

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CELANESE INTERNATIONAL CORPORATION,
Petitioner,

v.

DAICEL CORPORATION,
Patent Owner.

Case IPR2017-00163
Patent 8,940,932 B2

Before SHERIDAN K. SNEDDEN, ZHENYU YANG, and
TINA E. HULSE, *Administrative Patent Judges*.

YANG, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

INTRODUCTION

Celanese International Corporation (“Petitioner”) filed a Petition for an *inter partes* review of claims 1–14 of U.S. Patent No. 8,940,932 B2 (“the ’932 patent,” Ex. 1001). Paper 1 (“Pet.”). Daicel Corporation (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). On May 8, 2017, the Board instituted a review of the patentability of the challenged claims. Paper 9 (“Dec.”).

Thereafter, Patent Owner filed a Response (Paper 18 (“PO Resp.”)), and Petitioner filed a Reply (Paper 26). The parties also briefed whether certain exhibits should be excluded from the record. Papers 34, 35, 37–40. In addition, Patent Owner filed observations on the cross-examination of Petitioner’s reply declarant (Paper 33), and Petitioner filed a response thereto (Paper 36). An oral hearing for this proceeding was held on January 23, 2018. *See* Paper 45 (“Tr.”).

The Board has jurisdiction under 35 U.S.C. § 6 and issues this final written decision pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons provided below, we conclude Petitioner has established by a preponderance of the evidence that claims 1 and 3–14 of the ’932 patent are unpatentable. Petitioner, however, has failed to meet its burden of proof regarding the unpatentability of claim 2.

Related Proceedings

The parties represent that there are no related matters that would affect or be affected by this proceeding. Pet. 1; Paper 14, 1.

The '932 Patent

The '932 patent “relates to a process for stably producing acetic acid by carbonylation of methanol in the presence of a metal catalyst (such as a rhodium catalyst) and methyl iodide.” Ex. 1001, 1:5–8.

Before the '932 patent, “[v]arious industrial production processes of acetic acid ha[d] been known.” *Id.* at 1:12–13. One of them, according to the '932 patent, is “highly efficient” because of the “addition of a catalyst stabilizer (such as an iodide salt) and the reaction under a low water content condition.” *Id.* at 1:17–22. The '932 patent states that the reaction mixture contains impurities, such as acetaldehyde, which deteriorates the quality of acetic acid. *Id.* at 1:25–34. The '932 patent acknowledges that prior-art methods exist to reduce the concentration of acetaldehyde in the reaction system. *Id.* at 1:57–2:41. For example, according to the '932 patent,

Japanese Patent Application Laid-Open Publication No. 8-67650 (JP-8-67650A, Patent Document 2) discloses a process for producing high-purity acetic acid, comprising allowing methanol to continuously react with carbon monoxide in the presence of a rhodium catalyst, an iodide salt, and methyl iodide, wherein the reaction is carried out by removing acetaldehyde from a process liquid being circulated into a reactor to maintain the acetaldehyde concentration in the reaction mixture at 400 ppm or lower. . . .

In addition, this patent document discloses, relating to a process for producing acetic acid while removing acetaldehyde, that the process comprises separating the reaction mixture into a volatile phase containing acetic acid, methyl acetate and methyl iodide and a low-volatile phase containing the rhodium catalyst, distilling the volatile phase to obtain a product mixture containing acetic acid and an overhead containing methyl acetate and methyl iodide, and recirculating the resulting overhead into the reactor, wherein the overhead or a carbonyl impurity

(particularly acetaldehyde) condensate thereof is allowed to contact with water to separate an organic phase containing methyl acetate and methyl iodide and an aqueous phase containing the carbonyl impurity, and the organic phase is recirculated into the reactor.

Id. at 2:6–35. This document, however, the '932 patent states, “does not disclose that the flow rate of the overhead is controlled in recirculating the overhead into the reactor.” *Id.* at 2:42–44.

The invention of the '932 patent allegedly provides a process for stably producing acetic acid while (1) efficiently removing acetaldehyde, and/or (2) recycling methyl iodide as a catalyst with a high efficiency. *Id.* at 2:57–62.

Illustrative Claim

Among the challenged claims, claim 1 is independent. It is reproduced below:

1. A process for producing acetic acid, which comprises:
 - a reaction step for continuously allowing methanol to react with carbon monoxide in the presence of a catalyst system comprising a metal catalyst, a halide salt, and methyl iodide in a carbonylation reactor,
 - a flash evaporation step for continuously feeding a flasher with a reaction mixture from the reactor and separating a lower boiling point component (2A) containing product acetic acid and methyl iodide and a higher boiling point component (2B) containing the metal catalyst and the halide salt,
 - an acetic acid collection step for continuously feeding a distillation column with the lower boiling point component (2A), and separating a lower boiling point component (3A) containing methyl iodide and by-product acetaldehyde and a stream (3B) containing acetic acid to collect acetic acid,

- a condensation step for condensing and temporarily holding the lower boiling point component (3A) in a decanter and discharging the lower boiling point component (3A) from the decanter, and
 - a separation and recycling step for separating the lower boiling point component (3A) discharged from the decanter into acetaldehyde and a liquid residue and recycling the liquid residue to a step from the reaction step to the acetaldehyde-separation step,
- wherein in the condensation step, the amount of the lower boiling point component (3A) to be held is adjusted or controlled based on a fluctuating flow rate of the lower boiling point component (3A) to be fed to the decanter, and the amount of the lower boiling point component (3A) to be fed to the separation and recycling step is adjusted or controlled.

Reviewed Grounds of Unpatentability

We instituted *inter partes* review of the following grounds of unpatentability:

Ground	Claims	Basis	References
1	1, 4, 8, 12, 14	§ 103	Zinobile, ¹ Hallinan, ² and Ochiai ^{3,4}

¹ Zinobile, et al., U.S. Patent Application Publication No. 2006/0247466 A1, issued November 2, 2006 (Ex. 1010).

² Hallinan, et al., U.S. Patent No. 6,552,221 B1, issued April 22, 2003 (Ex. 1011).

³ Shinya Ochiai, U.S. Patent No. 5,352,415, issued October 4, 1994 (Ex. 1009).

⁴ Petitioner does not explicitly include Ochiai in the asserted obviousness grounds. See Pet. 19, 32, 37, 44, 47. In the Decision to institute, we, however, declined to, as Patent Owner would have us, deny the Petition based on this fact. Dec. 10–11. Instead, we added Ochiai to all reviewed grounds. *Id.* at 11.

Ground	Claims	Basis	References
2	2–4	§ 103	Zinobile, Hallinan, Balchen, ⁵ and Ochiai
3	5–7	§ 103	Zinobile, Hallinan, Aubigne, ⁶ and Ochiai
4	4, 13	§ 103	Zinobile, Hallinan, Balchen, Baasel, ⁷ and Ochiai
5	3, 9–11	§ 103	Zinobile, Hallinan, Balchen, Baasel, Kister, ⁸ and Ochiai

In support of their respective arguments, Petitioner relies on the Declarations of James B. Riggs, Ph.D. (Ex. 1002) and Ronnie Michael Hanes, Ph.D. (Ex. 1041), and Patent Owner relies on the Declaration of Vijay S. Bhise, Eng. Sc.D. (Ex. 2006).⁹

ANALYSIS

Principles of Law

To prevail in this *inter partes* review of the challenged claims, Petitioner must prove unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

⁵ Balchen et al., Process Control, Structures and Applications (1988) (Ex. 1019).

⁶ Aubigne et al., U.S. Patent No. 5,416,237, issued May 16, 1995 (Ex. 1012).

⁷ William D. Baasel, Preliminary Chemical Engineering Plant Design (2d Ed. 1990) (Ex. 1021).

⁸ Henry Z. Kister, Distillation Operation (1990) (Ex. 1025).

⁹ Patent Owner has moved to exclude the Declarations of Dr. Riggs and Dr. Hanes (Paper 34), whereas Petitioner has moved to exclude the Declaration of Dr. Bhise (Paper 35). As explained below, we deny the motions to exclude filed by both parties. Instead, we consider each challenged testimony and accord it proper weight.

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). The strength of each of the *Graham* factors must be weighed in every case and must be weighted en route to the final obviousness determination. *See, e.g., Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538–39 (Fed. Cir. 1983) (instructing that evidence of secondary considerations, when present, must always be considered in determining obviousness).

“[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR*, 550 U.S. at 418. “[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine elements in the way the claimed new invention does.” *Id.* Moreover, a person of ordinary skill in the art must have had a reasonable expectation of success of doing so. *PAR Pharm., Inc. v. TWi Pharms., Inc.*, 773 F.3d 1186, 1193 (Fed. Cir. 2014).

We analyze the instituted grounds of unpatentability in accordance with these principles.

