

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BUTAMAX ADVANCED BIOFUELS LLC,
Petitioner,

v.

GEVO, INC.,
Patent Owner.

Case IPR2014-00144
Patent 8,487,149 B2

Before SHERIDAN K. SNEDDEN, CHRISTOPHER L. CRUMBLEY, and
GEORGIANNA W. BRADEN, *Administrative Patent Judges*.

BRADEN, *Administrative Patent Judge*.

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

I. INTRODUCTION

Butamax Advanced Biofuels LLC (“Petitioner”) filed a Petition to institute an *inter partes* review of claims 1–19 of U.S. Patent No. 8,487,149 B2 (“the ’149 patent”) pursuant to 35 U.S.C. § 311–319. Paper 1 (“Pet.”). Gevo, Inc. (“Patent Owner”) did not file a preliminary response to the Petition. On May 22, 2014, we instituted an *inter partes* review of claims 1–14 and 16–19 on certain grounds of unpatentability alleged in the Petition. Paper 9 (“Dec. to Inst.”). After institution of trial, the Patent Owner filed a Patent Owner Response (Paper 17, “PO Resp.”), to which Petitioner filed a Reply (Paper 18, “Reply”). An oral argument was held on January 14, 2015.¹

We have jurisdiction under 35 U.S.C. § 6(c). In this Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, we determine Petitioner has shown by a preponderance of the evidence that claims 1–14 and 16–19 of the ’149 patent are unpatentable.

A. *Related Proceedings*

Petitioner informs us of no related litigations. Pet. 2. Concurrent with the present *inter partes* review, Petitioner also requested review of, and the Board instituted trial on, the following claims in patents in the same family as the ’149 patent: claims 1–23 of U.S. Patent No. 8,193,402, Case IPR2014-00142 (PTAB May 22, 2014) (Paper 13); claims 1–21 of U.S. Patent No. 8,378,160, Case IPR2014-00143 (PTAB May 22, 2014) (Paper 9); and claims 1–21 of US Patent No. 8,546,627, Case IPR2014-00250 (PTAB May 22, 2014) (Paper 8). Because of overlapping issues between the four proceedings, we consolidated the oral hearings for IPR2014-00250, IPR2014-00142, IPR2014-00143, and IPR2014-00144. *See*

¹ A transcript (“Tr.”) of the oral hearing is included in the record. Paper 29.

Paper 21. Additionally, Petitioner requested review of, and the Board instituted trial on claims 1–15 of unrelated U.S. Patent No. 8,373,012 in IPR2014-00402. See Paper 11.

B. The '149 Patent (Ex. 1001)

Transportation fuels are defined as mixtures of typically aliphatic and (optionally) aromatic hydrocarbons that meet a collection of physical properties and requirements, as defined in standards such as ASTM D4814 (gasoline), ASTM D975 (diesel fuel), ASTM D910 (aviation gasoline), and ASTM D1655 (jet fuel). Ex. 1001, 12:24–17:34. Gasoline, for example, is defined not by its composition, but by its ability to function in a spark ignition engine according to properties defined by ASTM D4814. *Id.* at 11:45–52. Such properties include vapor pressure, energy density, octane number, water solubility, thermal oxidation stability, gum content, and drivability. *Id.* at 15:36–54. The properties of gasoline can be adjusted by modifying the amounts and types of organic molecules that make up the gasoline. *Id.* For example, the octane number of a gasoline mixture can be raised by adding high octane components. *Id.*

The '149 patent, titled “Renewable Compositions,” describes methods for making renewable hydrocarbons. *Id.* at 3:66–4:61. The methods involve preparing a feedstock from a biomass to serve as a carbon source. *Id.* at 5:49–6:16. The feedstock is fermented with microorganism(s) to form C₂–C₆ alcohols. *Id.* at 3:65–67. The alcohols are dehydrated to form C₂–C₆ olefins (alkenes). *Id.* at 4:5–7. The olefins are reacted with an oligomerization catalyst to form more highly alkylated aromatic hydrocarbons, for example, C₆–C₂₄ unsaturated oligomers. *Id.* at 4:9–11 and 10:1–16. The dehydration step and oligomerization step may be carried out separately or combined into a single process. *Id.* at 23:59–63. The olefins then are reduced to heat-stable saturated hydrocarbons in a hydrogenation

reaction. *Id.* at 23:64–24:3. The '149 patent discloses that the compositions produced according to the methods of the patent meet the fuel-defining ASTM specifications. *Id.* at 18:35–47.

C. Illustrative Claim

Claim 1 is the only independent claim of the '149 patent, and is reproduced below:

1. A process for preparing renewable hydrocarbons comprising:
 - (a) culturing a microorganism capable of producing one or more C₂–C₆ alcohols in a fermentor, thereby forming a fermentation broth comprising microorganisms and one or more C₂–C₆ alcohols;
 - (b) removing a portion of the fermentation broth from the fermentor;
 - (c) distilling the portion, thereby forming an alcohol-depleted liquid phase and an alcohol-enriched vapor phase comprising water and one or more C₂–C₆ alcohols;
 - (d) condensing the alcohol-enriched vapor phase formed in step (c), thereby forming an alcohol-rich liquid phase and a water-rich liquid phase; and
 - (e) separating the alcohol-rich phase liquid from the water-rich liquid phase using a liquid-liquid separator;
 - (f) dehydrating at least a portion of the one or more C₂–C₆ alcohols in the alcohol-rich phase of step (e), thereby forming a product comprising one or more C₂–C₆ olefins;
 - (g) isolating the one or more C₂–C₆ olefins;
 - (h) oligomerizing at least a portion of the one or more C₂–C₆ olefins isolated in step (g), thereby forming a product comprising one or more C₆–C₂₄ unsaturated oligomers; and
 - (i) hydrogenating at least a portion of the product of step (h) in the presence of hydrogen, thereby forming a product comprising one or more C₆–C₂₄ saturated alkanes;

whereby the product of step (i) itself meets the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910, or ASTM D1655, or a blend of at least 10% of the product of step (f) with a mixture of hydrocarbons meets the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910 or ASTM D1655; and

wherein said steps (b) – (e) are conducted simultaneously with step (a).

Id. at 59:24–60.

D. Prior Art References Alleged to Support Unpatentability Challenges

The following prior art references were asserted in the instituted grounds:

Reference	Patent/Printed Publication	Date	Exhibit
D’Amore	US Patent Pub. No. 2008/0132741 A1	June 5, 2008	1003
ASTM D4814	American Society for Testing and Measurement, <i>Standard D4814</i> , “ <i>Standard Specification for Automotive Spark-Ignition Engine Fuel</i> ,” ASTM International, West Conshohocken, PA, http://www.astm.org .	Sept. 2007	1014
ASTM D975	American Society for Testing and Measurement, <i>Standard D975</i> , “ <i>Standard Specification for Diesel Fuel Oils</i> ,” ASTM International, West Conshohocken, PA, http://www.astm.org .	Aug. 2007	1015
ASTM D910	American Society for Testing and Measurement, <i>Standard D910</i> , “ <i>Standard Specification for Aviation Gasolines</i> ,” ASTM International, West Conshohocken, PA, http://www.astm.org .	Aug. 2007	1016
ASTM D1655	American Society for Testing and Measurement, <i>Standard D1655-07</i> , “ <i>Standard Specification for Aviation Turbine Fuels</i> ,” ASTM International, West Conshohocken, PA, http://www.astm.org	July 2007	1017

Petitioner further relies on the Declaration of Dr. Joseph T. Joseph (Ex. 1030) and the Second Declaration of Dr. Joseph T. Joseph (Ex. 1040).

