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

Case IPR2025-01173
Patent No 11,673,805

PATENT OWNER PRELIMINARY RESPONSE

TABLE OF CONTENTS

PATENT OWNER'S EXHIBIT LIST

Exhibit	Shorthand	Description
2001	Darde-US	U.S. Patent Application Pub. No. 2015/0321914
2002		File History of U.S. Patent Application Pub. No. 2015/0321914
2003	Reinertsen-PCT	PCT Publication WO 2021/175662
2004	Reinertsen FW	File History of U.S. Patent Application Pub. No. 2023/0119784
2005		Search Results of Subclasses from Google Patents available online at: https://patents.google.com/?q=(C01B3%2f40+OR+B01D53%2f047+OR+C01B3%2f48+OR+C01B2203%2f0233+OR+C01B2203%2f0244+OR+C01B2203%2f0405+OR+C01+B2203%2f042+OR+C01B2203%2f046+OR+C01B2203%2f1058+OR+C01B2203%2f1241+OR+B01D53%2f002+OR+C01B32%2f50+OR+B01D53%2f22+OR+B01D2256%2f16+OR+BO1D2257%2f504+OR+CO1B2203%2f0283+OR+CO1B2203%2f043+OR+C01B2203%2f0475+OR+C01B2203%2f147+OR+Y02C20%2f40+OR+Y02P20%2f151+OR+C01B3%2f56+OR+C01B3%2f38+OR+C01B3%2f503+OR+C01B3%2f506+OR+C01B2203%2f0261+OR+C01B2203%2f0811+OR+C01B2203%2f1235+OR+C01B3%2f382+OR+F25J3%2f067+OR+F25J3%2f08+OR+C01B2203%2f0833+OR+C01B2203%2f0838)&country=WO,US,EP,JP&before=filing:20221005
2006	Search Printout	Listing of Patent Families in Examiner's Search Printout from the '805 Patent File History
2007	Kresnvak	U.S. Patent Application Pub. No. 2015/0141535
2008	Family 1	Espacenet Listing of Patent Family for WO2006042986A1

Exhibit	Shorthand	Description
2009	Family 2	Espacenet Listing of Patent Family for WO2022178439A1
2010	Family 4	Espacenet Listing of Patent Family for WO2010022162A2
2011	Family 5	Espacenet Listing of Patent Family for WO2007123673A1
2012	Family 6	Espacenet Listing of Patent Family for WO2014005745A1
2013	Family 7	Espacenet Listing of Patent Family for CN113795460A
2014	Family 8	Espacenet Listing of Patent Family for WO2014091097A1
2015	Family 9	Espacenet Listing of Patent Family for JP5677659B2
2016	Family 10	Espacenet Listing of Patent Family for WO2014091098A1
2017	Family 11	Espacenet Listing of Patent Family for WO2015173290A1
2018	Family 14	Espacenet Listing of Patent Family for WO2019162236A1
2019	’805 Patent Family	Espacenet Listing of Patent Family for US11673805B2
2020	L’Air Liquide Publications	Espacenet Listing of Patent Family for US20210155478

I. Introduction

Institution should be denied because the Petition fails to demonstrate a reasonable likelihood of success on any of the sole independent claim or any of its respective dependents. This is so for each of two independent reasons.

First, all of Grounds 1-3 rely on an ***inherency*** theory to meet Claim Element [1.2.1]'s recitation of a first synthesis gas stream comprising CO_2 produced by the endothermic reforming step (mapped to a gas heated reformer or GHR). To start, the portion of Reinertsen and Rytter cited as allegedly disclosing this feature instead addresses what Petitioner maps to the *third* synthesis gas stream of Element [1.3.1]. As to what Petitioner maps to the *first* synthesis gas stream of Element [1.2.1.], testimony from Petitioner's own expert, Dr. Klein, unambiguously undermines Petitioner's inherency theory. In particular, Dr. Klein's sole identification of alleged CO_2 in the output of Reinertsen's or Rytter's GHR is that CO_2 is ***almost*** always present. That necessarily falls short of the "necessarily present" inherency standard.

Second, Grounds 2 and 3 each fail because none of Petitioner's purported "motivations" would have led a POSITA to the particular combination of features on which the Petition relies. For example, the Petition generically relies on the common purpose of all of Reinertsen, Rytter, and Darde to produce hydrogen with CO_2 capture, and the benefits touted by Reinertsen and Rytter of their dual-reforming configuration. But each of Reinertsen and Rytter already disclose hydrogen separation that is superior to that of Darde, and other generic benefits already disclosed by Reinertsen and Rytter could not have motivated a POSITA to modify Reinertsen and Rytter themselves.

As explained in PO's Request for Discretionary Denial, all three references were before the Examiner, who reasonably concluded that the claims were patentable over all three. *See* Paper 9, 2-9. Institution should therefore be denied.

II. The Petition Maps Only the Series Configuration of Claim 1

The sole independent claim—Claim 1—recites two options for the configuration of the endothermic reforming step and the autothermal reforming step: (1) a series configuration and (2) a parallel configuration. *Compare* EX1001, FIG. 14:57-67 (parallel: mixing respective outputs of parallel endothermic reforming and autothermal reforming) *with id.*, 15:1-3 (series: routing first synthesis gas output of endothermic reforming as a feed into an autothermal reforming step). Examples of these two alternative configurations are also shown in the figures of the '805 Patent.

Figure 2 (annotated below) shows an example of the parallel configuration. *See* EX1001, 9:28-31 ("parallel arrangement of the reforming units for the endothermic and autothermal reforming steps"). In the parallel configuration, "[a] feed gas stream FG is divided into two substreams," a first of which "is introduced into an [blue] endothermic reforming unit 200" and the second of which is "introduced into an [red] autothermal reforming unit 201." EX1001, 11:16-23.

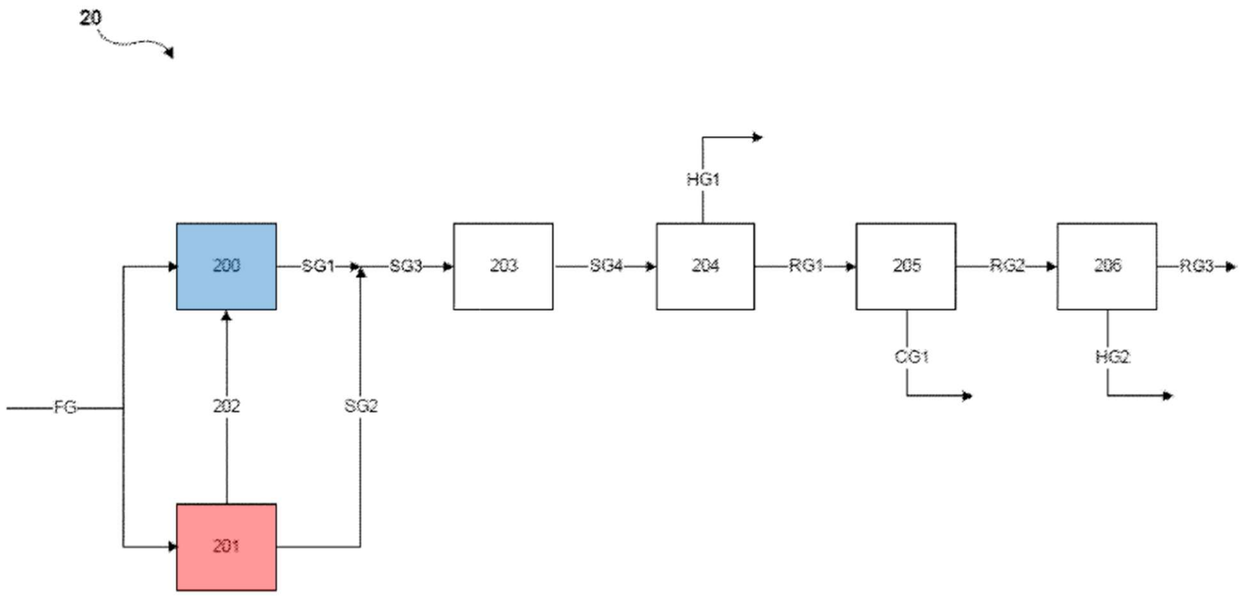

Fig. 2

Figure 3 (annotated below) shows an example of the series configuration. *See* EX1001, 9:32-35 ("series arrangement"). In the series configuration, "[a] feed gas strem FG is introduced into an [blue] endothermic reforming unit 200 and converted into a synthesis gas stream SG1" that "is [next] converted not to a synthesis gas stream in the [red] autothermal reforming unit 201." EX1001, 13:9-13.