Claim Construction

In an *inter partes* review, the Board interprets a claim term in an unexpired patent according to its broadest reasonable construction in light of the specification of the patent in which it appears. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016). Under that standard, and absent any special definitions, we assign claim terms their ordinary and customary meaning, as would be understood by one of ordinary skill in the art at the time of the invention, in the context of the entire patent disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definitions for claim terms must be set forth with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In the Decision to Institute, we agreed with Petitioner and construed the term “buffering function” to mean “ability to temporarily retain.” Dec. 6–7. We also stated that there was no need to construe any other term expressly. *Id.* at 7. During trial, Patent Owner does not dispute these determinations. PO Resp. 3. Having considered the complete record developed at trial, we see no reason to change our interpretation of the claims.

The Level of Ordinary Skill in the Art

The determination of the level of ordinary skill in the art is an integral part of the *Graham* analysis. *Custom Accessories, Inc. v. Jeffrey–Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986). The person of ordinary skill in the art is a hypothetical person who is presumed to know the relevant prior art. *Id.*

The parties propose facially different definitions of a person of ordinary skill in the art. Even though the parties challenge each other's argument on this point, for purposes of this Decision, we do not discern material differences between the definitions.

According to Petitioner,

A person of ordinary skill in the art of acetic acid production as of October 6, 2010 is a person with a background in chemical engineering and chemical processes who has a range of knowledge roughly equivalent to the knowledge and/or training of a person holding the degree of Bachelor of Science in Chemistry, Chemical Engineering, or equivalent, and at least three years of experience with chemical processes. (Ex. 1002, ¶¶ 16-20). A POSITA [person of ordinary skill in the art] would also have a working knowledge of carbonylation processes. (*Id.*).

Pet. 16. Patent Owner contends that

the POSA [person of ordinary skill in the art] for acetic acid production in October 2010 would have either a bachelor's degree or a master's degree in chemistry or chemical engineering and (i) 2-4 years of industry experience in acetic acid production or (ii) 2-4 years of industry experience in the production of materials similar to acetic acid, such as acetic anhydride.

PO Resp. 10 (citing Ex. 2006 ¶ 35).

Petitioner asserts that by defining a POSITA as having production experience for acetic acid or acetic anhydride, "Patent Owner proposed two contradictory POSITA[s]." Reply 8. According to Petitioner, the formation of acetic anhydride is an anhydrous (water-free) process, which does not involve either the "condensation step" or the "separation and recycling step" of claim 1. *Id.* Thus, Petitioner argues that "Patent Owner's POSITA

definition is off-base and inappropriate for this proceeding.” *Id.* We disagree.

As an initial matter, challenged claim 1 includes multiple steps other than the “condensation step” and the “separation and recycling step.” Thus, we decline to discount Patent Owner’s proposed definition of the ordinary skill level merely because it includes experience with an anhydrous process. More importantly, it is undisputed that acetic anhydride, like acetic acid, is produced through carbonylation processes. *See, e.g.*, Ex. 1005, 3:26–50; Ex. 1027, 116–17. In our view, an ordinary artisan having production experience for acetic anhydride falls squarely within Petitioner’s definition: one with a working knowledge of carbonylation processes.

Patent Owner argues that an ordinary artisan according to Petitioner’s definition “requires only ‘at least three years of experience with chemical processes’ generally.” PO Resp. 4. We disagree with this characterization. Indeed, Petitioner proposes that an ordinary artisan, in addition to having the general background in chemical engineering and chemical processes, “would also have a working knowledge of carbonylation processes.” Pet. 16 (citing Ex. 1002 ¶¶ 16–20). According to Dr. Riggs, “working knowledge” means “plant experience,” including “experience in an actual acetic acid production plant.” Ex. 2005, 27:6–12.

We also decline, as Patent Owner would have us, to limit the relevant art narrowly to acetic acid production only. To define the proper scope of prior art, we determine (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is

reasonably pertinent to the particular problem with which the inventor is involved. *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004).

Here, the challenged '932 patent is directed to producing acetic acid through a carbonylation process. See Ex. 1001, 1:5–8. A general carbonylation process, although broader than, is nevertheless reasonably pertinent to, a process for acetic acid production, because “it is one which, because of the matter with which it deals, logically would have commended itself to an inventor’s attention in considering his problem.” *In re Clay*, 966 F.2d 656, 659 (Fed. Cir. 1992). Indeed, as Patent Owner emphasizes, an ordinary artisan must understand all the steps in the “continuous or integrated process” of acetic acid production. PO Resp. 7. Challenged claim 1 recites a reaction step that requires a metal catalyst as well as steps to separate and remove impurities. Evidence of the record shows that these steps are not unique to acetic acid production, but rather, are common to carbonylation processes.

For example, as Patent Owner points out, Zinobile, Ochiai, and Aubigne all relate to the production of acetic acid. PO Resp. 9 (citing Exs. 1009, 1010, 1012). Yet, each of these references discusses prior art relating to general carbonylation process. Indeed, both Zinobile and Ochiai refer to U.S. Patent No. 3,769,329 (“the '329 patent”) for teaching the carbonylation catalysts. Ex. 1009, 1:13–22; Ex. 1010 ¶ 4. The '329 patent relates to a process for producing carboxylic acids and esters, including, but not limited to, acetic acid. Ex. 3001, Abstract, 3:15–30, claims. Similarly, Aubigne refers to “UK patent GB 1,233,121[, which] describes a process for the production of an organic acid or its corresponding ester by carbonylation

using a rhodium catalyst.” Ex. 1012, 1:13–15. It also discusses UK patent GB 1,350,726 and UK patent GB 1,343,855, each of which teaches the purification of carboxylic acids, and not acetic acid specifically. *Id.* at 1:16–48. In other words, the prior art shows that an ordinary artisan, in addressing acetic acid production, would have considered references related to general carbonylation processes.

In sum, for purposes of this Decision, we do not find material differences between the parties’ proposed skill level. We further note that the prior art itself demonstrates the level of skill in the art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that specific findings regarding ordinary skill level are not required where the prior art itself reflects an appropriate level).

Obviousness over Zinobile, Hallinan, and Ochiai

Petitioner argues that claims 1, 4, 8, 12, and 14 would have been obvious over the combination of Zinobile, Hallinan, and Ochiai. Pet. 19–31. After reviewing the entire record, we determine that Petitioner has established by a preponderance of the evidence that claims 1, 4, 8, 12, and 14 are unpatentable over the combination of Zinobile, Hallinan, and Ochiai. We focus our analysis on claim 1.

Zinobile

Zinobile teaches its invention of “an improved process for the reduction and/or removal of permanganate reducing compounds” is particularly useful in the low water rhodium-catalyzed carbonylation of methanol to produce acetic acid. Ex. 1010 ¶¶ 2, 26. Permanganate reducing

compounds include acetaldehyde. *Id.* ¶ 8. Figure 1 illustrates various embodiments of the invention of Zinobile.

FIG.1

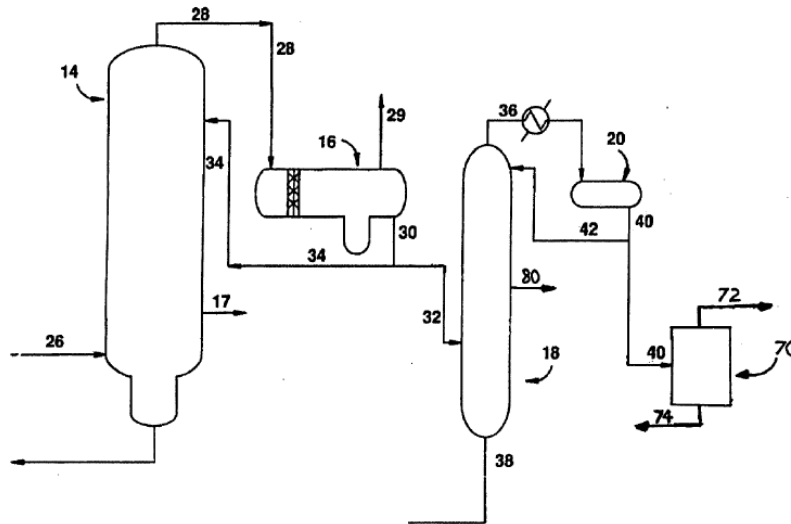


Figure 1 of Zinobile shows a “typical reaction and acetic acid recovery system that is used for the iodide-promoted rhodium catalyzed carbonylation of methanol to acetic acid,” which “includes a liquid phase carbonylation reactor, flasher, and a methyl iodide acetic acid light ends column (‘light ends column’) **14**.”¹⁰ Ex. 1010 ¶ 34. According to Zinobile,

In the process, carbonylation product obtained in the reactor is provided to the flasher where a volatile (“vapor”) overhead stream comprising acetic acid and a less volatile catalyst phase (catalyst-containing solution) are obtained. The volatile overhead stream comprising acetic acid is provided by stream **26** to the light ends column **14** where distillation yields a purified acetic acid product that is removed via sidestream **17** and an

¹⁰ It is undisputed that the “splitter column” described in the Specification (or the “distillation column” recited in claim 1) of the ’932 patent and Ochiai, is the same as the “light ends column” in Zinobile and Hallinan.

overhead distillate stream **28** (hereafter “low-boiling overhead vapor stream”). Acetic acid removed via sidestream **17** can be subjected to further purification, such as to a drying column for selective separation of acetic acid from water.

