

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AIR PRODUCTS AND CHEMICALS, INC.,
Petitioner

v.

EVONIK OPERATIONS GMBH and EVONIK CORPORATION,
Patent Owner

Case IPR2024-00611
Patent 10,471,380

PETITION'S REPLY TO PATENT OWNER'S RESPONSE

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EXHIBITS

AP-1001	U.S. Patent No. 10,471,380 to Priske (“the ’380 patent”)
AP-1002	Prosecution History of the ’380 Patent (“the Prosecution History”)
AP-1003	Declaration of Dr. Richard W. Baker
AP-1004	<i>Curriculum Vitae</i> of Dr. Richard W. Baker
AP-1005	November 29, 2022 Complaint in <i>Evonik Operations GmbH et al. v. Air Products and Chemicals, Inc. et al.</i> , C.A. No. 1:22-cv-01543-UNA (D. Del.)
AP-1006	U.S. Patent No. 8,999,038
AP-1007	Scholz, Marco et al., <i>Structural optimization of membrane-based biogas upgrading processes</i> , J. Membr. Sci., 474 (Available online 28 September 2014), 1-10 (“Scholz”)
AP-1008	Japanese Patent Application No. JP2009-242773 (“Tsuchida”)
AP-1009	Qi, Runhong et al., <i>Membrane system design for multicomponent gas mixtures via mixed-integer nonlinear programming</i> , Comput. Chem. Eng., 24 (2000) (“Qi”)
AP-1010	Datta, Anjan K., <i>Optimization of membrane unit for removing carbon dioxide from natural gas</i> , J. Membr. Sci., 283 (2006), 291-300 (“Datta”)
AP-1011	Machine translation of Japanese Patent Application No. JP2009-242773
AP-1012	Zhang, Yuan et al., <i>Current status and development of membranes for CO₂/CH₄ separation: A review</i> , Int. J. Greenhouse Gas Control, 12 (2013), 84-107 (“Zhang”)

AP-1013	Baker, Richard W., <i>Membrane Technology and Application</i> (3d Ed. 2012)
AP-1014	U.S. Patent No. 7,968,758
AP-1015	Baker, Richard W. et al., <i>Permeability, permeance, and selectivity: A preferred way of reporting pervaporation performance data</i> , J. Membr. Sci., 348 (2010), 346-352
AP-1016	Alshehri, Ali et al., <i>Membrane Systems Engineering for Post-combustion Carbon Capture</i> , Energy Procedia, 37 (2013), 976-985
AP-1017	CAS Registry for Polymers 9046-51-9 and 134119-41-8
AP-1018-1028	RESERVED
AP-1029	February 23, 2023 Waiver of the Service of Summons in <i>Evonik Operations GmbH et al. v. Air Products and Chemicals, Inc. et al.</i> , C.A. No. 1:22-cv-01543-MN (D. Del.)
AP-1030	July 18, 2023 Scheduling Order in <i>Evonik Operations GmbH et al. v. Air Products and Chemicals, Inc. et al.</i> , C.A. No. 1:22-cv-01543-JPM (D. Del.)
AP-1031	February 21, 2024 docket sheet for <i>Evonik Operations GmbH et al. v. Air Products and Chemicals, Inc. et al.</i> , C.A. No. 1:22-cv-01543-JPM (D. Del.)
AP-1032	2023 Comparison of Districts Trial Statistics
AP-1033	<i>Memorandum: Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation</i> (June 21, 2022).
AP-1034	Declaration of June Munford
AP-1035	Declaration of Nathaniel E. Frank-White

AP-1036	Declaration of Luaine Bandounas
AP-1037	Scholz, Marco et al., <i>Structural Optimization of membrane-based biogas upgrading processes</i> , J. Membr. Sci. http://dx.doi.org/10.1016/j.memsci.2014.08.032 , Authors Accepted Manuscript (from Dr. Richard Baker)
AP-1038	U.S. Patent App. Pub. No. 2013/0098242 (“Ungerank”)
AP-1039	January 20, 2025 deposition of Dr. Geoffrey Geise
AP-1040	March 28, 2025 deposition of Dr. Geoffrey Geise
AP-1041	Supplemental Declaration of Dr. Richard W. Baker
AP-1042	EU 3240620 patent
AP-1043	Evonik opposition appeal brief for EU 3240620 patent
AP-1044	Machine translation of Evonik opposition appeal brief for EU 3240620 patent
AP-1045	Prosecution History of U.S. Patent 8,999,038
AP-1046	Huang, Yu et al., <i>Pressure ratio and its impact on membrane gas separation processes</i> , Journal of Membrane Science 463 (2014) 33–40
AP-1047	Baker, Richard W. et al., <i>Natural Gas Processing with Membranes: An Overview</i> , Ind. Eng. Chem. Res. 2008, 47, 2109–2121
AP-1048	Bhatti, Inamullah et al., <i>Polymeric Membranes Used in Natural Gas Processing to Separate Carbon Dioxide: the Facing Problems and Solutions</i> , Journal of Environmental Science and Engineering, ISSN 1934-8932, Jan. 2010, Volume 4, No.1 (Serial No. 26)

AP-1049

Staudt-Bickel, Claudia et al., *Improvement of CO₂/CH₄ separation characteristics of polyimides by chemical crosslinking*, Journal of Membrane Science 155 (1999) 145-154

I. INTRODUCTION

In 2011, Patent Owner Evonik filed the Ungerank patent application, claiming higher-selectivity membranes in three-stage gas separation apparatuses. The application included Comparative Example 1 (“UCE1”), a three-stage system with lower-selectivity membranes, for comparison to examples with higher-selectivity membranes. The application published in 2013. AP-1038.