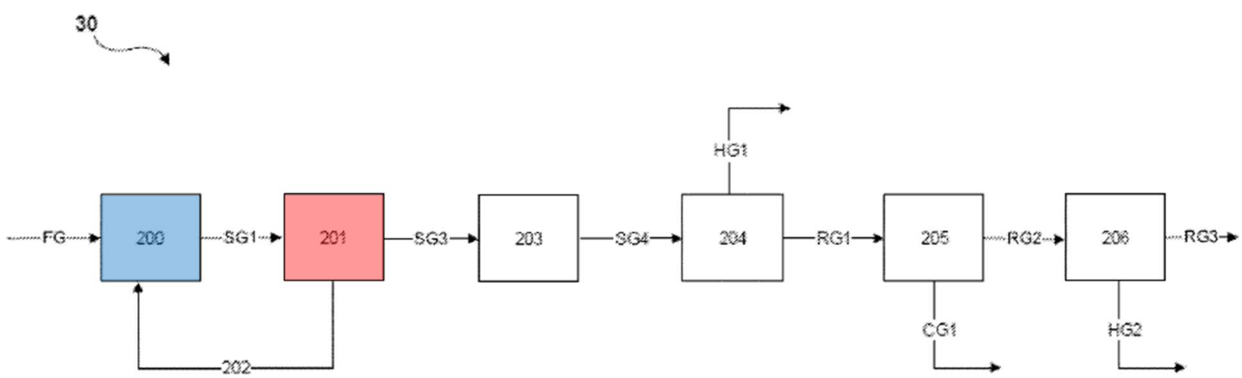

Fig. 3

Of these two configurations, the Petition in this proceeding addresses only the series configuration. *See, e.g.*, Pet., 10 ("Reinertsen describes a dual reformer arranged in a ***series*** configuration"), 14 ("Figure 1 of Rytter illustrates a process including a GHR and an ATR arranged in a series configuration"); *see also* Paper 3, 4 (contrasting with the different "01174 'Parallel' Petition"—"the 'Series' Petition (Petition 1, IPR2025-01173) demonstrates that it was known and/or obvious to employ such a [series] configuration").

Thus, the Petition maps only the series configuration of claim 1.

III. Claim Construction

The claims are interpreted according to the Phillips claim construction standard. 83 Fed. Reg. 51340, 51340-44 (Oct. 11, 2018); Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*).

Patent Owner does not believe formal constructions are necessary to understand what is claimed. Nevertheless, the Petition glosses over key differences between the claims and the cited art, and the below summaries are therefore included to illuminate certain features of the claims.

A. first synthesis gas stream

Element 1.2 recites "reforming at least a portion of the feed gas stream in an endothermic reforming step over a reforming catalyst thereby producing a first synthesis gas stream." The plain language of this feature indicates that the first synthesis gas stream is the *synthesis gas* output of the endothermic reforming step. The specification reinforces this plain language: "In the endothermic reforming unit 200, the first substream of the feed gas stream FG is ***converted*** to a synthesis gas stream SG1." EX1001, 11:23-25; *see also id.*, FIG. 2 (SG1 output from endothermic reforming unit 200).

B. third synthesis gas stream

Element 1.3 also recites, for the series configuration mapped in this Petition, "reforming the first synthesis gas stream in an autothermal reforming step thereby producing a third synthesis gas stream." The plain language of this feature means that the *synthesis gas* output of the endothermal reforming step is routed to the autothermal reforming step and thereby converted into the *third* synthesis gas stream. The specification reinforces this plain language: "The synthesis gas stream SG1 is converted to a synthesis gas stream SG3 in the autothermal reforming unit 201." *See* EX1001, 12:65-67, 13:9-13, FIG. 3.

The specification also distinguishes conversion of the first synthesis gas stream SG1 into SG3 in the autothermal reforming unit 201 from the different approach of the parallel configuration. *Compare* EX1001, 11:14-23 *with id.*, 12:65-67, 13:9-13. Specifically, in the parallel configuration, "[t]he synthesis gas streams SG1 and SG2 that are produced by the endothermic reforming unit 200 and the autothermal reforming unit 201 [respectively] are combined to give a mixed synthesis gas stream SG3 …." EX1001, 11:59-62; *see also id.*, FIG. 2 (SG2 output from autothermal reforming unit 201 combined with SG1 output from endothermic reforming unit 200). The series configuration does not include a *second* synthesis gas stream. *Compare* EX1001, 12:65-67, 13:9-13, FIG. 3 *with id.*, 11:26-28.

The plain language of the claims therefore requires that the output of the endothermic reformer step (first synthesis gas stream) is routed to the autothermal reformer step to form the third synthesis gas stream.

IV. Ground 1: Reinertsen Does Not Anticipate Claim 1

Reinertsen fails to disclose *all elements* of independent claim 1 *arranged as in the claim*. To anticipate claim 1, Reinertsen must "disclose all elements of the claim within the four corners of the document," and it must "disclose those elements 'arranged as in the claim.'" *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008) (quoting *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983)). Reinertsen does not.

A. Claim Elements [1.5] & [1.6]: Reinertsen does not disclose PSA hydrogen separation followed by cryogenic CO_2 separation

Claim 1 of the '805 Patent recites [Element 1.5] "(e) separating hydrogen from the fourth synthesis gas stream by pressure swing adsorption …" and [Element 1.6] "(f) separating carbon dioxide from the first residual gas stream obtained in step (e) by cryogenic carbon dioxide separation…" EX1001, 15:15-35.

The Petition points to Reinertsen's Figure 4 as allegedly anticipating claim 1. *See, e.g.*, Pet. 20-22, 24, 25, 27, 29-32, 34-37. But Reinertsen's Figure 4 does not separate hydrogen by pressure swing adsorption or "PSA." *See, e.g.*, Pet., 33 ("[I]n Figure 4, Reinertsen discloses producing a hydrogen stream 121 by hydrogen separation using a Pd-membrane 12."); *see also* EX1005, [0109] ("Pd-membrane"). Thus, the embodiment of Reinertsen's Figure 4 does not anticipate claim 1.

The Petition tries to plug that gap by taking general passages out of context to misleadingly suggest that Reinertsen might disclose substituting PSA for Pd-membrane hydrogen separation *in the embodiment of Reinertsen's Figure 4*. But Reinertsen does not. More specifically, the Petition points to Reinertsen's mention that "[e]mbodiments may alternatively use PSA to separate hydrogen from the gas output from the WGS reactor." Pet., 34 (citing EX1005, ¶¶[0081], [0085]). The Petition also points to a sentence stating that "[p]referably, the hydrogen separation process comprises a PSA process." Pet., 34 (quoting EX1005, ¶[0012]).