Id. Low-boiling overhead vapor stream 28 is condensed and directed to an overhead receiver decanter 16. *Id.* ¶ 38. Once in decanter 16, low-boiling overhead vapor stream 28 separates into a light phase and a heavy phase. *Id.* The condensed light liquid phase 30 is directed to distillation column 18 for further processing and to remove acetaldehyde and other impurities (*id.* ¶ 46), whereas the condensed heavy liquid phase can be recirculated, either directly or indirectly, to the reactor (*id.* ¶ 45). A portion of stream 30 also can be directed back to the light ends column 14 as reflux stream 34. *Id.* ¶ 51.

Petitioner provides a claim chart, matching each step of claim 1 with the teachings of Zinobile. Pet. 19–22 (citing e.g., Ex. 1010 ¶¶ 4, 31, 32, 34, 37, 38, 44, 46, 47, 52, Fig. 1). Patent Owner does not dispute these representations. After reviewing the record, we adopt this claim chart as our own findings, and we are persuaded that Zinobile teaches a reaction step, a flash evaporation step, an acetic acid collection step, a condensation step, and a separation and recycling step, as recited in challenged claim 1.

In addition to the steps, claim 1 also recites “wherein in the condensation step, the amount of the lower boiling point component (3A) to be held is adjusted or controlled based on a fluctuating flow rate of the lower boiling point component (3A) to be fed to the decanter, and the amount of the lower boiling point component (3A) to be fed to the separation and recycling step is adjusted or controlled.”

Petitioner acknowledges Zinobile “does not explicitly disclose that the lower boiling point component (3A) has a fluctuating flow rate.” Pet. 22. Citing the Declaration of Dr. Riggs, however, Petitioner argues that fluctuating flow rates in continuous carbonylation processes were well known to an ordinary artisan. *Id.* (citing Ex. 1002 ¶¶ 64–66). According to Petitioner, Ochiai “definitively states that fluctuations in flow rates begin with the carbonylation reactor product, and carry through the separation process, including in the low boiling overhead stream 28 of Zinobile.” *Id.* at 22–23 (citing Ex. 1002 ¶¶ 64–66), *id.* at 25 (citing Ex. 1009, 2:25–37, Figs. 1, 7A–C).

Petitioner also acknowledges Zinobile does not expressly disclose that “the amount of the lower boiling point component (3A) to be held is adjusted or controlled based on a fluctuating flow rate of the lower boiling point component (3A) to be fed to the decanter,” as recited in the wherein clause of claim 1. Pet. 23. According to Petitioner, however, Hallinan teaches this limitation. *Id.* at 24. Petitioner argues that Hallinan teaches “level controlling the decanter of the light ends (splitter) column in response to fluctuating flow rates.”¹¹ Pet. 24 (citing Ex. 1011, 5:41–60), *see also id.* (“Hallinan specifically describes adjusting the level, and in turn the flow of the light and heavy phases of the splitter column decanter.”) (citing

¹¹ Level control is “control of the level of liquid in a tank.” Ex. 1019, 7. Petitioner does not explicitly rely on Balchen (Ex. 1019) in this obviousness ground of challenge. But, because, as Patent Owner states, “Balchen is a decades-old textbook” (PO Resp. 51), we find an ordinary artisan would have been aware of the basic teachings therein.

Ex. 1011, 5:43–67, 8:1–20, 8:40–42), *id.* at 25–26 (citing Ex. 1011, 5:42–55, 6:41–47).

Petitioner further matches teachings of both Zinobile and Hallinan with the limitation “the amount of the lower boiling point component (3A) to be fed to the separation and recycling step is adjusted or controlled,” as recited in the wherein clause of claim 1. Pet. 26–27 (citing Ex. 1010 ¶¶ 44, 45; Ex. 1011, 5:57–61).

In addition, Petitioner asserts that an ordinary artisan would have had a reason to combine the teachings of Zinobile and Hallinan. Pet. 27–28. According to Petitioner, an ordinary artisan “beginning with Zinobile and aware of the economically disadvantageous flow fluctuations explained by Ochiai, would look to Hallinan because Hallinan discloses process control during acetic acid production that reduces flow fluctuations by use of level control.” *Id.* at 27. Petitioner also argues because the level control taught in Hallinan is a “generally accepted method of overall plant control,” the combination of Zinobile and Hallinan “would operate according to known methods to yield predictable results” and provide a reasonable expectation of success. *Id.* at 28 (citing Ex. 1011, 5:42–44).

Patent Owner contends Petitioner has not met its burden of showing the obviousness of claim 1 over the combination of Zinobile, Hallinan, and Ochiai. PO Resp. 14–43. According to Patent Owner, neither Hallinan nor Ochiai teaches the limitation recited in the wherein clause of claim 1. *Id.* at 28–35. Patent Owner also asserts there is no reason to combine the teachings of Zinobile, Hallinan, and Ochiai (*id.* at 15–27, 36–41), and there is no reasonable expectation of success when doing so (*id.* at 42–43). After

reviewing the entire record, we find Petitioner’s argument more persuasive. We address each argument presented by Patent Owner in turn.¹²

Ochiai

Patent Owner argues “Ochiai does not teach that the flow rate of the lower boiling point component (3A) *necessarily fluctuates* in the carbonylation process” because “Ochiai specifically solves the problem of fluctuation and therefore, teaches the POSA that not all flows in an acetic acid production process fluctuate.” *Id.* at 33 (citing Ex. 1009, 2:47–65, 3:56–61, 6:57–59; Ex. 2006 ¶¶ 89–90). We are not persuaded.

Ochiai teaches an improved level control system “to control the liquid levels in a reactor-flasher combination used particularly for the carbonylation of methanol to acetic acid.” Ex. 1009, Abstract. According to Ochiai,

Implementation of the low water carbonylation process necessitated changes in the means to control the liquid levels in the reactor and flasher that were used under high water carbonylation conditions. Unfortunately, such changes have led to a wider variability in these liquid levels as well as reactor product flow rate and flasher recycle flow rate per a given methanol feed rate to the reactor.

Id. at 2:24–31.

¹² Patent Owner faults Petitioner for not being “able to locate and cite a singular reference that disclosed all of the allegedly very common claim elements.” PO Resp. 2. Petitioner challenges the claims based on obviousness, and not anticipation. Thus, there is no requirement that a single reference must disclose all claim limitations.

We agree with Patent Owner that Ochiai focuses on the reactor and flasher, and specifically discusses the reactor product flow rate to the flasher, the reactor and flasher liquid levels, and the catalyst recycle flow rates. See PO Resp. 34–35 (citing Ex. 2006 ¶¶ 86–88, 118, 120–122; Ex. 1009, 2:58–65, 3:50–55, 4:3–9). We, however, disagree with Patent Owner that “Ochiai Invention Eliminates Flow Fluctuations.” See *id.* at 33; see also *id.* at 35 (arguing “Ochiai solves those needs through a process where [certain type of] controllers for the reactor and flasher are used”) (citing Ex. 1009, 3:56–4:14).

As support, Patent Owner refers us to a single sentence, where Ochiai states its control system “eliminates” the oscillations caused by the integral control. Tr. 28:22–26 (citing Ex. 1009, 11:26). But, the rest of Ochiai, including the passage Patent Owner relies on, generally acknowledges its system “reduces”—not “eliminates”—the oscillations in process variables, including the liquid levels and flow rates of the intermediate streams. See, *e.g.*, Ex. 1009, 3:56–4:14 (repeatedly stating “reduce the variability,” “oscillations in process variables are reduced,” and “reduces the oscillations”); see also *id.* Fig. 7, 13:2–3 (explaining that Fig. 7 shows “the catalyst recycle flow and reactor product flow were *relatively* constant”) (emphasis added). In fact, Dr. Bhise, the declarant for Patent Owner, admitted that, even with the controls of Ochiai, there still are fluctuations within the system. Ex. 1050, 346:4–15, 350:3–12. As such, we agree with Petitioner that “even when the reactor and flasher flows are controlled with level controls, fluctuations are still present.” See Reply 11.