In 2014, Evonik filed the application for the ’380 patent (“Priske”), broadly claiming three-stage systems that “could produce high purity products even with membranes with a lower selectivity.” AP-1001, 2:43–45.

UCE1 expressly meets every limitation in Priske’s claim 1 except the “capacity” limitation (which UCE1 does not address) and meets limitations in several dependent claims. Evonik does not and cannot dispute this.

Claim 1 requires that stage 2’s membranes have a higher “capacity” than stage 1’s membranes. “Capacity” is a coined term in Priske, but is simply a membrane’s surface area multiplied by its permeance—two fundamental membrane properties well known to POSITAs in 2014.

Algebraically, when two membranes have identical permeances, their capacity ratio equals their surface area ratio. In Scholz’s Figure 7 systems, the membranes have identical permeances and the surface areas in stage 2 are larger than in stage 1.

Thus, as explained in the Petition and below, Priske's claims are not patentably distinct from the combination of UCE1 and Scholz. Indeed, Priske is based on a false premise: a "new problem," which was not new. Neither was the solution.

II. THE PARTIES' EXPERTS

A. Evonik Has No Expert That Has A POSITA's Qualifications

The parties agree a POSITA would have had (among other qualifications) "at least three years of work experience in membrane gas-separation systems, including...*biogas membrane separations*."¹ POR, 26–27. Evonik has no expert that has these qualifications.

Evonik initially submitted a declaration from Ungerank (EX2001), but it was withdrawn when Petitioner sought Ungerank's deposition.

Evonik's second declarant, Geise, has no experience in biogas membrane separations: "Q: We talked about before how you had not done any work on membrane gas separation apparatuses for biogas, right? A: That's correct." AP-1039, 225:1–6, 77:7–12, 83:18–20.

Indeed, Geise has little experience in gas separations. "[T]he types of characterization that" he and his research group "do are generally all focused on

¹ Emphasis added unless otherwise noted.

liquid phase separations...*The group does not work on gas separations...*” *Id.*, 61:6–23, 63:17–66:22, 69:23–70:23, 72:24–73:16, 76:17–22, 225:17–22. Geise has never designed or worked on any multi-stage gas membrane separation apparatuses. *Id.*, 76:17–22, 225:17–22. He has never simulated a three-stage separation process. *Id.*, 143:24–144:2. Geise pointed to one class he teaches on “mass transfer” that addresses membrane gas separations, but approximately 90% of that class is dedicated to other topics. *Id.* at 217:22–219:24; EX2008, ¶6.

Thus, Geise’s opinions should be given little weight. *Kyocera Senco Indus. Tools Inc. v. Int’l Trade Comm’n*, 22 F.4th 1369, 1376–77 (Fed. Cir. 2022).

B. Petitioner’s Expert Has A POSITA’s Qualifications

Petitioner’s expert, Baker, is one the world’s foremost authorities on membrane gas separations, with over 40 years experience and numerous awards, papers, books, patents, etc. AP-1003, ¶¶5–26; AP-1004.

Evonik agrees Baker is a “super expert,” but confusingly argues he “never was a POSITA.” POR, 7 fn 1. Evonik’s criticisms are unfounded, and Baker expressly and repeatedly stated he opined from a POSITA’s perspective. AP-1003, throughout; *Norgren Inc. v. Int’l Trade Comm’n*, 699 F.3d 1317, 1324–25 (Fed. Cir. 2012) (rejecting argument that expert was “overly-qualified”); *Endress + Hauser, Inc. v. Hawk Measurement Sys. Pty. Ltd.*, 122 F.3d 1040, 1042 (Fed. Cir. 1997).

III. PRIOR ART

Evonik's arguments misapprehend the prior art.

First, starting years before 2014, computer simulations were commonly used in attempts to optimize the types of methods in Priske's claims. AP-1041, ¶¶5–7. Priske's examples, UCE1 and the systems in Scholz are simulations. POR, 56; AP-1001, 15:34-35; AP-1041, ¶¶8–19. POSITAs would have understood Scholz's Figure 7 systems were simulations and would have understood UCE1 was a simulation because its mass balances sum nearly exactly to three significant digits, many of its flowrates and other variables have three or more significant digits, and its size. AP-1041, ¶¶8–19.

Simulations can use different assumptions, data, and/or inputs. EX2008, ¶29; AP-1041, ¶¶6, 20. For example, membrane areas can be an input into a simulation, or membrane areas can be calculated by the computer (if enough other information is provided). EX2009, 60:9–17; AP-1041, ¶20.