Petitioner's reliance on these statements is both misleading and insufficient. Neither statement bears any relation to the embodiment of Figure 4. The second, "preferably" statement appears in the summary and is preceded with "[p]referably, the hydrogen separation process … [uses] a Paladium membrane … [not PSA]." EX1005, ¶[0011]. The first, "alternatively" statement on its face refers to *other embodiments*. And Petitioner fails to mention that, in those *other embodiments*, Reinertsen's system uses amine separation for CO_2 before the PSA separation for hydrogen—which is both opposite to the order and lacks the requisite cryogenic separation of claim 1 here. *See, e.g.*, EX2005, Figure 2 and ¶[0103] ("Amine type separation process 8 separates CO_2 …"). Notably, Figure 2—the only disclosed system with PSA—is a "Comparative Example" as a contrast for Reinertsen's Embodiment Examples 1-12 (*all* of which use Pd-membrane). EX1005, Figure 10.

Reinertsen also explains in several places—ignored by Petitioner—why PSA hydrogen separation is used only *after* CO_2 separation in Reinertsen's system. *See, e.g.*, EX1005, [0056] ("PSA processes may also result in CO_2 being released at low pressure … so there is a subsequent need for compression and cooling. Still, it can be feasible to use PSA for some hydrogen production plants [such as Figure 2 in which CO_2 is separated *before* PSA hydrogen separation]."). Critically, Reinertsen also explains that while "embodiments include the reforming process shown in FIG. 1 [relied on for Claim Elements 1.2 and 1.3], embodiments also include *alternatively* using any other type of reforming process … [e.g.,] *only* using an autothermal reformer or *only* using a gas-heated reformer." EX2005, ¶[0075]. Thus, the "other embodiments" with PSA explicitly need not include the reformers of Reinertsen's Figure 1 that Petitioner relies on for its mapping of Claim Elements 1.2 and 1.3.

Reinertsen thus does not anticipate claim 1, which Petitioner tacitly concedes. *See* Pet., 41 ("may nonetheless argue that the specific combination of PSA upstream of cryogenic CO2 separation is not specifically exemplified in Reinertsen."). The Examiner thus did not err in allowing the claims over Reinertsen.

B. Claim Element [1.2.1]: Reinertsen does not disclose a first synthesis gas stream comprising carbon dioxide

Claim Element [1.2.1] recites that "the first synthesis gas stream comprises hydrogen, carbon monoxide, *carbon dioxide*, and unreacted methane." The Petition points to Reinertsen's "partially reformed gas stream 21" as allegedly "equivalent to that of the first synthesis gas stream of the '805 Patent" and contends that it "necessarily includes hydrogen, CO, CO_2, and unreacted methane as a natural result of the GHR process of Reinertsen." Pet., 25-26.

1. Reinertsen does not expressly disclose a first synthesis gas stream with carbon dioxide exiting its endothermic reformer

First, the Petition quotes paragraph [0076] of Reinertsen, which states that "[t]he gas mixture from the reformer reactor contains mainly the gas components CO, H_2, H_2O, CO_2, and some CH_4." Pet., 26 (quoting EX1005, ¶[0076]). But Petitioner neglects to mention that this sentence relates to Reinertsen's Figure 1 and discusses the autothermally reformed gas [22] exiting the autothermal reactor [ATR 2], ***not*** the "partially reformed gas in stream 21." EX1005, ¶¶[0074], [0076]. This much is apparent in the Petition's reliance on the same sentence for the contents of the *third* synthesis gas stream that exits the autothermal reformer introduced later in Claim Element [1.3]. *See* Pet., 27 ("autothermal reforming of the ATR in Reinertsen is equivalent to the autothermal reforming step" of Claim Element [1.3]).

Nevertheless, Dr. Klein also quotes this sentence from Reinertsen's paragraph [0076], and also references Reinertsen's paragraph [0067] as "describing[ing] chemical reactions that occur during the production of synthesis gas by reforming of natural gas (methane). EX1003, ¶122. But Dr. Klein glosses over the fact that the only one of the reactions in Reinertsen's paragraph [0067] that introduces CO_2 is the "Shift Reaction," which Reinertsen itself describes as occurring ***after*** the reforming in the "water-gas-shift (WGS) reactor." EX1005, ¶¶[0076]-[0077]; Pet., 31 (for Claim Element [1.4], mapping "converting CO present in third synthesis gas stream with steam thereby producing hydrogen and CO_2" in Reinertsen's ***downstream*** "shift reactor 6"). At base, the Petition fails to show that Reinertsen expressly discloses that the "partially reformed gas in stream 21" includes CO_2.

2. Reinertsen does not inherently disclose a first synthesis gas stream with carbon dioxide exiting its endothermic reformer

Second, the Petition relies on inherency: "partially reformed gas stream 21 … necessarily includes hydrogen, CO, CO_2, and unreacted methane as a natural result of the GHR process of Reinertsen." Pet., 26 (citing EX1003, ¶¶121-123). However, Dr. Klein's testimony makes clear that CO_2 is **<u>not</u>** ***necessarily*** present. *See, e.g.*, EX1003, ¶28 ("It is known by a POSA that steam reforming is ***almost always*** accompanied by the water-gas shift reaction shown in Reaction 3."). "Inherency can be established when 'prior art ***necessarily*** functions in accordance with, or includes, the claimed limitations.'" *Bettcher Indus, v. Bunzl USA Inc.*, 661 F.3d 629, 639 (Fed. Cir. 2011) (quoting *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1349 (Fed. Cir. 2002)). "Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Bettcher*, 661 F.3d at 639 (quoting *In re Oelrich*, 666 F.2d 578, 581 (CCPA 1981)).

Here, Dr. Klein contends that Reaction 3 "***almost always***" accompanies steam reforming. EX1003, ¶28. Reaction 3 is the only place in Dr. Klein's paragraphs 28-30 that assert the presence of CO_2 in synthesis gas. EX1003, ¶30. That directly undermines Dr. Klein's later opinion that "Reinertsen discloses a first synthesis gas stream comprising … carbon dioxide." EX1003, ¶121. Dr. Klein's paragraph 123 alleges the presence of CO_2 in the alleged first synthesis gas stream (Reinertsen's "partially reformed gas stream 21") "because steam reforming is accompanied by some level of the water-gas shift reaction, CO_2 will also be present, ¶28, supra." EX1003, ¶123. But that same paragraph 28 undermines the allegation of inherency by tacitly conceding that CO_2 is <u>**not**</u> ***necessarily*** present: "It is known by a POSA that steam reforming is ***almost always*** accompanied by the water-gas shift reaction shown in Reaction 3." EX2003, ¶28. The remainder of Dr. Klein's paragraph 123 says nothing that would require CO_2 to be formed in Reinertsen's GHR (the alleged endothermic reaction step of Claim Element 1.2).

Indeed, Dr. Klein's own testimony elsewhere makes clear that—even if "steam reforming" *generally* is almost always accompanied by the water-gas shift reaction—the same is not necessarily true of an endothermal reforming (*i.e.*, a GHR where the *first* synthesis gas stream is alleged to be produced). Specifically, Dr. Klein describes CO_2 being formed the exothermal reforming processes (ATR), but ***not*** in endothermal reforming processes. *E.g.*, *compare* EX1003, ¶63 (describing GHR with ***no mention*** of CO_2) *with id,* ¶64 ("Reaction 2 is a simplified way of describing the partial oxidation of methane that occurs ***in an ATR***, for example, some level of the highly exothermic full oxidation occurs to generate CO_2.").

Thus, Dr. Klein's own testimony undermines Petitioner's inherency theory, and the Petition therefore fails to show a likelihood of success on at least Claim Element 1.2.1.

V. Ground 2: Reinertsen-Darde Does Not Render Obvious Claim 1

In Ground 2, the Petition contends it would have been obvious to modify Reinertsen's Figure 4 embodiment with Darde to include PSA hydrogen separation upstream of cryogenic CO_2 separation. Pet., 39-44. Ground 2 fails each of at least two independent reasons. First, Darde does not supply the deficiencies of Reinertsen for Claim Element 1.2.1 noted above. Second, the Petition fails to articulate motivations that would have led to the particular modifications asserted.