E. Grounds of Unpatentability Instituted for Trial

The following table summarizes the challenges to patentability that were instituted for *inter partes* review:

Challenged Claim(s)	Basis	Reference[s]
1–9, 13–14, and 16–19	§ 102(e)	D’Amore
1–9, 13–14, and 16–19	§ 103(a)	D’Amore and ASTM D4814
10	§ 103(a)	D’Amore and ASTM D975
11	§ 103(a)	D’Amore and ASTM D1655
12	§ 103(a)	D’Amore and ASTM D910

II. ANALYSIS

A. Claim Interpretation

We interpret claims using the “broadest reasonable construction in light of the specification of the patent in which [they] appear[.]” 37 C.F.R. § 42.100(b); *see also In re Cuozzo Speed Techs., LLC*, 778 F.3d 1271, 1279–83 (Fed. Cir. 2015) (“Congress implicitly adopted the broadest reasonable interpretation standard in enacting the AIA,” and “the standard was properly adopted by PTO regulation.”). Under that standard, and absent any special definitions, we give 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 re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

We interpret the following claim terms of the challenged claims as part of our analysis.

1. “whereby the product of step (f) itself meets the requirements of at least one of ASTM D4814. . . .”

Challenged claims 1, 9, and 17 require products produced by the claimed method to meet requirements of certain standards developed by ASTM International, such as ASTM D4814, which is the standard specification for gasoline. Ex. 1014. Petitioner contends that the Patentee of the ’149 patent acted as his own lexicographer by expressly disavowing ASTM D4814’s distillation curve from being a requirement for gasoline produced by the claimed process. Pet. 17–18. Petitioner directs our attention to the following portion of the ’149 patent:

The distillation range of gasoline is a property that captures many different key aspects of how the gasoline composition behaves in a combustion engine to produce usable energy. For example, volatile compounds are necessary for proper ignition of the fuel in the combustion chamber of the engine. Additionally, less volatile but energy dense compounds are required to increase overall fuel performance, especially mileage. The distillation curve of a gasoline mixture is measured using ASTM method D86, and the specification is calibrated by how the typical hydrocarbon mixtures that comprise gasoline behave in an engine. When a substantial amount of the hydrocarbon component in a gasoline mixture is replaced with a different type of organic compound, i.e. an alcohol such as n-butanol or isobutanol, the distillation curve will differ from what is specified in ASTM D4814, even though the blend has similar, if not identical, engine performance compared to unblended gasoline. For this reason, *the distillation curve specification is not used to describe the gasoline compositions of the present invention.*

Ex. 1001, 15:64–16:15 (emphasis added).

Patent Owner does not address claim construction or Petitioner’s contention regarding the ’149 patent disavowing ASTM D4814’s distillation curve from being a requirement for gasoline produced by the claimed process. See, e.g., PO Resp. 8–11.

We agree with Petitioner that the above disclosure in the '149 patent amounts to an express disavowal of ASTM D4814's distillation curve as a requirement for products produced according to the method of challenged claims 1, 9, and 17.

2. *“the product of step (f)”*

The second-to-last clause in claim 1 of the '149 patent states: “a blend of at least 10% of the product of step (f).” Petitioner contends that the recitation of “the product of step (f)” in claim 1 is a scrivener's error and that the claims are interpreted properly to read “the product of step (i),” rather than “the product of step (f).” Pet. 12–16 (citing Ex. 1030 ¶¶ 39–44). Petitioner argues that claim 1's recitation of a blend makes logical sense only if read to require a blend of the product of step (i), the culmination of the whole process, because the product of step (f) comprises one or more C₂–C₆ olefins, not one or more C₆–C₂₄ saturated alkanes. *Id.* at 13. Petitioner further directs us to claims 9–12, which purportedly reference correctly “the product of step (i)” in claim 1. *Id.* Petitioner contends that the scrivener's error was inserted during prosecution. *Id.* at 14.

Patent Owner does not address claim construction or Petitioner's contention regarding claim 1's recitation of “the product of step (f).” *See, e.g.*, PO Resp. 8–11.

Regardless of Patent Owner's silence regarding claim construction, we decline to adopt Petitioner's proposed claim construction to refer to the product of step (i). Claims are construed as written, and where claims are susceptible to only one reasonable interpretation we must construe the claims based on the patentee's version of the claim, even if “that interpretation results in a nonsensical construction of the claim as a whole.” *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1357 (Fed. Cir. 1999); *see also Chef America, Inc. v. Lamb-*

Weston, Inc., 358 F.3d 1371, 1374 (Fed. Cir. 2004) (“[I]n accord with our settled practice we construe the claim as written, not as the patentees wish they had written it.”). Here, claim 1, as written, unambiguously refers to the product of step (f) and is not subject to different interpretations. We, therefore, construe claim 1 as written.

B. Principles of Law

To prevail in its challenges to the patentability of the claims, a petitioner must establish facts supporting its challenges by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). A claim is unpatentable under 35 U.S.C. § 102 if a prior art reference discloses every limitation of the claimed invention, either explicitly or inherently. *Glaxo Inc. v. Novopharm Ltd.*, 52 F.3d 1043, 1047 (Fed. Cir.1995); see *MEHL/Biophile Int’l Corp. v. Milgraum*, 192 F.3d 1362, 1365 (Fed. Cir. 1999) (holding that “[t]o anticipate, a single reference must teach every limitation of the claimed invention,” and any limitation not taught explicitly must be taught inherently and would be so understood by a person experienced in the field); *In re Baxter Travenol Labs.*, 952 F.2d 388, 390 (Fed. Cir. 1991) (the dispositive question is “whether one skilled in the art would reasonably understand or infer” that a reference teaches or discloses all of the elements of the claimed invention).

The principle of inherency, in the law of anticipation, requires that any information missing from the reference would nonetheless be known to be present in the subject matter of the reference, when viewed by persons experienced in the field of the invention. We note, however, that “anticipation by inherent disclosure is appropriate only when the reference discloses prior art that must *necessarily* include the unstated limitation, [or the reference] cannot inherently anticipate the claims.” *Transclean Corp. v. Bridgewood Servs., Inc.*, 290 F.3d 1364, 1373 (Fed.

Cir. 2002) (internal citation omitted); see *Hitzeman v. Rutter*, 243 F.3d 1345, 1355 (Fed. Cir. 2001) (“consistent with the law of inherent anticipation, an inherent property must necessarily be present in the invention described by the count, and it must be so recognized by persons of ordinary skill in the art”) (citations omitted); *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999) (that a feature in the prior art reference “could” operate as claimed does not establish inherency). Thus, when a claim limitation is not set forth explicitly in a reference, evidence “must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill.” *Continental Can Co.*, 948 F.2d 1264, 1268–69 (Fed. Cir. 1991) (citations omitted). It is not sufficient if a material element or limitation is “merely probably or possibly present” in the prior art. *Trintec Indus., Inc. v. Top–U.S.A. Corp.*, 295 F.3d 1292, 1295 (Fed. Cir. 2002) (citations omitted); see *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1554 (Fed. Cir. 1983) (anticipation “cannot be predicated on mere conjecture respecting the characteristics of products that might result from the practice of processes disclosed in references”) (citation omitted); *In re Oelrich*, 666 F.2d 578, 581 (CCPA 1981) (to anticipate, the asserted inherent function must be present in the prior art).