Because, as Patent Owner emphasizes, acetic acid production is a continuous or integrated process (PO Resp. 7 (citing Ex. 2006 ¶¶ 35, 37–39)), and because, in Zinobile, the light ends column is downstream of the flasher (Ex. 1010 ¶ 34), we agree with Dr. Riggs and Petitioner that fluctuation in the output of the flasher would affect the flow of the low boiling overhead stream 28 exiting the light ends column and cause it to fluctuate. *See* Pet. 22–23 (arguing that an ordinary artisan would have known “from general chemical engineering principles (as explained for example, in Ochiai) that the low boiling overhead stream 28 of Zinobile would have a fluctuating flow rate during operation”) (citing Ex. 1002 ¶¶ 64–66); *see also* Ex. 1019, 7 (describing “fluctuations in flows in cascade systems where the output of one unit is the input to the next”).

Hallinan

Patent Owner argues Hallinan teaches away from controlling the amount in the decanter. *Id.* at 28–32 (citing Ex. 1011, 1:64–2: 14, 4:33–50, 5:40–7:5, 7:9–23, 7:26–30, 7:52–8:1, 8:4–7; Ex. 2006 ¶¶ 80, 81, 82, 84, 123–127, 130). Instead, according to Patent Owner, Hallinan teaches control based on concentration only. *Id.* at 30. We are not persuaded by this argument, either.

To be sure, the invention of Hallinan teaches “a method of real time process control of component concentrations in a reaction system for the production of acetic acid from the carbonylation of methanol” by analyzing “the concentration of one or more components” in various samples using an infrared analyzer, and the “concentration measurements are used to make adjustments in the process.” Ex. 1011, 1:66–2:11. Hallinan, however, also

teaches the “generally accepted . . . concept of inventory control, also known as level control.” *Id.* at 5:42–44. And that teaching of Hallinan, is what Petitioner relies on. See Pet. 24 (citing Ex. 1011, 5:43–67), *id.* at 25–26 (citing Ex. 1011, 5:42–55, 6:41–47); Reply 17–18.

Hallinan states that “[a]n acetic acid manufacturing plant practicing methanol carbonylation technology, as depicted schematically in FIG. 1, can be conveniently divided into three functional areas: reaction, light ends recovery, and purification.” Ex. 1011, 3:44–47. FIG. 1 of Hallinan is reproduced below:

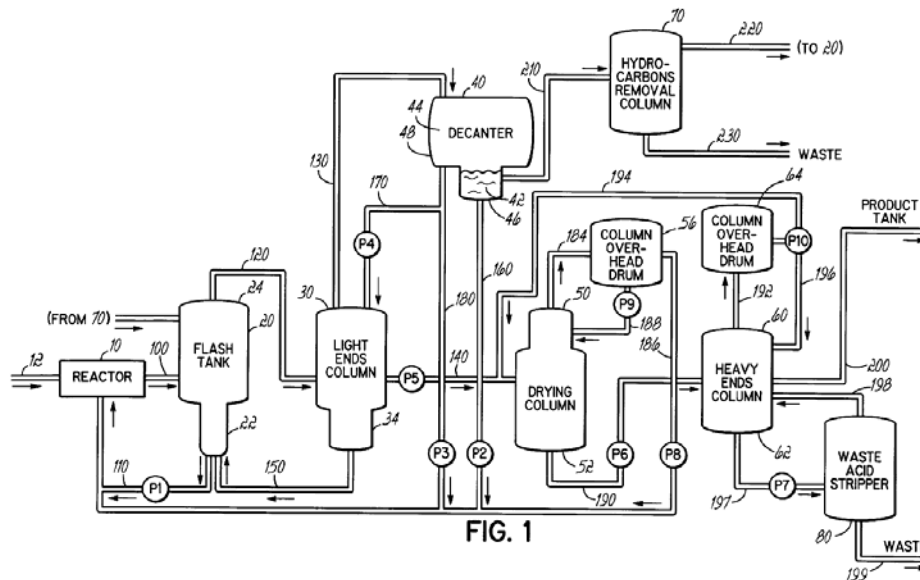


FIG. 1 of Hallinan is a schematic representation of an acetic acid manufacturing plant. *Id.* at 2:47–48. Hallinan teaches level control in two areas: the reaction section and the light ends recovery section. *Id.* at 5:44–45. The light ends recovery section consists of light ends column 30 and phase separation vessel 40 (decanter). *Id.* at 3:55–57. Here, light ends column 30 is fed from overhead vapor stream 120 from flash tank 20. *Id.* at 4:20–21.

Overhead stream 130 from light ends column 30 is sent to decanter 40, where

heavy phase 42 (consisting primarily of methyl iodide (MeI)) and light phase 44 (consisting primarily of aqueous acetic acid) are separated. *Id.* at 4:25–27, 4:35–37. According to Hallinan,

In the light ends section, the inventory concept has two primary functions. The first function is to return MeI back to the reactor 10 with a minimum of inventory shift. Level controlling the heavy phase 42 in the boot 46 [of decanter 40] achieves this objective. The second function is to remove the correct amount of acetic acid from the light ends column sidedraw stream 140 and feed it forward to the drying column 50. . . . [F]low controlling the decanter light phase recycle stream 180 to the reactor 10 accomplishes this objective.

Id. at 5:50–61.

Petitioner maps this teaching to the limitation recited in the wherein clause of claim 1. Pet. 25–27 (citing Ex. 1011, 5:42–61). Petitioner asserts that level control at the light ends recovery section in Hallinan “is *necessarily* based on a fluctuating flow rate of material that is to be fed to the decanter and *necessarily* adjusts or controls the flow rate of the material that is discharged from the decanter.” *Id.* at 24 (citing Ex. 1002 ¶ 80). According to Petitioner, if the flow rate to the decanter were constant, there would be no need for level control at the light ends recovery section. *Id.*

Patent Owner contends that “[t]here is no disclosure of controlling the amount or level in the decanter.” PO Resp. 32 (citing Ex. 2006, ¶¶ 80, 123–124, 126–127). Patent Owner’s argument is directly contradicted by specific teachings in Hallinan. In particular, Hallinan teaches “[l]evel controlling the heavy phase 42 in the boot 46.” Ex. 1011, 5:53–54. Boot 46 is an integral part of decanter 40. *Id.* at 4:40. Level control in the boot would control the amount of material held therein; and because the boot is integral to the

decanter, that control in the boot necessarily would be controlling the level in the decanter.

Patent Owner argues that “[t]he control disclosed in Hallinan is not based on the total amount in any vessel.” PO Resp. 29 (citing Ex. 1011, 5:40–7:5; Ex. 2006 ¶¶ 80, 82, 127). But the challenged claims do not require level control of the total amount in the decanter. Indeed, the ’932 patent discloses “in the case where the lower boiling point component (3A) to be held to the decanter is phase-separated (or is separated into two layers (or two phases)) . . . *the interface level* of the lower boiling point (3A) to be held to the decanter (for example, the liquid level of the lower layer) may be adjusted” to be maintained substantially constant. Ex.1001, 21:5–15 (emphasis added). Similarly, challenged claim 3, which depends from claim 1, recites

wherein in the condensation step, the amount of the lower boiling point component (3A) to be held is adjusted by the following method (1) and/or (2): (1) assuming that each of the average liquid level and the average interface level of the lower boiling point component (3A) to be held in the decanter is 100, the lower boiling point component (3A) is discharged from the decanter so as to adjust the liquid level and/or *the interface level* of the lower boiling point component (3A) to be held in the decanter to 90 to 110 in the process operation

Id. at 36:6–17 (emphasis added). The ’932 patent explains:

The liquid level means a height of the contact surface of the condensed lower boiling point component (3A) with gas (gas phase) in the decanter. When the condensed lower boiling point component (3A) is separated into two phases (upper phase and lower phase), *the interface level means a height of the boundary between two phases (or a height of the lower phase)*. Thus the

concept of the interface level is used when the lower boiling point component (3A) undergoes layer separation (phase separation).

Id. at 4:61–5:3 (emphasis added).

As Patent Owner correctly points out, in Hallinan, the contents of the decanter includes two phases: heavy phase 42 and an immiscible light phase 44. PO Resp. 31; Ex. 1011, 4:35–37. Thus, the interface level is the height of heavy phase 42. “Level controlling the heavy phase 42 in the boot 46” (Ex. 1011, 5:53–54) would adjust the interface level, and according to challenged claim 3, would achieve adjusting “the amount of the lower boiling point component (3A) to be held” in the decanter. *See also* Ex. 1013, 3–4 (“The position of the interface can be controlled, with or without the use of instruments, by use of a syphon take-off for the heavy liquid.”).

Citing the deposition testimony of Dr. Riggs (Ex. 2005, 108:4–7), Patent Owner also asserts that “any interpretation that the decanter in Hallinan is adjusted *solely* based on the total amount in the decanter is contrary to the entirety of its teaching and such an interpretation would actually render the process disclosed inoperable.” PO Resp. 33 (emphasis added). But Petitioner does not argue that Hallinan teaches adjustment solely based on the amount in the decanter. Instead, Petitioner merely points out that Hallinan teaches level control in the decanter. *See* Pet. 24–27; *see also* Reply 18 (acknowledging the invention of Hallinan but arguing it “is not disclosed as a substitute for level controlling”).