Evonik's suggestion that actual membrane modules were used in UCE1's simulation is wrong. POR, 8, 21, 28, 41–42. Simulations do not have actual membranes or membrane modules, and despite UCE1 stating that “[e]ach stage consisted of a hollow fiber membrane module consisting of hollow polyimide fibers from UBE (NMB01 A type),” there were no actual polyimide fibers or modules in the simulation. AP-1006, 10:25–27; AP-1038, [0073]; AP-1041, ¶¶20–

23. Moreover, POSITAs would have understood commercial membrane modules would have been far too large for UCE1. AP-1041, ¶23.

In reality, UCE1's simulation used *properties* of polyimide membranes, but UCE1 does not specify the membranes' areas, area ratios, or if the areas were input into the simulation or calculated by the computer. *Id.*, ¶¶21–22.

Second, in Scholz's Figure 7 simulations, identical membrane properties were used in each stage ("properties of cellulose acetate membranes with a selectivity of 20"). AP-1007, 3, 5–6; AP-1041, ¶24. The same is true in UCE1's simulation (identical polyimide membrane properties). AP-1006, 10:25–27; AP-1038, [0073]; AP-1041, ¶¶21–22.

Accordingly, as Baker explained, in each system in Scholz's Figure 7 and in UCE1, the membrane permeances—measured at *any* standard set of conditions—are identical. AP-1003, ¶¶156–158; AP-1041, ¶¶36–43; Corrected Petition, 30.

Third, as Evonik acknowledges, "Scholz assumes that energy costs will be high and thus a limiting factor in designing a gas separation system." POR, 36; AP-1007, 4. Geise explained Ungerank similarly "does not discuss scenarios where lower energy cost is present." EX2008, ¶77.

That is, Scholz and Ungerank recommended using higher-selectivity membranes in the typical situation where energy costs are a primary consideration—i.e., not where membrane cost and/or size are primary drivers. In

repeatedly arguing Ungerank and Scholz recommended higher-selectivity membranes, Evonik ignores this distinction. POR, 20–21, 35–38, 45–46.

Even setting that aside, Scholz’s and Ungerank’s teachings on lower-selectivity membranes are not “inapt for obviousness purposes” “just because better alternatives exist in the prior art.” *In re Mouttet*, 686 F.3d 1322, 1334 (Fed. Cir. 2012) (“a known system...does not become patentable simply because it has been described as somewhat inferior to some other product for the same use”); *In re Applied Materials, Inc.*, 692 F.3d 1289, 1298 (Fed. Cir. 2012).

IV. CLAIM CONSTRUCTION: SCHOLZ’S AND UCE1’S CAPACITY RATIOS AND SURFACE AREA RATIOS ARE EQUAL

Evonik contends “capacity” should be construed because it is defined in Priske (underscoring “capacity” is a coined term in Priske²); and “under standard conditions as defined in the description” should be construed. POR, 27.

Evonik’s contentions are a red herring: these terms do not require construction for the prior art here, and regardless, the prior art invalidates the claims even under Evonik’s proposed constructions. Corrected Petition, 29–31.

Limitation [1f.ii] requires comparing the membranes’ “capacities” in stages 1 and 2, “the total capacity being measured for nitrogen Grade 4.8 under standard

² Evonik previously contended “capacity” was a known term but only pointed to its use in ways other than how it is defined in Priske. Preliminary Response, 17.

conditions as defined in the description.” AP-1001, claim 1.

Priske defines “capacity” “as the product of the membrane surface and the *permeance* of the membrane at operating temperature that is determined for nitrogen (Grade 4.8) under standard conditions.” *Id.*, 2:53–57. Accordingly, as Baker explained, the reference in [1f.ii] to measuring capacity under certain conditions is “the result of and depends on measuring *permeance* at those conditions.” AP-1003, ¶154.

Baker also explained, as common sense suggests, when membranes are identical, their permeances—measured at *any* given set of conditions (including “for nitrogen Grade 4.8 under standard conditions as defined in the description”)—are necessarily identical. AP-1003, ¶¶154–158; AP-1041, ¶¶36–39. Evonik concedes this: “where the materials are identical, they may have identical permeances and thus relative total capacity may be proportional to membrane surface area.” POR, 33.

Scholz’s Figure 7 and UCE1 are simulations based on identical membrane properties (except for their areas) in the three stages in each system. *Id.*, 56; AP-1007, 5 (Figure 7 based on “*properties* of cellulose acetate membranes with a selectivity of 20”); AP-1006, 10:25–27 (“Each stage consisted of a hollow fiber

membrane module consisting of hollow polyimide fibers”); AP-1038, [0073].³

AP-1041, ¶¶20–24.

Because in Scholz’s Figure 7 and UCE1, the membranes have identical properties (including identical permeances “for nitrogen Grade 4.8 under standard conditions as defined in the description”), the capacity ratio for any two stages equals the surface area ratio—i.e., the identical permeances cancel each other out:

$$\frac{\text{Capacity}_{\text{stage 2}} = \text{surface area}_{\text{stage 2}} * \text{permeance}_{\text{stage 2 (equal to stage 1)}}}{\text{Capacity}_{\text{stage 1}} = \text{surface area}_{\text{stage 1}} * \text{permeance}_{\text{stage 1 (equal to stage 2)}}}$$

AP-1041, ¶¶36–41.