A. Claim Element [1.2.1]: Reinertsen-Darde does not render obvious a first synthesis gas stream comprising carbon dioxide

Claim Element [1.2.1] recites that "the first synthesis gas stream comprises hydrogen, carbon monoxide, *carbon dioxide*, and unreacted methane." The petition first points to Ground 1's mapping of Reinertsen, and then asserts that "the combination with Darde makes this property explicit. Pet., 47. Both contentions are insufficient.

First, the Ground 1 mapping of Reinertsen to Claim Element [1.2.1] is insufficient for the reasons explained in Section IV.B above.

Second, Darde does not supply the deficiency. The Petition quotes Darde's statement that "the synthesis gases can have different compositions, but are always in the form of a mixture containing mainly hydrogen (H2) and carbon monoxide (CO) and in smaller proportions carbon dioxide (CO_2), but also unreacted methane (CH_4), excess steam and traces of various compounds." Pet., 47 (quoting EX1008, 5:29-34 and citing EX1003, ¶182). Critical to Petitioner's position is that the quoted language from Darde addresses the reforming processes used in Darde's invention: "***The invention*** applies in the context of steam reforming processes, in particular …." EX1008, 5:13-34. Of course, Darde uses a single reformer—"steam methane reforming (SMR) module 4"—that is different than Reinertsen's combination of GHR 1 and ATR 2. *Compare* EX1008, 15:28-30 *with* EX1005, ¶[0109] ("syngas production, by the ATR 2, GHR 1 and ASU 5").

On its face, Darde does not describe the output of any GHR, much less that of Reinertsen's GHR. And the Petition does not contend that it would have been obvious to use Darde's SMR module 4 in place of Reinertsen's GHR 1. To the contrary, the Petition expressly relies on Reinertsen's GHR 1 in combination with Reinertsen's ATR 2. *See* Pet., 47 (for each of Elements 1.2 and 1.3, referencing Reinertsen mappings for Ground 1). Finally, neither the Petition nor Dr. Klein explains why the output of Darde's SMR module 4 would be the same as the output of Reinertsen's GHR 1. *See* Pet., 47; EX1003, ¶182.

Thus, Reinertsen-Darde does not supply the deficiencies of Ground 1 for Claim Element 1.2.1, and Ground 2 therefore fails for at least this reasons.

B. Claim Elements [1.5] & [1.6]: The Petition's purported motivations would not have led a POSITA to modify Reinertsen to include PSA hydrogen separation upstream of cryogenic CO_2 separation

As explained in Section IV.A above, Reinertsen's system uses either (1) membrane hydrogen separation upstream of cryogenic CO_2 separation <u>or</u> (2) amine CO2 separation upstream of PSA hydrogen separation. The Petition purports to modify Reinertsen to instead include PSA hydrogen separation upstream of cryogenic CO_2 separation. Pet., 41 ("The Patent Owner may nonetheless argue that the specific combination of PSA upstream of cryogenic CO2 separation is not specifically exemplified in Reinertsen. EX1005, ¶[0012]. However, a POSA would have been motivated to select this option of PSA in view of description in Darde. EX1003, ¶¶168–172.”). In support of this alleged modification, the Petition offers three “motivations.”

First, the Petition contends that Reinertsen and Darde share “a common problem recognized in the art, namely the production of hydrogen with reduced CO_2 emissions.” Pet., 40. Second, the Petition contends that “Darde shows PSA upstream of cryogenic CO_2 separation achieves a ‘gaseous stream of highly pure (greater than 99%) hydrogen’ (EX1008, p.16, ln.7) and an offgas having a high CO_2 content such that ‘[b]y virtue of this relatively high CO_2 content, the cryogenic CO_2 capture solution may be applied to the PSA offgas’. EX1008, p.8, ln.10–11.” Pet., 42. Third, the Petition contends that “performance benefits achieved by implementing hydrogen separation and carbon capture in gas reforming provided additional motivation to combine.” Pet., 42. Finally, the Petition contends that a POSITA would have “reasonably expected to successfully practice the method of claims 1-6, 11, and 12 of the Challenged Patent” because “overlapping reforming and separation processes of Reinertsen with Darde would be compatible with similar process conditions …, process inputs, … intermediates …, and process outputs….” Pet., 43-44. Ultimately, as explained in more detail below, the Petition’s alleged "motivations" are generic to hydrogen production with CO_2 capture—*i.e.*, none would have led to a POSITA to the particular combination of PSA hydrogen separation followed by cryogenic CO_2 separation recited in Elements [1.5] & [1.6].

1. That Reinertsen and Darde both disclose hydrogen production with CO_2 separation would not motivate a POSITA to modify Reinertsen with isolated parts of Darde

The Petition states that both Reinertsen and Darde recognize "the problem known in the art of reducing CO_2 emissions from gas reforming." Pet., 40. The Petition then contends that "[t]o solve this art recognized problem, each of Reinertsen and Darde use a combination of hydrogen separation and CO_2 separation to provide for gas reforming with capture of CO_2." Pet., 41. The Petition then asserts that "Reinertsen provides processes for hydrogen separation using a Pd-membrane provided upstream of cryogenic CO_2 separation" and notes recognizes PSA as "an alternative for hydrogen separation." *Id.* Yet the Petition tacitly concedes that, as explained in Section IV.A above, Reinertsen does not disclose PSA as an alternative *upstream* of cryogenic CO_2 separation in Reinertsen's system. Pet., 41, ("The Patent Owner may nonetheless argue that the specific combination of PSA upstream of cryogenic CO_2 separation is not specifically exemplified in Reinertsen.").

So, the Petition continues, "a POSA would have been motivated to select this option of PSA in view of description in Darde." *Id.* (citing EX1003, ¶¶168-172). However, if it were as simple as "PSA is preferable to Pd-membrane," then a

POSITA would have chosen amine CO_2 separation followed by PSA hydrogen separation as disclosed in Reinertsen for Reinertsen's particular system. Specifically, as explained in Section IV.A above, Reinertsen discloses either (1) amine CO_2 separation followed by PSA hydrogen separation or (2) Pd-membrane hydrogen separation followed by cryogenic CO_2 separation. If a POSITA were motivated simply to select PSA over Pd-membrane, then that motivation would have led to the selection of Reinertsen's option (1) with amine-CO_2 separation followed by PSA hydrogen separation.

2. ***Darde's 99%+ pure hydrogen is* inferior to *Reinertsen's 99.9%+ pure hydrogen and, thus, would* not *have motivated a POSITA to modify Reinertsen's hydrogen and CO_2 separation***

The Petition states that "Darde shows PSA upstream of cryogenic CO_2 separation achieves a 'gaseous stream of ***highly pure (greater than 99%) hydrogen'*** (EX1008, p.16, ln.7) and an offgas having a high CO_2 content such that '[b]y virtue of this relatively high CO_2 content, the cryogenic CO_2 capture solution may be applied to the PSA offgas'. EX1008, p.8, ln.10–11." Pet., 42. However, Reinertsen already achieves superior hydrogen purity using Pd-membrane hydrogen separation:

> Embodiments include using a Palladium membrane (Pd-membrane) to separate hydrogen from the reformed natural gas; or more generally from a reformed gas containing hydrocarbons. One advantage is that hydrogen is obtained with high purity; that may be greater than 99% and is ***often greater than 99.9%***.

EX1005, ¶[0062]. Similarly, a POSITA would have been aware that options ***other than*** Darde's PSA H_2-cryogenic CO_2 would also provide better hydrogen separation than in Darde. *See, e.g.*, EX1009, p. 15/35, ll. 26-27 ("Hydrogen specification is > 99.97 mol% for fuel cells …." Using amine CO_2 separation followed by PSA hydrogen separation).