A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented 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, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

We analyze the instituted grounds of unpatentability in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

In determining whether an invention would have been obvious at the time it was made, 35 U.S.C. § 103 requires us to determine the level of ordinary skill in the pertinent art at the time of the invention. *Graham v. John Deere*, 383 U.S. at 17. “The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991).

Petitioner contends that a person of ordinary skill in the art at the time of the ’149 patent would have a Ph.D. in Chemistry, Chemical Engineering, or a similar related discipline and would have experience in organic chemistry and/or fuel chemistry, as well as transportation fuel production. Pet. 4; Ex. 1030 ¶ 16. Petitioner argues that, in the alternative, a person of ordinary skill in the art would have a Bachelor’s degree in Chemistry, Chemical Engineering, or a similar related discipline and substantial experience in an industry involving organic chemistry and/or fuel chemistry, as well as transportation fuel production. Pet. 4; Ex. 1030 ¶ 16. Patent Owner states that one of ordinary skill in the art at the time of the ’149 patent would have a Ph.D. in Chemistry, Chemical Engineering, or a similar related discipline and would have experience in fuel chemistry. Tr. 42:21–43:12. Based on our review of the ’149 patent and the types of problems and solutions described in the ’149 patent and cited prior art, we conclude a person of ordinary skill in the art at the time of the ’149 patent would have a Ph.D. degree in Chemistry, Chemical Engineering, or a similar related discipline and some

experience in an industry involving organic chemistry and/or fuel chemistry. Based on the stated qualifications of Joseph T. Joseph, Ph.D. (Ex. 1030 ¶¶ 9–14) and his Curriculum Vitae (Ex. 1035), Petitioner’s declarant meets the requirements of this definition. We further note that the applied prior art reflects the appropriate level of skill at the time of the claimed invention. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

D. Anticipation of Claims 1–9, 13–14, and 16–19 by D’Amore

Petitioner contends D’Amore anticipates, under 35 U.S.C. § 102(e), claims 1–9, 13–14, and 16–19 of the ’149 patent. Pet. 19–42. For the following reasons, we determine Petitioner has not shown by a preponderance of the evidence that claims 1–9, 13–14, and 16–19 are unpatentable under 35 U.S.C. § 102(e).

1. Overview of D’Amore

D’Amore describes an invention useful for the production of intermediate compounds used in transportation fuels such as gasoline. Ex. 1003 ¶ 20. Specifically, D’Amore discloses producing isobutanol (a C₂–C₆ alcohol) by culturing microorganisms in the presence of carbohydrates. *Id.* ¶¶ 23, 56. D’Amore specifically teaches converting isobutanol into butene (a C₂–C₆ olefin) in the presence of a catalyst (*id.* ¶ 56, Fig. 1) and converting dimerized butene into isooctene (*id.* ¶¶ 64, 76). Recovered isooctene can be reacted with a hydrogenation catalyst to produce isooctane. *Id.* ¶¶ 57, 64, 76. D’Amore discloses that isooctane produced by the disclosed processes is useful as an additive to transportation fuels, such as gasoline. *Id.* at Abstract and ¶¶ 20, 64, 76.

2. Analysis

a. D’Amore Qualifies as 102(e) Prior Art

D’Amore was filed on June 13, 2007, published on June 5, 2008, and claims priority to U.S. Provisional Application No. 60/814,137 (“the ’137 application”),

filed on June 16, 2006. *See* Ex. 1004. The disclosure in the '137 application (Ex. 1004) is the same disclosure found in D'Amore (Ex. 1003). Ex. 1030 ¶ 46. Thus, we conclude that D'Amore qualifies as prior art to the claims of the '149 patent under 35 U.S.C. § 102(e) as of the '137 application's filing date of June 16, 2006.

b. Independent Claim 1

Petitioner contends D'Amore, as summarized in the overview above, discloses each limitation of claim 1 of the '149 patent (Pet. 19–42), except that D'Amore does not disclose explicitly that its products (e.g., isooctane) meet the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910, or ASTM D1655, as recited in claim 1 (*id.* at 29–30). Petitioner contends, however, that the isooctane of D'Amore necessarily meets the requirements of, for example, ASTM D4814 without blending. *Id.*; *see* Tr. 9:1–10:3. According to Petitioner, the product of D'Amore's process could contain up to 30% contamination with isobutene and the mixture would still meet the standards in ASTM D4814. Tr. 9:1–18; Ex. 1040 ¶¶ 17–18.

Petitioner relies on two Declarations from Dr. Joseph to support its position. *See* Exs. 1030, 1040. Dr. Joseph testifies that isooctane, a product of D'Amore's disclosed processes, meets the following criteria set forth in ASTM D4814: (i) the maximum vapor pressure of ASTM D4814 Table 1 (Ex. 1030 ¶¶ 59–60); (ii) the lead content maximum, copper strip corrosion maximum, silver strip corrosion maximum, solvent-washed gum content maximum, sulfur % mass maximum, oxidation stability minimum, and water tolerance of ASTM D4814 (*id.* ¶¶ 61–65); (iii) the vapor/liquid maximum ratio of ASTM D4814 Table 3 (*id.* ¶¶ 66–69); (iv) the “Workmanship” requirements of ASTM D4814 (*id.* ¶ 70); and (v) the antiknock requirements of ASTM D4814 (*id.* ¶ 71). Dr. Joseph also testifies that D'Amore's process necessarily would result in the production of isooctane free of

lower molecular weight hydrocarbons, such as isobutene, and the recovered isooctane would meet the requirements of ASTM D4814 on its own. Ex. 1040 ¶¶ 11–12. Dr. Joseph opines that a person of skill in the art would not be concerned overly by the presence of “contaminating” isobutene and that the isooctane produced by D’Amore’s process still necessarily would meet the requirements of ASTM D4814 on its own or when blended, even if contaminating amounts isobutene were present. *Id.* ¶ 14.

Patent Owner disagrees with Petitioner’s characterization of D’Amore and argues that D’Amore does not disclose, directly or inherently, a process for producing (1) “renewable hydrocarbons” which meet the requirements of at least one of ASTM D975, ASTM D910, or ASTM D1655, or (2) a blend of at least 10% of the product renewable hydrocarbons produced by the claimed process which meet the requirements of at least one of ASTM D975, ASTM D910, or ASTM D1655. PO Resp. 4–5. Patent Owner argues that the isooctane produced by D’Amore may not be of sufficient purity to meet the standards recited in claim 1. *Id.* at 6. According to Patent Owner,

the process of *D’Amore* **may** just as readily produce isooctene having sufficiently high, *e.g.*, isobutene or other low molecular weight alkene content, whereby after hydrogenation the isooctane produced contains enough lower molecular weight hydrocarbons such that it fails to meet, *e.g.*, (i) the maximum vapor pressure standard of ASTM D4814 Table 1. For example, a fuel meeting the requirements of ASTM D4814 (distillation class AA) can have a maximum vapor pressure of 54 kPa. Isobutane has a vapor pressure of 760 mm Hg (101.325 kPa) at –11.7°C. Thus, even the presence of a small amount of, *e.g.*, isobutane in the isooctane allegedly provided by the process of *D’Amore* could result in a product that itself fails to meet the requirements of, *e.g.*, ASTM D4814. . . .