In short, in Scholz Figure 7 and UCE1, the capacity ratios are equal to the surface area ratios. *Id.*

Evonik argues Petitioner did not address the capacities in Scholz’s Figure 7 and UCE1 specifically “measured for nitrogen Grade 4.8 under standard conditions as defined in the description.” POR, 31–33. But again, in those systems,

³ Because they are simulations based on identical membrane properties, Evonik’s arguments about the membranes’ “thickness and manufacturing processes and treatments” and variances in “chemical composition” are nonsensical. POR, 33. There are no actual membranes in simulations.

comparing the capacities in the different stages “measured for nitrogen Grade 4.8 under standard conditions as defined in the description” is the same as comparing their surface areas. AP-1003, ¶¶156–157; AP-1041, ¶¶36–41.

Moreover, because in Scholz’s Figure 7, the membrane surface areas in stage 2 are larger than in stage 1, those systems meet claim 1’s capacity limitation [1f.ii]. AP-1041, ¶42.

Likewise, if UCE1’s membrane in stage 2 was larger than in stage 1, that would also meet claim 1’s capacity limitation. AP-1041, ¶43.

V. UNGERANK IS PRIOR ART

The corrected Petition identified AP-1038 (the Ungerank application publication) as “Ungerank” and made clear Petitioner relied on AP-1038 as prior art, which it indisputably is. Corrected Petition, 3. The corrected Petition explains that the “portions of” AP-1006 (the Ungerank patent) cited “herein...are prior art...*as they were published*” in “(AP-1038) (*Ungerank*)” and the “publication’s specification and figures are identical to the patent.” *Id.* In other words, the cited disclosure in AP-1006 was previously published in AP-1038, and the corrected Petition relies on the disclosure in AP-1038 as prior art.

Evonik attempts to distort this, arguing the corrected Petition relies on AP-1006 as prior art. POR, 29–30. But Exhibit 3001 (which Evonik did not cite) demonstrates Evonik is incorrect. The specific purpose of the correction was to

rely on AP-1038 as prior art: Petitioner explained it “noticed an error,” which was that “the petition cites” AP-1006 “as prior art instead of” AP-1038. EX-3001. Indeed, if Petitioner were relying on AP-1006 as prior art, there would have been no reason for a correction because the original petition already (incorrectly) referred to AP-1006 as prior art.

Petitioner sought the correction less than a week after filing, Evonik agreed to it, and the Board accepted the corrected Petition. *Id.* Evonik has never claimed any prejudice and was on notice of AP-1038 at least nine months before its Response. *Id.* Moreover, by citing AP-1006’s column and line numbers instead of AP-1038’s paragraph numbers, Petitioner provided much more specific citations in support of its arguments.⁴

If Evonik believed Petitioner was relying on AP-1006 as prior art, then it could and should have raised that issue much earlier—at the time of the correction or even in its Preliminary Response—before the Board and parties expended significant resources to get to this stage. Evonik did not and thus waived this argument.

⁴ Some paragraphs in AP-1038 are more than half a column long.

VI. POSITAS WOULD HAVE BEEN MOTIVATED TO USE LOWER-SELECTIVITY MEMBRANES

Before 2014, tradeoffs between higher-selectivity and lower-selectivity membranes were well-known. Higher-selectivity membranes reduce the amount of gas recycled, thereby reducing the amount of gas re-compressed, thereby reducing the energy used by the compressor, thereby reducing energy costs. AP-1003, ¶¶120–122; Corrected Petition, 18–20. As Evonik explains, however, higher-selectivity membranes have “decreased permeability,” and are thus larger and “higher cost.” POR, 10–11.

Scholz explained that this “trade-off between permeability and selectivity is well known...low selectivities...result[] in increased compression duty. For high selectivity, permeance drops which increases the required membrane area remarkably” resulting in “higher investment costs and membrane replacement costs.” AP-1007, 4; EX2009, 73:21–75:13, 135:8–136:22.

These known “trade-offs” were reasons for POSITAs to use both higher-selectivity and lower-selectivity membranes, depending on the circumstances, as evidenced by Scholz optimizing systems with both higher-selectivity and lower-selectivity membranes. AP-1007, Figures 5 and 7; AP-1003, ¶129.

Evonik argues “Petitioner’s assertion that in 2014 there was a market ‘need’ for ‘lower-selectivity, lower-cost membranes’...is wrong.”⁵ POR, 37–38. But in 2014, during prosecution of the Ungerank patent (where Priske was an inventor), Evonik told the Patent Office precisely the opposite, explaining POSITAs “would not have found motivation” to “use[] high selective membranes instead of membranes with low selectivity.” AP-1045, 353. Further, Evonik’s Response acknowledges lower-selectivity membranes were “the industry standard at that time and...regularly used.” POR, 37–38.

Consistent with that, Baker provides several reasons POSITAs would have used lower-selectivity, smaller, less-expensive membranes in 2014. One was to address the supposed “new problem” in Priske—i.e., as Baker explained in 2012, “on offshore platform applications, where smaller membranes were needed because of weight concerns and low-cost energy was readily available.” AP-1003, ¶125; AP-1013, 363; Corrected Petition, 20–22.