Thus, a POSITA would not have been motivated by any improvement in hydrogen separation to replace the Pd-membrane hydrogen separation of Reinertsen's Figure 4 embodiment with Darde's PSA hydrogen separation. *See, e.g.*, *Ex parte Rinkevich*, Appeal No. 2007-1317, slip op. at 8-9 (BPAI May 29, 2007) ("the problem proffered by the Examiner is already solved" by the primary reference, and explaining that "a person of ordinary skill in the art having common sense at the time of the invention would not have reasonably looked at [a secondary reference] to solve a problem already solved by [the primary reference].").

Moreover, Darde's explanation that high CO_2 content in its PSA offgas means that cryogenic CO_2 capture ***may be*** used does not add anything to motivate a POSITA to modify Reinertsen. *See Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (obviousness concerns not only whether POSITA "***could*** have made" the proposed combination, but whether they "***would have been motivated to [do so]***" (emphasis in original)). Specifically, the Petition points to Darde's explanation that "[b]y virtue of this relatively high CO_2 content, the cryogenic CO_2 capture solution

may be applied to the PSA offgas." Pet., 41-42 (quoting EX1008, 8:10–11). But the fact that cryogenic CO_2 separation "may be" used downstream of PSA hydrogen separation says nothing about any advantage or benefit that would have motivated a POSITA to do so.

Ultimately, the Petition fails to address Reinertsen's superior hydrogen purity, and does not explain why a POSITA would have preferred Darde's 99% hydrogen purity to Reinertsen's 99.9% hydrogen purity. Pet., 41. That silence is fatal to the alleged combination given that the Petition points to "highly pure … hydrogen" as a desired product.

3. The Petition's two-option premise for selecting PSA hydrogen separation is false and therefore does not support the replacement of Reinertsen's Pd-membrane with Darde's PSA

The Petition asserts that Darde's 99% hydrogen purity and that PSA "may be" used downstream of PSA in Darde's system would have been viewed by a POSITA as "directly applicable to the dual reforming process of Reinertsen." Pet., 42. The Petition therefore continues that "a POSA would have been motivated to select PSA as one of the finite options disclosed in Reinertsen (i.e., PSA and Pd-membrane) to function in its normal and expected way, as demonstrated in Darde, to achieve the benefit of reduced CO_2 emissions by energetically efficient CO_2 capture." Pet., 42 (citing EX1003, ¶168).

Setting aside that Reinertsen already achieves superior hydrogen purity (99**.9**%) than Darde (99%), Petitioner's premise that Reinertsen discloses only two ways of separating hydrogen is demonstrably false and thereby undermines the rest of Petitioner's theory. In particular, Reinertsen discloses that gases (e.g., H_2 and CO_2) can be separated by "absorption, adsorption and cryogenic distillation" (EX1005, ¶[0082]) and membranes, of which a Pd-membrane is only one type (*id.*, ¶[0083]). Reinertsen goes on to discuss multiple types of membranes, including combinations of solid and liquid membranes. *Id.*, ¶[0085]. Reinertsen also discloses swing adsorption in which "temperature can swing instead of the pressure." *Id.* Thus, Reinertsen expressly undermines the premise of Petitioner's "finite options" reasoning, which necessarily fails given the Petition's failure to acknowledge the majority of options (and the resulting permutations) Reinertsen actually discloses for hydrogen separation.

4. Reinertsen's own "performance benefits" would **not** *have led a POSITA to change Reinertsen's hydrogen and CO_2 separation methods*

Next, the Petition points to "performance benefits achieved by implementing hydrogen separation and carbon capture in gas reforming." Pet., 42-43. But this is utterly generic, and would not have motivated a POSITA to modify Reinertsen because Reinertsen already implements hydrogen separation and carbon capture. *See, e.g.*, Pet., 41 ("Reinertsen and Darde use a combination of hydrogen separation and CO_2 separation"); *see also Ex parte Rinkevich*, Appeal No. 2007-1317, slip op. at 8-9 (a POSITA "would not have reasonably looked at [a secondary reference] to solve a problem already solved by [the primary one].").

5. The Petition's only benefits even alleged to be specific to PSA hydrogen separation would **not** *have motivated a POSITA to modify Reinertsen's hydrogen and* CO_2 *separation*

The Petition finally pays lip service to PSA hydrogen separation specifically, but relies entirely on unsupported conclusions from its expert. Pet., 42-43 (citing EX1003, ¶¶169-170 (expert not citing any documentary support for motivations)). The Petition ultimately alleges just two benefits allegedly specific to PSA: "(i) the capability for generating high purity H_2 at a useful pressure, and (ii) the practical robustness and ease of implementation of PSA with gas reforming and cryogenic CO_2 separation." Pet., 43. But Petitioner fails to define "useful pressure" or compare the performance of PSA to that of membrane separation. *Id.*

In any event, Reinertsen uses membrane separation to already obtain hydrogen at useful pressure (membrane that "leav[es] hydrogen at a [elevated] pressure … comparable to the process gas"). EX1005, ¶¶[0083], [0084]. Reinertsen also shows "the practical robustness and ease of implementation of [Pd-membrane hydrogen separation] with gas reforming and cryogenic CO_2 separation." And, with Reinertsen's Pd-membrane, "hydrogen is [already] obtained with high purity." EX1005, ¶[0062] (often >99.9%). Petitioner's "motivations" therefore add nothing to Reinertsen, and would not lead a POSITA to modify Reinertsen. Indeed, Reinertsen also expressly explains in the context of an ammonia synthesis loop that a plant using PSA for hydrogen separation was "*not* favorably designed for separating a pure CO_2-stream for storage." EX1005, ¶[0094].

Reinertsen also shows that Pd-separation recovered significantly more hydrogen than PSA hydrogen separation. For example, Reinertsen expressly compares a "Comparative Example" with PSA hydrogen separation to multiple "Embodiment Examples" with Pd-membrane hydrogen separation. *See, e.g.*, EX1005, FIG. 11. Critically—given that Reinertsen's fundamental purpose is hydrogen production (*see, e.g.*, *id.*, Title, Abstract)—Reinertsen shows that its embodiments using Pd-membrane hydrogen separation recover 93% of hydrogen versus only 86% for PSA hydrogen separation. *Id.*, FIG. 11. Thus, Reinertsen itself would have directly dissuaded a POSITA viewing Reinertsen and Darde from modifying Reinertsen's Figure 4 embodiment to use PSA hydrogen separation instead of Pd-membrane hydrogen separation.

6. Petitioner's "reasonable expectation of success" allegations rely on hindsight and wholly neglect the differences between the processes of Reinertsen and Darde

First, the Petition contends that "a POSA combining the teachings of Reinertsen and Darde would have reasonably expected to successfully practice the method of claims 1–6, 11, and 12." Pet., 43. This reference to the challenged claims, on its face, reveals the hindsight basis of Petitioner's theory. And the explanation that follows fares no better in that it utterly fails to address the particular modifications the Petition asserts:

> Reinertsen discloses the process steps, in the same sequence, as the process of claim 1 of the '805 patent. To the extent that a POSA would require some additional degree of teaching, Darde addresses the goal identified in Reinertsen of generating hydrogen by gas reforming with reduced CO_2 emissions using the same downstream processes of WGS conversion with hydrogen separation and cryogenic CO_2 separation. Given that each of Reinertsen and Darde use well-known processes to achieve the same solution of CO_2 capture to reduce CO_2 emissions in gas reforming, a POSA would have been readily able to adapt the teachings of these references to arrive at the claimed invention with a reasonable likelihood of success. EX1003, ¶¶224–228; see *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1240 (Fed. Cir. 2010) ("where all of the limitations of the patent were present in the prior art references, and the invention was addressed to a known problem, KSR...compels the grant of summary judgment of obviousness.").

Pet., 43-44. Nothing in this paragraph addresses PSA hydrogen separation. The Petition's explanation of the purported "reasonable expectation of success" therefore fails even to address the differences between the prior art and the claims, much less explain why the allegedly modified system would have had a reasonable expectation of success.