Id. at 6 (citing Ex. 1003, 74–76; Ex. 1004, Table 1). Patent Owner concludes that D’Amore’s failure necessarily and inevitably to produce a product that meets claim 1 prohibits a finding that D’Amore inherently anticipates claim 1. *Id.* at 6–7.

We are unpersuaded by Petitioner’s arguments. First, we do not find that D’Amore discloses a method of blending C₂–C₆ olefins with hydrocarbons that necessarily would meet the “whereby” clause of claim 1. Pet. 30; Ex. 1030 ¶¶ 56–72. According to Petitioner, a blend of 10% of the isooctane made by D’Amore’s process mixed with hydrocarbons that already meet ASTM D4814 requirements, also would meet the requirements of ASTM D4814. Petitioner’s argument regarding the recited blend of hydrocarbons is premised on the blend being created using the product of step (i) and not step (f). Pet. 30; Ex. 1030 ¶ 72. The “whereby clause” of claim 1, however, requires that a blend of the product of step (f) with a mixture of hydrocarbons meets the specifications set forth in ASTM D4814. As discussed above, we do not interpret the unambiguous language of claim 1 to refer to the product of step (i), rather, we read the claim as written to require the blending of the product of step (f) blended with a mixture of hydrocarbons. *See supra*, Section II.A.2. Petitioner proffers insufficient evidence that 10% of the C₂–C₆ olefins produced by D’Amore mixed with hydrocarbons would meet the standards specified in claim 1. Therefore, we do not find that D’Amore discloses a method of blending C₂–C₆ olefins with hydrocarbons that necessarily would meet the “whereby” clause of claim 1.

Second, we are unpersuaded by Petitioner’s argument that isooctane produced by the process disclosed in D’Amore necessarily and inherently meets the specifications in ASTM D4814 as required in the “whereby” clause of claim 1. Pet. 29; *see* Ex. 1001, 59:52–57. Although we credit the testimony of Dr. Joseph regarding the characteristics of pure isooctane and the impact of certain impurities

on whether isooctane would meet the criteria set forth in ASTM D4814, we find insufficient support for Dr. Joseph's statement that "D'Amore's process would necessarily result in the production of isooctane free of lower molecular weight hydrocarbons, such as isobutane." See Ex. 1040 ¶ 11. Dr. Joseph's testimony appears to be directed to the characteristics of pure isooctane (Tr. 7:16–20), however, D'Amore does not disclose the purity level of the isooctane produced by its process. See Ex. 1003 ¶ 76. Despite the information provided by Dr. Joseph, we have insufficient information to determine how much isooctene is converted in D'Amore to isooctane. *Id.*; Ex. 1030 ¶¶ 50–53; Ex. 1040 ¶¶ 10–11. Furthermore, we have insufficient evidence to determine (1) what low molecular weight hydrocarbons may result from D'Amore's process or (2) the level of other low molecular weight hydrocarbons that may be present. The missing crucial link in Petitioner's analysis is the difference between pure isooctane as opined by Dr. Joseph and the products possibly produced in D'Amore. Thus, we conclude that Petitioner has not carried its burden to show that D'Amore's product is pure isooctane, that the only possible contaminant is isobutene, that the isobutene is less than 30%, or that D'Amore's product has the exact properties as discussed by Dr. Joseph.

Accordingly, we find that Petitioner has not shown by a preponderance of the evidence that claim 1 is anticipated under 35 U.S.C. § 102(e) by D'Amore.

c. Dependent Claims

Claims 2–9, 13–14, and 16–19 depend from claim 1, and Petitioner contends that D'Amore discloses embodiments that teach aspects of each dependent claim. Pet. 30–40; Ex. 1030 ¶¶ 48–92. Patent Owner does not provide separate contentions regarding additional limitations recited in the dependent claims. After careful consideration of the language recited in claims 2–9, 13–14, and 16–19, we

are unpersuaded that D'Amore anticipates these dependent claims for the same reasons discussed with respect to claim 1.

Accordingly, we find that Petitioner has not shown by a preponderance of the evidence that claims 2–9, 13–14, and 16–19 are anticipated under 35 U.S.C. § 102(e) by D'Amore.

E. Obviousness of Claims 1–9, 13–14, and 16–19 over the Combination of D'Amore and ASTM D4814

Petitioner argues that the combination of D'Amore, as summarized in the overview in Section II.D.1 above, and ASTM D4814 renders each of claims 1–9, 13–14, and 16–19 obvious. Pet. 41–48. For reasons that follow, we determine Petitioner has shown by a preponderance of the evidence that claims 1–9, 13–14, and 16–19 are unpatentable under 35 U.S.C. § 103(a).

1. Overview of ASTM D4814

ASTM D4814 describes standard specifications for automotive spark-ignition engine fuel (i.e., automotive fuel or gasoline). Ex. 1014 ¶ 1.3. Such specifications include the materials and manufacture of automotive fuel, how the automotive fuel is tested, and the required performance characteristics of such fuel. *Id.*

2. Analysis

a. Independent Claim 1

Petitioner contends D'Amore, as summarized in the overview above, discloses each limitation of claim 1 of the '149 patent (Pet. 19–29), except that D'Amore does not disclose explicitly that its products (e.g., isooctane) meet the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910, or ASTM D1655, as recited in claim 1 (*id.* at 29, 42). Petitioner further contends that a person of ordinary skill in the art would have had reason to reach the invention

recited in claim 1 based on the combined teachings of D'Amore and ASTM D4814 (Ex. 1014), which discloses the standards for automotive fuel (i.e., gasoline) within the fuel industry. Pet. 42–48. According to Petitioner, although D'Amore does not disclose explicitly renewable isooctane meeting the standards set forth in ASTM D4184, a person of ordinary skill in the art would have had reason to review and meet the ASTM specifications when preparing automotive fuel, because the ASTM standards are used by governmental agencies to regulate the transportation fuel industry. Pet. 42 (citing Ex. 1030 ¶¶17–19, 101–105). Petitioner reasons that a person of ordinary skill in the art would have had reason to modify the products of D'Amore to meet the ASTM D4814 specification in order to have a commercially useful fuel. Pet. 43; Ex. 1030 ¶¶ 100–102.

