p.13/35, ll.1-9). Darde confirms each consideration. EX1008, p.7/23, ll.30-37 (WGS conversion; substantially pure H₂ product); p.9/23, l.37-p.10/23, l.3 (cooling and water condensation, steps e)-g)); p.8/23, ll.24-30 (compression of the CO₂-rich offgas for cryogenic separation). EX1031, ¶¶56-59.

Dr. Smith agreed with every relevant principle at deposition: chemical engineers possess a “toolbox” of standard options and best practices (EX1032 76:9-

77:15, 81:1-10); a POSA can determine the compression requirements for these arrangements by hand or with standard tools such as Aspen (EX1032, 113:3-22); the PSA-then-cryogenic ordering is “within a toolbox of a person of ordinary skill in the art” (EX1032, 134:16-135:3); best practice would lead a POSA to remove the hydrogen first (EX1032, 194:8-195:12); and, when Reinertsen offers PSA as an alternative, “a person of ordinary skill in the art would know how to apply that in the Reinertsen process” (EX1032, 204:16-21). That final admission—from PO’s own expert—concedes a reasonable expectation of success. EX1031, ¶35.

Patent Owner’s related “incompatibility” arguments (POR at 27-29, 43-46) fail for the same reasons. Rytter itself teaches that the WGS arrangement follows from the separation choice (EX1009, p.11/35, ll.25-29), and Dr. Smith agreed that selecting WGS severities, temperatures, and reactor counts are “tools in the toolbox” of a POSA (EX1032, 81:1-10). The supposed “incompatibility” of a 2 bar(a) PSA offgas with a cryogenic unit is no incompatibility: it is the compression step that all three references teach and that claim 11 expressly recites. EX1031, ¶52.

Finally, the POR’s characterization of Dr. Klein’s deposition testimony as a concession (POR at 24-25, 29) omits his explanation on redirect: “[T]o find a general judgment of all the options and the pros and the cons of all the options, it’s not required to do a detailed calculation.” EX2023, 124:14-21. The pros and cons of the two disclosed H₂-separation options—pressure allocation, compression duty, purity,

maturity, safety—are stated in the references themselves and were common knowledge to a POSA, as Dr. Smith’s own testimony confirms. EX1031, ¶61.

G. Patent Owner’s Rytter-Specific Arguments Fail

Patent Owner’s remaining Ground 3 arguments (POR at 30-49) fare no better. First, Rytter points a POSA directly to the claimed arrangement: it recites “performing a water-gas-shift on the gas output from the reforming processes; and separating hydrogen from the shifted gas” (EX1009, p.4/35, ll.32-33); its PSA description is materially identical to Reinertsen’s (EX1009, p.12/35, ll.21-29); and it expressly discloses the claimed ordering—“Embodiments also include the hydrogen being separated from the gas mixture before the carbon dioxide is separated from the gas mixture.” EX1009, p.20/35, ll.7-10; EX1031, ¶47.

Second, PO’s argument that amine CO₂ capture outperforms cryogenic capture (POR at 35-36; EX2021, ¶¶92, 94-96) is beside the point. The claims recite cryogenic CO₂ separation; the question is whether the claimed process configuration was obvious (i.e., PSA H₂ separation upstream of cryogenic CO₂ separation), not whether an unclaimed amine alternative might also have been chosen. *Fulton*, 391 F.3d at 1200; *In re Mouttet*, 686 F.3d 1322, 1334 (Fed. Cir. 2012). In any event, the art commends the cryogenic choice: Reinertsen prefers cryogenic separation as “a cost and energy efficient method” that delivers CO₂ “directly in the liquid form” needed for transportation to a deposition site (EX1005, ¶¶[0059]-[0060], [0086]),

and PO itself selected cryogenic capture for its commercial Cryocap™ technology (EX1018, pp.7, 24/108). EX1031, ¶49.

Third, PO's assertion that a POSA reversing Rytter's order "would have selected" a Pd-membrane rather than PSA (POR at 35-36, 48-49; EX2021, ¶¶93, 99-102, 114) rests on the purity and pressure premises rebutted in Sections III.C and III.D, *supra*. Rytter itself describes the membrane's efficiency as a benefit that merely "can" outweigh the hydrogen-at-pressure advantage of technologies like PSA (EX1009, p.13/35, ll.8-9), and the selection actually made at commercial scale, overwhelmingly, was PSA. EX1031, ¶50.

Fourth, for claim 11 (POR at 46-49), the analysis of Section II.C applies with equal force: if PSA is used, the CO₂-rich tail gas is inherently released at low pressure regardless of the approximately 32 bar feed pressure—that is how PSA regeneration works (EX1009, p.12/35, ll.26-27)—so compression of that stream before cryogenic separation is required, exactly as Rytter, Reinertsen, and Darde each teach and as Dr. Smith conceded. EX1009, p.13/35, ll.1-4; EX1005, ¶[0056]; EX1008, p.8, ll.8-11, 24-30; EX1032, 115:11-116:1, 161:11-163:4; EX1031, ¶51.

H. Dr. Smith's Testimony Is Entitled to Little Weight

Dr. Smith's declaration largely recites the references' purity and recovery figures without independent technical analysis, and its central premises did not survive his deposition. Expert testimony that consists of conclusory assertions

unsupported by underlying facts or data is entitled to little or no weight. 37 C.F.R. § 42.65(a); *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 at 15 (PTAB Aug. 24, 2022) (precedential); *TQ Delta, LLC v. Cisco Sys., Inc.*, 942 F.3d 1352, 1358-59 (Fed. Cir. 2019).

The declaration’s deciding consideration—PSA’s supposedly inferior purity (EX2021, ¶59)—was abandoned at deposition, where Dr. Smith testified that purity “won’t be a deciding factor for me.” EX1032, 202:1-6; *see* Section III.C, *supra*. And while Dr. Smith criticizes Dr. Klein for not performing simulations, his own declaration identifies no simulation, no comparative energy or cost analysis, and no design study; his performance comparisons consist of reading assumed values from Reinertsen’s Figure 11 and quoting purity figures whose significance he disclaimed. EX1031, ¶60. He confirmed that he has never himself simulated a PSA unit. EX1032, 17:20-18:8. A POSA, moreover, “is also a person of ordinary creativity, not an automaton.” *KSR*, 550 U.S. at 421.

IV. CONCLUSION

Dr. Smith’s own deposition testimony confirmed each material fact underlying Dr. Klein’s opinions. EX1031, ¶62. For the foregoing reasons and those set forth in the Petition, claims 1-6, 11, and 12 of the ’805 Patent should be cancelled.

Respectfully submitted,

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CERTIFICATION OF WORD COUNT COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), I hereby certify that this Reply to Patent Owner's Response complies with the type-volume limits of 37 C.F.R. § 42.24(c)(1). As calculated by the word count feature of the word-processing system used to prepare this Reply, it contains 5,588 words, excluding parts of the Reply that are exempted by 37 C.F.R. § 42.24(a)(1) (including a table of contents, a table of authorities, and a certificate of service or word count).

Date: July 13, 2026

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), I certify that on this 13th day of July, 2026, a true and correct copy of the foregoing Petitioner's Reply to Patent Owner's Response was served by electronic mail on Patent Owner's lead and backup counsel at the following email addresses:

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