Baker also explained that in 2014, membrane-separation systems were expensive; initial costs were incurred before a system operates and provides income; and operating costs could be deferred with income from a system once

⁵ Evonik illogically implies a market need must be unfulfilled at the priority date, and the earlier prior art must fill the (later) unfulfilled need. POR, 37–38.

operational. AP-1003, ¶¶126–129. For these reasons, before 2014 and since, some operators sought to minimize initial investment costs (with the consequence they would incur higher operating costs) by using lower-selectivity membranes. *Id.* Evonik’s Response does not address this.

Additionally, in mid-2014, Baker explained that many systems must be operated with limited feed-to-permeate pressure ratios, meaning “the optimum membrane may not be the one with the highest selectivity; rather, a membrane with lower selectivity, but tailored to the pressure ratio, may result in a more economical process.” AP-1046, Abstract; AP-1041, ¶45. In 2008, Baker discussed reducing “skid costs” by using higher permeance, smaller (i.e., lower-selectivity) membranes. AP-1047, 3; AP-1041, ¶46, 44.

Evonik further argues the reasons Baker explained that POSITAs would have used lower-selectivity membranes are “too general” and not “specific enough” and cites paragraphs 72–79 in Geise’s declaration as supposed support. POR, 38 n.10. Those paragraphs do not address this point. EX2008, ¶¶72–79.

In sum, POSITAs would have been motivated to use lower-selectivity membranes in 2014.

VII. EVONIK’S ARGUMENTS THAT PRIOR ART HAD TO ADDRESS THE “NEW PROBLEM” IS WRONG

Evonik argues “neither...Ungerank...or Scholz[] say anything about how to design a membrane gas separation system where the price of electricity is low”

(POR, 35); “systems with lower-selectivity...membranes” is “neither the problem that Priske-’380 solves nor what the prior art...discloses or solves” (POR, 34); and “[w]ithout any recognition of the problem actually addressed by Priske-’380 (i.e., the need for a system optimized for low energy costs), Petitioner’s Ground I must fail” (POR, 37).

That is, Evonik wrongly argues that for Priske’s claims to be obvious, POSITAs must have been motivated to solve the supposed “new problem,” and solve it the same way the inventors allegedly did.

Priske’s claims do not have any limitations regarding the “new problem” or its supposed solution. AP-1001, claims. They say nothing about “where the price of electricity is low” or anything like that. *Id.*; POR, 35. The claims are broader.

Likewise, Priske’s claims do not require an “energy optimum” (POR, 6, 36), a “maintenance cost optimum” (POR, 6), “significantly reduced overall membrane capacity” (POR, 15), “high purity” (POR, 14–15), “advantageous operation and maintenance costs” (POR, 14), “optimize[d] maintenance costs where energy costs are low” (POR, 15), methods “optimized for low energy costs” (POR, 36–37), or “optimal” pressure quotient or total capacity ratios (POR, 44).

Evonik’s attempt to avoid the prior art by narrowing the claims to the “new problem” and unclaimed features should be rejected.

Indeed, in *KSR*, the Supreme Court held that in determining “obvious[ness],

neither the particular motivation nor the avowed purpose of the patentee controls” and it was error to “look only to the problem the patentee was trying to solve.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 419–20 (2007)); *Honeywell Int’l Inc. v. 3G Licensing, S.A.*, 124 F.4th 1345, 1353–54 (Fed. Cir. 2025).

The real issue is whether POSITAs had a motivation to combine the references’ teachings with a reasonable likelihood of success in a way that would have led to the claimed methods. *Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016); *KSR*, 550 U.S. at 419–20.

VIII. POSITAS WOULD HAVE LOOKED TO UCE1

As explained, POSITAS would have been motivated to use lower-selectivity membranes. Such POSITAS would have looked to UCE1 because it achieves “[p]ure product streams” using three stages with one compressor (a known advantageous configuration), and provides detailed information on the system configuration, membrane selectivity, and the gases’ compositions, flowrates, pressures and temperatures. AP-1006, 10:64–65; AP-1038, [0073]–[0074]; AP-1007, Abstract; AP-1003, ¶¶131–133; Corrected Petition 22–23.

In the opposition appeal for the European Priske patent (with the same specification and very similar claim 1 as Priske), Evonik argued UCE1 is the closest prior art to Priske; and had “greater relevance” to POSITAS than other prior

art “since it has clearly already been identified as a suitable starting point for exploring the corresponding statement of the problem.” AP-1042; AP-1044, 21–27.

The reasons Evonik now argues POSITAs would not have looked to UCE1 are unconvincing.

First, Evonik notes UCE1 states it has “‘moderate’ (not ‘low’)” selectivity membranes. POR, 21–22. But UCE1 was from 2011, and in 2014, Scholz identified membranes with the same selectivity as “low selective.” AP-1007, 9; AP-1041, ¶¶25–27. Baker testified similarly in his deposition, that there were no “absolute” definitions of lower-selectivity and higher-selectivity, and that POSITAs would have considered UCE1’s membranes to be lower-selectivity. EX2009, 70:19–73:5; AP-1041, ¶¶25–27.