Petitioner asserts that producing a renewable isooctane using D'Amore's process that meets the specifications of ASTM D4184 would have been obvious to a person of ordinary skill in the art and would have required no more than routine optimization. *Id.* at 43 (citing Ex. 1030 ¶¶ 103–105). Petitioner supports this assertion with the first Declaration of Dr. Joseph T. Joseph (“Dr. Joseph”), who testifies that the transportation fuel additives discussed in D'Amore are regulated by the Environmental Protection Agency (“EPA”) and/or Federal Aviation Administration (“FAA”), which have incorporated ASTM standards into their regulations governing transportation fuel approvals. Ex. 1030 ¶¶ 56–57. Dr. Joseph further testifies that a person of ordinary skill in the art would understand that in order to be approved for commercial use as a transportation fuel, a hydrocarbon product would have to meet the ASTM standards. *Id.* ¶ 56. Dr. Joseph reasons that any alternative mechanism for bringing the product to market for the fuel industry would require “going through the lengthy, burdensome, and expensive testing process,” and such process would render the

fuel commercially unviable. *Id.* Dr. Joseph specifically states a person of skill in the art “reading D’Amore’s disclosure of methods of making renewable isooctanes for use as a transportation fuel, including gasoline, would have had a reason to ensure that isooctane met the ASTM D4814 industry standard” because “meeting the requirements of ASTM D4814 is one step in the process of obtaining EPA approval to sell a gasoline.” *Id.* ¶ 102. Moreover, Dr. Joseph testifies that isooctane, a product of D’Amore’s disclosed processes, would meet the standards set forth in ASTM D4814. *Id.* ¶¶ 59–71.

Patent Owner contests Petitioner’s position, arguing that ASTM D4814 merely provides a set of metrics to determine whether or not a given composition meets the limitations of the subject ASTM standard. PO Resp. 8–11. Patent Owner contends ASTM D4814 does not provide any disclosure or guidance regarding a **process** to make a fuel that meets the requirements of ASTM D4814. *Id.* at 9. According to Patent Owner, a person of skill in the art would need a reference detailing the process steps between D’Amore and ASTM D4814 in order to create a product that would comply with the specification in ASTM D4814, because “such information is not evidently and indisputably within the common knowledge of those skilled in the art.” *Id.* at 9–10; Tr. 39:1–40:18. Patent Owner argues that the Declaration of Dr. Joseph (Ex. 1030) cannot support a finding of obviousness based on D’Amore and ASTM D4814, because: (1) the testimony is conclusory; (2) claim rejections must be based on prior art; and (3) rather than merely relying on the opinion of Dr. Joseph, a reference should be provided to establish that modifying the process of D’Amore as proposed was obvious. PO Resp. 10.

Patent Owner further argues that D’Amore fails to disclose any process for preparing renewable hydrocarbons including continuously removing from the

fermentor a portion of the fermentation broth, and distilling the portion to recover a C₂–C₆ alcohol, as provided in the present claim 1. *Id.* at 11. According to Patent Owner, the processes D’Amore describe, which distill the portion of fermentation broth removed from the fermentor to recover an alcohol (i.e., processes of Figs. 2 and 7 of D’Amore), are not continuous, and those processes which are continuous (i.e., the processes of Figs. 4 and 6 of D’Amore), do not distill the portion of fermentation broth removed from the fermentor. *Id.* Patent Owner, thus, concludes that D’Amore does not disclose all the limitations of claim 1. *Id.*

We find that D’Amore discloses each required steps (a)–(i) of claim 1. First, D’Amore discloses steps (a) and (b) by treating an aqueous stream of biomass-derived carbohydrates that are fermented with microorganisms to create a fermentation broth that produces isobutanol (C₄H₁₀O, an alcohol). Ex. 1003 ¶¶ 56, 57. Second, D’Amore discloses steps (c) and (d) by distilling the isobutanol, removing isobutanol-water azeotrope as a vapor phase, and then condensing the vapor to separate an isobutanol-rich phase from a water-rich phase. *Id.* ¶¶ 39, 57. Third, D’Amore discloses steps (e), (f), and (g) by separating the isobutanol-rich phase from a water-rich phase (*id.* ¶ 39), dehydrating isobutanol (*id.* ¶¶ 3, 21), and using an acid catalyst to convert the dry isobutanol into isolated butene (C₄H₈, an alkene olefin) (*id.* ¶¶ 56–57). Lastly, D’Amore discloses steps (h) and (i) by oligomerizing butene into isooctene (C₈H₁₆, an unsaturated oligomer) (*id.* ¶¶ 64, 74) and hydrogenating the isooctene to form isooctane (C₈H₁₈, an saturated alkane)(*id.* ¶ 76). Therefore, we find that D’Amore discloses the required steps (a)–(i).

We also are persuaded that D’Amore meets the wherein clause of claim 1, which states “wherein said steps (b) – (e) are conducted simultaneously with step (a).” See Ex. 1001, 59:59–60. D’Amore states that its separation techniques (i.e.,

distilling, condensing, and separating) can be integrated with the fermentation step. Ex. 1003 ¶¶ 36; *see also* Ex. 1030 ¶¶ 53 (Dr. Joseph explains where D’Amore describes a simultaneous process). Therefore, we find that D’Amore discloses the wherein clause recited in claim 1.

Claim 1 further recites “whereby the product of step (i) itself meets the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910, or ASTM D1655, or a blend of at least 10% of the product of step (f) with a mixture of hydrocarbons meets the requirements of at least one of ASTM D4814, ASTM D975, ASTM D910 or ASTM D1655.” *See* Ex. 1001, 59:52–57. Despite Patent Owner’s contentions, we are persuaded by Petitioner’s arguments and find that a person of ordinary skill in the art could have combined the teachings of D’Amore and ASTM D4814 to reach the invention recited in the whereby clause of claim 1, and would have had reason to do so.

As discussed above, the level of skill in the art is that of a person with a doctoral degree in chemistry or related discipline (*see supra*, Section II.C.), and it is easier to establish obviousness under a higher level of ordinary skill in the art. *Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1366 (Fed. Cir. 2012); *see also Innovention Toys, LLC v. MGA Entm’t, Inc.*, 637 F.3d 1314, 1323–24 (Fed. Cir. 2011) (finding that a less sophisticated level of skill generally favors a determination of nonobviousness, while a higher level of skill favors the reverse). Given this high level of skill in the art, we credit the testimony of Dr. Joseph that a person of ordinary skill in the art would have had reason to modify the isooctanes of D’Amore to meet the ASTM D4814 specification (Ex. 1030 ¶¶ 98–105), and that such modifications could have been accomplished using routine optimization techniques that were common in the art (*id.* ¶ 104). Dr. Joseph cites to multiple publications providing several examples of well-known properties of isooctane and

techniques to produce a mixture of saturated alkanes and aromatic hydrocarbons that meet ASTM D4814. *Id.* ¶¶ 109–110 (citing Exs. 1019, 1021, 1029, 1037). Thus, we are persuaded that a Ph.D. chemist would have knowledge of routine techniques as discussed by Dr. Joseph and would have had a reasonable expectation that such techniques would be successful. *See, e.g., Randall Mfg. v. Rea*, 733 F.3d 1355, 1363 (Fed. Cir. 2013) (recognizing that combining familiar elements with known functions, according to known methods, and yielding predictable results likely is obvious).

We are unpersuaded by Patent Owner’s contention that “[p]etitioner attempts to circumvent the requirement that claims rejections be based on prior art by relying on Dr. Joseph’s opinions.” PO Resp. 11. Rather, we conclude that Petitioner relies on the testimony of Dr. Joseph to indicate the knowledge of one of ordinary skill in the art in order to demonstrate that the teachings of D’Amore, in view of the teachings ASTM D4814, as understood by one of ordinary skill in the art, would have rendered the challenged claims obvious at the time of the invention. *See* Ex. 1030 ¶¶ 100–104.