Patent Owner further contends that Hallinan teaches away from controlling the amount in the decanter, as evinced by its “repeated strong statements regarding the critical importance of concentration in an acetic acid production process.” PO Resp. 30–32. A reference teaches away “when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken” by the inventor. *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). A reference may not teach away even if a particular solution is not the preferred solution or is inferior to another solution. *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004).

In this case, despite pointing out that level control may not detect, or at least not detect in a timely fashion, some undesirable conditions in the process, Hallinan describes level control “works reasonably well in ensuring quality control.” Ex. 1011, 6:11–16. Thus, we do not find the focus on concentration in the invention of Hallinan amounts to teaching away because it “does not criticize, discredit, or otherwise discourage” the use of level control. *See In re Fulton*, 391 F.3d at 1201; *see also In re Mouttet*, 686 F.3d 1322, 1334 (Fed. Cir. 2012) (explaining “just because better alternatives exist in the prior art does not mean that an inferior combination is inapt for obviousness purposes”).

In sum, we agree with Petitioner that Hallinan teaches level controlling the decanter based on the fluctuating incoming flow rate, as recited in the wherein clause of claim 1. *See Pet.* 24–27.

Reason to Combine

Patent Owner argues there is no reason to combine the teachings of Zinobile, Hallinan, and Ochiai. PO Resp. 15–27, 36–41. Specifically, Patent Owner asserts that Zinobile identifies both temperature and concentration as conditions for separating the low-boiling overhead vapor stream 28. *Id.* at 15–19 (citing Ex. 1010 ¶¶ 38, 48). According to Patent Owner, other references also confirm the importance of temperature and concentration on condensation and separation in an acetic acid production process. *Id.* at 22–27 (citing Exs. 1007, 1011, 1012, 1022, 2009). Thus, Patent Owner contends “when Zinobile is considered as a whole, the disclosure is complete” and “[t]here is no need to look further.” *Id.* at 19 (citing Ex. 2006 ¶¶ 67–73, 102–111); *see also id.* at 15 (“Zinobile Discloses All of the ‘Conditions’ the POSA Would Require for Condensation and Separation”). We are not persuaded.

As a preliminary matter, we disagree with Patent Owner that in science and technology, including the field of acetic acid production, an ordinary artisan would view any single disclosure as complete, and thus, look no further. Were that the case, society would have halted progress long ago. Instead, artisans always seek improvement in their respective fields. Indeed, as Zinobile recognizes, despite “successful” processes in the prior art, “further improvements can still be made” and “there remains a need for alternative processes to improve the efficiency of acetaldehyde removal.” Ex. 1010 ¶ 16. And Zinobile characterizes its invention as merely “one such alternative solution.” *Id.*

More importantly, we acknowledge, and Petitioner does not dispute, that both temperature and concentration are factors to be considered in phase separation. *See* Reply 16–17. They, however, are not the only factors. Indeed, both Dr. Bhise, the expert witness for Patent Owner, and Dr. Riggs, the expert witness for Petitioner, testified that other factors, such as residence time, affect separation. Ex. 1050, 288:6–10; Ex. 2005, 47:20–48:11.

As Dr. Bhise testified, residence time relates to flow rates. Ex. 1050, 287:15–19; *see also* Ex. 1025, 11 (explaining that residence time is calculated by dividing the volume of the vessel by the volumetric flow rate into the vessel). Thus, we agree with Dr. Riggs that fluctuation in the flow rate into the decanter would affect the residence time (Ex. 2005, 132:1–8), and in turn, would affect the separation in the decanter.

And as explained above, in acetic acid production, a continuous process, the flow rate of the overhead stream exiting the light ends column and into the decanter fluctuates. *See supra* 18–19; *see also* Ex. 196:1–198:3 (Dr. Bhise testifying that it is “very unlikely” to achieve “perfect steady state” and there is always some minor variation in a chemical process).

Petitioner argues, and we agree, an ordinary artisan would have known that such fluctuating flow rates in a carbonylation process are economically disadvantageous. Pet. 27 (citing Ex. 1002 ¶¶ 80, 81). Indeed, Ochiai teaches “[w]hile a steady state of dry acetic acid product has been maintained from the distillation system per methanol feed rate, process inefficiency in the form of variable liquid levels and flow rates of the

intermediate process streams is economically disadvantageous.” Ex. 1009, 2:31–36.

Patent Owner contends that an ordinary artisan would have understood the process inefficiencies referred to in Ochiai as limited to those in the reaction and flash evaporation steps, and not including inefficiencies in the decanter or in the condensation and separation steps. *See id.* at 35 (citing Ex. 2006 ¶¶ 120–122). We are not persuaded.

As explained above, even though Ochiai focuses on the reactor and flasher, an ordinary artisan would have understood that the flow rates downstream of the flasher, including the overhead stream exiting the light ends column and into the decanter, would also fluctuate. *See supra* 18–19. Ochiai teaches it is important to “reduce variability of the flow rates of the intermediate streams relative to the methanol feed rate so as to improve process efficiency.” Ex. 1009, 4:5–9. Dr. Bhise testified, and we agree, that relative to the methanol feed, the overhead stream exiting the light ends column and into the decanter is an intermediate stream. *See* Ex. 1050, 136:10–15. As a result, an ordinary artisan would have understood that Ochiai suggests reducing the fluctuation of the overhead stream to improve process efficiency.

Patent Owner also asserts that an ordinary artisan would not combine the teachings of Zinobile and Hallinan because the processes disclosed in the two references seek to achieve different purposes. *Id.* at 38–40 (citing Ex. 1010 ¶ 17; Ex. 1011, 4:34–39, 5:50–55, 7:52–57, 8:4–7; Ex. 2006 ¶¶ 81, 114, 126–129). We do not define the purposes of the two references so narrowly.

Zinobile relates to “a process for the production of acetic acid” with “an improved process for the reduction and/or removal of” impurities, such as acetaldehyde. Ex. 1010 ¶ 17. Hallinan relates to “a method of manufacturing acetic acid utilizing improved process control.” Ex. 1011, 1:17–18. The two even employ similar systems. *Compare* Ex. 1010, FIG. 1 with Ex. 1011, FIG. 1. More importantly, Hallinan refers to several prior art references for disclosing acetic acid processes that “have additional treatments of heavy phase **42** and light phase **44** to remove impurities such as acetaldehyde and its condensation products.” Ex. 1011, 4:60–63. It explicitly teaches that “[a]ll of the acetic acid process streams can be analyzed using the current invention to provide improved control of the individual processing steps as well as overall process control.” *Id.* at 4:66–5:2.

Thus, we agree with Dr. Riggs that

A person having ordinary skill in the art, faced with implementing the process of Zinobile, would have found it obvious to use process control disclosed in Hallinan to improve discharge from the decanter, and to improve phase separation in the decanter, thereby improving the process for removing impurities in the carbonylation process described in Zinobile and reducing economic disadvantages caused by fluctuating flow rates.

Ex. 1002 ¶ 81; *see also* Pet. 27 (arguing that an ordinary artisan “beginning with Zinobile and aware of the economically disadvantageous flow fluctuations explained by Ochiai, would look to Hallinan because Hallinan discloses process control during acetic acid production that reduces flow fluctuations by use of level control”) (citing Ex. 1002 ¶¶ 80–81).

Reasonable Expectation of Success

Patent Owner further argues that Petitioner fails to explain how to combine Zinobile and Hallinan and how an ordinary artisan would have a reasonable expectation of success in doing so. *Id.* at 42–43 (citing Ex. 2006 ¶ 137). We are not persuaded.

“The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference.” *In re Keller*, 642 F.2d 413, 425 (C.C.P.A. 1981). “Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.” *Id.* In this case, an ordinary artisan would have used level control in Hallinan to improve the process in Zinobile. Hallinan teaches that level control is a “generally accepted method of overall plant control” that “works reasonably well in ensuring quality control.” Ex. 1011, 5:42–44, 6:11–12. Thus, we agree with Petitioner that “the combination of the prior art elements disclosed in Zinobile and Hallinan would operate according to known methods to yield predictable results,” and provide a reasonable expectation of success. Pet. 28 (citing *KSR*, 550 U.S. at 416).

In sum, based on the entire record,¹³ we conclude that Petitioner has shown by a preponderance of the evidence that claim 1 would have been obvious over the combination of Zinobile, Hallinan, and Ochiai.

Petitioner also provides claim charts, matching the additional limitations of claims 4 (method (a)), 8, 12, and 14 with the teachings of

¹³ Patent Owner does not present any evidence on secondary considerations.