Second, Evonik argues UCE1’s polyimide membranes “were uncommon” and “were not available from the major membrane suppliers,” citing Baker’s deposition. POR 40. In reality, Baker testified that polyimide membranes had “a small fraction of the market”—consistent with Scholz describing them as “commercial membrane[s].” EX2009, 143:6–16; AP-1007, 5. Indeed, Baker wrote in 2008 that polyimide membranes had been available “[in] the past 10 years.” AP-1047, 2.

Third, Evonik argues POSITAs could have turned to “one of the simpler prior art systems as disclosed in Figures 2 through 10” in Ungerank “as opposed to” UCE1. POR, 44. But there are no examples in Ungerank using the configurations in figures 2 through 10, whereas UCE1 has extensive details about its system.

Evonik similarly argues Scholz’s Figure 7 has the characteristics Baker pointed to as reasons POSITAs would have looked to UCE1. *Id.*, 39–40. But Scholz was based on GAMS, which was a relatively uncommon simulation method, is an academic paper, and as Evonik acknowledges, makes assumptions such as isothermal operation and ideal gases that are not as realistic as UCE1, which was from a known membrane supplier. AP-1041, ¶¶12–15; AP-1007, 1–3; POR, 52–53.

Fourth, Evonik argues POSITAs would not have looked to UCE1 because it had 1% methane in the carbon dioxide product stream. POR, 21, 26, 39, 46, 50. Evonik references “European laws,” with no supporting cites, alleging they require less than 1% methane. *Id.*

Evonik never identifies the specific laws or regulations it refers to, whether they were in place in 2014, or whether such regulations also existed in the United States and other places. *Id.* For example, Baker explained that in “the Far East” “permeate that contains 93% CO₂...can be vented.” AP-1047, 8. Meanwhile,

Geise testified he is not an expert on any environmental laws or regulations. AP-1040, 39:5–19.

Also, in industrial systems, it is routine and inexpensive to decrease small amounts of organic compounds in a stream. AP-1041, ¶¶47–49.

Fifth, Evonik argues UCE1 is “a ‘tiny’ system with no commercial application” because it has a 1.78 m³/hr crude gas flowrate. POR, 7, 21. There are no size or commercial limitations in Priske’s claims—the claims are broader. AP-1001, claims. Indeed, in all Priske’s examples, the crude gas flowrates (17) are 1.78 m³/hr or less (in most, 1 m³/hr). AP-1001, 16:28–30, 16:44–45, 17:65, 18:46, 19:10, 19:33, 20:9, 20:54, Tables 9–15; AP-1041, ¶¶10–11. Further, Evonik claims “Baker conceded” UCE1 “is not likely to be a commercially useful starting point,” citing EX2009 at 127:4-11, but Baker never said that. He testified UCE1 was a “functionally complete” “operative system.” See POR, 42–43, citing EX2009, 113:21-114:8.

IX. POSITAS WOULD HAVE BEEN MOTIVATED TO COMBINE UCE1’S AND SCHOLZ FIGURE 7’S TEACHINGS, THEREBY MEETING CLAIM 1’S CAPACITY LIMITATION

UCE1 contains many details but not the membranes’ areas. AP-1006, 10:20–67, AP-1038, [0073]–[0074]. POSITAs thus would have been motivated to look to other sources describing similar systems to better understand UCE1’s membrane areas. AP-1003, ¶¶134–36; Corrected Petition 22–24.

As previously explained, the systems in Scholz's Figure 7 are similar in several respects to UCE1 and Scholz's systems have optimized membrane areas. AP-1003, ¶¶114–119, 135–136, 140. This would have given POSITAs reason to look to Scholz's Figure 7 to better understand UCE1's relative membrane areas.

As Baker explained, POSITAs "might have already figured out" that in UCE1, stage 2's surface was larger than stage 1's area. EX2009, 111:3–113:6. POSITAs would have understood that smaller membranes result in increased permeate concentration, and in UCE1, a high permeate (CO₂) concentration was needed in stage 1 (i.e., in stream (6)) to create the driving force necessary in stage 3 to achieve the relatively high CO₂ concentration (99.0%) in the third permeate stream (11). AP-1041, ¶¶28–30. POSITAs also would have understood that in stage 2, a relatively large membrane was needed to allow much of the CO₂ to pass through, to achieve the relatively high methane concentration (98.5%) in the second retentate stream (8). *Id.*

The fact that Scholz's Figure 7 systems had larger stage 2 membrane areas than stage 1, and that was consistent with POSITAs' likely intuition about UCE1's stage 2 and stage 1 areas, was an additional reason POSITAs would have found it appropriate to look to Scholz's Figure 7 to better understand UCE1's relative surface areas. AP-1041, ¶¶31–32.

As Baker explained, Scholz's Figure 7 would have given POSITAs "a feel for what's the relative size for...membrane area" and that accordingly, "Scholz is helpful; no question about it." EX2009, 111:3–112:8. Regarding using Scholz to better understand UCE1, Baker further explained that "if someone else has done it before, you better find out. It's always a good thing...it's the cheapest sort of research, see what the other guys did." *Id.*, 113:15-19.

Evonik's arguments otherwise are unconvincing.