We also are unpersuaded by Patent Owner’s contentions that:

[i]f the presently claimed process were indeed obvious, and the knowledge in the art was so readily known and available to one skilled in the art, petitioner would not rely on the opinions of Dr. Joseph, but rather, would simply provide a reference to establish that modifying the process of D’Amore as proposed was obvious

(PO Resp.10), because the Supreme Court has cautioned against the overemphasis on publications and the explicit contents of issued patents during an obviousness analysis. *KSR*, 550 U.S. at 415–16. In *KSR*, the Supreme Court criticized a rigid approach to determining obviousness based on the disclosures of individual prior art references, with little recourse to the knowledge, creativity, and common sense

that an ordinarily skilled artisan would have brought to bear when considering combinations or modifications. *Id.* at 415–22. Thus, we conclude that a person with a doctoral degree in chemistry would not need a reference detailing the process steps between D’Amore and ASTM D4814 in order to create a product that would comply with the specification in ASTM D4814.

Additionally, we are unpersuaded by Patent Owner argument that D’Amore does not anticipate claim 1 because D’Amore fails to disclose any process for preparing renewable hydrocarbons including continuously removing from the fermentor a portion of the fermentation broth, and distilling the portion to recover a C₂–C₆ alcohol. *See* PO Resp. 11. Claim 1 does not recite a step for continuously removing from the fermentor a portion of the fermentation broth, and distilling the portion to recover a C₂–C₆ alcohol, nor does the claim 1 require a product produced by such a process.

Accordingly, we find Dr. Joseph’s testimony persuasive and hold that Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable under 35 U.S.C. § 103(a) for obviousness in view of the disclosures of D’Amore and ASTM D4814.

b. Dependent Claims

Claims 2–9, 13–14, and 16–19 depend from claim 1, and Petitioner contends that D’Amore and ASTM D4814 teach or suggest each dependent claim. Pet. 46–48; Ex. 1030 ¶¶ 102–105. Patent Owner does not provide separate contentions regarding additional limitations recited in the dependent claims. PO Resp. 11. After careful consideration of the language recited in claims 2–9, 13–14, and 16–19, we are satisfied D’Amore in view of ASTM D4814 teaches or suggest the elements recited in the dependent claims. *See e.g.*, Ex. 1003 ¶¶ 56, 75, 76 (disclosing dehydrating, oligomerizing, and hydrogenating in the presence of a

catalyst, as recited in claim 2); ¶ 79 (disclosing two steps of claim 2 being carried out in the same reaction zone, as recited in claim 4); ¶¶ 21, 50, 75 (disclosing dehydrating and oligomerizing, and hydrogenating in the presence of an acidic catalyst, as recited in claim 6); ¶ 77 (disclosing list of hydrogenation catalyst, as recited in claim 8); ¶ 74 (disclosing C₁–C₆ alcohol isobutanol converted to isooctane to be used as a biofuel precursor, as recited in claim 14); ¶ 64 (disclosing C₂–C₆ alcohol isobutanol is converted to butene, which is oligomerized to isooctane and used as a biofuel precursor, as recited in claim 16); and ¶¶ 49, 91 (disclosing dehydration “reaction can be carried out in liquid or vapor phase . . . ,” with a vapor phase being a gas phase as recited in claim 18).

Accordingly, we find that Petitioner has shown by a preponderance of the evidence that claims 2–9, 13–14, and 16–19 are unpatentable under 35 U.S.C. § 103(a) because they would have been obvious in view of D’Amore and ASTM D4814.

F. Obviousness of Claim 10 over the Combination of D’Amore and ASTM D975

Petitioner argues that the combination of D’Amore and ASTM D975 renders claim 10 obvious. Pet. 48–50. In view of the overview of D’Amore provided above (*see supra*, Section II.D.1) and for reasons that follow, we determine Petitioner has shown by a preponderance of the evidence that claim 10 is unpatentable under 35 U.S.C. § 103(a).

1. Overview of ASTM D975

ASTM D975 describes standard specifications for diesel fuel oils (i.e., diesel fuel). Ex. 1015. Such specifications include the materials and manufacture of diesel fuel, how the diesel fuel is tested, and the required performance characteristics of such fuel. *Id.*

2. Analysis

Claim 10 provides as follows:

10. A process of preparing a renewable diesel fuel comprising the method of claim 1, whereby the product of step (i) itself meets the requirements of ASTM D975, or a blend of at least 10% of the product of step (i) with a mixture of hydrocarbons meets the requirements of ASTM D975.

Petitioner contends that a person of ordinary skill in the art would have had reason to reach the invention recited in claim 10 based on the combined teachings of D'Amore, which discloses a method for producing isooctane used in transportation fuels such as diesel fuel (Ex. 1003 ¶ 20), and ASTM D975, which discloses the standards for diesel fuel within the fuel industry (Ex. 1015). Pet. 48–50. According to Petitioner, although D'Amore does not disclose explicitly renewable isooctane meeting the standards set forth in ASTM D975, a person of ordinary skill in the art would have had reason to review and meet the ASTM specifications when preparing diesel fuel, because the ASTM standards are used by governmental agencies to regulate the transportation fuel industry. Pet. 48–49 (citing Ex. 1030 ¶¶ 106–113). Petitioner reasons that a person of ordinary skill in the art would have had reason to modify the products of D'Amore to meet the ASTM D975 specification in order to have a commercially useful diesel fuel. Pet. 49–50; Ex. 1030 ¶ 108.

Petitioner further contends that producing a renewable isooctane using D'Amore's process that meets the specifications of ASTM D975 would have been obvious to a person of ordinary skill in the art and would have required no more than routine optimization. *Id.* at 49–50 (citing Ex. 1030 ¶¶ 109–110). Petitioner's position is supported by the testimony of Dr. Joseph, who states a person of skill in the art “would have been able to modify D'Amore's process to produce (i) a

product of one or more C₆–C₂₄ saturated alkanes that meet the requirements of ASTM D975 or (ii) blends that meet the requirements of ASTM D975.” Ex. 1030 ¶¶ 106–113. Dr. Joseph explains that “[f]or example, isooctane's kinematic viscosity is below that required in ASTM D975[, but a person of ordinary skill in the art] would have readily been able to modify D’Amore’s process to increase the kinematic viscosity of the product by running the oligomerization step further to produce not only dimers, but also trimers and tetramers in order to ASTM D975’s requirements.” *Id.* ¶ 109. Dr. Joseph further testifies that “[s]imilarly, D975 requires a certain cetane number for diesel fuel[, and but a person of ordinary skill in the art] would have known that a fuel with a high octane number has a low cetane number (and vice versa).” *Id.* ¶ 110 (citing Ex. 1015, Table 1; Ex. 1021, 8). Dr. Joseph concludes that a person of ordinary skill in the art would have the knowledge and skill to optimize the processes disclosed in D’Amore to meet the parameters of ASTM D975. *Id.* ¶ 110.