Zinobile. Pet. 28–31 (citing e.g., Ex. 1010 ¶¶ 38, 45, 47, 52, 61, 62, Fig. 1). Patent Owner does not address these dependent claims separately. After considering the entire record, we determine that Petitioner has shown by a preponderance of the evidence that claims 4 (method (a)), 8, 12, and 14 would have been obvious over the combination of Zinobile, Hallinan, and Ochiai, as well.

Obviousness over Zinobile, Hallinan, Ochiai, and Balchen

Petitioner asserts that claims 2–4 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Balchen. Pet. 32–37. After reviewing the entire record, we determine that Petitioner has established by a preponderance of the evidence that claims 3 (method (1)) and 4 (method (c)) are unpatentable over the combination of Zinobile, Hallinan, Ochiai, and Balchen. Petitioner, however, has not met its burden in showing obviousness of claim 2 over the combination of Zinobile, Hallinan, Ochiai, and Balchen.

Relevant portions of claims 2–4 are reproduced below:

2. A process according to claim 1, wherein assuming that the average flow rate of the lower boiling point component (3A) to be fed to the decanter is 100 in terms of liquid volume, the flow rate of the lower boiling point component (3A) to be fed to the decanter is 80 to 120 in the process operation.

3. A process according to claim 1, wherein in the condensation step, the amount of the lower boiling point component (3A) to be held is adjusted by the following method (1) and/or (2):

(1) assuming that each of the average liquid level and the average interface level of the lower boiling point component (3A) to be held in the decanter is 100, the lower boiling point component (3A) is discharged from the decanter so as to adjust

the liquid level and/or the interface level of the lower boiling point component (3A) to be held in the decanter to 90 to 110 in the process operation,

(2)

4. A process according to claim 1, wherein in the condensation step, the amount of the lower boiling point component (3A) to be fed to the separation and recycling step is adjusted or controlled by at least one method selected from the group consisting of the following methods (a), (b) and (c):

(a) . . .

(b) . . .

(c) a method for adjusting the amount of the lower boiling point component (3A) to be discharged from the decanter in the process operation to 95 to 105, assuming that the average flow rate of the lower boiling point component (3A) to be discharged from the decanter is 100.

Petitioner argues these claims require the flow rate of the lower boiling point component (3A) should be adjusted or controlled to be within $\pm 20\%$ (claim 2), to hold the liquid or interface level in the decanter to within $\pm 10\%$ (claim 3, method (1)), and to hold the decanter discharge to within 5% (claim 4, method (c)), of a set point to provide suitable control of the decanter.¹⁴ Pet. 32–33. Petitioner acknowledges that “[t]he combination of Zinobile and Hallinan does not expressly disclose quantifying variations

¹⁴ Dr. Riggs testifies that in these claims, “[n]o time variable is provided for the average flow rate, and it is impossible to tell over what period of time these ranges occur.” Ex. 1002 ¶ 85. Because a challenge in an *inter partes* review can only be raised under 35 U.S.C. § 102 or § 103, we express no opinion regarding whether claims 2–4 may be unpatentable under 35 U.S.C. § 112.

in flow rate to/from the decanter or decanter levels.” *Id.* at 33. According to Petitioner, however, Balchen teaches each of these limitations. *Id.*

Balchen teaches process level control of basic functions, including control. Ex. 1019, 7. According to Balchen, “[m]any unit processes function best when the volume of material in the process is constant. Typical examples are the bottom section and the accumulator at the top of a distillation column. . . . These processes usually require that the levels be held within a few percent of the set point.” *Id.*

Petitioner contends that

One skilled in the art would thus appreciate the desire for flow rates that are close to constant to/from the decanter and liquid/interface levels within the decanter, i.e., within a “few percent,” of a set point (set as the desired level) in order to, for example, improve process efficiency as described by Ochiai and to ease flow rate fluctuations throughout the process.

Pet. 33 (citing Ex. 1002 ¶ 88). Thus, according to Petitioner, an ordinary artisan would have had a reason to combine the teachings of Zinobile, Hallinan, and Balchen, and to modify the process of Zinobile with the process controls of Hallinan and the acceptable variation of Balchen. *Id.* at 37 (citing Ex. 1002 ¶ 88).

Patent Owner argues that Petitioner improperly relies on hindsight when choosing Balchen as a reference. PO Resp. 45. According to Patent Owner, an ordinary artisan would not have combined Balchen with the other references because it “is a decades-old textbook” and “does not relate to an acetic acid production process.” *Id.* at 51 (citing Ex. 1019; Ex. 2006 ¶ 145). We are not persuaded by Patent Owner’s argument.

“[T]he mere age of a reference is not persuasive of unobviousness absent evidence that the art tried and failed to solve the problem notwithstanding knowledge of the reference.” *In re Wright*, 569 F.2d 1124, 1127 (C.C.P.A. 1977). Similarly, the textbook nature of Balchen is not persuasive of unobviousness unless it is in an unrelated field. *See, e.g., In re Translogic Tech., Inc.*, 504 F.3d 1249, 1254 (Fed. Cir. 2007) (affirming obviousness rejection over the combination of a textbook and other references); *In re Adamson*, 275 F.2d 952, 953 (C.C.P.A. 1960) (the same). After all, just as a rocket scientist still has to rely on the math skills taught in elementary school to calculate the path of the International Space Station, an artisan in the field of acetic acid production would not have discounted basic principles of process control merely because they are described in an old textbook. *See Reply 19–20.*

Here, Hallinan teaches level control, but does not specify the parameters needed. Thus, an ordinary artisan would have resorted to the knowledge from textbooks, such as Balchen. *See Reply 20–21* (“Hallinan only provides general details of the level controls precisely **because** they are the known and accepted method of plant control.”); *see also KSR*, 550 U.S. at 418 (instructing that, in an obviousness inquiry, we must consider the background knowledge possessed by a person having ordinary skill in the art).

Claim 2

Although we find an ordinary artisan would have had a reason to combine the teachings of Balchen with those of Zinobile, Hallinan, and

Ochiai, Petitioner has not shown that Balchen teaches the additional limitation recited in claim 2.

In the claim chart for this claim, Petitioner cites the following teachings of Balchen:

Many unit processes function best when the volume of material in the process is constant. Typical examples are the bottom section and the accumulator [decanter] at the top of a distillation column. . . . These processes usually require that the levels be held within a few percent of the set point.

Pet. 34 (citing Ex. 1019, 7). Petitioner also cites the Declaration of Dr. Riggs, in which he testified that “‘a few percent’ falls within the $\pm 20\%$, $\pm 10\%$, and $\pm 5\%$ variance claimed in Claims 2, 3, and 4.” Ex. 1002 ¶ 87. We find Petitioner’s argument insufficient.

According to Balchen, level control is “control of the level of liquid in a tank.” Ex. 1019, 7. Thus, when Balchen teaches “the levels be held within a few percent of the set point,” it refers to the level of liquid in the decanter, and not the flow rate to the decanter. Neither Petitioner nor Dr. Riggs adequately explain how level control in the decanter would affect the flow rate *upstream* of the decanter. As such, we agree with Patent Owner that Petitioner has not shown that claim 2 is unpatentable over the asserted prior art. See PO Resp. 47–48.

Claims 3 and 4

Claims 3 and 4 are a different story. Patent Owner points out that claim 3 recites method (1) and (2), whereas claim 4 recites methods (a), (b), and (c). PO Resp. 49. According to Patent Owner, “Petitioner does not state which method, or methods, are analyzed.” *Id.* (citing Pet. 32–37). Patent

Owner is mistaken. In the claim chart for claims 3 and 4, Petitioner clearly analyzes claim 3 (method (1)) and claim 4 (method (c)). Pet. 34–36.

Claim 3 (method (1)) requires adjusting the liquid level “to be held in the decanter” to within $\pm 10\%$ of a set point. Here, we are persuaded by Dr. Riggs testimony that “the levels be held within a few percent of the set point” in Balchen teaches this additional limitation. See Ex. 1002 ¶¶ 87, 88.

Claim 4 (method (c)) requires adjusting the discharge from the decanter to within $\pm 5\%$ of a set point. Petitioner cites Ochiai for teaching “process inefficiency in the form of variable liquid levels and flow rates of the intermediate process streams is economically disadvantageous.” Pet. 35 (citing Ex. 1002 ¶¶ 65, 78, 81; Ex. 1009, 2:25–37). Patent Owner repeats its challenge that “flow rates of the intermediate process streams” referred to in Ochiai are limited to “reactor product flow rate and flasher cycle flow rate.” PO Resp. 50 (citing Ex. 1009, 2:28–37; Ex. 2006 ¶¶ 86–89, 118–122). As explained above, we reject this argument. See *supra* 18–19. Instead, we are persuaded by Petitioner’s evidence and argument that even with the controls of Ochiai, there still are fluctuations within the system. *Id.* We also agree with Dr. Riggs an ordinary artisan would have known that “maintaining substantially constant flow rates is desirable” (Ex. 1002 ¶ 85) and that “‘substantially constant’ allows for a few percent variation, in order to dampen (absorb) flow rate fluctuations” (*id.* ¶ 88). As a result, we find the combination of the prior art teaches the additional limitation of claim 4.