First, Evonik mischaracterizes Petitioner's arguments, claiming they are based on POSITAs implementing Scholz's "*specific* membranes" (or their specific "surface area[s]") into UCE1. POR, 44–46, 28, 52–53. For example, Evonik argues Ground I is based on "incorporat[ing]...the separation membranes taught in Figure 7 of Scholz *instead of* the membranes used in" UCE1. *Id.*, 57.

Obviousness does not require that. *Allied Erecting*, 825 F.3d at 1381 (holding "it is not necessary that" prior art "be physically combinable" for obviousness); *In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (en banc) ("assertions that Azure cannot be incorporated in Ambrosio are basically irrelevant, the criterion being not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole").

As Baker explained, UCE1 is “missing...how much membrane area you’re going to use”; and POSITAs would have turned to Scholz because “it’s the cheapest sort of research”—especially since the systems in Scholz’s Figure 7 are similar in several respects to UCE1. EX2009, 111:20–25, 113:15–19.

That is, Scholz would have suggested to POSITAs that in UCE1, stage 2’s membrane was larger than stage 1’s, but POSITAs need not and would not have implemented Scholz’s specific features into UCE1.

Second, Evonik argues POSITAs would not have combined Scholz’s teachings with UCE1 because Scholz is not “reflective of real-world conditions” or “real-world applications,” erroneously implying UCE1 is “real-world.” POR, 52. UCE1 is a simulation, like Scholz’s Figure 7. POR, 56. Also, as explained, POSITAs would have looked to Scholz’s optimized surface areas to better understand UCE1’s relative surface area sizes, not for the types of detailed system information Evonik argues about.

Third, UCE1 does not specify its membrane areas, but Evonik argues, based on incorrect and unsupported premises, the areas were the same in each stage. POR, 21–22, 28, 41–42.

Evonik’s argument is solely based on UCE1’s statement that “[e]ach stage consisted of a hollow fiber membrane module consisting of hollow polyimide fibers from UBE (NMB01 A type).” AP-1006, 10:25–27; AP-1038, [0073]. As

explained, however, UCE1 is a simulation, which POSITAs would have understood. POR, 56; AP-1041, ¶¶16–19. There were no actual “modules” or “hollow polyimide fibers.” The simulation used the *properties* of such membranes, but does not specify the areas, or if the membrane areas were input into the simulation or calculated by the computer. For example, like in UCE1, Scholz’s simulations used the same membrane properties in each stage, and referred to membrane modules, but in Figure 7 (and in Figure 5 and 8) each membrane is a different size. AP-1007, 5–8.

In sum, UCE1 does not provide its membrane sizes, and that would have motivated POSITAs to look elsewhere for information to better understand their sizes.

Moreover, in Baker’s deposition, and in its Response, Evonik suggested the “modules” in UCE1 are “commercially available”—but then conversely argues UCE1 is “a ‘tiny’ system with no commercial application.” EX2009, 89:6–90:21; POR 7, 21, 41. In reality, as Baker discussed in his deposition, POSITAs would have understood “commercially available” modules would be far too large for UCE1. EX2009, 94:14–96:21; AP-1041, ¶23.

Fourth, Evonik argues POSITAs could have learned about UCE1’s membrane areas in various ways (POR, 42), but each is far more complicated than looking to Scholz, “the cheapest sort of research.” EX2009, 113:15–19. In the

first instance, POSITAs would have expeditiously and inexpensively looked to Scholz's Figure 7, and in doing so would have been led to claim 1's capacity limitation. AP-1041, ¶¶36–43. As explained, in Scholz's Figure 7 and UCE1, the capacity ratios are equal to the surface area ratios; the systems in Scholz's Figure 7 meet claim 1's capacity limitation; and if UCE1 had a stage 2 membrane larger than in stage 1, that would also meet claim 1's capacity limitation.

X. POSITAS WOULD HAVE HAD A REASONABLE EXPECTATION OF SUCCESS

Evonik's arguments on expectation of success largely follow its argument that POSITAs would not have looked to Scholz's Figure 7.

Again, POSITAs would have looked to Scholz's Figure 7 to better understand the relative surface areas in UCE1, and in doing so would have been led to the understanding that in UCE1, stage 2's membrane is larger than stage 1's membrane. Corrected Petition, 17–18, 24–25; AP-1041, ¶¶28–31, 36–43.

Contrary to Evonik's repeated suggestions, POSITAs would not have imported the specific membranes, specific membrane areas, or specific membrane

area ratios from Scholz's Figure 7 into UCE1, nor is that required for obviousness.⁶

POR, 28, 49–50, 52; *Allied Erecting*, 825 F.3d at 1381.

For similar reasons, Evonik's arguments that Baker did not provide any simulations using the combined features of UCE 1 and Scholz Figure 7 is misguided. POR, 48; *In re Etter*, 756 F.2d at 859 (finding "assertions that" one reference's teachings "cannot be incorporated in" another reference's teachings "basically irrelevant"). Indeed, Evonik accuses Petitioner of using the wrong legal standard, but Evonik attempts to hold Petitioner to a higher standard than is required. POR, 48.