Patent Owner contests Petitioner’s position, contending that claim 1 is not rendered obvious merely by providing D’Amore’s methods and a set of metrics to determine whether or not a given composition meets the limitations of a subject ASTM standard. PO Resp. 12–16. Patent Owner also proffers the same arguments as presented against the combination of D’Amore and ASTM D4814. *Id.*

We are persuaded by Petitioner’s arguments and the supporting testimony of Dr. Joseph. Specifically, as discussed above, we are persuaded that D’Amore teaches each required steps (a)–(i), the wherein clauses, and the whereby clause of claim 1. *See supra*, Section II.D.3.b. Claim 10 depends directly from claim 1. *See* Ex. 1001, 60:30–34. Despite Patent Owner’s contentions, we are persuaded by Petitioner’s arguments and find that a person of ordinary skill in the art could have combined the teachings of D’Amore and ASTM D975 to reach the invention

recited in dependent claim 10, and would have had reason to do so. As discussed above, the level of skill in the art is that of a person with a doctoral degree in chemistry or related discipline (*see supra*, Section II.C.), and it is easier to establish obviousness under a higher level of ordinary skill in the art. Given this high level of skill in the art, we credit the testimony of Dr. Joseph that a person of ordinary skill in the art would have had reason to modify the isooctanes of D'Amore to meet the ASTM D975 specification (Ex. 1030 ¶¶ 106–113), and that such modifications could have been accomplished using routine optimization techniques that were common in the art (*id.* ¶ 110). Dr. Joseph cites to multiple publications providing several examples of well-known properties of isooctane and techniques to produce a mixture of saturated alkanes and aromatic hydrocarbons that meet ASTM D975. *Id.* ¶¶ 108–112 (citing Exs. 1019, 1021, 1029, 1037, 1038). Thus, we find that a Ph.D. chemist would have knowledge of routine techniques as discussed by Dr. Joseph and would have had a reasonable expectation that such techniques would be successful. *See, e.g., Randall Mfg.*, 733 F.3d at 1363.

As discussed in detail above (*see supra*, Section II.D.3.b), we are unpersuaded by Patent Owner's contentions regarding Dr. Joseph's testimony. PO Resp. 13–15. Rather, we conclude that Petitioner relies on the testimony of Dr. Joseph to indicate the knowledge of one of ordinary skill in the art in order to demonstrate that the teachings of D'Amore, in view of the teachings ASTM D975, as understood by one of ordinary skill in the art, would have rendered the challenged claims obvious at the time of the invention. *See* Ex. 1030 ¶¶ 108–112 (citing Exs. 1019, 1021, 1029, 1037, 1038).

Accordingly, we find Dr. Joseph's testimony persuasive and hold that Petitioner has shown by a preponderance of the evidence that claim 10 is

unpatentable under 35 U.S.C. § 103(a) for obviousness in view of the disclosures of D'Amore and ASTM D975.

G. Obviousness of Claim 11 over the Combination of D'Amore and ASTM D1655

Petitioner contends that claim 11 would have been obvious over the combination of D'Amore and ASTM D1655. Pet. 50–52. Claim 11 provides as follows:

11. A process of preparing a renewable automotive fuel comprising the method of claim 1, whereby the product of step (i) itself meets the requirements of ASTM D1655, or a blend of at least 10% of the product of step (i) with a mixture of hydrocarbons meets the requirements of ASTM D1655.

As in previous grounds, Petitioner refers to D'Amore's disclosure of a method for producing isooctane for use as an additive to transportation fuels such as jet fuel. *Id.* (citing Ex. 1003 ¶ 20). ASTM D1655 describes standard specifications for aviation turbine fuels. Ex. 1017. Such specifications include the materials and manufacture of aviation turbine fuels, how the fuels are tested, and the performance characteristics of such fuel. *Id.*

Petitioner contends that a person of ordinary skill in the art would have had reason to reach the invention recited in claim 11 based on the combined teachings of D'Amore and ASTM D1655. Pet. 50–52. According to Petitioner, although D'Amore does not disclose explicitly renewable isooctane meeting the standards set forth in ASTM D1655, a person of ordinary skill in the art would have had reason to review and meet the ASTM specifications when preparing jet fuel, because the ASTM standards are used by governmental agencies, such as the FAA, to regulate the jet fuel industry. Pet. 50–51 (citing Ex. 1030 ¶¶ 114–119). Petitioner reasons that a person of ordinary skill in the art would have had reason

to modify the products of D'Amore to meet the ASTM D1655 specification in order to have an approvable and sellable jet fuel. Pet. 50–51; Ex. 1030 ¶ 119.

Petitioner further contends that producing a renewable isooctane using D'Amore's process that meets the specifications of ASTM D1655 would have been obvious to a person of ordinary skill in the art and would have required no more than routine optimization. *Id.* at 50–51 (citing Ex. 1030 ¶¶ 114–119). Petitioner's position is supported by the testimony of Dr. Joseph, who indicates a person of skill in the art would have been able to modify D'Amore's process to produce (i) a product of one or more C₆–C₂₄ saturated alkanes that meet the requirements of ASTM D1655 or (ii) blends that meet the requirements of ASTM D1655. Ex. 1030 ¶¶ 114–119. Dr. Joseph explains that “[f]or example [person of ordinary skill in the art] would have that if the specific properties of a reaction product, such as its density, would fail to meet ASTM D1655's requirements, then continuing oligomerization to increase the chain length of the reaction product would increase those properties.” *Id.* ¶ 116. Dr. Joseph concludes that a person of ordinary skill in the art would have the knowledge and skill to optimize the processes disclosed in D'Amore to meet the parameters of ASTM D1655. *Id.* ¶ 119.

Patent Owner contests Petitioner's position contending that ASTM D1655 merely provides a set of metrics to determine whether or not a given composition meets the limitations of the subject ASTM standard, and proffering the same arguments as present regarding the combination of D'Amore and ASTM D4814. PO Resp. 16–21.

We are persuaded by Petitioner's arguments and the supporting testimony of Dr. Joseph. Specifically, as discussed above, we are persuaded that D'Amore teaches each required steps (a)–(i), the wherein clauses, and the whereby clause of

claim 1. *See supra*, Section II.D.3.b. Claim 11 depends directly from claim 1. *See* Ex. 1001, 60:35–40. Despite Patent Owner’s contentions, we are persuaded by Petitioner’s arguments and find that a person of ordinary skill in the art could have combined the teachings of D’Amore and ASTM D1655 to reach the invention recited in dependent claim 11, and would have had reason to do so. As discussed above, the level of skill in the art is that of a person with a doctoral degree in chemistry or related discipline (*see supra*, Section II.C.), and it is easier to establish obviousness under a higher level of ordinary skill in the art. *Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1366 (Fed. Cir. 2012); *see also Innovention Toys, LLC v. MGA Entm’t, Inc.*, 637 F.3d 1314, 1323–24 (Fed. Cir. 2011) (finding that a less sophisticated level of skill generally favors a determination of nonobviousness, while a higher level of skill favors the reverse). Given this high level of skill in the art, we credit the testimony of Dr. Joseph that a person of ordinary skill in the art would have had reason to modify the isooctanes of D’Amore to meet the ASTM D1655 specification (Ex. 1030 ¶¶ 114–119), and that such modifications could have been accomplished using routine optimization techniques that were common in the art (*id.* ¶ 116). Dr. Joseph cites to multiple publications providing several examples of well-known properties of isooctane and techniques to produce a mixture of saturated alkanes and aromatic hydrocarbons that meet ASTM D1655. *Id.* ¶¶ 114–119 (citing Exs. 1019, 1023). Thus, we find that a Ph.D. chemist would have knowledge of routine techniques as discussed by Dr. Joseph and would have had a reasonable expectation that such techniques would be successful. *See, e.g., Randall Mfg.*, 733 F.3d at 1363.