Patent Owner’s other arguments (PO Resp. 45–46, 51–52) do not change our assessment that an ordinary artisan would not have been deterred by the fact that Balchen is an old textbook, and would instead, have had a

reason to combine its teachings with those of Zinobile, Hallinan, and Ochiai. Thus, based on the entire record, we conclude that Petitioner has established by a preponderance of the evidence that claim 3 (method (1)) and claim 4 (method (c)) would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Balchen.

Obviousness over Zinobile, Hallinan, Ochiai, and Aubigne

Petitioner asserts that claims 5–7 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Aubigne. Pet. 37–43. After reviewing the entire record, we determine that Petitioner has established the unpatentability of claims 5–7 by a preponderance of the evidence.

Each of claims 5–7 depends from claim 4, and further recites that wherein in the method (a), “not less than 10%,” “not less than 20%,” and “40 to 90%,” of the average flow rate of the lower boiling point component (3A) to be fed to the decanter is circulated.

As explained above, we are persuaded that claim 4 (method (a)) would have been obvious over the combination of Zinobile, Hallinan, and Ochiai. *See supra* 29. Petitioner refers to Zinobile for teaching recirculating the condensed heavy liquid phase to the decanter and a portion of the light aqueous phase to the splitter column. Pet. 38 (citing Ex. 1010 ¶ 45, Fig. 1). Petitioner acknowledges that “Zinobile does not expressly disclose, however, the percentage of the low-boiling overhead vapor stream that is recirculated.” *Id.*

According to Petitioner, determining “the percentage to be recirculated versus the percentage fed forward in the process are routine and within the skill of a POSITA.” *Id.* Dr. Riggs testifies that

[I]t is well within the skill of one skilled in the art to determine the percentage of the lower boiling point component (3A) fed forward and the percentage circulated to the splitter column 14. To circulate less than 20% or more than 90% would decrease the efficiency of the circulation and removal of acetaldehyde.

Ex. 1002 ¶ 91.

In addition, Petitioner asserts that “Aubigne does disclose a percentage of the low-boiling overhead vapor stream that is recirculated to the column prior to the decanter.” Pet. 38 (citing Ex. 1002 ¶¶ 94–105; Ex. 1012, Examples 1–2; Exs. 1023, 1024¹⁵). Aubigne teaches “a process for the production of acetic acid by carbonylation of methanol in the presence of a rhodium carbonylation catalyst, methyl iodide and an iodide salt stabiliser.” Ex. 1012, Abstract. The process in Aubigne includes a reaction step in a reactor, a flash evaporation step in a flasher, and an acetic acid collection step from a distillation column. *Id.* at 2:29–3:7, 9:44–10:41. Specifically, in Examples 1 and 2, “[t]he light ends recycle stream from the head of the distillation column was recycled to the reactor as two streams:” a methyl-iodide-rich stream and an aqueous stream. Ex. 1012, 9:67–10:5, 10:29–34. “Light, aqueous phase from the cooled column overhead vapour was fed to the column as reflux.” *Id.* at 10:5–6, 10:34–35.

Relying on the calculations provided by Dr. Riggs, Petitioner argues that in Examples 1 and 2 of Aubigne, “49% and 48%, respectively, of what was removed and sent to the decanter as the low boiling overhead stream,

¹⁵ Dr. Riggs explains that Exhibits 1023 and 1024 are calculations based on Examples 1 and 2 of Aubigne, respectively. Ex. 1002 ¶¶ 94–105.

was recirculated as reflux to the splitter column from which the light ends stream was removed.” Pet. 42 (citing Ex. 1002 ¶¶ 94–105). Thus, Petitioner concludes, Aubigne teaches a percentage of the low-boiling overhead vapor stream that is recirculated, as required by claims 5–7. *Id.* at 42–43.

Patent Owner does not challenge the calculations performed by Dr. Riggs. Instead, Patent Owner emphasizes that Aubigne is based on the use of a single distillation column, and does not disclose multiple distillation column processing to remove iodide contaminants. PO Resp. 53 (citing Ex. 1012, Abstract, 9:63–10:6, 10:36–41; Ex. 2006 ¶¶ 91–94). We agree with Patent Owner’s observation. We, however, disagree with Patent Owner that “due to differences in the purpose and process of Aubigne versus Zinobile or Hallinan, the POSA would not combine those references.” *Id.* at 54 (citing Ex. 2006 ¶¶ 139–142).

First, as explained above, in an obviousness inquiry, we decide “what the combined teachings of the references would have suggested to those of ordinary skill in the art,” not whether the structures in the references may be bodily incorporated into each other. *See supra* 28 (citing *In re Keller*, 642 F.2d at 425). Thus, to the extent Patent Owner intends to challenge physically combining single-column and multi-column systems, we are not persuaded.

Second, Aubigne is directed to a process for producing acetic acid and uses the same reaction process as Zinobile. *Compare* Ex. 1010 ¶ 34 with Ex. 1012, 2:29–3:7. As Petitioner correctly points out, Zinobile teaches (1) directing a portion of the light phase to the acetaldehyde removal step, and (2) returning a portion of the light phase to the splitter column. Pet. 43

(citing Ex. 1010 ¶¶ 45–46, Fig. 1); *see also* Ex. 1010 ¶ 51 (describing providing a portion of the light phase to the distillation column, while directing another portion back to the light ends column as a reflux stream). Similarly, Aubigne teaches refluxing the light phase to the distillation column as light ends recycle. Ex. 1012, 7:38–45. The difference between the two disclosures in this respect is Zinobile does not teach how much should be refluxed relative to the other portion, whereas Aubigne provides sufficient information to enable an ordinary artisan to calculate the reflux ratio. *See* Pet. 43; Ex. 1002 ¶ 93. Thus, we agree with Petitioner that an ordinary artisan “beginning with Zinobile, would look to Aubigne for guidance as to reflux flow rates because Aubigne teaches reflux flow rates that provide the desired water content and separation efficiency in the splitter column while providing the desired amount of methyl iodide recycle to the reactor.” Pet. 43 (citing Ex. 1002 ¶ 105; Ex. 1012, 7:38–47).

Patent Owner also alleges that the processes in Zinobile and Aubigne are different because in Aubigne “the process for Examples 1 and 2 includes a step where the vapor fraction from the flash tank ‘was condensed and introduced as a liquid into a distillation column operated at 1.2-1.3 barg.’” PO Resp. 55 (citing Ex. 1002, 9:8–15; Ex. 2006 ¶¶ 141, 142). We disagree.

Even though Aubigne generally describes condensing the vapor fraction from the flash tank (Ex. 1012, 9:8–15), it repeatedly states that the vapor fraction may be introduced to the distillation zone as a vapor, *or* as a mixed vapor/liquid, *or* as a liquid with non-condensibles. *See id.* at 6:50–54; *see also id.* at 2:63–65 (“introducing the vapour fraction (as a vapour and/or liquid) from the flash zone into the distillation zone”), claim 1(d) (the same).

Thus, we agree with Dr. Riggs that “Aubigne also discloses the same initial purification process” as Zinobile does, and find his calculations of reflux ratio based on Examples 1 and 2 reasonable. See Ex. 1002 ¶¶ 92–105.

In sum, based on the entire record, we conclude that Petitioner has established by a preponderance of the evidence that claims 5–7 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Aubigne.

Other Obviousness Challenges

Petitioner asserts in Ground 4 that claims 4 (method (b)) and 13 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, and Baasel. Pet. 32–55. After reviewing the entire record, we determine that Petitioner has established by a preponderance of the evidence that claims 4 (method (b)) and 13 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, and Baasel.

Relevant portions of claims 4 and 13 are reproduced below:

4. A process according to claim 1, wherein in the condensation step, the amount of the lower boiling point component (3A) to be fed to the separation and recycling step is adjusted or controlled by at least one method selected from the group consisting of the following methods (a), (b) and (c):

(a) . . .

(b) a method for feeding the separation and recycling step with the lower boiling point component (3A) discharged from the decanter through a storage vessel having a buffering function,

(c)

13. A process according to claim 1, wherein in the separation and recycling step, the liquid residue is recycled through a storage vessel having a buffering function.

Petitioner acknowledges that the combination of Zinobile and Hallinan does not expressly disclose “a storage vessel having a buffering function.” Pet. 45. Petitioner, however, refers to Balchen for teaching that a surge tank may be used to dampen flow fluctuations and improve operation of downstream columns, and to Baasel for suggesting increasing tank size to dampen fluctuations. *Id.* (citing Ex. 1019, 7; Ex. 1021, 10).