UCE1 does not provide the membrane surface areas, leaving POSITAs a finite number of identified options in terms of stage 2's relative size versus stage 1. *KSR*, 550 U.S. at 421. Stage 2 could be larger, equal to, or smaller than stage 1. As explained above, Scholz's Figure 7 (as well as UCE1 itself) would have led to the belief that stage 2 was larger than stage 1.

Given the finite options, POSITAs would have had a reasonable expectation of success using Scholz's Figure 7, in conjunction with the information in UCE1

⁶ Evonik cites Qi and Henson Figure 9, but POSITAs in 2014 would not have looked to that system from fourteen years earlier instead of Scholz's 2014 Figure 7 systems that are much more similar to UCE1. POR, 49. AP-1041, ¶¶33–35.

itself, to understand that in UCE1, stage's 2's surface area was larger than in stage

1. Using Scholz's Figure 7 in this way would not have involved changing any variables expressly identified in UCE1. On the contrary, POSITAs would have used Scholz's Figure 7 to better understand information missing from UCE1, which in and of itself would have provided a reasonable expectation of success. And that POSITAs "might have already figured out" that in UCE1, stage 2's surface was larger than stage 1's area would have only improved that expectation. EX2009, 111:3–114:8; AP-1041, ¶¶28–30.

Evonik argues POSITAs would not have expected success from combining UCE1's and Scholz's Figure 7 teachings because UCE1 was a smaller system than the Figure 7 systems. POR, 7–8, 53. Scholz's Figure 7 systems are larger than UCE1, but Baker testified that Figure 7's systems are also "relatively small." EX2009, 126:9–22. Moreover, and again, POSITAs would have looked to Scholz to better understand the relative membrane areas in UCE1—not to combine specific features of the different systems.

XI. DEPENDENT CLAIMS

Ground 1 challenged claims 1–5, 7, 9 and 11–23. Evonik's Response does not contest that UCE1 discloses the requirements of claims 2–5, 7, 11, 13–16 and 18–23, meaning those claims should be found obvious if claim 1 is found obvious over Ungerank and Scholz.

Regarding claim 9, Evonik cites *In re Patel*, an unpublished opinion. POR, 54. Evonik then implies that in *Titanium Metals*, the differences between the prior art percentages and claimed percentages were smaller than the difference between UCE1's 86.7% and the claimed 65–85%. POR, 54–57. That is incorrect. AP-1041, ¶¶56–58.

Evonik then argues “Petitioner has not shown that value is ‘so close’ that a POSITA ‘would have expected it to have the same properties,’” but just after quotes Baker stating “such differences ‘do not typically cause substantial differences in performance.’” POR, 54–55 citing AP1003, ¶174. In other words, Evonik argues Baker did not use the exact language in *Titanium Metals* (even though he expressed the same idea). Moreover, the only evidence Evonik cites is Geise's testimony, who is not a POSITA. *Id.*; Section II.A, *supra*; 37 C.F.R. § 42.65(a).

Claim 12 requires a “***pure*** gas selectivity...from 20 to 100” and UCE1 has a ***mixed*** gas selectivity of 20. *See* AP-1003, ¶178. Baker explained “pure-gas selectivity is higher than its mixed-gas selectivity, but nonetheless the pure-gas selectivity for the types of membranes in” UCE1 would not be five times higher than the mixed-gas selectivity, and cited data from his book in support. *Id.* citing AP-1013, 334–335; Corrected Petition, 36. Evonik offers unsupported Geise opinions quibbling with Baker's data, arguing it is for a different membrane

material and not for the exact feed stream composition in UCE1. POR, 57–58

citing EX2008, ¶¶108–109. Regardless, in 2010 Bhatti reported CO₂/CH₄ pure-gas selectivities for polyimide membranes of 29 to 59—nowhere near five times the mixed-gas selectivity of 20 in UCE1’s polyimide membranes, and in 1999, Staudt-Bickel reported similar data for polyimide membranes. AP-1048, 5; AP-1049, 6, 8; AP-1041, ¶¶50–55.

Claim 17 requires “a multistage compressor and the second permeate stream, the third retentate stream, or both are introduced into the compressor between two compression stages.” AP-1001, claim 17. Evonik ignores that Ungerank discloses a multistage compressor in Figure 11 (the UCE1 configuration) and expressly discloses several times the second permeate stream and/or third retentate stream introduced between two compression stages. AP-1006, 15:12, 10:24, 6:42–45, 7:11–13, 8:1–4; AP-1038, [0098], [0073], [0048], [0054], [0055]. That UCE1 has a relatively small crude gas flowrate does not negate these teachings. *Allied Erecting*, 825 F.3d at 1381 (obvious determined based on “the teachings of the prior art as a whole”). Indeed, Baker testified “any POSITA” would have been familiar with using multistage compressors as claimed, and Geise testified Priske did not disclose any new types of multistage compressors. EX2009, 119:21–120:5; AP-1040, 70:5–20.

Respectfully submitted,

Dated 4/11/2025

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petitioner's Reply to Patent Owner's Response totals 5,569, which is less than the 5,600 allowed under 37 CFR § 42.24.

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4) and 42.205(b), the undersigned certifies that on April 11, 2025, a complete and entire copy of this Petitioner's Reply to Patent Owner's Response and supporting exhibits were provided by email to the Patent Owner by serving the correspondence email address of record as follows:

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