As discussed in detail above (*see supra*, Section II.D.3.b), we are unpersuaded by Patent Owner’s contentions regarding Dr. Joseph’s testimony. PO Resp. 17–20. Rather, we conclude that Petitioner relies on the testimony of Dr.

Joseph to indicate the knowledge of one of ordinary skill in the art in order to demonstrate that the teachings of D'Amore, in view of the teachings ASTM D1655, as understood by one of ordinary skill in the art, would have rendered the challenged claims obvious at the time of the invention. *See* Ex. 1030 ¶¶ 114–119 (citing Exs. 1019, 1023).

Accordingly, we find Dr. Joseph's testimony persuasive and hold that Petitioner has shown by a preponderance of the evidence that claim 11 is unpatentable under 35 U.S.C. § 103(a) for obviousness in view of the disclosures of D'Amore and ASTM D1655.

H. Obviousness of Claim 12 over the Combination of D'Amore and ASTM D910

Petitioner contends that claim 12 would have been obvious over the combination of D'Amore and ASTM D910. Pet. 52–53. Claim 12 provides as follows:

12. A process of preparing a renewable aviation gasoline comprising the method of claim 1, whereby the product of step (i) itself meets the requirements of ASTM D910, or a blend of at least 10% of the product of step (i) with a mixture of hydrocarbons meets the requirements of ASTM D910.

As in previous grounds, Petitioner refers to D'Amore's disclosure of a method for producing isooctane for use as an additive to transportation fuels such as gasoline and jet fuel. *Id.* (citing Ex. 1003 ¶ 20). ASTM D910 describes standard specifications for aviation gasolines. Ex. 1016. Such specifications include the materials and manufacture of aviation turbine fuels, how the fuels are tested, and the performance characteristics of such fuel. *Id.*

Petitioner contends that a person of ordinary skill in the art would have had reason to reach the invention recited in claim 12 based on the combined teachings

of D'Amore and ASTM D910. Pet. 52–53. According to Petitioner, although D'Amore does not disclose explicitly renewable isooctane meeting the standards set forth in ASTM D910, a person of ordinary skill in the art would have had reason to review and meet the ASTM specifications when preparing aviation gasolines, because the ASTM standards are used by governmental agencies, such as the FAA, to regulate the aviation fuel industry. *Id.* (citing Ex. 1030 ¶¶ 120–123). Petitioner reasons that a person of ordinary skill in the art would have had reason to modify the products of D'Amore to meet the ASTM D910 specification in order to have an approvable and sellable jet fuel. Pet. 53; Ex. 1030 ¶¶ 122–123.

Petitioner further contends that producing a renewable isooctane using D'Amore's process that meets the specifications of ASTM D910 would have been obvious to a person of ordinary skill in the art and would have required no more than routine optimization. *Id.* at 52–53 (citing Ex. 1030 ¶¶ 122–123). Petitioner's position is supported by the testimony of Dr. Joseph, who indicates a person of skill in the art would have been able to modify D'Amore's process to produce (i) a product of one or more C₆–C₂₄ saturated alkanes that meet the requirements of ASTM D910 or (ii) blends that meet the requirements of ASTM D910. Ex. 1030 ¶¶ 122–123. Dr. Joseph explains that, for example, a person of ordinary skill in the art “would have looked to isooctane's physical properties, such as vapor pressure, and compared those to the ASTM D910's requirements.” *Id.* ¶ 122. Dr. Joseph then states that “[t]o increase the vapor pressure, a [person of ordinary skill in the art] could have optimized D'Amore's process by blending lighter weight alkanes, such as isobutanes to meet the vapor pressure requirement.” *Id.* Dr. Joseph concludes that a person of ordinary skill in the art would have the knowledge and skill to optimize the processes disclosed in D'Amore to meet the parameters of ASTM D910. *Id.* ¶¶ 122–123.

Patent Owner contests Petitioner's position, contending that ASTM D910 merely provides a set of metrics to determine whether or not a given composition meets the limitations of the subject ASTM standard, and proffering the same arguments as presented regarding the combination of D'Amore and ASTM D4814. PO Resp. 21–24.

We are persuaded by Petitioner's arguments and the supporting testimony of Dr. Joseph. Specifically, as discussed above, we find that D'Amore teaches each required steps (a)–(i), the wherein clauses, and the whereby clause of claim 1. *See supra*, Section II.D.3.b. Claim 12 depends directly from claim 1. *See* Ex. 1001, 60:41–44. Despite Patent Owner's contentions, we are persuaded by Petitioner's arguments and find that a person of ordinary skill in the art could have combined the teachings of D'Amore and ASTM D910 to reach the invention recited in dependent claim 12, and would have had reason to do so. As discussed above, the level of skill in the art is that of a person with a doctoral degree in chemistry or related discipline (*see supra*, Section II.C.), and it is easier to establish obviousness under a higher level of ordinary skill in the art. Given this high level of skill in the art, we credit the testimony of Dr. Joseph that a person of ordinary skill in the art would have had reason to modify the isooctanes of D'Amore to meet the ASTM D910 specification (Ex. 1030 ¶¶ 120–123), and that such modifications could have been accomplished using routine optimization techniques that were common in the art (*id.* ¶ 122). Dr. Joseph cites to multiple publications providing several examples of well-known properties of isooctane and techniques to produce a mixture of saturated alkanes and aromatic hydrocarbons that meet ASTM D910. *Id.* ¶¶ 120–123 (citing Ex. 1019). Thus, we find that a Ph.D. chemist would have knowledge of routine techniques as discussed by Dr. Joseph and would have had a

reasonable expectation that such techniques would be successful. *See, e.g., Randall Mfg.*, 733 F.3d at 1363.

As discussed in detail above (*see supra*, Section II.D.3.b), we are unpersuaded by Patent Owner's contentions regarding Dr. Joseph's testimony. PO Resp. 22–23. Rather, we conclude that Petitioner relies on the testimony of Dr. Joseph to indicate the knowledge of one of ordinary skill in the art in order to demonstrate that the teachings of D'Amore, in view of the teachings ASTM D910, as understood by one of ordinary skill in the art, would have rendered the challenged claims obvious at the time of the invention. *See* Ex. 1030 ¶¶ 120–123 (citing Ex. 1019).

Accordingly, we find Dr. Joseph's testimony persuasive and hold that Petitioner has shown by a preponderance of the evidence that claim 12 is unpatentable under 35 U.S.C. § 103(a) for obviousness in view of the disclosures of D'Amore and ASTM D910.

III. CONCLUSION

We conclude Petitioner has shown the following by a preponderance of the evidence:

1. Unpatentability of claims 1–9, 13–14, and 16–19 under 35 U.S.C. § 103(a) for obviousness over D'Amore and ASTM D4814;
2. Unpatentability of claim 10, under 35 U.S.C. § 103(a) for obviousness over D'Amore and ASTM D975;
3. Unpatentability of claim 11 under 35 U.S.C. § 103(a) for obviousness over D'Amore and ASTM D1655; and
4. Unpatentability of claim 12 under 35 U.S.C. § 103(a) for obviousness over D'Amore and ASTM D910.

IV. ORDER

For the reasons given, it is

ORDERED that claims 1–14 and 16–19 of the '149 patent are unpatentable;

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

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