Second, the Petition asserts that "overlapping reforming and separation processes of Reinertsen with Darde would be compatible with similar process conditions …, process inputs, … intermediates …, and process outputs…." Pet., 44. In full, the Petition contends:

> A POSA would have reasonably concluded that the overlapping reforming and separation processes of Reinertsen with Darde would be compatible with similar process conditions (e.g., pressures, flow rates, temperatures), similar process inputs (e.g., feed stream), intermediates (synthesis gas streams, shifted syngas stream and residual gas stream) and similar process outputs (e.g., hydrogen-rich stream and CO_2 rich stream). EX1003, ¶¶172, 227.

Pet., 44. However, neither the Petition nor Dr. Klein address or compare any particular process conditions.

Petitioner instead blatantly neglects the complexity of the respective Reinertsen and Darde systems. For example, the properties of Reinertsen's WGS reactor and Pd-membrane are carefully selected to work together, such that switching to PSA separation would also require changes to the WGS reactor scheme. EX1005, ¶[0080]; *see also id.*, ¶[0081] (suggesting use of PSA [as in Figure 2 with amine CO_2 separation before PSA for hydrogen] would likely require ***different and more*** WGS reactors). Yet the Petition relies on the original WGS reactor of Reinertsen's Figure 4. Pet., 48 (for Element [1.4], referencing Reinertsen mapping of Ground 1, citing Darde for generic disclosure without modification to Reinertsen); Pet., 31 (for Element [1.4], pointing to Reinertsen's shift reactor 6).

Similarly, Reinertsen makes clear that its Pd-membrane hydrogen separation is important for cryogenic CO_2 separation, namely that "the CO_2 gas can be separated from the H_2/CO_2 mixture *at an elevated pressure*, [such that] *significant compression work can be avoided*. EX1005, ¶[0087]. On the other hand, Darde takes an *opposite* approach that of Reinertsen—specifically noting that "[t]he PSA offgas [from which CO_2 is separated in Darde] … is available at a [very low] pressure below 2 bar(a)." *Id.*, ¶[0024]. Petitioner neglects these differences, relying instead on a sweeping conclusion of its expert that "Reinertsen with Darde would be compatible with similar process conditions (e.g., pressures, flow rates, temperatures)." Pet., 44 (citing EX1003, ¶¶172, 227 (not addressing any Reinertsen or Darde pressure, flow rate, or temperature needs)). Thus, the Petition's assertions of a reasonable expectation of success—even to the extent parroted by its expert—are therefore mere conclusory assertions that are entitled to no weight. *See, e.g.*, 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."); *see also* Consolidated Trial Practice Guide (CTPG) at 35, 40-41 (PTAB Nov. 2019).

VI. Ground 3: Rytter-Darde Does Not Render Obvious Claim 1

A. Claim Element [1.2.1]: Rytter-Darde does not include a first synthesis gas stream comprising carbon dioxide

Claim Element [1.2.1] recites that "the first synthesis gas stream comprises hydrogen, carbon monoxide, *carbon dioxide*, and unreacted methane." For Ground 3, the Petition points to disclosure in Rytter that is nearly identical to the Reinertsen disclosure relied on for Element [1.2.1] for Ground 2. In particular, the Petition points to Rytter's "partially reformed gas stream 21" as allegedly "equivalent to that of the first synthesis gas stream of the '805 Patent" and contends that it "necessarily includes hydrogen, CO, CO_2, and unreacted methane as a natural result of the GHR process of Rytter." Pet., 69-70.

1. Rytter does not expressly disclose a first synthesis gas stream with carbon dioxide exiting its endothermic reformer

First, the Petition quotes page 11, lines 2-3 of Rytter, which states that "[t]he gas mixture from the reformer reactor contains mainly the gas components CO, H_2, H_2O, CO_2, and some CH_4." Pet., 70 (quoting EX1009, 11:2-3). But Petitioner neglects to mention that this sentence relates to Rytter's Figure 1 and discusses the autothermally reformed gas [22] exiting the autothermal reactor [ATR 2], ***not*** the "partially reformed gas in stream 21." EX1009, 10:23-24, 10:30-35, 11:1-3. This much is apparent in the Petition's reliance on the same sentence for the contents of the *third* synthesis gas stream that exits the autothermal reformer introduced later in

Claim Element [1.3]. *See* Pet., 73 ("Therefore, the components of syngas stream 12 are equivalent to third synthesis gas stream of the '805 patent and necessarily includes hydrogen, CO, CO2, and unreacted methane as a ***natural result from the ATR process*** of Rytter.").

Nevertheless, Dr. Klein also quotes this sentence from Rytter's page 11, lines 2-3, and also references Rytter's page 9, lines 15-19 as "describing[ing] reversible chemical reactions that occur during the production of synthesis gas." EX1003, ¶253. But Dr. Klein glosses over the fact that the only one of the reactions in Rytter's page 9, lines 15-19 that introduces CO_2 is the "Shift Reaction," which Rytter itself describes as occurring ***after*** the reforming in the "water-gas-shift (WGS) reactor." EX1009, 11:1-10; Pet., 31 (for Claim Element [1.4], mapping "converting CO present in the third synthesis gas stream with steam thereby producing hydrogen and CO_2" in Rytter's ***downstream*** "shift reactor 12"). At base, the Petition fails to show that Rytter expressly discloses that the "partially reformed gas in stream 21" includes CO_2.

2. Rytter does not inherently disclose a first synthesis gas stream with carbon dioxide exiting its endothermic reformer

Second, the Petition relies on inherency: "partially reformed gas stream 21 … necessarily includes hydrogen, CO, CO_2, and unreacted methane as a natural result of the GHR process of Rytter." Pet., 26 (citing EX1003, ¶¶253-256). However, Dr. Klein's testimony makes clear that CO_2 is **<u>not</u>** necessarily present. *See, e.g.*, EX1003, ¶28 ("It is known by a POSA that steam reforming is ***almost always*** accompanied by the water-gas shift reaction shown in Reaction 3.").

For his explanation of why Rytter discloses CO_2 in Rytter's "partially reformed gas in stream 21," Dr. Klein refers to his testimony regarding why Reinertsen's "partially reformed gas in stream 21" allegedly does so. EX1003, ¶254 (referencing EX1003, §XI.A.5 (¶¶121-123)). But that explanation for Reinertsen fails to show inherency for the reasons explained herein in Section IV.B.2 above, and therefore also cannot support inherency for Rytter.

For his explanation of why "to the extent Rytter may not explicitly disclose such a composition of a synthesis gas stream, Darde discloses reforming processes for producing synthesis gases comprising hydrogen, carbon monoxide, carbon dioxide, and unreacted methane," Dr. Klein simply refers to his testimony regarding why Darde would have supplemented Reinersten's disclosure. EX1003, ¶255 (referencing EX1003, §XI.B.2(f) (¶¶181-182)). And that explanation for Reinertsen-Darde also fails to show inherency or obviousness for the reasons explained herein in Section V.A above, and therefore also cannot support inherency or obviousness for Rytter-Darde.

The Petition thus fails to show Rytter-Darde would include Element [1.2.1].

B. Claim Elements [1.5] & [1.6]: The Petition's purported motivations would not have led a POSITA to modify Rytter to include PSA hydrogen separation upstream of cryogenic CO_2 separation

The portions of Rytter relied upon by Petitioner are largely cumulative of Reinertsen. *E.g.*, *compare* EX1005, Figure 1 *with* EX1009, Figure 1. For example, Petitioner relies upon Rytter's Figure 3, which is nearly identical to Reinertsen's Figure 2 addressed above (with CO_2 separation *preceding* PSA hydrogen separation). The Petition concedes that "Rytter discloses CO_2 separation (13) occurs upstream of H_2 separation (15) in … FIGURE 3," but points to Rytter's statement that "[e]mbodiments also include the hydrogen being separated from the gas mixture before the carbon dioxide is separated …, or … at the same time in a single process." Pet., 59 (citing EX1009, p. 20/35, ll. 8-10). But this does not suggest that the order might be reversed *with* cryogenic CO_2 separation *after* PSA hydrogen separation. Rytter—like Reinertsen—also discloses Pd-membrane hydrogen separation (EX1009, p. 12/35, ll. 10-20), and other methods of separating hydrogen and CO_2, like absorption, adsorption, and membranes. *Id.*, p. 11/35, ll. 30 – p. 12/35, ll. 29.