Baasel teaches process control and instrumentation in chemical engineering plants design. Ex. 1021, 3. According to Baasel, “in any process there are changes that will affect the uniformity of products, by-products, and/or costs,” which necessitate process control. *Id.* Specifically, Baasel teaches flow control. *Id.* at 10 (stating “the use of *averaging flow* is desirable”).

Petitioner contends that

It would have been obvious for a POSITA beginning with Zinobile and Hallinan and aware of flow rate fluctuations in the process to turn to Balchen and Baasel for methods of dampening such fluctuations and thus to employ a surge tank, i.e., the claimed “storage vessel,” between the decanter and the column of the separation and recycling step to dampen fluctuations and improve operation of the downstream column, as recited in Claim 4 (method (b)).

Pet. 45 (citing Ex. 1002 ¶ 110).

In addition, Petitioner asserts that “[i]t similarly would have been obvious to employ a storage vessel having a buffering function for recycling the liquid residue from the separation and recycling step, as recited in Claim 13.” *Id.* at 46 (citing Ex. 1002 ¶ 146). According to Petitioner, an ordinary artisan would have done so because doing so would allow for dampening of

flow rate fluctuations in the storage vessel, which “would be beneficial for the recycle step because the recycled stream would introduce less flow rate fluctuations into the vessel into which it is recycled.” *Id.* at 47 (citing Ex. 1002 ¶ 110).

Petitioner also argues in Ground 5 that claims 3 and 9–11 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, Baasel, and Kister. Pet. 32–55. Because we have concluded that claim 3 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Balchen (*see supra* 33), we do not need to decide, again, the patentability of claim 3 here. After reviewing the entire record, we determine that Petitioner has established by a preponderance of the evidence that claims 9–11 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, Baasel, and Kister.

Claims 9–11 are reproduced below:

9. A process according to claim 4, wherein in the method (b), the retention time of the lower boiling point component (3A) in the storage vessel is not less than 0.5 minutes.

10. A process according to claim 4, wherein in the method (b), the total time of the retention time of the lower boiling point component (3A) in the decanter and the retention time of the lower boiling point component (3A) in the storage vessel is not less than 1.5 minutes.

11. A process according to claim 4, wherein in the method (c), a decanter having a buffering function is used as the decanter, and the retention time of the lower boiling point component (3A) in the decanter may be not less than 1 minute.

Petitioner acknowledges that none of Zinobile, Hallinan, Ochiai, Balchen, and Baasel specifies a residence time “in the storage vessel (claim

9), in the decanter and the storage vessel (claim 10), and in the decanter having a buffering function (claim 11).” Pet. 49. According to Petitioner, however, Kister teaches this missing limitation. *Id.* at 49–50.

Kister is a book titled “Distillation Operation.” Ex. 1025, 1. It teaches that “[p]roviding adequate residence time is a primary consideration in arrangements that avoid vapor in liquid outlets.” *Id.* at 11. According to Kister, such arrangements include surge drums. *Id.* Kister recommends minimum residence times based on operating conditions. *Id.* at 13, 16. Specifically, Kister states that sump residence times of the order of 20 to 40 seconds were insufficient and recommends at least 1 minute as the minimum residence time. *Id.* at 13. For a reflux drum, such as a decanter, Kister recommends residence times based on where the product is sent from the reflux drum. *Id.* at 16. For a product that is sent to another tower, the recommended residence time is 10–12 minutes. *Id.*

Petitioner argues that an ordinary artisan, “beginning with Zinobile, Hallinan, Balchen and Baasel would have looked to Kister for guidance as to recommended minimum residence times in decanters and storage tanks.” Pet. 50. In view of the teachings of Kister, Petitioner contends, claims 3 (method (2)) and 9–11, each reciting a specific range of a retention time, would have been obvious. *Id.* at 50–55.

Patent Owner does not argue on the merits in Grounds 4 and 5. Instead, Patent Owner challenges Baasel because it is a general textbook and not directed to acetic acid production specifically. PO Resp. 57. Similarly, Patent Owner challenges Kister because it is a textbook related to distillation

operations, and not acetic acid production. *Id.* at 58. Neither argument is persuasive.

As explained above, the textbook nature is not persuasive of unobviousness unless it is in an unrelated field. *See supra* 31. Though not specifically directed to acetic acid production, both Bassel and Kister are sufficiently related to it. After all, as Patent Owner emphasizes, “[a]cetic acid production is a continuous or integrated process, so the POSA has to understand all of the steps,” including the distillation step. PO Resp. 7. Thus, an ordinary artisan would have had the knowledge of Kister, which teaches distillation operations. *See* Ex. 1025, 1. In addition, as Patent Owner proposes, which we adopt, an ordinary artisan would have a degree in chemistry or chemical engineering with certain industry experience. *Id.* at 10; *see also supra* at 12 (adopting Patent Owner’s proposed definition of skill level). Such an artisan would have possessed the knowledge of Baasel, which teaches chemical engineering plants design. *See* Ex. 1021, 3.

We also are not persuaded by Patent Owner’s other arguments. For example, Patent Owner faults Dr. Riggs for citing to different sections of Balchen in analyzing different challenges. According to Patent Owner, “in Ground 4 regarding claim 4, Dr. Riggs’ citation to Balchen suddenly changes to a different section of the same page he cited for claim 4 in Ground 2. *Compare* Ex. 1002, ¶108 (Ground 4) to Ex. 1002, ¶¶87-90, (Ground 2).” PO Resp. 58. Patent Owner fails to appreciate that in Ground 2, Petitioner challenges claim 4 (method (c)), whereas in Ground 4, Petitioner challenges claim 4 (method (b)).

After considering the entire record, we find persuasive Petitioner’s arguments that an ordinary artisan would have had a reason to combine the asserted references, and the additional references teach the additional limitations in the claims challenged in Grounds 4 and 5. We adopt Petitioner’s analyses as our own. *See* Pet. 44–55. Thus, we conclude that Petitioner has shown by a preponderance of the evidence that claims 4 (method (b)) and 13 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, and Baasel, and claims 9–11 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, Baasel, and Kister.

MOTIONS TO EXCLUDE EVIDENCE

Patent Owner filed a Motion to Exclude the Declaration of Dr. Riggs (Ex. 1002), Declaration of Dr. Hanes (Ex. 1041), and Exhibit 1031. Paper 34. Petitioner filed a Motion to Exclude the Declaration of Dr. Bhise (Ex. 2006) in its entirety. Paper 35.

Because we do not rely on Exhibits 1031 and 1041 in rendering this Decision, we dismiss Patent Owner’s Motion to Exclude these two exhibits as moot. For the following reasons, we deny the parties’ Motions to Exclude in all other aspects.

Patent Owner argues that we should exclude the Riggs Declaration because Dr. Riggs “applied the wrong POSA and provided a flawed analysis.” Paper 34, 2. As explained above, we find the parties’ definitions of skill level, although not identical, are not materially different from each other. *See supra* at 12. Thus, we disagree that Dr. Riggs “applied the wrong POSA” in his Declaration. And even if he did provide a flawed analysis,

that would affect only the weight we assign to, and not the admissibility of, his testimony. Thus, we deny Patent Owner's Motion to Exclude Exhibit 1002.

Petitioner asserts that Dr. Bhise only had experience with acetic anhydride, and not acetic acid. Paper 35, 3. As explained above, we find Petitioner's definition of skill level encompasses one with experience with acetic anhydride. *See supra* at 10. Thus, we disagree that Dr. Bhise does not qualify as either an ordinary artisan or an expert in this proceeding. Petitioner also argues that Dr. Bhise was purposefully evasive during deposition. But that is directed to the credibility of the witness. In other words, Petitioner's challenges of the Bhise Declaration all relate to the weight we assign to, and not the admissibility of, his testimony. Thus, we deny Patent Owner's Motion to Exclude Exhibit 2006.

CONCLUSION

After reviewing the entire record and weighing evidence offered by both parties, we determine that Petitioner has shown, by a preponderance of the evidence, that (1) claims 1, 4 (method (a)), 8, 12, and 14 would have been obvious over the combination of Zinobile, Hallinan, and Ochiai; (2) claims 3 (method (1)) and 4 (method (c)) would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Balchen; (3) claims 5–7 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Aubigne; (4) claims 4 (method (b)) and 13 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, and Baasel; and (5) claims 9–11 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, Balchen, Baasel, and Kister. Petitioner,

however, has not shown, by a preponderance of the evidence, that claim 2 would have been obvious over the combination of Zinobile, Hallinan, Ochiai, and Balchen.

ORDER

Accordingly, it is

ORDERED that claim 2 of the '932 patent has not been shown to be unpatentable;

FURTHER ORDERED that claims 1 and 3–14 of the '932 patent are held unpatentable;

FURTHER ORDERED that Petitioner's Motion to Exclude is denied;

FURTHER ORDERED that Patent Owner's Motion to Exclude is denied-in-part and dismissed-in-part; and

FURTHER ORDERED that, because this is a final written decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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