Ultimately, the Petition contends that it would have been obvious "to substitute the sequence of hydrogen separation provided upstream of cryogenic CO_2 separation, as disclosed in Darde." Pet., 59. In support of this alleged modification, the Petition offers four "motivations." First, the Petition contends that "Rytter and Darde implement a similar combination of known gas reforming and separation processes to achieve a common purpose, namely production of a hydrogen product by reforming with reduced CO_2 emissions." Pet., 59. Second, the Petition contends that "A POSA would have been motivated to substitute the sequence of hydrogen separation provided upstream of cryogenic CO_2 separation, as disclosed in Darde, into the process of Rytter to achieve energetically efficient CO_2 capture for reducing emissions of CO_2. Pet., 60 (referencing Pet., §§VIII.B.1.(m)–(p) (mapping *Reinertsen*-Darde to Elements [1.5]-[1.6.1]); EX1003, ¶¶234–237). Third, the Petition contends that PSA hydrogen separation followed by cryogenic CO_2 separation would have been an obvious choice from among only six possible combinations based on routine optimization. Pet., 61. Fourth, the Petition points generically to "recognized performance benefits achieved by implementing hydrogen separation and carbon separation/capture in gas reforming." Pet., 62.

Ultimately, as explained in more detail below, the Petition's alleged "motivations" are generic to hydrogen production with CO_2 capture—*i.e.*, none would have led to a POSITA to the particular combination of PSA hydrogen separation followed by cryogenic CO_2 separation recited in Elements [1.5] & [1.6]. The Petition therefore offers nothing to suggest that a POSITA would have expected any benefit to modifying Rytter's system—neither better hydrogen production, nor better CO_2 capture. To the contrary, as explained in more detail below, Petitioner's own evidence demonstrates that a POSITA would have expected better hydrogen separation and better CO_2 capture from Rytter's unmodified system and, therefore, would not have been motivated to pursue the alleged modifications. The Petition fails to address the contrary teachings of the evidence of record. Instead, the Petition heavily supports its motivations with the mere *ipse dixit* of Dr. Klein, and therefore fails to adequately support any of its purported motivations.

1. That Rytter and Darde both disclose hydrogen production with CO_2 separation would not motivate a POSITA to modify Rytter with isolated parts of Darde

The Petition states that both Rytter and Darde share "a common purpose, namely production of a hydrogen product by reforming with reduced CO_2 emissions." Pet., 59 (citing EX1003, ¶¶234-241). The Petition therefore contends that "a POSA would have been motivated to incorporate [some, but only some] aspects from Darde into the reforming process in Rytter to reduce CO_2 emissions by cryogenic capture of CO_2." Pet., 59 (citing EX1003, ¶¶231–233). But neither the premise nor the motivation are specific to cryogenic CO_2 separation and, thus, would not have led a POSITA to modify Rytter to <u>both</u> (1) separate CO_2 ***after*** separating hydrogen <u>and</u> (2) use cryogenic CO_2 separation instead of amine CO_2 separation. To the contrary, as in Reinertsen, Rytter's one specific disclosure of CO_2 separation downstream of hydrogen separation uses membrane hydrogen separation ***instead of*** PSA. EX1009, p. 12/35, ll. 19-20 ("By combining solid ***membranes*** and liquid

membranes it is also possible to achieve a rapid permeation of CO_2, while H_2 is kept back."); *contra id.*, p. 12/35, ll. 21-29 (separately describing PSA).

2. The Petition's six-option premise for selecting PSA hydrogen separation is false and therefore does not support the wholesale modification of Rytter's system

Second, Petitioner contends that "[a] POSA would have readily been aware that the processes and order of H_2/CO_2 separation steps are selectable, as recognized in Rytter, depending on the goals and requirements of the overall process." Pet., 60 (citing EX1002, ¶¶235-237). To support this contention, Petitioner begins from a premise that Rytter discloses only six practical permutations for H_2/CO_2 separation. Pet., 60. But this is demonstrably false because Petitioner ignores that Rytter discloses that gases (e.g., H_2 and CO_2) can be separated by "absorption, adsorption and cryogenic distillation" (EX1009, p. 11/35, ll. 30 – p. 12/35, ll. 9) and membranes, of which a Pd-membrane is only one type (*id.*, p. 12/35, ll. 10-20]). Rytter goes on to discuss multiple types of membranes, including combinations of solid and liquid membranes. *Id.*, 12/35, ll. 10-20. And a POSITA would have been aware of alternative swing adsorption processes in which "temperature can swing instead of the pressure." EX2005, ¶[0085]. Thus, Rytter expressly undermines the premise of Petitioner's "finite options" reasoning, which necessarily fails given the Petition's failure to acknowledge the majority of options (and the resulting permutations) Rytter actually discloses for hydrogen and CO_2 separation.

Regardless, Petitioner fails to proffer a motivation specific to PSA (H_2)→cryogenic (CO_2) as one of six possibilities, much less 14.

3. Petitioner's routine optimization theory is wholly unsupported and, even if credited, would have led to the membrane hydrogen separation-cryogenic CO_2 separation option of Rytter itself

The Petition continues the asserted modification of Rytter would be mere routine optimization based on a finite number of possibilities. Pet., 61. But Petitioner fails to explain what would be optimized, or how reversing both of Rytter's separation steps and methods to achieve Darde's PSA (H_2)→cryogenic (CO_2) configuration would have improved Rytter. For purported "additional motivation for selecting" CO_2 separation downstream of H_2 separation "for the hydrogen separation process of Rytter," the Petition points to Darde's disclosure that [t]he PSA offgas is the gaseous stream richest in CO_2 of the process …" such that "[b]y virtue of this relatively high CO_2 content, the cryogenic CO_2 capture ***may be*** applied to the PSA offgas." Pet., 61 (quoting EX1008, p. 8/13, ll. 8–11).

This purported "motivation" fails for each of two reasons. First, Darde's explanation that high CO_2 content in its PSA offgas means that cryogenic CO_2 capture ***may be*** used does not add anything to motivate a POSITA to modify Rytter. *See Belden*, 805 F.3d at 1073 (obviousness concerns not only whether POSITA "***could*** have made" the proposed combination, but whether they "***would have been***

motivated to [do so]" (emphasis in original)). Specifically, the fact that cryogenic CO_2 separation "may be" used downstream of PSA hydrogen separation says nothing about any advantage or benefit that would have motivated a POSITA to do so. Second, even if this provided a motivation "to place a CO_2 separation step downstream of H_2 separation" (Pet., 61), Rytter already discloses such an option that a POSITA would have simply selected. Specifically, Rytter explains that "[b]y combining solid ***membranes*** and liquid ***membranes*** it is also possible to achieve a rapid permeation of CO_2, while H_2 is kept back." EX1009, p. 12/35, ll. 19-20; *contra id.*, p. 12/35, ll. 21-29 (separately describing PSA).

4. Rytter's own "performance benefits" would not have led a POSITA to change Rytter's hydrogen and CO_2 separation methods

Petitioner next points to nonspecific "performance benefits achieved by implementing hydrogen separation and carbon capture in gas reforming." Pet., 62. But this is utterly generic to any particular combination of hydrogen separation and CO_2 separation techniques, much less that PSA hydrogen separation followed by cryogenic CO_2 separation recited in Claim Elements [1.5] and [1.6]. As purported support, the Petition first references the Petition's earlier asserted motivations to combine Reinertsen and Darde. Pet., 62 (referencing Pet., §VIII.B.1). Those Reinertsen-Darde "motivations" fail for the reasons explained in Section V.B above. The Petition next contends that "Rytter itself provides results demonstrating the increased energy efficiency achieved by combining dual reforming with CO_2 separation, thereby reinforcing this motivation to combine." Pet., 62 (quoting EX1009, p. 16/35, ll. 10-16). Yet, this too is utterly generic to any particular combination of hydrogen separation and CO_2 separation techniques, much less that PSA hydrogen separation followed by cryogenic CO_2 separation recited in Claim Elements [1.5] and [1.6].

The Petition thus seeks to support the reversal of Rytter's own separation order and methods by pointing to Rytter's own disclosure of the benefits of its use of a GHR and an ATR. Pet., 62 (quoting EX1009, p. 16/35, ll. 10-16). This is has nothing to do with benefits a POSITA would purportedly expect from modifying Rytter's separation steps with Darde's. If anything, that Rytter achieves these benefits would discourage a POSITA from any modification. As such, this "motivation" would not have motivated a POSITA to modify Rytter because Rytter already implements hydrogen separation and carbon capture. *See, e.g.*, Pet., 59 ("Rytter and Darde implement a similar combination of combination of known gas reforming and separation processes to achieve a common purpose, namely production of hydrogen product by reforming with reduced CO_2 emissions"); *see also Rinkevich*, Appeal No. 2007-1317, slip op. at 8-9.

5. *Darde's 99%+ pure hydrogen is* **inferior to** *Rytter's 99.97% pure hydrogen and, thus, would* **not** *have motivated a POSITA to modify Rytter's hydrogen and CO_2 separation*

The Petition states that "Darde shows PSA upstream of cryogenic CO_2 separation achieves a 'gaseous stream of ***highly pure (greater than 99%) hydrogen'*** (EX1008, p.16, ln.7) and an offgas having a high CO_2 content such that '[b]y virtue of this relatively high CO_2 content, the cryogenic CO_2 capture solution may be applied to the PSA offgas'. EX1008, p.8, ln.10–11." Pet., 42 (referenced by Pet., 62 (citing Pet., §VIII.B.1). However, like Reinertsen, Rytter already achieves superior hydrogen purity using its amine CO_2 separation followed by PSA hydrogen separation: "Hydrogen specification is > 99.97 mol% for fuel cells …." EX1009, p. 15/35, ll. 26-27. Similarly, a POSITA would have been aware that options ***other than*** Darde's PSA H_2-cryogenic CO_2 would also provide better hydrogen separation than in Darde. *See, e.g.*, EX1005, ¶[0062] ("using a Palladium membrane (Pd-membrane) to separate hydrogen … advantage is that hydrogen is obtained with high purity; that may be greater than 99% and is ***often greater than 99.9%***").

Thus, a POSITA would not have been motivated by any improvement in hydrogen separation to replace the amine CO_2-PSA H_2 separation of Rytter's Figure 3 embodiment with Darde's PSA H_2-cryogenic CO_2 separation. Ultimately, the Petition fails to address Rytter's superior hydrogen purity, and does not explain why a POSITA would have preferred Darde's 99% hydrogen purity to Rytter's

99.97% hydrogen purity. That silence is fatal to the alleged combination given that the Petition points to "highly pure … hydrogen" as a desired product.

6. Petitioner's "reasonable expectation of success" allegations rely on hindsight and wholly neglect the differences between the processes of Rytter and Darde

First, the Petition contends that "a POSA combining the teachings of Rytter and Darde would have reasonably expected to successfully practice the method of claims 1–6, 11, and 12." Pet., 62. This reference to the challenged claims, on its face, reveals the hindsight inherent in Petitioner's theory. And the explanation that follows fares no better in that it utterly fails to address the particular modifications the Petition asserts:

> Darde addresses the technical goal identified in Rytter of generating hydrogen by gas reforming with reduced CO_2 emissions using the same downstream processes of WGS conversion, hydrogen separation and cryogenic CO_2 separation. Given that well-known, overlapping processes are used, in the same manner, to achieve the same technical solution in Rytter and Darde, a POSA would have been readily able to adapt the teachings of these references to arrive at the claimed invention with a reasonable likelihood of success. EX1003, ¶¶282–285; *see, Wyers*, 616 F.3d at 1231.

Pet., 62-63. Nothing in this paragraph addresses PSA hydrogen separation. The Petition's explanation of the purported "reasonable expectation of success" thus fails even to address the differences between the prior art and the claims, much less explain why a POSITA would have had a reasonable expectation of success in the modified system as alleged.

Second, the Petition asserts that "overlapping reforming and separation processes of Rytter with Darde would be compatible with similar process conditions …, process inputs, … intermediates …, and process outputs…." Pet., 44. In full, the Petition contends:

> A POSA would have also reasonably concluded that the overlapping processes of Rytter with Darde would be compatible with similar process conditions (e.g., pressures, flow rates, temperatures), similar process inputs (e.g., feed stream), intermediates (synthesis gas streams, shifted syngas stream and residual gas streams), and similar process outputs (e.g., hydrogen-rich stream and CO_2 rich stream). EX1003, ¶¶282–285.

Pet., 63. However, neither the Petition nor Dr. Klein address or compare any particular process conditions.

Petitioner instead blatantly neglects the complexity of the respective Rytter and Darde systems. For example, Rytter—like Reinertsen—explains that the properties of its WGS reactor and Pd-membrane are carefully selected to work with one another, such that using PSA hydrogen separation would also require changes to the WGS reactor scheme. EX1009, p. 11/35, ll. 25-29. Yet the Petition relies on the original WGS reactor of Rytter's Figure 3. Pet., 75 (mapping Element [1.4] to

Rytter's "shift reactor 12" and citing Darde for generic disclosure without modification to Rytter).

Similarly, Rytter—like Reinertsen—makes clear that its Pd-membrane hydrogen separation is important to its cryogenic CO_2 separation, namely that "the CO_2 gas can be separated from the H_2/CO_2 mixture *at an elevated pressure*, [such that] *significant compression work can be avoided*. EX1009, p. 13/35, ll. 2-4. On the other hand, Darde takes an *opposite* approach that of Rytter—specifically noting that [t]he PSA offgas [from which CO_2 is separated in Darde] … is available at a [very low] pressure below 2 bar(a)." *Id.*, ¶[0024]. Petitioner neglects these differences, relying instead on a sweeping conclusion of its expert that the two "would be compatible with similar process conditions (e.g., pressures, flow rates, temperatures)." Pet., 44 (citing EX1003, ¶¶172, 227 (not addressing any Rytter or Darde pressure, flow rate, or temperature needs)). Thus, the Petition's assertions of a reasonable expectation of success—even to the extent parroted by its expert—are therefore mere conclusory assertions that are entitled to no weight. *See, e.g.*, 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."); *see also* Consolidated Trial Practice Guide (CTPG) at 35, 40-41 (PTAB Nov. 2019).

Critically, nowhere does the Petition allege any motivation specific to modifying Rytter to use PSA hydrogen separation followed by cryogenic CO_2

separation. That alone is fatal to Petitioner's Rytter-Darde combination, and the Petition thus cannot show a reasonable likelihood of success for Ground 3.

VII. CONCLUSION

For the foregoing reasons, institution should be denied.

Dated: October 9, 2025

Respectfully submitted,

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Lead Counsel for Patent Owner

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(b)(1), the undersigned certifies that this Paper —exclusive of the table of contents, exhibit list, certificate of service, and this certificate of word count—includes 8,805 words. The undersigned relies upon the word count feature of Microsoft Word.

/Eagle H. Robinson/
Eagle H. Robinson (Reg. No. 61,361)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies that on October 9, 2025, a complete copy of the foregoing Patent Owner's Request for Discretionary Denial of Institution was served on Petitioner via email (by consent), at the following email address(s):

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